Draft Technical Memorandum

To: *Eric Hecox, CWCB*
Todd Doherty, CWCB

From: *Susan Morea, CDM*
Nicole Rowan, CDM
Hal Simpson, CDM
Seth Turner, CDM

Date: *July 16, 2010*

Subject: *Alternative Agricultural Transfer Methods Grant Program*
Summary of Key Issues Evaluation

Introduction

In a recent Colorado Water Conservation Board (CWCB) report, Colorado's population is projected to nearly double from 5.1 million to upward of 9.1 million people in 2050. The majority of these new people will reside on the Front Range. By 2050, the South Platte basin alone is forecasted to grow from 3.5 million to 5.8 to 7.1 million people. By 2050, Colorado will need between 590,000 and 950 million acre-feet of additional water for municipal and industrial (M&I) needs (CWCB 2010). Most of this demand will be met through three main water supply strategies: conservation, agricultural transfers, and new water supply development.

As part of the Statewide Water Supply Initiative, CWCB identified water provider's specific projects and processes that they plan to implement to meet their future water demands. CWCB found that if 100 percent successful, these projects could yield approximately 511,000 acre-feet. Even if completely successful, there still remains a water supply gap. Over the past several years, many of these water projects have been proceeding through the federal permitting process with no guarantee of their success. If these projects and others—that are premised on the development of new water supplies—are not built, future water demand will have to be met mostly through a combination of agricultural transfers and conservation. While conservation will occur, a large portion would likely be through agricultural transfers.

Traditional agricultural water transfers have been and will continue to be an important part of water providers' plans for meeting their future water demand and there are farmers and ranchers willing to sell their water rights. Realizing this, there is a concern that some water

transfers may have negative third-party effects such as impacts to the agricultural supply, service, and processing sectors that are fundamental to rural economies. It is also understood that there are other factors contributing to the reduction of farming and ranching in Colorado (i.e., economic, financial, and demographic factors). To better understand and to help address this trend, the CWCB investigated alternatives to traditional purchase and transfer of water from irrigated lands to new uses in the "Statewide Water Supply Initiative—Phase 2 Report" (CWCB 2007). This report examined trends in irrigated acreage, dynamics leading to agricultural transfers, economic and social consideration, and a discussion of five alternative methods to permanent transfers of water rights for M&I purposes. Listed below are the alternatives method identified and discussed in the report.

- Interruptible Supply Agreements
- Rotational fallowing (long and short term)
- Water Banks
- Reduced Crop Consumptive Use
- Purchase and lease-back

While some of these alternative methods are being utilized in western states such as California (e.g., Palo Verde Irrigation District and the Metropolitan Water District of Southern California [MWD]; Imperial Irrigation District and MWD; and the City of Aurora and the Rocky Ford High Line Canal Company), traditional water transfers predominate the market in Colorado. But, as municipal water demands continue to increase, irrigators will continue to see an increased interest in their water rights from cities. Irrigators may begin to view their water rights as another "crop" and cities may begin to view the cornfields as "reservoirs." In addition to increased M&I water demands, Coloradoans are increasingly interesting in protecting instream flows for fish, wildlife, and aesthetics.

While possible, most cities will probably not be interested in selling taps for homes that rely on a 20-, 30-, or 40-year water lease agreement that could potentially not be renewed. More likely, they will serve for drought mitigation, drought recovery, an emergency supply, and long-term conjunctive use. Historically, cities have often relied upon restrictions on residential landscaping to provide for an emergency supply of water. Essentially, as the demand for a limited amount of water increases, it will be necessary for all water users to optimize the use of a limited resource. This effort is only a part of the bigger picture where one day in the future, every drop of water will be accounted for through various metering and monitoring technologies. Possibly most important, revenues generated through the various agreements between irrigators and cities can provide much needed capital to invest back into the farm or irrigation systems. Some of the key benefits derived from alternative methods include:

- Relationships between irrigators and municipalities—water sharing

- Provides needed capital to upgrade farm or irrigation system equipment or infrastructure
- Helps to optimize the use of a scarce resource
- Sustain rural agricultural communities and economies
- Preserve productive agriculture open spaces
- Provide for great food security
- Helps sustain our natural environment and provide wildlife habitat

One of the outcomes of SWSI Phase 2 was the recognition that the State of Colorado might be able to provide incentives for M&I providers to consider alternative methods for their water supply options. In response, the Legislature authorized the CWCB to develop a grant program to facilitate the development and implementation of alternative agricultural water transfer methods (Senate Bill 07-122).

Since its inception in 2007, the CWCB's Alternative Agricultural Water Transfer Methods Grant Program has awarded $1.5 million to various water providers, ditch companies, and university groups for the funding of six unique projects. The purpose of this memorandum is to provide an overview of the grants that have been awarded by CWCB, discuss the process and results that the grant recipients have developed to date, identify if results to date have furthered understanding of alternative agricultural transfers analysis that was completed as part of the Statewide Supply Initiative (SWSI) Phase 2, and finally provide information to answer the question "what would it take to make an alternative agricultural transfer program work in Colorado?"

Project Summaries for Grant Program Recipients

The recipients of funding from the Alternative Agricultural Water Transfer Methods Grant Program are identified below, along with a brief synopsis of each entity's approach to identifying viable alternative agricultural water transfer methods.

- **Parker Water & Sanitation District (PWSD)/Colorado State University (CSU)** – The Lower South Platte Irrigation Research and Demonstration Project is a 4-year study to quantify potential consumptive water use savings resulting from the use of deficit irrigation practices. By reducing the consumptive use of irrigated crops, an incremental volume difference between historic and future consumptive use can be computed. With approval of the State Engineer's Office (SEO), it is believed that this volume of water could be transferred to municipal use. In addition to field-scale research, the test program will be implemented on three demonstration farms to ensure that working farmers understand the proposed practices and that the practices are operationally and economically practical. Phases 1 through 3 of the project are complete and were documented in a report submitted to CWCB in January 2010. Remaining phases are in progress, with the original schedule in

the grant application anticipating delivery of a final project report to CWCB at the end of 2010.

- **Colorado Corn Growers Association (CCGA) –** Working with Ducks Unlimited and the City of Aurora, the CCGA will investigate a variety of alternative agricultural water transfer methods. The transfer methods will be applied to three demonstration projects; two of which will involve wetlands. These wetlands provide a number of benefits, including recharge to the South Platte alluvial aquifer, which can be used in an augmentation plan for out-of-priority groundwater pumping. The third demonstration project will explore a marketing mechanism for facilitating transfers. The study will also produce a Business Plan, which will be made available to other water users to help facilitate practical utilization of alternative transfer methods. As of June 2010, technical and legal analyses associated with the CCGA project are complete, as is one of the demonstration projects. The remaining two demonstration projects and other analytical aspects of the project are underway, with project completion anticipated by the end of September 2010.

- **Lower Arkansas Valley Water Conservancy District (LAVWCD) –** The grant funding provides for continued economic and engineering analyses of the Super Ditch Company, which would provide a means for irrigators under a group of ditch companies to collectively lease agricultural water for other uses, including municipal use. Rotational fallowing is likely to be the primary means of alternative transfer. Interim summaries of project findings were submitted to CWCB in June 2010, along with a report proposing a methodology for associated "tipping point" analyses. According to a schedule update submitted by the Super Ditch team, assuming certain key tasks were completed by the end of June, the final report should be submitted to CWCB on or before September 30, 2010.

- **Farmers Reservoir & Irrigation Company (FRICO) –** FRICO is investigating a number of alternative agricultural water transfer methods, including rotational fallowing, interruptible supply agreements, lease back agreements, and changes in cropping patterns. Much like the PWSD/CSU study, the objective of these methods is to reduce consumptive use for purposes of transferring the "saved" consumptive use to municipal or industrial users. The project also includes the evaluation of a water bank concept that would utilize existing FRICO infrastructure to store this "saved" water and then convey it to other agricultural or municipal users when needed. In June 2010, FRICO submitted a memorandum to CWCB documenting the current findings for Tasks 1 through 4 of the project. Additional analysis is still underway for these and other tasks outlined in the project grant application. It is anticipated that ongoing work will be completed by the end of 2010, with a final report delivered to CWCB in early 2011.

- **Colorado State University Extension Office –** The CSU Extension Office is conducting a 4-year study to assess various technical aspects of returning fallowed land to production and maintaining or improving crop yields on those lands. The project involves field-scale research on plots either planted to corn or fallowed and then sequentially brought back into corn production. These plots are proposed to be located on farms under the Rocky Ford High Line Canal and the Holbrook Canal; coordination with the Super Ditch Company is anticipated. The study will include investigations of weed and erosion control measures during fallow years and monitoring of soil nutrients and salinity once production resumes. The first of 4 years of this study has been completed, and findings to date are summarized in a memorandum submitted to CWCB in June 2010. The project will be ongoing through 2012, with status reports anticipated annually.

- **High Line Canal Company –** The Highline Canal Company is conducting a project to explore implementation of various means of alternative water transfer including interruptible water supply agreements, long-term land fallowing, spot market leases (for use during drought), and water banking. Water developed under these methods will be provided to other users via existing irrigation infrastructure or via a proposed pipeline. The project includes engineering studies to determine the amount of water that could be transferred and the location, timing, and volume of historical irrigation return flows that would need to be maintained in order to prevent injury to downstream water users. Water made available will be leased to other water users. A grant was awarded to the High Line Canal Company in 2008, but their project is not yet under contract or in progress. Therefore, High Line Canal Company has no results to present in this memorandum; the timeline for project initiation and completion is unknown.

As indicated in these project descriptions, there are some common elements between projects. For example, both the PWSD/CSU study and the FRICO study seek to identify means to modify irrigation practices such that "saved" consumptive use water could be transferred from agricultural to municipal use. Synergies exist in the Arkansas Valley as well, with collaborative studies involving the Super Ditch Company, the CSU Extension Office, and the High Line Canal Company. Moreover, most, if not all, of the projects involve some level of analysis to assess the economic viability of selected alternative transfer methods. Through evaluations of production costs and estimation of acceptable prices to be paid for leased and/or transferred water, these analyses aim to assure farmers that the profitability of their operations can be maintained.

Detailed project summaries and additional information on project tasks, deliverables, and schedules were documented in a draft memorandum prepared for CWCB in November 2009. That memorandum has been updated to reflect changes in scope and/or schedule made by grant recipients during the course of project implementation. The updated memorandum is

included here as Appendix A. A report on the status of each project as of June 2010 is provided in Appendix B.

Alternative Transfers Issues Matrix

A specific objective of these projects is to evaluate alternative agricultural water transfer options in the context of a series of technical, legal/institutional, and financial/economic issues that were identified in the course of the SWSI Phase 2 study. Table 1 below identifies each issue and the perceived applicability of each project to that issue.

Table 1. Alternative Agricultural Water Transfers Issues Matrix

	Parker Water & Sanitation District/Colorado State University	Colorado Corn Growers Association/Ducks Unlimited/City of Aurora	Lower Arkansas Valley Water Conservancy District/Super Ditch	Farmers Reservoir & Irrigation Company	Colorado State University Extension Office	High Line Canal Company
Technical Issues						
Suitable irrigated lands (i.e., having adequate water yield, water quality/soil suitability)	X	X	X	X	X	X
Infrastructure requirements compared to traditional agricultural transfers	X	X	X	X		X
Impact of geography on alternative transfer viability (e.g., stateline vs. upstream water right)	X	X	X	X	X	X
Water quality impacts (e.g., effects of reduced river flows due to agricultural transfers on TMDLs, salinity, etc.)	X	X	X		X	X
Legal and Institutional Issues						
Administrative/Verification	X	X	X	X		X
Legislative or regulatory changes necessary to facilitate implementation of alternative agricultural transfer program	X	X		X		
Water court process related to program approach and implementation (i.e., water court test case)	X		X	X		X
Program administration (i.e., by end user, governmental agency, agricultural water rights owners, or ditch and reservoir companies)	X	X	X	X	X	X
Likelihood of success if agricultural user is not required to bind the land and water to irrigation (short term protection of agriculture)	X	X	X	X		
Program conditions necessary to ensure that private property rights are not impaired (how will a leasing program effect value of other water rights)	X	X	X	X		

Table 1. Alternative Agricultural Water Transfers Issues Matrix (cont.)						
	Parker Water & Sanitation District/Colorado State University	Colorado Corn Growers Association/Ducks Unlimited/City of Aurora	Lower Arkansas Valley Water Conservancy District/Super Ditch	Farmers Reservoir & Irrigation Company	Colorado State University Extension Office	High Line Canal Company
Financial Issues/Economic Considerations						
Estimate costs to organize and administer a program	X	X	X	X	X	X
Identify parties that could contribute to costs (governmental entity)	X	X	X	X		X
Estimate portion of the total land and water rights value that will need to be paid to an agricultural user as compensation for enrollment in a program	X	X	X		X	
Streamline/equalize water court transaction costs						
Cost vs. supply certainty for municipalities purchasing water via alternative agricultural transfers	X	X	X	X		
Compare annual local impacts of a rotational fallowing program with a permanent dry-up that includes voluntary payment in lieu of taxes	X		X			
Tipping points/thresholds to maintain viable agricultural economics/communities			X			

In addition, the CWCB has requested that the grant recipients provide insight gained from the experience of these projects in order to address the question "What would it take to make an alternative agricultural transfers program work in Colorado?"

Key findings to date for each of the ongoing alternative agricultural water transfer projects are summarized below in the context of the critical issues identified in the matrix. Not every project is designed to provide responses or insight to every issue; many projects will provide additional valuable information once all project phases or tasks are complete and final documentation has been provided to CWCB.

Technical Issues

Suitable Irrigated Lands (i.e., having adequate water yield and water quality)

Parker Water & Sanitation District/Colorado State University

The objective of the first study phase was to identify and evaluate a feasible set of cropping systems that have potential to meet M&I water demands while sustaining agricultural

production. The approach used was to evaluate existing research and published information, to seek input and suggestions from a focus group, and to conduct personal interviews with irrigators in the South Platte River Basin. Cropping systems with potential to reduce consumptive use by at least 20 percent compared to continuous corn with full irrigation were sought.

The discovery phase identified rotational cropping, limited irrigation, and partial season irrigation cropping systems as potential water conserving practices. Rotational cropping refers to sequences of full irrigation crops with fallow or dryland crops in subsequent years. Potential dryland crops for rotational cropping include winter wheat, annual forage crops, corn, sunflower, and proso millet. Limited irrigation cropping is the application of less water than required to meet the full water demand of the crop, with an emphasis on applying the limited water during critical crop growth stages to optimize the beneficial effects of the water. All crops in a limited irrigation system receive irrigation but at lower levels than fully irrigated crops. Potential limited irrigation crops identified are corn, winter wheat, annual forages, sugarbeet, sunflower, soybean, and canola. Partial season irrigation is a combination of full irrigation during part of the growing season with no irrigation during other parts of the same growing season. Partial season irrigation has relevance to perennial crops with documented success especially for alfalfa. A set of proposed cropping systems was identified for further evaluation in Phase 2.

Phase 2 of the study is a controlled small plot and an on-farm field-scale evaluation of water conserving cropping systems. The objectives of the controlled research are to document irrigation water application, consumptive water use, crop productivity, and profitability of representative water conserving cropping systems. A controlled research site was established in Iliff, Colorado with a linear-move sprinkler irrigation system customized for research and with an onsite weather station. The site facilitates research on approximately 250 small plots where a water balance approach is used to determine evapotranspiration (ET) and drainage, crop yield, and water use efficiency. The objective of the on-farm demonstrations is to evaluate the practicality and feasibility of the cropping systems when practiced on full sized fields with farmers managing the system.

In summary—rotational cropping systems that alternate irrigated crops with fallow or dryland crops were effective at reducing ET, with average ET reductions of 30 to 40 percent compared to continuous corn. Rotating irrigated crops with dryland crops was a much more water efficient approach than rotating with a non-cropped fallow because of high evaporation and drainage during fallow. Annual forage crops such as triticale are good choices for the dryland phase of these rotations because they use residual water and nutrients from irrigated crops and have lower production risk than dryland grain crops. Corn produced after a fallow period or a dryland crop had a higher yield and water use efficiency than continuous corn, illustrating the benefits of crop rotation to maximize water use efficiency.

Limited irrigation cropping systems reduced ET by an average of 30 percent. Both rotational cropping and limited irrigation of sugarbeet and an annual forage crop saved 40 percent of the reference crop ET. Sugarbeet is drought tolerant and shows good adaptability to limited irrigation. Soybean had moderate yield but is a lower water use crop than corn even under full irrigation. Its growth and performance suggested it may be a good alternative crop for water conserving cropping systems in the South Platte River Basin. While rotational cropping and limited irrigation systems both reduced ET relative to full irrigation and continuous corn, the rotational cropping systems have an economic advantage over limited irrigation systems because they maximize yields of profitable cash crops in the irrigated phase of the rotation and use lower input crops in the dryland phase.

An on-farm evaluation of limited irrigation corn established that practices can be successfully implemented into production scale, farmer-managed systems and can maintain viable levels of production. An on-farm evaluation of partial season irrigation of alfalfa showed that irrigation management alone cannot be used to control ET from a deep rooted crop in high water table environments. Partial season irrigation did effectively reduce ET for the more shallow rooted grass meadow hay. While water savings would be greatest by complete dry-up of irrigated land, the crop production in dryland is so low that it severely limits economic sustainability. Limited irrigation and rotational cropping systems should be considered as viable approaches to meeting changing water needs while maintaining irrigated agricultural systems.

Colorado Corn Growers Association
The project team did not conduct a comprehensive study to address this question specifically. However, it is noted that the adequacy of water yield and water quality depends on the needs of the end user. For example, a small community along the South Platte River with supplies consisting of alluvial wells will have a much different perception of adequate quantity and quality than a large municipality with treated surface water supplies.

Lower Arkansas Valley Water Conservancy District/Super Ditch
In order to have a greater pool of water to draw from and to minimize the impacts of fallowing in any particular ditch system, the Super Ditch incorporates shareholders from at least six ditch companies in the Lower Arkansas Valley, between Pueblo Reservoir (Bessemer Ditch) and the La Junta area (Fort Lyon Irrigation Company). Estimates of yield available for leasing are conservatively based on the assumption of 65 percent participation by irrigators (25 percent for Bessemer) and a 25 percent fallowing rate (1-in-4 year rotation). These numbers are viewed as minimum anticipated participation levels. The number of acres required to create a given transferable yield through a one-in-four year rotation is four times the number of acres that would be required under a traditional buy-and-dry scenario.

Farmers Reservoir & Irrigation Company
Using data from FRICO and various state and federal agencies, assessments were made to compare farm and irrigation practices in the FRICO counties (Adams and Weld) to practices in the overall South Platte and Arkansas Basins.

Compared to the rest of the South Platte River Basin, FRICO irrigated operations are similar in average size of irrigated operations, but irrigate a much larger percentage of total cropland. Partly due to this, FRICO county farm operations are close to twice as profitable on a per-acre basis. On average, South Platte operations are more profitable per acre and hold more assets per acre than the average Arkansas Basin farmland acre. Relative to the Arkansas Basin, the South Platte as a whole has a slightly more varied crop coverage, with a smaller percentage of acreage in corn and alfalfa, and a larger percentage in small grains. FRICO county operators tend to have a much higher percentage of acreage alfalfa (52 percent) compared with the 29 percent representative of the South Platte Basin. However, despite the difference in alfalfa and corn acreage in FRICO counties, crop trends over the last 50 years within FRICO counties are quite similar to the rest of the South Platte.

Colorado State University Extension
Two 8-acre demonstration sites were selected in the Lower Arkansas Valley—one under the Holbrook Canal and the other under the Rocky Ford High Line Canal. Each demonstration site is arrayed with 2-acre subplots that are either cropped (corn) or fallowed.

Infrastructure Requirements Compared to Traditional Agricultural Transfers

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010). However, Phase 5 will provide a final report at the completion of all work related to this project, including the research results, conclusions related to the on-farm demonstrations, local and regional economic analyses, preliminary planning studies related to delivery of water, and the proposed administrative and hydrologic procedures that are proposed to support change of use proceedings in Water Court.

Colorado Corn Growers Association
New infrastructure may be required for the DT Ranch and PVIC/WISE Private Market projects, but requirements are not anticipated to vary significantly from the requirements of a traditional transfer. The Lower South Platte Co-op concept could benefit greatly from the construction of new storage, pipelines, pumpstations, and recharge facilities.

Lower Arkansas Valley Water Conservancy District/Super Ditch
In summarizing the infrastructure question generally, the Super Ditch team finds that infrastructure to move water from agricultural areas to areas of municipal need is limited and/or lacking, a problem that will have to be resolved before alternative transfers can realize

their potential. Municipalities are reluctant to fund infrastructure for water they lease rather than own, and infrastructure is cost-prohibitive for the irrigators.

More specifically, according to the documentation supplied by the Super Ditch project team, river diversion and storage is needed near the Arkansas River to provide for cost-effective design of the conveyance facilities. Without storage, the pump stations and pipeline(s) would have to be designed for more widely varying flow rates requiring larger diameter pipe and either (1) more pumps, (2) combinations of smaller and larger capacity pumps, or (3) more variable frequency drives for the pumps. Storage is also needed near the water users systems to provide water to their treatment plants as their production rates vary seasonally and day-to-day. At least nine storage options were identified that could be readily incorporated into the Super Ditch system infrastructure.

Additional findings include:

- The available storage in Pueblo Reservoir alone can be used to meet the modeled demands.
- Additional initial storage vessels are available either (1) directly owned or managed by the Super Ditch entities, or (2) to be purchased. Additional storage vessels will help to optimize storage and administer exchanges in the future.

Farmers Reservoir & Irrigation Company
The project concept is designed to take advantage of opportunities that exist within FRICO's existing infrastructure and recharge capabilities. A key finding is that FRICO has significant capacity in its diversion and surface storage facilities. Furthermore, FRICO has significant potential to develop recharge facilities in the Beebe Draw alluvial aquifer with different unit response functions. The associated groundwater accounting is relatively straightforward, but involves the development of large spreadsheets to handle the monthly unit response functions for multiple recharge ponds.

Impact of Geography on Alternative Transfer Viability

Parker Water & Sanitation District/Colorado State University
This issue is not specifically addressed in the recent progress report. However, the project includes controlled research by CSU on a farm in Logan County, Colorado that is owned by PWSD. In order to ensure that the project proposals are implementable by agricultural producers on a farm-scale basis, there are also three on-farm demonstrations at PWSD's other farms in Logan County, which will have the farmers continue to work their farms with guidance from CSU.

Logan County is a significant distance from PWSD's service area in northeastern Douglas County, in the southern region of the Denver metropolitan area. Substantial investments in

conveyance infrastructure would be required to directly deliver transferred agricultural water from the research farms to PWSD.

Colorado Corn Growers Association
Geography has a significant influence on the ability to market water from alternative transfers (and permanent transfers as well). However, in the research on the programs associated with the demonstration projects, it was not apparent that geography would impact transfer methods differently. For example, it was not apparent that a rotational fallowing program would have a greater chance of success compared to a deficit irrigation program based on geography. More significantly, as discussed below, alternative transfer methods can be extremely beneficial to overcoming geographic barriers to water transfers.

- **DT Ranch –** The location of DT Ranch (just upstream of Fort Morgan) and the relatively small amount of water involved with the potential transfer limits the geographic area in which the water could be potentially marketed.

- **PVIC/WISE Private Water Market –** The location of the PVIC (just downstream of the Denver metropolitan area) makes it an ideal candidate for the private water market or other form of alternative transfer. This location makes it feasible to involve water users on both the South Platte River and Beebe Draw.

- **Lower South Platte Co-op –** The water users involved in the Lower South Platte Co-op are located in Districts 1 and 64. Thus, without the pooling of resources and investment in infrastructure, marketing water to Denver-area water providers would be very difficult. However, the demonstration project showed significant potential to exchange water from the downstream end of District 1 to the mouth of the Poudre River, where it could be potentially marketed to several water providers.

Lower Arkansas Valley Water Conservancy District/Super Ditch
The sources of supply for this proposed rotational land fallowing-water leasing program are irrigation ditches diverting water from Pueblo Reservoir (Bessemer Ditch) or the Lower Arkansas River east of Pueblo (all other sources). Identified potential customers are located in Northern El Paso County, thus requiring pipeline conveyance of up to 125 miles and vertical lift of 3,000 feet or higher. As indicated by AECOM, each alignment will traverse major roadways, railroads, public lands, waterways, and private property. Significant efforts are required to obtain the permits and easements to build a water conveyance system through or around these types of existing infrastructure, land uses, and land ownership.

Farmers Reservoir & Irrigation Company
FRICO is the largest irrigation company near the Denver metropolitan area. A list of potential water providers that have infrastructure and/or water rights that could interface with

FRICO's system was developed. Geographic information system (GIS) mapping was developed of key water provider storage and delivery facilities that could interface with the FRICO system. This list of M&I providers in the Denver metro area was narrowed to those providers that represent the most likely customers of water from the alternative agricultural transfer methods identified in the FRICO Barr and Milton shareholder surveys. These providers included South Adams Water and Sanitation District, the cities of Thornton and Brighton and the Towns of Lochbuie and Hudson.

Colorado State University Extension
By selecting demonstration sites under two ditch systems more than 20 miles apart, the CSU Extension will be able to provide a comparative assessment of whether location in the Lower Arkansas Valley affects the parameters being studied in the context of rebound from fallowing.

Water Quality Impacts

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010). However, Phase 5 will provide a final report at the completion of all work related to this project, including the research results, conclusions related to the on-farm demonstrations, local and regional economic analyses, preliminary planning studies related to delivery of water, and the proposed administrative and hydrologic procedures that are proposed to support change of use proceedings in Water Court.

Colorado Corn Growers Association
For each of the demonstration projects, water quality would be impacted positively by the use of wetlands for recharge and/or the provision of return flows. In terms of the individual demonstration projects, water quality would not be a major concern for an intra-ditch transfer by DT Ranch that is used for recharge purposes. The PVIC/WISE private water market could deliver water to the Aurora Prairie Waters wellfield having the same quality as other sources diverted by the wellfield.

Lower Arkansas Valley Water Conservancy District/Super Ditch
The water quality along the Arkansas River degrades as the river moves downstream from Pueblo Reservoir, primarily due to the physical characteristics of this reach and the influence of irrigation return flows. Specifically, the river has high levels of total dissolved solids (TDS) that increase as water travels downstream in the Arkansas River. High TDS, even though not necessarily a public health concern, is commonly used to characterize the quality and public acceptability of drinking water. High TDS affects the taste of the water, causing a salty taste that is not palatable to customers and can be damaging to irrigated landscapes and household appliances such as water heaters. Available treatment processes that remove TDS are relatively expensive to build and operate.

Water quality of the proposed source water is not fully defined at this time. Publicly available water quality data is limited and is monitored on an annual basis. As the water source may be canal water (rather than water taken directly from the river) and because irrigation canals operate on a seasonal basis, actual water quality may vary significantly from that used for the Task G evaluations. However, the need for advanced treatment will likely remain due to the multiple wastewater discharges upstream of any canal headgate that would be a potential source for this project.

Colorado State University Extension
The CSU Extension study involves the monitoring of soil water quality, which indirectly relates to water quality due to the fact that Arkansas River water quality degrades downstream due to the influx of agricultural irrigation return flows, which leach nutrients and other constituents from the soil.

Specifically, the study is monitoring soils for nitrate-nitrogen, phosphorus, organic matter, sulfate-sulfur, cations (K, Ca, Mg, Na), micronutrients (Zn, Fe, Mn, Cu), soluble salts, soil pH, and selenium.

One interesting trend that the researchers have noted is the relatively high retention of nitrogen on fallowed fields. They note that because nitrogen is a fairly mobile nutrient with soil water movement, the retention of nitrogen is most likely due to the low precipitation levels in the Arkansas Valley that do not afford a pathway to movement.

Legal and Institutional Issues

Legislative or Regulatory Changes Necessary to Facilitate Implementation of Alternative Agricultural Transfer Program

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010), which focused on Phases 1 through 3 of the study. Phase 4 will address administration and hydrologic considerations necessary for the successful implementation of rotational fallowing and limited irrigation cropping practices as water saving approaches in Colorado.

Colorado Corn Growers Association
Certain changes described below may encourage various transfer programs.

- **DT Ranch –** The study group is exploring the potential for an interruptible water supply agreement with a water user outside the FMRIC system pursuant to §37-92-309, CRS The §37-92-309 IWSA is an existing tool that has not been used very frequently, if at all. The study group considers this second DT ranch project approach to be an important

opportunity to "get inside" the IWSA process and gain an understanding of its strengths and weaknesses in the hope that it can make some recommendations for improving the process and encouraging greater use of this tool.

- **PVIC/WISE Private Water Market –** The core elements of the Private Market concept do not require any additional legislative approval. Parties are already free to enter into contractual arrangements regarding the purchase, sale, and lease of water rights. The 1969 Water Rights Determination and Administration Act provides for changes in use, and expressly recognizes the concept of rotational fallowing, one of the key implementation strategies. Reduced consumptive use strategies, though not expressly authorized by the Act, are probably within the definition of a "change in use," and could be approved so long as there is no injury to other water users. Recharge activities have been recognized by the Water Courts in Divisions 1 and 2 as a viable means of delivering water to the aquifer as return flow replacement or later diversion from the river. The fact that the Water Court approves each "Private Market," including the operational details related to the delivery of water changed to new uses, provides protection to vested water rights.

  Several legislative changes could support the Private Market concept. The completion of ditch-wide change in use cases for major ditches would greatly improve the potential for the development of Private Markets, because of the certainty they provide regarding the amount of consumptive use available for alternative transfers. Recent decisions in Division One, including the FRICO 403 case, have made ditch companies wary of water court proceedings and reluctant to proceed with changes in use. Legislation providing protections and incentives to ditch companies who apply for ditch wide changes in use could serve to open up markets.

  In addition, a change to the statute recognizing reduced consumptive use as a viable change in use could bolster parties considering this approach and encourage implementation. Though the current statutes do not prohibit reduced consumptive use, neither do they expressly allow it. As a result, there are mixed opinions among legal counsel and other professionals as to whether this strategy is authorized by the Act. This uncertainty should be removed.

- **Lower South Platte Co-op –** The Lower South Platte Co-op proposal relies upon contractual relationships and a series of administrative exchanges to facilitate delivery of water. Presumably, the agricultural users who are members of the Co-op would be bound together in an organizational structure. In turn, this entity would enter into contracts for the delivery of water to end users. Though the organizational structure of the Co-op has not been determined yet, there are a number of viable options open to it, and Colorado law would allow an entity of this sort to enter into contracts with end users for the delivery of water via exchange. Exchanges are recognized by the 1969 Water Rights Determination and

Administration Act. They may be operated administratively, without water court approval, or they may be adjudicated to achieve a priority date. As such, no legislative changes are necessary to implement the Co-op program.

Although not a prerequisite, changes to the law recognizing the viability of "Exchange Wells" could facilitate implementation. "Exchange Wells" would be a type of "Headgate well." "Headgate Wells" are wells installed so close to the river that the depletive effect is instantaneous for administrative purposes. These wells can be used to boost surface flows during times of low flow—usually for the benefit of an identified surface user immediately downstream of the well—or can be used to divert water from the river for decreed purposes. In some cases, the wells pump directly into a ditch, thereby supplementing ditch flows at times when river flows are very low.

An "Exchange Well" is a specific type of headgate well used strictly to facilitate an exchange. When a calling right in the exchange reach is preventing an exchange, an "Exchange Well" could pump the amount of water equivalent to the amount sought to be diverted upstream by exchange into the calling ditch, thereby negating the impact of the exchange on the calling right. Since the calling right is entitled to these flows, and the depletions from the Exchange Well are essentially instantaneous, it makes no difference to the calling right or downstream water users whether these flows come from the river or from the exchange well.

It is likely that the Co-op would use Exchange Wells in strategic locations to boost exchange capacity. Installation of these wells would ease river administration and increase the chances of successful exchange.

The 1969 Water Rights Administration Act does not explicitly recognize the concept of an Exchange Well. The Act defines "Augmentation Well," but this definition limits the use of such wells to replacing out of priority well depletions and meeting Compact obligations. §37-92-103(14)(a), CRS Adding a definition of "Exchange Well" that allows wells installed within a specified distance from the river to operate as such would facilitate the exchanges proposed by the Co-op.

Lower Arkansas Valley Water Conservancy District/Super Ditch

According to Peter Nichols, reporting on behalf of the Super Ditch project team,

It appears that the costs and time required for legal, engineering and accounting under a "business as usual" approach to a rotational fallowing change case may become cost prohibitive to the irrigator-lessors. There are several reasons for this: 1) the number of acres required to be "engineered" to create a given transferable yield through a one-in-four rotational fallowing program is four times the number of acres that would be required

under a traditional buy-and-dry scenario; 2) the accounting requirements (for decree compliance) under a one-on-four rotational fallowing program will be more complicated than a traditional buy- and-dry scenario; 3) engineering solutions to canal operations are more complicated under a rotational fallowing program than under a traditional buy-and-dry scenario; and 4) irrigator-lessors have little or no ability to finance the up-front engineering and legal costs of a water rights change case.

The ultimate conclusion is that "the time required to put together a program, negotiate leases, and resolve contingencies will delay and possibly kill fallowing-leasing."

Potential solutions to these problems include a simplification of the water rights engineering required for temporary transfers, which would help the irrigator-lessors to pursue a change case. Developing a "presumptive depletion" or "rebuttable presumption" type of change of water right process for temporary transfers that would "keep the river whole" could be an alternative to the very expensive "business-as-usual" engineering for a change of water right case. This might have to be accomplished at the legislative level and also provide for administrative approval of alternative agricultural transfers without water court action, like interruptible supply contracts and substitute water supply plans.

Farmers Reservoir & Irrigation Company
It is anticipated that this issue will be addressed through the ongoing project work and documented in the final report.

Colorado State University Extension
This project observes that a significant portion of fallowed land management is related to weed suppression, which does not add value to the field or soil, but simply maintains a condition for future farming. It would be more desirable, however, to utilize fallowed fields for productive purposes in line with SWSI Phase 2 Section 3 (page 3-15), which states that challenges with fallowed land management may be "may be minimized by dryland cropping on the fallowed lands so long as adequate safeguards to prevent expanded use by sub-irrigation." Therefore, in response to the question, "What would it take to make an alternative agricultural transfer program work in Colorado?" one obvious and immediate suggestion is to make viable the use of fallowed land for continued crop production on a dryland basis. This project is being expanded in 2010 to evaluate this possibility by further subdividing the sites to include a farmed portion of sorghum-sudan, which is a warm season grass that has grown fairly well in drier climates.

Water Court Processes Related to Program Approach and Implementation

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010), which focused on Phases 1 through 3 of the study. Phase 4 will address

administration and hydrologic considerations necessary for the successful implementation of rotational fallowing and limited irrigation cropping practices as water saving approaches in Colorado.

Colorado Corn Growers Association
Water court requirements vary depending on the type of transfers involved, as described below.

- **DT Ranch –** For an intra-ditch transfer, no water court process is necessary. The interruptible supply agreement is subject only to FMRIC's rules and regulations regarding leases between shareholders.

- **PVIC/WISE Private Water Market –** Water court approval would be necessary to change the use of agricultural water rights to municipal use and to adjudicate any exchanges that are necessary. Once the private water market is decreed, additional M&I users or agricultural suppliers could join, subject to the water court's approval under retained jurisdiction.

- **Lower South Platte Co-op –** Water court approval should be obtained to adjudicate an exchange and secure a priority date for administration.

Lower Arkansas Valley Water Conservancy District/Super Ditch
Included in discussion of legislative and regulatory changes.

Farmers Reservoir & Irrigation Company
Although not directly related to water court processes, there is a pending ruling from the Colorado Supreme Court that could significantly affect alternative transfer proposals for FRICO. Specifically, there is an appeal underway regarding the Water Court ruling in Case No. 02CW403. If that ruling stands, it will have the following impacts:

- The potential for alternative agricultural transfers from FRICO shareholders to M&I users will be limited.

- There will be a greater shortage for FRICO shareholders—another key finding was that FRICO shareholders in the Barr and Milton systems are water short—which will in turn increase the availability of FRICO infrastructure to divert, store, and regulate other supplies.

Program Administration

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010), which focused on Phases 1 through 3 of the study. Phase 4 will address administration and hydrologic considerations necessary for the successful implementation of rotational fallowing and limited irrigation cropping practices as water saving approaches in Colorado.

Colorado Corn Growers Association
Administration of the proposed alternative transfers would be a cooperative effort between the supplying agricultural users, the purchasing/leasing M&I users, and other involved parties (e.g., FMRIC, a Private Market Administrator, the Lower South Platte Co-op itself).

Lower Arkansas Valley Water Conservancy District/Super Ditch
Program administration would be conducted by the Lower Arkansas Valley Super Ditch Company, acting as representative for the participating ditch company shareholders.

A general recommendation to improve program administration for all types of alternative transfer programs is the development of standardized, professionally-accepted, and relatively inexpensive monitoring programs for verification. It appears that all ag-related activities will require a higher degree of measurement and monitoring than we currently have available. Verification of deficit irrigation measures and other options to reduce consumptive are examples where additional tools are needed. Some standardization and consistency with measurement devices and methodologies appears essential for moving transfers through the administrative process.

Farmers Reservoir & Irrigation Company
The shared water bank concept would involve cooperation between FRICO Barr and Milton shareholders and participating M&I water providers. As envisioned, the bank would be managed and administered by FRICO.

Colorado State University Extension
Although not directly aimed at addressing issues of program administration, the CSU Extension demonstration project seeks to provide answers to typical questions heard from farmers, which the researchers paraphrase as "How will fallowing my ground for a period of years affect the yields, nutrient needs and profitability of my land when I decide to farm it again?"

Likelihood of Success if Agricultural User is Not Required to Bind the Land and Water to Irrigation

Parker Water & Sanitation District/Colorado State University

This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010), which focused on Phases 1 through 3 of the study. Phase 4 will address administration and hydrologic considerations necessary for the successful implementation of rotational fallowing and limited irrigation cropping practices as water saving approaches in Colorado.

Colorado Corn Growers Association

M&I water users are generally reluctant to invest capital resources in water supply sources and infrastructure that do not provide guaranteed supplies. However, each demonstration project has certain benefits in this regard.

- **DT Ranch –** Ready access and low transaction costs may make intra-ditch transfers attractive to M&I users on an interruptible supply basis.

- **PVIC/WISE Private Water Market –** The water court process would permanently transfer the Base CU component to the M&I users (10 percent or otherwise, tailored to the end users' needs). A right of first refusal and water court-approved change of use on the Flex CU component would be advantageous to the M&I partners should other entities seek to purchase the agricultural supplies.

- **Lower South Platte Co-op –** The availability of excess recharge credits is highly variable and dependent on hydrologic conditions. The study group has found little support for the concept of a "spot market" with M&I users, which would send water upstream during times of excess. However, there is a greater potential for more reliable supply if the program were to incorporate storage and re-timing of excess flows.

Lower Arkansas Valley Water Conservancy District/Super Ditch

The Super Ditch project team offers a number of recommended program characteristics related to this issue that would help to improve the chances of success for alternative agricultural transfers:

- A willingness for municipalities to accept long-term leases as a secure form of water supply, similar to municipalities in other states under Bureau of Reclamation water service contracts.

- A willingness for municipalities to work with irrigators to minimize their own future water supply risks, such as the use of dry-year options and interruptible contracts.

- A more regional outlook from Front Range water providers in the context of providing delivery and exchange opportunities for agricultural water.

Farmers Reservoir & Irrigation Company
It is anticipated that this issue will be addressed through the ongoing project work and documented in the final report.

Program Conditions Necessary to Ensure that Private Property Rights are Not Impaired

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010), which focused on Phases 1 through 3 of the study. Phase 4 will address administration and hydrologic considerations necessary for the successful implementation of rotational fallowing and limited irrigation cropping practices as water saving approaches in Colorado.

Colorado Corn Growers Association
Water court processes would ensure that the concerns of other water users are addressed and that vested senior water rights are protected from injury.

Lower Arkansas Valley Water Conservancy District/Super Ditch
The water court process required for changing the use of irrigation water rights to allow for municipal uses under the proposed rotational land fallowing-water leasing program would allow for the concerns of interested parties to be addressed and would ensure no injury to vested senior water rights on the Arkansas River and its tributaries.

From the perspective of the irrigators, the Super Ditch team suggests benefits could be gained from some form of collective bargaining entity for the irrigators, possibly basin or region-specific, that could prevent some of the "divide-and-conquer" approach used historically during the acquisition of agricultural water rights.

Farmers Reservoir & Irrigation Company
FRICO irrigators were surveyed to collect types of demographic, farm, and irrigation data, as well as to gage interest in the various alternative transfer methods and the "shared" water bank concept. Participants were concerned that their voices were not heard nor represented at the state level. In addition, surveyed FRICO irrigators were concerned that the information they provided would be used against them by cities during lease or transfer negotiations.

Financial Issues

Estimate Costs to Organize and Administer a Program

Parker Water & Sanitation District/Colorado State University

This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010). However, Phase 5 will provide a final report at the completion of all work related to this project, including the research results, conclusions related to the on-farm demonstrations, local and regional economic analyses, preliminary planning studies related to delivery of water, and the proposed administrative and hydrologic procedures that are proposed to support change of use proceedings in Water Court.

Colorado Corn Growers Association

The project team did not make dollar estimates of the costs of organizing or administering the three selected demonstration projects. Conceptually, the administrative requirements and costs associated with these programs will vary. Administrative costs for DT Ranch to execute an intra-ditch transfer within the FMRIC system are anticipated to be minimal. On the other hand, the legal, engineering, infrastructure construction, and administrative costs for the private water market and co-op would likely be substantial. However, the pooling of resources by several agricultural providers and M&I end users could bring down costs to a reasonable level for interested parties.

Lower Arkansas Valley Water Conservancy District/Super Ditch

The Super Ditch team summarized several factors affecting program costs:

- Storage near the source and closer to the users significantly reduces conveyance costs and provides for more continuous operating of the pipeline.
- Storage that provides for reduced size of the advanced WTP allows for cost reductions as well as continuous operation of the treatment plant.
- Conveyance configurations indicate that the west (diversion from Pueblo Reservoir) or middle (diversion from Stonewall Springs gravel pit) alignments are more favorable from a capital and operations and maintenance (O&M) cost perspective.
- Total estimated capital costs for conveyance facilities range from $20,000 per acre-foot to $36,000 per acre-foot.
- O&M costs for all the conveyance configurations are high. Annual O&M costs range from $8 to $10 per 1,000 gallons. This is significantly above current consumption costs in the Front Range, which typically do not exceed $7 per 1,000 gallons at the top tier of an increasing block rate. Primary components of the annual O&M costs are leasing the water, pumping the water, and advanced treatment.

- The cost associated with improving water quality is directly related to the degradation in water quality: treatment costs increase as water quality declines.

In terms of potential customers for Super Ditch water, that translates to about $7,240 per acre-foot for capital and O&M costs for entities in Northern El Paso County, such as the Pikes Peak Regional Water Authority (PPWRA). This cost estimate is based on the following assumptions:

- Relatively poor water quality is diverted in the Lower Arkansas Basin, between La Junta and Las Animas, treated on-site, and delivered to the PPWRA in a dedicated pipeline.

- Treatment is by reverse osmosis, few economies of scale are achieved with the pumps and pipeline, and the vertical elevation change is substantial.

Potential mitigating factors to this high cost are (1) potential exchanges at Pueblo Reservoir that both improve the quality of the water and shorten the distance to the PPRWA service area, and (2) the potential use of the Southern Delivery System (SDS) pipeline allowing PPRWA to share in economies of scale in treatment and transmission. The combination of exchanges and the use of the SDS pipeline reduce estimated costs dramatically, from $7,240 per acre-foot to about $2,200 per acre-foot.

Farmers Reservoir & Irrigation Company
It is anticipated that this issue will be addressed through the ongoing project work and documented in the final report.

Colorado State University Extension
The project has also completed enterprise budgeting for Year 1 (2009) of the demonstration sites. The purpose of this exercise was to evaluate typical costs that will be associated with fallowed land management, such as weed suppression and the cost of "not farming" (as evaluated by gross receipts on a continuous corn index crop. The enterprise budgets for both demonstration sites reflect the value of corn ($3.65 per bushel) and cost of various farm inputs (e.g., fertilizer, herbicide, insecticide) for 2009. These are static costs, and therefore do not incorporate the inherent long-term variability in the costs of farming as well as the price of corn, which are not known definitively at the time a lease arrangement is written.

For 2009, however, the break-even point for the sites was $480.14 and $541.37, for the Highline and Holbrook Canal sites, respectively. These values were calculated by adding the net value of corn production (return to land, operator's labor, management, and risk) and the cost of managing land in the fallowed condition. Fallowed land management largely involves chemical application of an herbicide such as Roundup or Gly Star to manage weeds common

to the Lower Arkansas Valley area. These weeds include Kochia, Pigweed, Bindweed, Bull Nettle, and various grasses.

Identify Parties that Could Contribute to Costs

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010). However, Phase 5 will provide a final report at the completion of all work related to this project, including the research results, conclusions related to the on-farm demonstrations, local and regional economic analyses, preliminary planning studies related to delivery of water, and the proposed administrative and hydrologic procedures that are proposed to support change of use proceedings in Water Court.

Colorado Corn Growers Association
Included in the discussion of estimated costs to organize and administer a program.

Lower Arkansas Valley Water Conservancy District/Super Ditch
Included in the discussion of estimated costs to organize and administer a program.

Farmers Reservoir & Irrigation Company
Identified potential M&I partners in the shared water bank include South Adams Water and Sanitation District, the cities of Thornton and Brighton and the Towns of Lochbuie and Hudson. It was noted specifically that South Adams WSD has a need for consumable water sources to meet winter return flow obligations from transferred agricultural water and for well pumping depletions. In addition, there are many FRICO Barr and Milton shareholders who are also groundwater users in the Beebe Draw and in need of well augmentation.

South Adams WSD and Thornton were surveyed as part of ongoing project work. Both were willing to explore the concept of a shared water bank, but do not believe they will have significant volumes of surplus supplies to contribute in the long-term, due to planned gravel lake storage along the South Platte River and projections indicating that they will grow into their supplies.

Estimate the portion of the total land and water rights value that will need to be paid to an agricultural user as compensation for enrollment in a program

Parker Water & Sanitation District/Colorado State University
The project sought to understand the potential of South Platte farms to adopt limited irrigation, rotational cropping, partial season irrigation, and the barriers to adoption. A farmer survey was a key instrument to determine the potential water leasing rather than 'buy and dry' fallowing, as well as the adoption of limited irrigation strategies. Importantly, the limited irrigation cropland remains in production and mitigates reduced economic effects of

dry-up. The producer survey gauged the amount of water that might be made available in water leasing arrangements and the necessary compensation needed for farmers to participate in a lease arrangement. More than 60 percent of survey respondents are willing to lease water, with an aggregate of between 50,000 and 60,000 acre-feet of potential water supplies just among those who responded. Preferred compensation ranges from $300 - $500 per acre of irrigated cropland. Most farmers would prefer not to lease their entire water portfolio, thus these respondents are likely to remain in agriculture and generate positive economic activity.

In addition, a spreadsheet decision tool has been developed to help farmers determine the tradeoffs of various limited irrigation and water saving strategies. The spreadsheet allows farm managers to input their own business information and contrast alternative water saving cropping strategies.

Colorado Corn Growers Association
In each of the three case studies, the answer to this question would be the same: each farmer will need to determine these values based upon their individual circumstances. That is, the financial returns of each farmer's individual operations would need to be gained in compensation plus any fixed costs, such as debt service. Further, each farmer will need to determine what risk premium they must have as incentive to enter into such a program. Over and above operating and fixed costs, the amount of compensation necessary to make program participation worthwhile for each farmer would vary, depending upon their individual financial circumstances, family situation, and risk tolerance. The project team recognized that this question must be answered by each farmer individually and, therefore, we designed the AgLET evaluation program so that farmers could independently evaluate their required financial returns for participation.

Lower Arkansas Valley Water Conservancy District/Super Ditch
This issue does not appear to be within the scope of Tasks E, F, and G, which are funded by the Alternative Agricultural Water Transfer Methods Grant Program. However, a comprehensive report (Task H) on the water leasing concept and the Super Ditch Company is anticipated to be completed in late September 2010. This document may contain additional relevant information.

Farmers Reservoir & Irrigation Company
FRICO irrigators were surveyed to collect types of demographic, farm, and irrigation data, as well as to gage interest in the various alternative transfer methods and the "shared" water bank concept. When discussing prices at which they would be willing to lease, survey participants were uncertain (i.e., they hadn't seriously considered this issue) or anchored to prices of other water transactions that they had heard, even though the circumstances and types of those transactions were very different. For example, $500 per acre-foot was the most

common price indicated. It was subsequently revealed that a number of participants indicated this price because they had heard others received this price for short-term leases with cities.

The FRICO investigators utilized additional data from the 2007 Thorvaldson/Pritchett survey of South Platte irrigators. Based on this data, nearly two-thirds of operators surveyed indicated they were willing to enter into a leasing agreement, and close to half were willing to enter into an agreement with municipalities. Minimum payment required per acre required to forgo irrigation for one year as a part of a leasing agreement was approximately 30% higher among FRICO irrigators, which is consistent with the higher general productivity of irrigated land relative to the South Platte as indicated in the census data.

Colorado State University Extension
Included in the discussion of estimated costs to organize and administer a program.

Streamline/Equalize Water Court Transaction Costs

Lower Arkansas Valley Water Conservancy District/Super Ditch
See responses in Legal/Institutional issues section.

Cost vs. Supply Certainty for Municipalities Purchasing Water via Alternative Agricultural Transfers

Parker Water & Sanitation District/Colorado State University
This issue does not appear to be addressed directly in the current progress report (Hansen et al. 2010). However, Phase 5 will provide a final report at the completion of all work related to this project, including the research results, conclusions related to the on-farm demonstrations, local and regional economic analyses, preliminary planning studies related to delivery of water, and the proposed administrative and hydrologic procedures that are proposed to support change of use proceedings in Water Court.

Colorado Corn Growers Association
Aware of the tension between M&I user's desire for certainty and agricultural users' reluctance to commit to permanent transfers, the study team incorporated elements into each project that tried to strike a balance in a way that made the projects more attractive to agricultural suppliers and M&I users.

- **DT Ranch –** The DT Ranch Project has no element of permanence. However, by keeping the interruptible supply agreement within the FMRIC system, the transactional costs of the transfer are held so low that an interruptible supply agreement becomes a viable option for an M&I user positioned to take advantage of FMRIC deliveries. The study team postulates that M&I users' interest in less than permanent water supplies is inversely proportional to transaction cost. If an interruptible supply or short term lease can be achieved at a

reasonable rate, M&I users may view an interruptible supply or short term lease as an acceptable component of a larger water supply plan.

- **PVIC/WISE Private Water Market** –The Private Market model addresses the permanence issue by including a portion of the agricultural user's water supply (10 percent) as a permanent transfer or sale to the M&I user, while the remaining 90 percent is subject to shorter term arrangements. M&I users are more interested in participating if there is some amount of water that they own permanently. Ideally, the amount of the permanent transfer is enough to justify the transactional cost in and of itself, and leasing opportunities are an added benefit. The Private Market also addresses the permanence issue by providing that agricultural users may sell the remaining 90 percent of their consumptive use to any party, subject to a right of first refusal to the M&I user partner.

- **Lower South Platte Co-op** –The Co-op was initially envisioned as a means to provide short term supplies to upstream M&I users on an on-demand/as available basis. However, with the appropriate infrastructure and management, it is also possible that the downstream surpluses could be stored or retimed and provided to upstream M&I users on a relatively stable basis. Further study is needed to determine how reliable the source might be and whether the contemplated exchanges could be established and operated at a cost that is attractive to M&I users. Once a reliable exchange mechanism has been established, it is possible that Co-op agricultural members could provide additional water supplies by changing the use of senior irrigation rights and applying rotational fallowing and/or deficit/reduced irrigation techniques.

Lower Arkansas Valley Water Conservancy District/Super Ditch
See responses in Legal/Institutional section, specifically recommendations for municipalities that could make alternative agricultural transfer programs more likely to succeed.

Farmers Reservoir & Irrigation Company
It is anticipated that this issue will be addressed through the ongoing project work and documented in the final report.

Compare Annual Local Impacts of a Rotational Fallowing Program with a Permanent Dry-up that Includes Voluntary Payment in Lieu of Taxes

Parker Water & Sanitation District/Colorado State University
An objective of the third project phase was to develop a regional economic impact model to quantify the direct and indirect economic effects of adopting alternative irrigation systems. The South Platte River basin expects to fallow as many as 266,000 (22 percent) of its irrigated acres in the next 25 years. Each irrigated acre is estimated to generate economic activity equivalent to $690 in the basin. Economic effects of drying up irrigated land will be substantial, especially in sparsely populated rural areas with few other alternatives.

Colorado Corn Growers Association
The annual local economic impacts of a rotating fallowing program will be less than a permanent dry up that includes voluntary payment in lieu of taxes for the following reasons:

- The economic contribution from the farm would be lost to the local area under a permanent dry up, whereas they would only be reduced under a rotational fallowing program. Beyond the tax payments, expenditures, employment, and income from that farm would be lost to the region.

- The indirect or induced economic effects of the farm operation would be lost to the region. That is, as the farmers regional expenditures circulate through the local farming communities, additional economic effects occur which would also be lost as a result of the permanent dry up.

- "Upstream" economic linkages or farm products, which are used by cattle or ethanol plants, would also be lost to the region. With less feed stock, higher prices, more constrained supply might occur.

In sum, rotational fallowing programs allow for a continuation of farming and the contributions that farming brings to a region and the State as a whole. Property tax payments, even held at an equivalent level, only represent a part of the economic contribution of irrigated agriculture.

Lower Arkansas Valley Water Conservancy District/Super Ditch
This issue does not appear to be within the scope of Tasks E, F, and G, which are funded by the Alternative Agricultural Water Transfer Methods Grant Program. However, a comprehensive report (Task H) on the water leasing concept and the Super Ditch Company is anticipated to be completed in late September 2010. This document may contain additional relevant information.

Tipping Points or Thresholds to Maintain Viable Agricultural Production

Lower Arkansas Valley Water Conservancy District/Super Ditch
Acting as part of the Super Ditch project team, Honey Creek Resources and others have developed a draft methodology for incorporating tipping points in water transfer evaluations. The purpose of this effort is to determine if there is a correlation between loss of irrigated acres in a region and the rural economy. Key points are summarized below:

- The economic threshold approach is intuitively appealing and appears to have a strong theoretical foundation. Further development is justified on the basis that traditional economic analysis likely significantly understates the actual adverse impacts to rural communities resulting from irrigation to municipal water transfers. Additional economic

impacts caused by the "tripping" of population-business thresholds, in both the negative and positive directions, can increase total estimated impacts by as much as 50 percent or more.

- The model's framework and mathematical functional form are relatively simple and general in nature, allowing the model to be relatively easily transferred to different geographic areas.

- Additional effort is still needed in the area of "first round" employment impacts and the relationship between regional employment and population.

- Given this higher degree of economic impact and the important role that the location of the transfer plays in the total, transfers from particular economically sensitive areas could be re-evaluated. These sensitive areas would primarily be isolated small to medium-sized communities distant from the Front Range.

- The relatively higher degree of impact may call for a possible re-evaluation of long-range water supply plans that depend on the use of irrigation water. Alternative supply options, such as additional storage, may be relatively more attractive from a public perspective in light of higher than expected rural impacts.

- This approach is sufficiently general to examine increases in irrigated acreage as well as decreases. In addition, it could examine policies intended to increase agriculture's local value-added. For instance, new food processing industries that use local produce would increase the region's total employment multiplier, increasing population, and causing threshold impacts in a positive direction.

Conclusions and Next Steps

Another workshop with grant recipients will be held in August or September 2010 to present the summary of findings to date and to obtain feedback on the answers to the question "What would it take to make an alternative agricultural transfer program work in Colorado?" The following points taken from the discussion in the Legal and Institutional Issues section of this report would provide some initial guidance to the workshop discussion on this latter issue:

High Transaction Costs

Establishing a viable marketplace without an expensive Water Court process has been raised by some as a needed incentive to encourage participation in ATM programs. A potential barrier to a more active water market is that water rights change cases can entail high engineering and legal expenses. Reducing transaction costs and providing for impartial oversight by Division of Water Resources (DWR) staff could be incentives for alternative

agricultural transfer programs to succeed. One suggested way to reduce transaction costs related to a change in use is to have a rebuttable presumption standard established by legislation for a temporary change in use that would accept a lower level of engineering and technical analysis associated with a temporary change in use. Below are some additional suggestions from this report that would reduce transaction costs for alternative agricultural transfers:

1. The adoption of presumptive historical crop consumptive use procedures could streamline the process. This would reduce the time and effort needed to perform a detailed engineering study often done for a permanent agricultural water transfer application. If a presumptive consumptive use analysis procedure could be established by statute or regulation, then cost of the engineering could be reduced.

2. Determining historical consumptive use analysis for a canal or ditch system could also streamline the process and provide general information on the worth of a water right. This would allow the irrigators and cities some additional certainty before negotiating leasing agreements. There have been examples of successful ditch wide historical consumptive use analyses that the Water Courts have approved that allow a determination of the yield of a share of the water right that can be used for future change cases as other shares are purchased and the use changed to a new use. This can significantly reduce the engineering costs for a change-in-use application especially for either a rotational fallowing program or even a permanent dry-up application for a portion of a canal system.

3. Many of the ATM programs being pursued in Colorado are examining the potential of transferring for M&I purpose a portion of the consumptive use of a water right through deficit irrigation, different crop types, and/or irrigation scheduling. While the transfer of this water is possible under Colorado water law, it has not yet been tested in Water Court or codified by the Legislature. This increases the uncertainty associated with ATM programs. It may be helpful recognize the ability to transfer a part of the consumptive use of a water right and to provide clarification to the Water Courts when doing so. This could be accomplished through legislation and/or DWR rule making.

Certainty of Long Term Supply

Another issue often raised is the need to reduce the uncertainty for municipal water providers so they are willing to participate in an alternative agricultural transfer program. Reducing the transactional costs as discussed above could provide some encouragement for those programs that rely on individual farmer's participation. An additional area of discussion should be on how an alternative agricultural transfer program would work within a municipal provider's overall water strategy for firm yield by combining this concept with dry-year leases or interruptible water supply agreements allowed by statute (CRS 37-92-309) to provide for

future dry year water needs. It would have to be economically viable for a municipality to pursue this alternative to more traditional "buy and dry" water acquisitions.

After the workshop, the feedback from the attendees would be summarized and any viable recommendations identified for further discussion with the CWCB and its staff. Possible outcomes could be policy revisions and suggestions for legislation to encourage Alternative Transfer Method programs in Colorado.

References

AECOM. 2010. Memorandum RE: Alternative Water Transfer Methods – Interim Summary of Findings. Submitted to Peter Nichols.

Cabot, Dr. Perry, Jim Valliant, and Jeff Tranel. 2010. 2010 Annual Report to Colorado Water Conservation Board, Alternative Agricultural Water Transfers Methods.

Colorado Corn Growers Association, Ducks Unlimited, Aurora Water, and Lower South Platte Co-op. 2010. Summary of Selected Findings for Development of Practical Alternative Agricultural Water Transfer Methods. Prepared for Colorado Water Conservation Board. Prepared in association with Brown and Caldwell, Colorado Water Resources Research Institute, Harvey Economics, and Lind, Lawrence & Ottenhoff, LLC.

Colorado Water Conservation Board. 2007. Statewide Water Supply Initiative – Phase II Report.

Farmers Reservoir & Irrigation Company (FRICO). 2010. Alternative Agricultural Transfers Study.

Hansen, Neil, James Pritchett, Tom Holtzer, Joe Brummer, Mike Stephens, Joel Schneekloth, Bruce Bosley, Alan Helm, Dwayne Westfall, and J.R. Herman. 2010. Progress Report of The Lower South Platte Irrigation Research and Demonstration Project and Final Report for the Parker Water and Sanitation District Water Supply Reserve Account Grant. A cooperative project of Parker Water and Sanitation District; Department of Soil and Crop Sciences, Colorado State University; Department of Bioagricultural Sciences and Pest Management, Colorado State University; Department of Agricultural and Resource Economics, Colorado State University; and the Colorado State University Extension.

Honey Creek Resources, Inc. 2010. Memorandum RE: Key study results. Submitted to Peter Nichols.

Honey Creek Resources, Inc. 2010. A Proposed Method for Incorporating Rural Population-Business Thresholds, or "Tipping Points," in Water Transfer Evaluations. Draft Report.

Prepared for Colorado Water Conservation Board. Prepared with Bootstrap Solutions, Inc., The Flatwater Group, Inc., Ken Weber, Ph.D., and Charles W. Howe, Ph.D.

Nichols, Peter D. 2010. Personal email communication from Peter Nichols (Super Ditch legal counsel) to Todd Doherty (CWCB). Dated June 1, 2010.

Appendix A
Colorado Water Conservation Board
Alternative Agricultural Water Transfer Methods Grant Program
Summary of Deliverables

MEMORANDUM
Colorado Water Conservation Board
Alternative Agricultural Water Transfer Methods Grant Program
Summary of Deliverables
REVISED June 30, 2010

Executive Summary

Since it's inception in 2007, the Colorado Water Conservation Board's Alternative Agricultural Water Transfer Methods Grant Program has awarded $1.5 million to various water providers, ditch companies, and university groups for the funding of six unique research projects. The grant recipients are identified below, along with a brief synopsis of each entity's approach to identifying viable alternative agricultural water transfer methods.

- Parker Water & Sanitation District (PWSD)/Colorado State University (CSU) – The Lower South Platte Irrigation Research and Demonstration Project is a four-year study to quantify potential consumptive water use savings resulting from the use of deficit irrigation practices. By reducing the consumptive use of irrigated crops, an incremental volume difference between historic and future consumptive use can be computed. With approval of the State Engineer's Office, it is believed that this volume of water could be transferred to municipal use. In addition to field-scale research, the test program will be implemented on three demonstration farms to ensure that working farmers understand the proposed practices and that the practices are operationally and economically practical.
- Colorado Corn Growers Association (CCGA) – Working with Ducks Unlimited and the City of Aurora, the Colorado Corn Growers Association will investigate a variety of alternative agricultural water transfer methods. The transfer methods will be applied to three demonstration projects, two of which will involve wetlands. These wetlands provide a number of benefits, including recharge to the South Platte alluvial aquifer, which can be used in an augmentation plan for out-of-priority groundwater pumping. The third demonstration project will explore a marketing mechanism for facilitating transfers. The study will also produce a Business Plan, which will be made available to other water users to help facilitate practical utilization of alternative transfer methods.
- Lower Arkansas Valley Water Conservancy District (LAVWCD) – The grant funding provides for continued economic and engineering analyses of the Super Ditch Company, which would provide a means for irrigators under a group of ditch companies to collectively lease agricultural water for other uses, including municipal use. Rotational fallowing is likely to be the primary means of alternative transfer.
- Farmers Reservoir & Irrigation Company (FRICO) – FRICO is investigating a number of alternative agricultural water transfer methods, including rotational fallowing, interruptible supply agreements, lease back agreements, and changes in cropping patterns. Much like the PWSD/CSU study, the objective of these methods is to reduce consumptive use for purposes of transferring the "saved" consumptive use to municipal or industrial users. The project also includes the evaluation of a water bank concept that would utilize existing FRICO infrastructure to store this "saved" water and then convey it to other agricultural or municipal users when needed.

- Colorado State University Extension Office – The CSU Extension Office is conducting a four-year study to assess various technical aspects of returning fallowed land to production and maintaining or improving crop yields on those lands. The project involves field-scale research on plots either planted to corn or fallowed and then sequentially brought back into corn production. These plots are proposed to be located on farms under the Rocky Ford High Line Canal and the Holbrook Canal; coordination with the Super Ditch Company is anticipated. The study will include investigations of weed and erosion control measures during fallow years and monitoring of soil nutrients and salinity once production resumes.
- High Line Canal Company - The Highline Canal Company is conducting a project to explore implementation of various means of alternative water transfer including interruptible water supply agreements, long-term land fallowing, spot market leases (for use during drought), and water banking. Water developed under these methods will be provided to other users via existing irrigation infrastructure or via a proposed pipeline. The project includes engineering studies to determine the amount of water that could be transferred and the location, timing, and volume of historical irrigation return flows that would need to be maintained in order to prevent injury to downstream water users. Water made available will be leased to other water users.

As indicated in these project descriptions, there are some common elements between projects. For example, both the PWSD/CSU study and the FRICO study seek to identify means to modify irrigation practices such that "saved" consumptive use water could be transferred from agricultural to municipal use. Synergies exist in the Arkansas Valley as well, with collaborative studies involving the Super Ditch Company, the CSU Extension Office, and the High Line Canal Company. Moreover, most, if not all, of the projects involve some level of analysis to assess the economic viability of selected alternative transfer methods. Through evaluations of production costs and estimation of acceptable prices to be paid for leased and/or transferred water, these analyses aim to assure farmers that the profitability of their operations can be maintained.

Project schedules are summarized below.

Table ES-1. General project schedules

Name	Project Duration
Parker Water & Sanitation District (PWSD)/Colorado State University (CSU)	Late 2006 – End of 2010
Colorado Corn Growers Association (CCGA)	April 2009 – March 2010
Lower Arkansas Valley Water Conservancy District (LAVWCD) Super Ditch Company	January 2009 – January 2011
Farmers Reservoir & Irrigation Company (FRICO)	November 2008 – December 2009
CSU Extension Office	March 2009 – June 2012
High Line Canal Company	1st quarter 2010 – 4th quarter 2012

All projects are phased, with some tasks occurring sequentially, and some overlapping. Deliverables are anticipated to be submitted at the end of each task, with final documentation due at project completion.

Introduction

In 2007, the Colorado General Assembly authorized the Colorado Water Conservation Board (CWCB) to develop a grant program to facilitate the development and implementation of alternative agricultural water transfer methods. Through this program, known formally as the Alternative Agricultural Water Transfer Methods Grant Program, the CWCB has awarded $1.5 million to water and sanitation districts, irrigation companies, water conservancy districts, and other entities.

The purpose of the program is to study alternatives to the typical "buy-and-dry" approach to agricultural water transfers, with emphasis on the South Platte and Arkansas River basins. According to Doherty and Lindburg (2009), "Projects include field research and deficit irrigation and quantification of consumptive use savings; research regarding establishment of water banks; research on new institutional and legal mechanisms to facilitate alternative water transfers; and creation of tools to help agricultural producers and others evaluate the economic feasibility of alternative water transfers."

Districts and organizations receiving funds through the grant program are identified in Table 1 below:

Table 1. Recipients of CWCB Alternative Agricultural Water Transfer Methods Grants

Name	Grant Funding
Parker Water & Sanitation District (PWSD)/Colorado State University (CSU)	$477,500
Colorado Corn Growers Association (CCGA)	$349,650
Lower Arkansas Valley Water Conservancy District (LAVWCD) Super Ditch Company	$320,000
Farmers Reservoir & Irrigation Company (FRICO)	$202,500
CSU Extension Office	$80,350
High Line Canal Company	$70,000
TOTAL	**$1,500,000**

The objective of this memorandum is to provide answers to three important questions:

- What tasks are being conducted using CWCB money?
- What will be the deliverable products upon completion of these tasks?
- When will the deliverables be completed and submitted to CWCB?

For each project described in the following sections, an introductory summary is excerpted from the conference paper "Colorado's Grant Program to Explore Alternative Agricultural Water Transfer Methods" (Doherty and Lindburg 2009) and edited for relevant content. Additional revisions to the grant application summaries were provided by some grant recipients as a result of scope and/or schedule changes during the course of project implementation. Specific project tasks and deliverables were identified in the scope of work included with each organization's grant application and are reproduced herein; the level of detail provided varies in each application document. Other project information, such as detailed task methodologies, the anticipated benefits of various alternative agricultural water transfer methods, and estimates of potential water yield from each alternative are beyond the scope of this memorandum, but can be found in the application documentation prepared by the grant recipients.

Parker Water & Sanitation District/Colorado State University

Project summary

PWSD and CSU have teamed to conduct a project to explore means of reducing consumptive use of agricultural crops using deficit irrigation. The project, known as the Lower South Platte Irrigation Research and Demonstration Project, will include a four-year study of the response of crops to various levels of irrigation and demonstration projects.

The four-year project scope was developed by CSU and is being implemented by several of the agriculture-related departments at CSU. The project includes controlled research by CSU on a farm in Logan County, Colorado that is owned by PWSD. Various crops will be planted by CSU and these plots will be irrigated in different patterns to assess the crop's ability to thrive under varying irrigation practices, e.g., irrigating alfalfa prior to its first cutting, letting it grow without irrigation through the second cutting, and then irrigating it again prior to the third cutting. In this way, CSU will develop a database on the most efficient irrigation practices for various crops where the crop can still thrive under a lower irrigation volume. The difference between the reduced irrigation volume and the historic irrigation volume related to consumptive use could then be made available for transfer to PWSD for municipal use.

A series of ground water monitoring wells has been intalled around the research farms to better understand ground water levels and the potential for sub-irrigation. Participation by State Engineer's Office (SEO) will be critical to answering questions regarding the quantification of consumptive use that will be removed from the land while the land is still being irrigated and successfully administering a water transfer done in this way.

In order to ensure that these applications are implementable by agricultural producers on a farm-scale basis, there are also three on-farm demonstrations at PWSD's other farms in Logan County, which will have the farmers continue to work their farms with guidance from CSU. In this way, CSU will receive valuable input and feedback from the farmers about techniques that can work on a farm-scale basis. The challenge of this research is to not only develop implementable techniques for farmers, but also to measure understanding by the farmers that these techniques can still provide them with an economic use of their land.

Project tasks

The Lower South Platte Irrigation Research and Demonstration Project is divided into five phases, as follows:

- Phase 1 – The objective of Phase 1 is to identify and evaluate the "feasible set" of cropping systems, including rotational cropping, that meet M&I demands for water while sustaining agricultural production.
- Phase 2 – The primary objective of Phase 2 is to document the water savings and profitability.
- Phase 3 – Phase 3 involves (a) a farmer survey to capture variation in the likelihood of system adoption associated with farm-specific characteristics such as soil type or water

rights, or by demographic issues such as irrigator age and off-farm employment; and (b) development of an economic impact model to quantify the effects of altered farm cash flow.

- Phase 4 – Phase 4 will address administration and hydrologic considerations necessary for the successful implementation of rotational fallowing and limited irrigation cropping practices as water saving approaches in Colorado.
- Phase 5 – Phase 5 will provide a final report at the completion of all work related to this project, including the research results, conclusions related to the on-farm demonstrations, local and regional economic analyses, preliminary planning studies related to delivery of water, and the proposed administrative and hydrologic procedures that are proposed to support change of use proceedings in Water Court.

Project deliverables

Deliverables from the PWSD/CSU project are extensive, and include the following:

Phase 1

- Technical report outlining the farm resources, potential cropping systems and those alternatives that comprise the feasible set.
- Identification of the final location for the Irrigation Research and Innovation Farm and setup of the linear move sprinkler irrigation system.

Phase 2

- Annual technical report documenting the results of the on-farm demonstrations and the cropping systems research projects, including water balance data and economic outcomes.
- Farmer-oriented CSU Extension fact sheets on the individual practices demonstrated will be developed.
- Additional CSU Extension fact sheets will be produced for interested non-farm audiences such as regulatory agencies, elected officials, M&I water users, and water suppliers.

Phase 3

- Survey and regional economic impact results will be presented to a meeting of interested stakeholders.
- Published materials will included a technical bulletin from Colorado State University Agricultural Experiment Station and fact sheets via Cooperative Extension.

Phase 4

- ET maps for 2008, 2009, and 2010 will be developed using Landsat 5 imagery.
- The data collected from the multiple sites and multiple years of the project will be used to develop water reduction crop coefficients that can be applied to currently used crop coefficients.
- A technical bulletin will consider several water leasing and rotational fallowing arrangements, and then report the basin level impacts of these arrangements using the SPRAT tool. The technical bulletin will included background information, an outline of leasing scenarios, documentation of the model, description and interpretation of results, and an analysis of opportunities for future research.
- CSU Extension Fact Sheets will be written describing model results, and these will be made

available on the project website.

Phase 5 (Final Report)

- Description of the elements of the study, including the purpose and need of the study, maps of the studied areas, crop plots for each year of the study, summary of the overall studies completed, etc.
- Presentation of the results of the research, including alternative cropping systems, limited irrigation practices, partial season irrigation practices, and rotational fallowing. Results will be assessed primarily on the basis of water savings and effects on crop yields compared to more conventional irrigation methods.
- Presentation of the results related to other aspects of the irrigation research, such as pest management, fertilizer management, water balance issues (e.g., soil moisture profiles relative to return flows), groundwater level fluctuations during the irrigation and non-irrigation seasons, and the range of climatic conditions studied.
- Presentation of the results from on-farm demonstrations, including evaluation of partial season irrigation of forage crops, limited season irrigation of corn, and the effects of gypsum treatments on salt build-up in the soils.
- Evaluation of the on-farm results relative to water savings and effects on crop yields, and compare these data to the controlled research data collected from the linear sprinkler research conducted by CSU.
- Evaluation of the applicability and the acceptance of innovative irrigation techniques by local farmers involved in the on-farm demonstrations.
- Presentation of the analyses of economic feasibility of innovative irrigation techniques, including (a) analysis of survey results, (b) assessment of interest by farmers to participate in such a program, (c) estimated costs for farmers to commit land and water rights to this type of program, (d) identification of economic barriers to participation and the means to overcome these barriers, (e) the acceptance of leasing water rights versus outright sale of water rights, and (f) assessment of regional adoption of alternative irrigation systems.
- Presentation of the results from regional economic model, including effects on farm cash flow and productivity, as well as regional employment effects.
- Presentation of the results of evaluation of satellite imagery on demonstrating partial consumptive use savings, including results from the ReSET model.
- Presentation of the methodology, or methodologies, for developing modified crop coefficients for use in generally-accepted consumptive use models, by developing stress coefficients from the satellite imagery and ReSET model work, that would be used in conjunction with crop coefficients for fully-irrigated lands.
- Presentation of the methodologies that could be used to demonstrate the quantification of partial consumptive use savings in a change of water right proceeding. It is anticipated that a set of general terms and conditions can be developed as a template for any change of use proceeding.
- Identification of the conditions under which the quantification methodology for partial consumptive use savings was developed so others can assess its applicability at other locations and other climatic conditions.
- Presentation of the methodologies that will be used to assure that historic return flow patterns will be maintained even if water is transferred from agricultural to municipal use.
- Presentation of the results on water quality issues related to a change of use that would

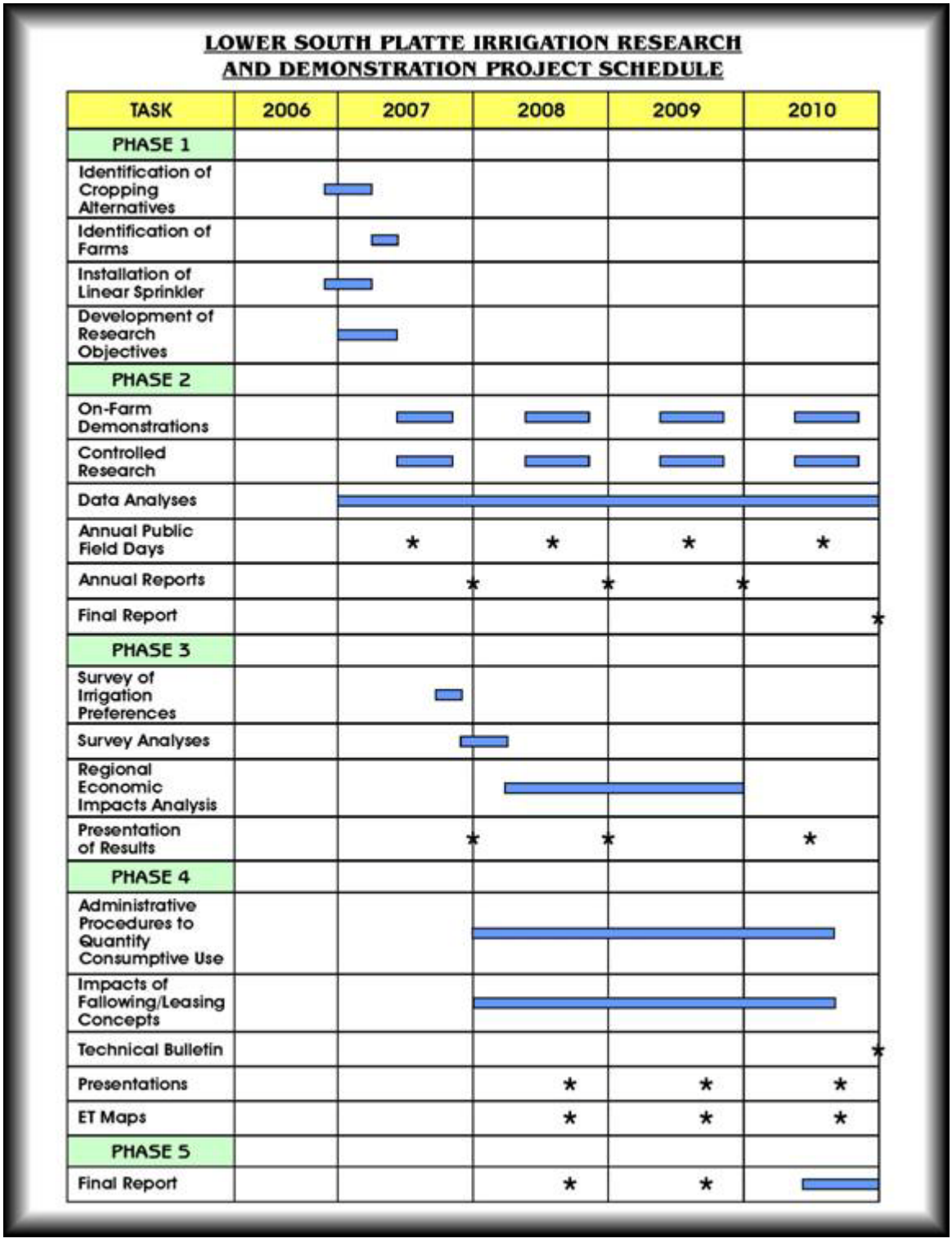
remove water from the river system and make it available for municipal use.

- Presentation of the results on water quality issues related to the potable nature of the water being delivered to municipal water users. Water treatment issues will be evaluated on a pre-feasibility level relative to providing a suitable water quality at the point of use.
- Presentation of the pre-feasibility water delivery system that would move water from farms in Logan County to the initial point of delivery at Rueter-Hess Reservoir. This will include the preliminary design of pipelines, pump stations, pipeline routes, and water collection methods from the South Platte River to deliver water to the pipeline, and the proposed location and method of water treatment.
- Presentation of the results on the institutional framework(s) that could potentially be used for setting up contractual relationships for the lease or sale of water rights to facilitate agricultural water transfers.
- Identification of the potential end users of water transferred from the agricultural sector to the municipal sector.
- Inclusion of appendices to include minutes from Advisory Committee meetings, data compilations, ground water level elevation graphs and tables, survey results, the annual technical reports, ET analyses, CSU Extension Service fact sheets distributed regarding the project, summaries of annual field days, copies of press releases during the study, etc.

Project schedule

Table 2 summarizes the four-year schedule for the PWSD/CSU study. The final report is anticipated to be completed in late 2010.

Table 2. PWSD/CSU project schedule.



Colorado Corn Growers Association

Project summary

The Colorado Corn Growers Association (CCGA), Ducks Unlimited (DU), and the City of Aurora (Aurora) were awarded a grant to develop tools to help agricultural producers understand the processes, economic implications, and the potential for conducting alternative agricultural water transfers such as rotational fallowing, interruptible supply agreements, deficit irrigation, and other transfer methods. Although the CCGA, DU, and Aurora are a diverse team, they are interested in a common goal – to develop win-win alternative transfers of water that can both meet growing urban and industrial demands and also maintain irrigated agriculture in Colorado.

During the course of the project, the Team joined forces with a group of water users and suppliers looking to form a water cooperative in the lower South Platte River (Co-op). One of the interests of the Co-op group is helping agricultural and other water users to develop efficient means to retime and optimize excess water that is available from time to time in the lower South Platte for agricultural and other beneficiaries.

As the above goal suggests, the primary focus of this project will be to examine alternatives to traditional "buy and dry" that can maintain sustainable irrigated agriculture and provide water to other users. The Team proposes to accomplish this objective by rigorously investigating alternative transfer methods and developing tools to help facilitate alternative transfers. These tools will be tested on two specific projects in the South Platte Basin. The tools will be packaged as a Business Plan that can be used primarily by agricultural producers but also municipalities, industry, etc. to evaluate and implement alternative agricultural water transfers in the South Platte River basin and across Colorado.

The Business Plan will include guidance on the steps necessary to implement an alternative water transfer and an economic evaluation tool that will allow an agricultural producer to understand the economic implications and benefits of a potential transfer. The Plan will be tested and validated by applying it to two demonstration projects involving alternative water transfers. In addition, it will be reviewed by agricultural producers associated with the CCGA and will draw on the practical experience gained from other water transfer projects completed by members of the Team. In short, the Plan will:

- Allow agricultural producers to evaluate various alternative means of transferring a portion of their water while maintaining a sustainable farming practice.
- Facilitate the practical implementation of alternative water transfers by agricultural producers to municipal and other users.
- Extend practical utilization of sustainable alternative agricultural water transfers throughout the state.

The CCGA team seeks to promote the practical utilization of alternative agricultural water transfer methods in Colorado by building on the work completed by the Statewide Water Supply Initiative (SWSI), DU's experience in the use of agricultural water rights for the development of wetlands and wildlife habitat, Aurora's experience in transfers and leases of agricultural water for municipal and

industrial purposes, and the experience and research conducted by other team members including the Colorado Water Resources Research Institute (CWRRI) concerning alternative agricultural water transfer measures. In addition, the Team also seeks to compliment or to enhance the work done by other recipients of these grant funds.

Two of the demonstration projects will involve wetlands owned or potentially owned by DU in the South Platte River basin. In each of these projects, an alternative water transfer will be developed that will supply water to the wetlands either through direct delivery of historical consumptive use or through delivery of return flows and will recharge the alluvial aquifer. Based on DU's past experience in Colorado, these projects contribute numerous benefits, including the following:

- Recreational hunting and bird watching.
- Water quality improvements through contamination filtering.
- Recharge to the South Platte alluvial aquifer.

As this project has progressed, it has become apparent that a marketing mechanism will be needed in order to facilitate moving water efficiently from water owners (agriculture) to those in need (both municipal and industrial users and other agricultural users). Research is being conducted that can be used to help implement a marketing mechanism in the future. For example, part of this project involved exploring the ability to exchange recharge credits from wetlands to municipal water suppliers. This research was enhanced by the involvement of the Co-op, which is interested in connecting those in need of water to those who may have excess supplies from time to time. In fact, a third demonstration project was developed that focuses on the ability to exchange excess water that is periodically available and analyzing potential enhancements that would optimize exchange capabilities. Additional infrastructure is being considered that will enhance exchange and help provide reliability to a marketing mechanism that could facilitate alternative transfers. In addition, a private water market is being evaluated in one of the demonstration projects.

One of the program goals is to provide a perpetual water supply for users other than agriculture. The CCGA team feels that this project can result in perpetual supplies for several reasons:

- The CCGA team has developed a private water market concept. The private water market seeks to provide perpetual supplies though the permanent transfer of a small portion of an agricultural water user's historical consumptive use. In addition, the agricultural water user's remaining consumptive use could be made available for transfer under a flexible arrangement that would involve rotational fallowing, interruptible supply, or other means.
- A recent survey conducted by Colorado State University suggested that at least 60% of respondents were willing to lease water rather than sell so long as they are suitably compensated.
- Ducks Unlimited projects ensure long term transfers by using conservation agreements which include leases of water for 30 years and conservation easements which provide protection of water supplies in perpetuity. The use of these legal tools ensures that water supplies and lands remain in agriculture and/or open space.

In addition to the above, the CCGA team is anticipating that by developing the Business Plan tools and by providing some publicity and education on the tools, agricultural producers will feel that

they have more control over their water rights assets and will be more likely to enter into long term leases.

It should be noted that the CCGA does not anticipate that this project will end permanent transfers of agricultural water to other uses. It is important to remember that agricultural producers are the owners of water rights and can sell their rights if they choose. The CCGA feels that there is currently a trend for non-agricultural water interests to buy water rights as a hedge against future inflation of water prices.

However, it is also felt that non-agricultural water users are primarily interested in reliability of supply rather than ownership in and of itself. As these interests satisfy their needs for purchased water, it is anticipated that there will be increased demand for temporary transfers of water to fulfill dry-year and other water needs. The results of this project will be applicable both as a potential alternative to purchased water and to directly fill the need for temporary transfers. In addition, this program will provide alternatives to producers that they may not have fully understood in the past, and the CCGA is confident that this project will result in future perpetual leases of water that allow for the preservation of irrigated agriculture.

Project tasks

The project is divided into eight tasks, as follows:

- Task 1 – Project Kickoff.
- Task 2 – Obtain List of Candidate Projects.
- Task 3 – Assemble Data and Determine Feasibility of Implementing Alternative Agricultural Water Transfer Methods to the List of Candidate Projects.
- Task 4 – Select Three Specific Projects Using Alternative Agricultural Water Transfer Methods.
- Task 5 – Produce Detailed Engineering, Economic, and Institutional Data for the Three Selected Projects Sufficient to Facilitate Implementation of the Three Selected Projects.
- Task 6 – Develop Business Plan to Facilitate the Practical Implementation of Alternative Agricultural Water Transfer Methods throughout Colorado.
- Task 7 – Summary Report to the CWCB.
- Task 8 – Project Management.

Project deliverables

Deliverables from the CCGA project include the following:

- Task 1 – Minutes from the kickoff meeting will be developed and will be distributed to all of the meeting participants. Administrative deliverables include written procedures for how the team members will contribute funding to the project, timing of payments, etc.
- Task 2 – The list of candidate projects and the GIS-based project map.
- Task 3 – All appropriate data and analyses will be summarized in technical memoranda which form the basis for the three specific projects (two wetland projects and the Co-op demonstration project) which will employ alternative agricultural water transfer methods.

This technical memorandum will also be included in the project summary report (see Task 7).

- Task 4 – There will be no major deliverables to the State from this task; the CWCB Project Manager, however, will be informed after the selection of the three specific projects and which alternative agricultural water transfer methods will be employed in these specific projects.
- Task 5 – The data and analysis produced by this task will be provided to water users in a series of technical memoranda or other suitable forms to allow water users to begin implementation of the projects. These technical memoranda and other documents can be included in the Summary Report to CWCB (see Task 7). Another significant deliverable from this task will be experience and information developed for the three specific projects that will be used to enhance the Business Plan for alternative agricultural water transfers that will be developed Task 6.
- Task 6 – Deliverables to the State will include the Business Plan in a form suitable for posting on the CWCB or on the Colorado Corn Growers website. Hardcopies can also be made available at the request of a user or an organization for the costs of reproduction.
- Task 7 – A final summary report for the entire project will be prepared which will include:
    - A description of the Business Plan.
    - A technical section providing the additional data produced in Task 4 concerning water quality benefits of wetlands, exchange potential, and other data useful for asessing potential locations of wetlands used for recharge. In addition, the technical section will describe potential indirect benefits of conducting alternative transfers.
    - Sections describing the demonstration projects. These sections will present the information, calculations, and analysis used to develop demonstration projects and will include the basis for determining the operating requirements for the specific alternative water transfer projects; the basis for the administration and reporting required; and the benefits of open space preservation/creation and wildlife habitat preservation/creation. The information presented in these reports will subsequently be used in developing the Business Plan.
    - A summary of the private market.
- Task 8 – Monthly progress reports will be submitted to CWCB and regular progress meetings with the CWCB Project Manager will be held.

Project schedule

Table 3summarizes the anticipated project schedule. Based on this schedule, the summary report is to be provided to CWCB in August or September 2010.

Table 3. Project schedule for CCGA alternative agricultural transfer methods study

SCHEDULE FOR COLORADO CORN GROWERS TEAM ALTERNATIVE ARICULTURAL WATER TRANSFER METHODS PROJECT

	2009									2010								
TASK	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
1. Project Kickoff																		
2. Obtain List of Candidate Projects																		
3. Assemble Data and Determine Feasibility of Implementing Alternative Agricultural Water Transfer Methods to the List Of Candidate Projects																		
4. Select Three Specific Projects Using Alternative Agricultural Water Transfer Methods																		
5. Produce Detailed Engineering, Economic, And Institutional Data For The Three Selected Projects Sufficient To Facilitate Implementation Of The Three Selected Projects																		
6. Develop Business Model To Facilitate Practical Implementation Of Alternative Agricultural Water Transfer Methods Throughout Colorado																		
7. Summary Report To CWCB																		
8. Project Management																		

Lower Arkansas Valley Water Conservancy District

Project summary

The objective of this project is to conduct further research regarding the establishment of the Super Ditch Company. The Lower Arkansas Valley Water Conservancy District has driven the establishment of the Super Ditch Company, which is an independent entity that will facilitate leases of water to municipal or other users from irrigators who voluntarily forego irrigation. It is anticipated that the primary means for foregoing irrigation will be through rotational fallowing.

The water leases may take various forms, including long-term leases, interruptible water supply agreements, and water banking. Water leases will be for specific terms of years and binding upon both the municipal water user-lessees and the irrigator-lessors. The leases will constitute a continuing legal obligation of the owner of the ditch shares. In this manner, the leases will provide certainty to the municipal/water user lessees. There will be a variety of lease terms necessary to meet the differing needs of lessees, but it is expected that leases will run for as long as 40 years with a right of renewal.

Based on preliminary results from a daily point-flow model developed under a companion Roundtable Grant to evaluate the exchange potential on the Arkansas River between ditch company headgates and Pueblo Reservoir, Leonard Rice Engineers estimated that 3,600 acre-feet would be available for lease in a dry year, 30,000 acre-feet would be available for lease in a median year, and 53,000 acre-feet would be available for lease in a wet year. These lease yields conservatively assume a 65% participation rate by irrigators (except the Bessemer, where a 25% participation rate was assumed) and a 25% fallowing rate, which are well below expected participation and fallowing rates.

Project tasks

Ongoing Super Ditch work is divided into eight primary tasks, labeled A through H. Tasks A through D are funded through the CWCB's Water Supply Reserve Account Grant Program and will

therefore be excluded from the present memorandum. Tasks E through H are summarized as follows:

- Task E – Economics.
  - Subtask E-1 – Refinement of rotational fallowing concept and assumptions.
  - Subtask E-2 – Refinement of critical assumptions.
  - Subtask E-3 – "Tipping point" study.
- Task F – Pipeline alternatives.
- Task G – Delivered water quality.
- Task H – Comprehensive report on water leasing concept and Super Ditch Company.

Project deliverables

Deliverables from the continuation of the Super Ditch study include the following:

- Task E – All of the deliverables for TASK E will be included in an Economics Technical Memorandum, except that the deliverable for Subtask E-3 is a stand-along report (completed).
  - Subtask E-1 – Refined conceptual framework and assumptions, which may include a range of assumptions that would establish the outer boundaries of a successful water leasing program.
  - Subtask E-2
    - Estimates on a basis comparable to Lower Valley leased water including delivery costs and water treatment costs where applicable, perhaps presented as ranges, of the cost of raw water delivered to Front Range municipal water providers.
    - Development and evaluation of alternate price escalation factors for long-term water leases.
    - Assessment of alternative pay-out methods and evaluation of their tax implications with respect to various lease structures.
    - Economic optimization of additional storage facilities and pipeline configurations.
    - Forty-year Financial Plan for the operation of the Super Ditch Company, including the spreadsheet model and its supporting documentation.
  - Subtask E-3
    - Economic Threshold, "Tipping Point" Study, Phase 1 – Report on the development and viability of the new economic methodology, including its use for sample case studies in the Crowley County and Lamar areas of the Lower Arkansas Valley.
- Task F – Recommended pipeline alignment, capacity, and configuration, preliminary cost estimate, and construction schedule for one or more pipelines that can deliver water from the Ft. Lyon Canal and upstream on the Arkansas River to northeastern El Paso County, i.e., to serve a potential customer such as Pikes Peak Regional Water Authority.
- Task G – A Summary Report will be prepared covering Tasks F and G, which includes pipeline alternatives and recommendations, storage alternatives and recommendations, and water treatment alternatives and recommendations.

- Task H – Comprehensive Report on Water Leasing Concept and Super Ditch Company, with technical appendices, such as articles of incorporation, bylaws. The report would integrate technical, legal, and institutional information developed in support of the water leasing concept and creation of the Super Ditch Company in a manner that would provide useful background information, directly usable information, and a template or roadmap for others to pursue the concept in other areas.

Project schedule

The Super Ditch study is expected to take 18 months to complete after thecontracts are signed with the CWCB and subcontractors (March 31, 2009). Schedules for those tasks funded by the Alternative Agricultural Water Transfer Methods Grant Program are set forth below in tabular form.

Table 4. Project schedule for Super Ditch Task E - Economics

Subtask	2009						2010					
	1/09 – 6/09			7/09 – 12/09			1/10 – 6/10			7/10 - 12/10		
E-1. Refined Concept												
Progress Report												
E-2. Refined Assumptions												
E-3. Tipping Point												
Final Report												

Table 5. Project schedule for Super Ditch Tasks F and G - Engineering

Task	2009						2010					
	1/09 – 6/09			7/09 – 61209			1/10 – 6/10			7/10 - 12/10		
F. Pipeline Alternatives												
Progress Report												
G. Delivered Water Quality												
Final Report												

Task H, the comprehensive report on water leasing and the Super Ditch Company, will be completed within 3 months of the completion of Tasks E through G. Thus, assuming Tasks E through G are on target for completion on or before June 30, 2010, Task H should be complete on or before September 30, 2010.

Farmers Reservoir & Irrigation Company

Project summary

FRICO, the largest irrigation company near the Denver metropolitan area, has initiated a project to evaluate the potential effectiveness of a variety of alternative agricultural water transfer methods including rotational fallowing, interruptible supply agreements, lease back agreements, and changes in cropping patterns. The objective of these methods is to reduce consumptive use for purposes of transferring the "saved" consumptive use to municipal or industrial users. In addition, an innovative "shared" water bank concept shall be tested to optimize the physical, economic, and administrative structure needed to capture, store, and transfer water to purchasers in the Denver metropolitan area.

The "shared" water bank concept to be developed in this project will use existing FRICO infrastructure and recharge capabilities to capture and store unused agricultural and municipal/industrial consumptive use that is available in relatively wet years. The resulting water would then be available to be used by agriculture and municipal/industrial users. The bank will be managed and administered by FRICO.

The shared water bank concept in this project will allow for both intra and inter year banking opportunities. The potential for these opportunities exist due to FRICO's infrastructure and recharge capabilities. Engineering studies currently underway to identify consumptive use, recharge capabilities, and the timing of return flows will provide much needed technical information that is not typically available on irrigation delivery systems in Colorado.

Project tasks

The FRICO project is divided into seven tasks, summarized below:

Task 1 – Survey of FRICO Barr and Milton shareholders

Prepare and complete a survey of FRICO Barr and Milton Shareholders representing potential suppliers of water for the alternative agricultural transfer methods. In addition, the shareholders will be surveyed to determine if they have the interest and physical infrastructure to participate in a shared water bank with M&I users.

Task 2 – Survey of M&I providers

Prepare and complete a survey of M&I providers in the Denver metro area representing potential customers of water from the alternative agricultural transfer methods identified in the FRICO Barr and Milton shareholder surveys. In addition, the M&I providers will be surveyed to determine if they have the interest and surplus water supplies to participate in a shared water bank with agricultural users.

Task 3 – Shared water bank structure

Analysis will be made of the mechanics of a shared water bank that could provide benefits for FRICO, Barr and Milton shareholders, and M&I providers. The shared water bank will initially take "deposits" of surplus water from M&I users that cannot be efficiently stored by these M&I users. The benefits of any water deposited will accrue to the M&I providers, FRICO and individual shareholders on a negotiated sharing basis. This task will evaluate sharing arrangements based on the results of the surveys in Tasks 1 and 2 and will develop the mechanics of how a shared bank will operate and the likelihood of water deposits based on a historical streamflow analysis. Once the accounting and administrative structure of the shared water bank is established, opportunities to bank and market water obtained through alternative transfer mechanisms will be piloted with willing agricultural shareholders within the FRICO system.

Task 4 – Engineering analysis of alternative transfer mechanics

Engineering analysis will be made of the feasibility and mechanics of alternative agricultural transfer methods that could provide benefits for FRICO, Barr and Milton shareholders, and M&I providers. The various alternative agricultural transfer methods identified by the SWSI Alternative Agricultural Transfer Round Table will be tested, in addition to other concepts developed as a result of the Task 1 and 2 survey results. Engineering reality checks will be made including the volume and location of water potentially made available, physical infrastructure to wheel the water, recharge capacities and underground and surface storage locations and volumes and compliance with Colorado water law to prevent injury to other users.

Task 5 – Water administration challenges

Consult with the Division Engineer on logistics of administration of proposed alternatives. Meetings will be held with the Division Engineer and other Division of Water Resources staff to discuss and evaluate the administration and water rights issues associated with the alternative agricultural transfer methods and shared water bank remaining after the analysis in Tasks 1 – 4.

Task 6 – Legal analysis

Legal analysis will be made of the implementation issues associated with implementing the viable alternative agricultural transfer methods and shared water bank.

Task 7 – Summary report
Report summarizing project findings.

Project deliverables

Anticipated deliverables from the FRICO alternative agricultural transfers study are as follows:

- Task 1 – Survey and written summary of survey results delivered in electronic format.
- Task 2 – Survey and written summary of survey results delivered in electronic format.
- Task 3 – Table of surplus water supplies available for banking delivered in electronic format (Excel). Table summarizing surplus capacities in key FRICO structures under historical conditions delivered in electronic format (Excel).
- Task 4 – Tables and maps showing volumes of water potentially available, diversion points, recharge sites, and return locations, amounts, and timing and retiming delivered in electronic format (GIS and Excel) and four color oversized paper copies of maps.
- Task 5 – Results will be incorporated in the Task 7 deliverable.
- Task 6 – Results will be incorporated in Task 7 deliverable.
- Task 7 – Final summary report and briefing to CWCB. Report to be delivered in electronic format (PDF) and 20 total paper copies to be distributed between FRICO and CWCB.

Project schedule

Based on Table 6 below, which originally appeared in the FRICO grant application, it is anticipated that the Task 7 summary report of the FRICO study will be complete by the end of December 2009.

Table 6. Project schedule, alternative agricultural water transfers in the South Platte Basin using the FRICO system

	2008		2009											
Tasks	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task 1 - Survey of FRICO Barr and Milton Shareholders														
Task 2 - Survey of M&I Providers														
Task 3 - Shared Water Bank Structure														
Task 4 - Engineering Analysis of Alternative Transfer Mechanics														
Task 5 - Water Administration Challenges														
Task 6 - Legal Analysis - FRICO In-Kind														
Task 7 - Summary Report														

CSU Extension Office

Project summary

The CSU Extension Office is evaluating technical (i.e., economic, biophysical, and management) issues involved in maintaining or improving yields on fallowed lands when they are put back into production after a lease arrangement ends. In addition, this project will provide a logistical analysis regarding the practicability of coordinating these arrangements with a broker (likely the Super Ditch Company), and also canal companies possessing both senior and junior water rights in the Arkansas River Valley.

Leasing water saved from rotational fallowing, interruptible supply agreements, etc. are common vehicles for temporarily transferring water from agriculture to other uses. However, farmers who are unfamiliar with the concept raise key questions about:

- The extent to which this strategy can help sustain farming operations economically.
- The biophysical impacts (e.g., soil quality) on farmland during fallowing, and how these impacts may affect future crop yields.
- The required costs and management associated with bringing land back into production after it has been fallowed.

These questions must be answered to inform irrigators of the lease value of their water rights. Actual and ongoing demonstrations of water transfer will be included with this project and are intended to address the information gap regarding the economic value and practicality of water leasing. In addition, the results of these demonstrations will allow CSU Extension to provide recommendations on land fallowing and returning fallowed land back to production.

Project tasks

The CSU Extension study is divided into five tasks, summarized as follows:

<u>Task 1 – Establishment of demonstration farms</u>
Select two demonstration farms, with one being on the Rocky Ford High Line Canal and the other on Holbrook Canal. Next, section off an 8-acre sub-field at each farm, to be planted to corn according to recommended practices for optimum yields and returns in the Arkansas Valley. The 8-acre sub-fields will be further divided into 2-acre replicates for planting and rotational fallowing.

<u>Task 2 – Fallowed land maintenance practices and benefits</u>
Document the management and associated costs necessary to maintain fallowed fields during Year 1, Year 2, and Year 3. Practices may include preventing weed infestation and protecting soils from excessive erosion. Arrange for water transfers and lease agreements in coordination with Super Ditch Company. Monitor water transfer logistic aspects and associated net value to demonstration farms.

Task 3 – Returning fallowed land to irrigated production
Determine nutrient needs and costs necessary in Year 2, Year 3, and Year 4 to return fallowed lands to levels of production comparable to 2, 3, and 4 years of continuous corn. Measure yields and productivity from fields returned to production in Years 2, 3, and 4 in comparison with fields continuously farmed.

Task 4 – Evaluate soil nitrate and salinity patterns
Determine the effect of fallowing on the movement of nitrates and salts in the soil profile. Soil sample analyses will compare the movement of nitrates, salts and selenium under production corn land and fallowed land to a depth of 24 inches.

Task 5 – Extension outreach programming and education
Provide information on the results from the demonstrations through field days, workshops and published reports. Also, make information from the study available to the public through news releases and on University and related websites. Compile and analyze the results of the study and publish a bulletin containing the information, conclusions and recommendations for proper practices when fallowing land from corn production for 1, 2 or 3 years. It is expected that this project will receive state-wide attention; therefore, a portion of the budget is devoted to developing high-quality materials (e.g., color plots, photo layouts, etc.) to provide outreach via Internet and Podcasting.

Project deliverables

Deliverables expected to be produced during the course of the CSU Extension study are as follows:

- Task 1 – Establishment of long-term demonstration farms in the Arkansas Valley. Signage and visitor stations will be built in order to allow neighboring farmers to gather information on progress.
- Task 2 – Maintenance handbook (or fact sheet) for fallowed land maintenance published through CSU Extension; recorded information and local enterprise budgets for rotational fallowing.
- Task 3 – Update to fact sheets for fallowed land maintenance published through CSU Extension; information on end costs of fallowing to be used in calculating value of water lease arrangement.
- Task 4 – Knowledge of fallowing (e.g., non-irrigation) impacts on soil fitness characteristics; enterprise budgetary effects of fallowing on nutrient requirements for when fields are brought back to production; professional paper or local fact sheet on nutrient management for managing land during water leases.
- Task 5 – Informational events (e.g., field days) at the Arkansas Valley Research Center and throughout the Valley and state; prepare one professional paper for submission to Journal of American Water Resources Association; one presentation on rotational fallowing to a professional society (e.g., American Society of Agricultural Engineers)

Project schedule

The grant application for the CSU Extension project included a tabulated project schedule, shown below in Table 7 ("Table 2" in the title within the table is from the original and cannot be edited here).

Table 7. Milestone schedule for CSU Extension rotational fallowing project

Table 2 (revised). Milestone Schedule for Rotational Fallowing Project	YEAR 1												YEAR 2												YEAR 3												YEAR 4			
	2009												2010												2011												2010			
TASK and OBJECTIVES	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
TASK 1: ***Establishment of Demonstration Farms***	X																																							
Coordination with LAVWCD (water leasing structure)	X																																							
Development of record-keeping system	X																																							
Sectioning and planting (two 12 ac. fields each with 2 ac. replicates)	X																																							
Baseline soil samples (nutrients, salinity)	X																																							
TASK 2: ***Fallowed Land Maintenance Practices and Benefits***	X																																							
Weed removal and spraying	X																																							
Enterprise budgets for maintenance	X																																							
Maintenance and Rot. Fallowing Extension Fact Sheet	X																																							
TASK 3: ***Returning Fallowed Land to Irrigated Production***	X																																							
Planting non-fallowed reps. (Y1 = 4 ac, Y2 = 6 ac, Y3 = 8 ac, Y4 = 12 ac)	X																																							
Harvest non-fallowed reps. (Y1 = 4 ac, Y2 = 6 ac, Y3 = 8 ac, Y4 = 12 ac)	X																																							
Enterprise budgets for re-farming fallowed lands	X																																							
Fact Sheets and Workshops on re-farming fallowed land	X																																							
TASK 4: ***Evaluate Soil Nitrate and Salinity Patterns***	X																																							
Annual soil sampling and testing	X																																							
Cross-field comparisons between fallowed and farmed replicates	X																																							
TASK 5: ***Extension Outreach Programming and Education***	X																																							
Annual field days	X																																							
Rotational Fallowing Workshop	X																																							
Professional Paper (not funded through CWCB)	X																																							
Professional Conference (national level; not funded through CWCB)	X																																							
Annual reporting to CWCB, City of Aurora, and LAVWCD	X																																							
Final Report to CWCB, City of Aurora, and LAVWCD	X																																							

Note that Year 4 should actually be 2012, not 2010 as shown above. Based on this schedule, final project deliverables are not anticipated until the first half of 2012.

High Line Canal Company

Project summary

The Highline Canal Company is conducting a project to explore implementation of various means of alternative water transfer including interruptible water supply agreements, long-term land fallowing, spot market leases (for use during drought), and water banking. Water developed under these methods will be provided to other users via existing irrigation infrastructure or via a proposed pipeline. The project includes engineering studies to determine the amount of water that could be transferred and the location, timing, and volume of historical irrigation return flows that would need to be maintained in order to prevent injury to downstream water users. Water made available will be leased to other water users.

According to High Line Canal Company's scope of work, specific project objectives include the following:

- Establish an entity, to broker leases of water from the Arkansas River to entities that need water.
- Determine the amount of water to be provided.
- Determine how it can be transferred to other locations.
- Determine what improvements in canal structures are needed.
- Determine water quality issues.
- Determine pipeline location.
- Determine if an Augmentation Plan is required.

Project tasks

The project is divided into seven tasks, but the scope of work states that CWCB grant money will be used only to fund Task 1 and Task 5, identified below:

- Task 1 – Establishment of leasing entity.
- Task 5 – Based on a task-specific scope of work prepared by Boyle Engineering (now a part of AECOM Water) and attached to High Line Canal Company's 2008 grant application, "The purpose of this portion of the project is to perform a preliminary analysis for the delivery of water from the Boone area to the Front Range municipal areas. This portion of the project will include the pumping, pipeline, and treatment requirements from the Arkansas River alluvium assuming a new well field will be constructed." This portion of the project is further divided into six subtasks:
    - Project definition/information gathering.
    - Evaluation of water quality.
    - Well field analysis.
    - Conveyance route.
    - Opinion of probable project costs.
    - Report and administrative tasks.

Project deliverables

The High Line Canal Company scope of work presently available is a draft document dated October 1, 2009. The document states that "At completion of the project, the applicant shall provide the CWCB a final report that summarizes the project and documents how the project was completed. This report may contain photographs, summaries of meetings and engineering reports/designs." Task-specific deliverables are as follows:

- Task 1 – Deliverables will be copies of the papers filed for the establishment of the leasing entity.
- Task 5 – According to the 2008 grant application, Boyle/AECOM will prepare a report documenting the findings of Task 5, with each subtask comprising a chapter of the report. Maps of the identified conveyance route(s) will be provided.

No further details are provided regarding project deliverables.
Project schedule

The High Line Canal Company's draft scope of work dated October 1, 2009 includes a project schedule table extending through the fourth quarter of 2012, but no line items are completed in the table.

References

Colorado Corn Growers Association. 2009. Exhibit A – Scope of Work. Development of Practical Alternative Agricultural Water Transfers Measures for Preservation of Colorado Irrigated Agriculture.

Colorado State University Extension Office. 2009. Exhibit A – Scope of Work. The Effect of Land Fallowing and Water Rights Lesing on Corn Yield, Nutrient Needs and Economics in the Lower Arkansas River Valley of Colorado.

Doherty, T., and M. Lindburg. 2009. Colorado's Grant Program to Explore Alternative Agricultural Water Transfer Methods.

Farmers Reservoir & Irrigation Company. 2009. Exhibit A – Scope of Work. Alternative Water Transfers in the South Platte Basin using the FRICO system.

Lower Arkansas Valley Water Conservancy District. 2008. Exhibit A – Scope of Work. Water Leasing – Super Ditch Company.

Parker Water & Sanitation District. 2008. Exhibit A – Scope of Work. Lower South Platte Irrigation Research and Demonstration Project.

Rocky Ford High Line Canal. 2009. Exhibit A – Scope of Work.

Appendix B
Colorado Water Conservation Board
Alternative Agricultural Water Transfer
Current Status of Projects (June 2010)

Appendix B - Current Status of Projects (June 2010)

The sections that follow include brief status reports for each of the grant recipients' projects that are currently underway. Note that while a grant was awarded to the High Line Canal Company in 2008, their project is not yet under contract or in progress. Therefore, High Line Canal Company has no results to present in this memorandum.

Parker Water & Sanitation District/Colorado State University

The Lower South Platte Irrigation Research and Demonstration Project is an ongoing project that has received funding from several different sources. Current findings submitted to CWCB in June 2010 are described by Hansen et al. (2010) as follows:

> This report presents the results of work completed under Parker Water and Sanitation District's Water Supply Reserve Account (WSRA) grant (Contract Routing No. 08 PDA 00071). While this report presents the results from work conducted under the WSRA grant, the Lower South Platte Irrigation Research and Demonstration Project is ongoing under the CWCB's Alternative Agricultural Transfer Methods Grant Program (Contract No. C-150426). Therefore, this report can be considered a final report for the WSRA grant funds and a progress report for the overall project.

Specifically, the progress report includes findings for Phases 1 through 3 of the study. The remaining phases of the study are assumed to be ongoing, with the original schedule in the grant application anticipating delivery of a final project report to CWCB at the end of 2010.

Colorado Corn Growers Association

Documentation of current project findings and conclusions were provided to CWCB in a report titled "*Summary of Selected Findings for Development of Practical Alternative Agricultural Water Transfers Methods*" (CCGA et al. 2010).

The report summarizes the project status as of May 2010 as follows:

- Technical analyses referenced in the application are complete.
- The demonstration project for Lower South Platte Co-op is complete.
- Legal analyses of various alternative methods are complete.
- Barriers to alternative transfers and solutions to those barriers have been considered.
- The economic evaluation tool is complete. The project team is currently in the process of providing training on the economic evaluation tool.
- The guidance manual is under development.
- The remaining demonstration projects are underway.

It is anticipated that the project will be complete by the end of September 2010.

Three demonstration projects have been established to assess the viability of several alternative transfer methods, as follows:

- **DT Ranch (Interruptible Water Supply Agreement) –** As described by CCGA et al. (2010), DT Ranch is an entity owning shares of the Fort Morgan Reservoir and Irrigation Company (FMRIC) that is willing to lease to a municipal or industrial user on an interruptible supply basis. Two alternatives are being evaluated to determine the viability of interruptible supply agreements with end users both within and outside of the FMRIC system.

- **PVIC/WISE Private Water Market (rotational fallowing; reduced consumptive use; purchase and leaseback; interruptible supply) –** The "private market" as conceived for this project incorporates a variety of alternative transfer approaches and would be a "water court approved contractual relationship between one or more municipal and industrial (M&I) users and one or more agricultural suppliers" (CCGA et al. 2010). In such an arrangement, the agricultural user permanently sells a small percentage of shares (e.g., 10 percent, known as Base CU) to the M&I user(s). The remaining volume is referred to as Flex CU and is made available to the M&I users through variable leases (e.g., short-term, long-term, or interruptible).

- **Lower South Platte Co-op (Water Bank) –** Although not technically envisioned as a statutory water bank, the concept for this project is similar. Augmentation plans on the Lower South Platte River often generate excess recharge credits that accrue to the river and leave the state. This alternative transfer proposal would facilitate the exchange of these excess credits to upstream users who are in need of augmentation supplies.

The CCGA et al. (2010) report specifically addressed each item in the issues matrix in the context of each of the three demonstration projects. Full details are provided in that document; key aspects are summarized later in this report, frequently by use of direct excerpts.

Lower Arkansas Valley Water Conservancy District/Super Ditch

The establishment of the Lower Arkansas Valley Super Ditch Company has been an ongoing pursuit since at least mid-2006, when pre-feasibility engineering studies were initiated. The Alternative Agricultural Water Transfer Methods Grant Program funded a portion of the ongoing project work in 2009-2010.

Current findings of Task E were documented in two places:

- Memorandum titled "Key study results" from George Oamek of Honey Creek Resources to Peter Nichols, Super Ditch legal counsel. Dated June 2, 2010.

- Draft Report *A Proposed Method for Incorporating Rural Population-Business Thresholds, or "Tipping Points," in Water Transfer Evaluations.* Honey Creek Resources et al. May 2010.

Current findings of Tasks F and G were documented in a memorandum titled "Alternative Water Transfer Methods – Interim Summary of Findings," from Rachel Pittinger and Steve Price of AECOM to Peter Nichols, dated June 1, 2010.

In addition, a personal e-mail communication from Peter Nichols to Todd Doherty of CWCB, dated June 1, 2010, offers the Super Ditch project team's thoughts on the question "What would it take to make an alternative agricultural transfer program work in Colorado."

These documents were reviewed to determine how the Super Ditch program has addressed the key issues identified in SWSI Phase 2.

Farmers Reservoir & Irrigation Company

The alternative transfers program proposed by FRICO uniquely integrates both agricultural and M&I water supplies. Water would be made available by irrigators through the implementation of various alternative transfer methods. Simultaneously, M&I providers may have surplus water supplies, particularly in wet years. Both sources of water could be deposited in a "shared" water bank, with all deposited water then being made available to project participants on a negotiated basis.

A memorandum submitted by FRICO to CWCB in June 2010 summarizes the current findings of several project tasks:

- Task 1 – Survey of FRICO Barr and Milton shareholders
- Task 2 – Survey of M&I providers
- Task 3 – Shared water bank structure
- Task 4 – Engineering analysis of alternative transfer mechanics

Additional analysis is still underway for these and other tasks outlined in the project grant application. It is anticipated that ongoing work will be completed by the end of 2010, with a final report delivered to CWCB in early 2011.

Colorado State University Extension

Project activities being conducted by the CSU Extension office are focused on quantifying changes in yield, nutrient needs, and profitability that result on irrigated fields when they are brought back into production after various periods of fallowing. The project was designed to represent both interruptible supply and rotational fallowing arrangements. The demonstration sites are managed using practices typical to the region, including residue management for reduction of soil erosion and chemical applications for weed suppression.

The first of 4 years of this study has been completed, and findings to date are summarized in the report "2010 Annual Report to Colorado Water Conservation Board Alternative Agricultural Water Transfer Methods" (Cabot et al. 2010).