Appendix H

Agriculture Conservation Plan

HYDROSPHERE
Resource Consultants

Second Draft

Socorro-Sierra Regional Water Conservation Plan

Prepared for

Socorro-Sierra Regional Water Planning Steering Committee

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1. INTRODUCTION

When developing a regional water plan for an area dominated by arid and semi-arid landscapes such as the Socorro-Sierra planning region, conservation of water should be a major consideration. The planning region, like much of New Mexico, has a very limited water supply. Our state's current water resources increasingly are being impacted by population growth, high costs of water development and treatment, groundwater mining, water pollution, drought, Endangered Species Act and interstate water delivery requirements. We need to be consciously aware of the value of our water resource and use it as wisely as possible. Conserving water means we can extend the water supply for future generations, reduce the risk of water shortages, improve the health of rivers and groundwater, and save tax dollars by avoiding the construction of new water treatment facilities or the development of new water supplies.

Besides these practical considerations, New Mexico law requires that the State Engineer consider water conservation when reviewing water rights applications, and ISC regional water planning guidelines require the consideration of water conservation measures. Water right permits that are issued include a water conservation condition stating that the permittee "shall utilize the highest and best technology available to ensure conservation of water to the maximum extent practical." These requirements also impact regional water planning in that water right transfers will face State Engineer scrutiny with regard to conservation. OSE policy on specific water conservation requirements for water right applicants is still evolving. However, all these considerations underline the importance of water conservation in the development of an overall long-term water plan.

Following a brief summary of the water supply and demand characteristics of the Socorro – Sierra water planning region (Section 1.2), this document will:

- provide concise descriptions and case histories of water conservation measures that have a proven track record for saving water in a wide range of water use sectors and categories (e.g., agriculture, industrial, municipal) (Section 2);
- evaluate their applicability to water systems in the study area, we estimate qualitatively the amount of water that may be saved and at what cost, and identify existing measures in place (Section 3); and
- based on the findings from Sections 2 and 3, identify measures most applicable for the planning region, identify obstacles to their implementation, and discuss actions that can be taken for implementing a conservation program (Section 4).

1.1 Overview of Water Supply and Demand Characteristics for the Socorro-Sierra Region

A regional water plan is designed to address three issues:

(1) what is the supply of water available to a region?

(2) what are historical, current, and expected future demands for water? and

(3) what steps should be taken to ensure that supplies are sufficient to meet expected future demands?

This water conservation plan is one part of addressing question (3).

As described in the Sections 4-7 of the regional water plan, on the one hand the planning region has a finite and relatively fixed supply of water available for development. On the other hand, human population in the region is thriving and existing water supplies will soon be a limiting factor to the healthy development of natural and human communities. As human population grows in the middle Rio Grande Valley, both in the planning region as well as (in fact probably more importantly) in the Albuquerque metropolitan area to the north, there is potential for urban, agricultural, and recreational water users to conflict with each other over water. Add to this mix a high potential for conflict with groups purported to support healthy riparian areas and aquatic habitats of rivers and streams, and it is inevitable that demands on our stretched water resources will only increase.

Faced with high costs of water development and treatment, water conservation in New Mexico is one of the most cost-effective water supply alternatives available to help supplies meet demands. In the Socorro-Sierra, water conservation measures will be particularly important to assist with extending supplies during times of drought.

2. Water Conservation Definition and Measures

In this section, we provide descriptions and case histories of water conservation measures that have a proven track record for saving water in municipalities, rural public systems, and irrigation districts. Given the large proportion of depletions in the planning region that are associated with irrigated agriculture, a particular focus is given to this water use category (section 2.3.1).

2.1. Definition of Water Conservation

The Office of the State Engineer has adopted the following definition of "water conservation:"

> *Water conservation is defined as any action or technology that reduces the amount of water withdrawn from water supply sources, reduces consumptive use, reduces the loss or waste of water,*

> *improves the efficiency of water use, increases recycling and reuse of water, or prevents the pollution of water.*

Water waste may be defined as the indiscriminate, unreasonable, or excessive running or dissipation of potable water; and non-essential water use may be defined as the indiscriminate, or excessive dissipation of potable water which is unproductive, or does not reasonably sustain economic benefits or life forms, where there is a shortage of potable water (NMSEO, 1996).

Before proceeding further, it is important to draw a distinction between water diversions and depletions. *Diversion* refers to that volume of water removed from the environment for beneficial use. *Depletion*, also frequently referred to as *consumptive use*, refers to that portion of diverted water that is entirely consumed. Diverted water that is not depleted is generally returned to the environment where it is available for diversion/depletion by downstream water users; this water is typically referred to as *return flow*. The ratio of depletion to diversion can be referred to as water use efficiency. In the following discussion of water conservation, some of the conservation measures considered lead to reduced diversions (thereby increasing the water use efficiency), and some lead to reduced depletions. While there certainly can be benefits realized from reducing diversions, it is only from reducing depletions that water can be obtained for new uses.

2.2. Examples of water conservation measures

The table below (Table 2.1) lists water conservation measures by water-use category. The information in this table is not exhaustive and attempts solely at illustrating the variety of water conservation options available.

Table 2.1 – Examples of Water Conservation Measures associated with major water use categories

Type/Area of Water Conservation measure	Example(s)
Indoor Plumbing Fixtures / Domestic	Toilets – ultra low volume or ULV - , showerheads, faucets, insulated hot water pipes
Appliances / Domestic	Air conditioners, dishwashers, hot water heaters, washing machines, water softeners
Landscaping / Domestic, Municipal, and Commercial	Xeriscape, landscape design requirements, training landscape maintenance personnel, irrigation with reclaimed water, irrigation in the early morning/evening, water harvesting
Recreational water facilities and other water features / Commercial	Timers on showers at municipal pools
Design and operation of water system / Municipal (publicly supplied)	Pressure reduction, metering, rate structures (water pricing), record-keeping and water audits
Irrigation / Agriculture	Use of pipelines and ditch lining to decrease evaporation and conveyance losses, low water demand crops, irrigation system design criteria (i.e. drip irrigation systems), soil moisture controls, irrigation scheduling based on soil moisture monitoring, conjunctive management of surface and groundwater supplies
Re-use / Municipal (publicly supplied)	Direct re-use – return of highly treated wastewater into the potable drinking water system – indirect re-use – return of highly treated wastewater into the potable water supply – non-potable re-use – return of treated wastewater for non-domestic purposes such as irrigation of landscaping and non-food crops and industrial manufacturing – use of gray water – gardens and golf courses – develop infrastructure/systems for gray water use, retrofit car dealership carwashes to re-use water
Education / Domestic	Public Information Programs and School Education Programs, customer water use audits and water-saving demonstrations
Wastewater Discharge - Treatment Issues / Municipal (publicly supplied)	Reuse of purified effluent, pretreatment requirements, anaerobic treatment for high strength water streams, solvent recovery, waste stream reduction and off-site disposal for high solids and/or contaminant concentration streams, innovative technologies for toxic removal, energy recovery from wastewater discharge.
Other non-domestic conservation practices / Municipal (publicly supplied) and Domestic	Recycle systems in car wash, lower water use vacuum pump seals, laboratory sinks, aspirators and condensors.

Legal solutions are typically required to implement some of the water conservation measures listed above. Such legal measures may include: create ordinances that establish appropriate times for watering lawns; address regulation for water re-use, and revise the domestic well permitting system to prohibit or limit new wells in fragile areas.

The amount of water (and energy) saved through the implementation of the conservation measures presented above depends upon many factors. Existing degree of conservation measures, system's efficiencies, public reception to voluntary conservation measures, budget restrictions, and legal support are only some examples of constraints to the success of conservation goals. For illustrative purposes, below are presented some potential water conservation goals in the domestic sector (Table 2.2). The water conserved in this example would allow for reduced diversions, but generally would not affect depletions.

Table 2.2 - Domestic Uses (Potential water conservation goals)

	Typical Flow	Best Practice	Conservation Goal
Toilets	3.5 – 7.0 gpf	1.6 gpf	1.9-5.4 gpf
Urinals	1.5 – 3.0 gpf	1.0 gpf	1.5-2.0 gpf
Faucets*	2.0 – 4.0 gpm	0.5 gpm	1.5-3.5 gpm
Showers*	3.0 – 5.0 gpm	2.5 gpm	1.5-2.5 gpm

gpf – gallons per flush
gpm – gallons per minute
* Energy savings associated with hotwater conservation – typically 400Btu/gal
Source: Lombardo, 1999.

2.3. Examples of water conservation measures in New Mexico

In this section, we provide examples of water conservation measures implemented in New Mexico by water use category. While we provide a simple listing of possible measures here, it is in Section 3 where we provide a critical evaluation of each of the listed measures.

For completeness, we explicitly address all water use categories defined by the NM Office of the State Engineer. However, given that *agricultural water us*e associated with irrigation comprises by far the largest human depletion to water supplies, our first focus and discussion in this section is on irrigated agriculture. The *publicly supplied water-us*e category is another major water use category in the planning region, and as such it is considered second. The other OSE-defined water use sectors (*livestock, mining, commercial, institutional, industrial, and power generation*), currently exhibit relatively low water use and/or limited opportunities for conservation; we therefore offer only briefly consider these categories below for completeness. Two other water use categories, *open water evaporation* and *riparian vegetation evapotranspiration*, have quite large depletions and as such they may offer opportunities for significant water savings (although the largest component of open water depletion, Elephant Butte reservoir evaporation, is controlled largely by decision makers outside the planning region, i.e. state and federal water managers); these two categories are discussed last.

2.3.1 Irrigated Agriculture

As discussed in Section 6 of the regional water plan, agriculture accounts for more than 90% of the water diversions (averaging approximately 130,000 af/yr), and depletes approximately 70,000 af in the planning region on an annual basis. The sum total of all other depletions in the region attributable to human uses are less than 7,000 af/yr, and these uses are expected to grow at a rate of a few percent per year based on population and demographic projections. Thus, even minor improvements in agricultural water use efficiency or reductions in agricultural depletions can yield huge dividends for the planning region as a whole.

With regard to diversions, water savings in the irrigated agricultural sector could be gained by implementation of one or more of the following measures:

- Flexible water delivery rotations / improved delivery scheduling,
- Water metering on delivery ditch conveyance system and at farm headgates,
- Water metering at farm headgates and irrigation wells,
- Weed and brush control along delivery ditches and laterals,
- Concrete lining and/or pipelining of on-farm ditches,
- Laser-leveling of fields,
- Irrigation scheduling based on crop demand / soil moisture monitoring
- Conversion of land out of agricultural production, permanently or by forebearance,
- Conjunctive management of surface and groundwater supplies,
- Alternative more efficient irrigation water delivery systems, such as drip irrigation and sprinklers, and
- Conjunctive management of surface water and groundwater, including transferring point of diversion for small farms remote from ditches to on-farm groundwater wells.

Reductions in agricultural water depletions may be obtained by implementation of one or more of the following measures:

- Weed and brush control along delivery ditches and laterals,
- Concrete lining and/or pipelining of on-farm ditches,
- Changing to lower-water-use crops,
- Conversion of land out of agricultural production, permanently or by forebearance,
- Improved irrigation water delivery systems, such as drip irrigation and sprinklers, particularly if point of diversion is transferred to groundwater well, and
- Conjunctive management of surface water and groundwater, including transferring point of diversion for small farms remote from ditches to on-farm groundwater wells.

Most of the measures listed above have been adopted in one or more irrigated agricultural districts in New Mexico, and several have been implemented in varying degrees in the planning region. Table 2.3 identifies locations in the state where these measures have been successfully adopted. In Section 3, we evaluate their applicability to water systems in the study area, and we estimate the amount of water that may be saved and at what cost.

Table 2.3 - Examples of Water Conservation Measures Applicable to Irrigated Agriculture in New Mexico.

Water Conservation Measure	Reduces Diversions?	Reduces Depletions?	Location(s) implemented	Applicability to Planning Region
Flexible water delivery rotations / improved delivery scheduling	Yes	No	MRGCD	Yes
Allotment system of water supply allocation	Yes	No	CID, EBID	No
Water metering on ditch conveyance system and farm headgates	Yes	No	CID, EBID	Yes
Weed and brush control along delivery ditches and laterals	Yes	Yes	MRGCD, CID, EBID, La Joya Acequia	Yes
Concrete lining and/or pipelining of on-farm ditches[1]	Yes	Yes	CID, EBID, La Joya Acequeia, MRGCD	Yes
Laser-leveling of fields[1]	Yes	Yes, (Reduces Ponding and evaporation)	MRGCD, CID, EBID, La Joya Acequia	Yes
Conversion of land out of agricultural production, permanent or forebearance	Yes	Yes	PVACD, CID, EBID	No
Alternative irrigation systems, such as drip irrigation and low-head high-efficiency sprinkler	Yes	Yes	MRGCD[2], EBID[2], Mimbres Basin	Yes
Conversion to lower-water-use crops	Yes	Yes	MRGCD	Yes
Conjunctive management of surface and groundwater supplies	Yes	Yes (reduces ditch system losses)	CID, EBID	Yes
Concrete lining or pipelining of irrigation district conveyance ditches	Yes	Yes	CID, EBID, MRGCD, La Joya	Yes
On-farm irrigation water management	Yes	No	CID, EBID, MRGCD, La Joya	Yes

Definitions:
MRGCD, Middle Rio Grande Conservancy District
CID, Carlsbad Irrigation District
EBID, Elephant Butte Irrigation District
PVACD, Pecos Valley Artesian Conservancy District

Footnotes:
1. It must be emphasized that these physical improvements can not provide their maximum water savings potential without good irrigation water management by the farmer, thus the inclusion of the last measure in the table.
2. Alternative irrigation systems have NOT been widely deployed; only tested on a field scale via pilot studies / research projects.

2.3.2 Public Water Utilities and Domestic Water Use

Given the relatively dry environment in the southwestern and intermountain US, most of the nation's most water intensive water-using municipalities can be found in this region. While the cities of Las Vegas (Nevada) and Salt Lake City exhibit the highest per capita water use on all municipalities in the US, the data presented in Table 2.4 illustrate that water conservation measures can be adopted in the dry southwest to significant drive down water use without any apparent adverse effects on their economic development (e.g., Santa Fe, Tucson). Per capita use by the publicly supplied systems in the planning region are also listed in Table 2.4. While the Mutual Domestic (MDWCA) supplied systems tend to have low per capita use because they do not include commercial uses, it is clear that for the two larger municipal systems Socorro and Truth or Consequences there is room for conservation to help stretch water supplies as have municipalities in the southwest with aggressive water conservation programs.

Examples of water utility conservation programs in New Mexico are summarized in the table below (Table 2.5). Relevant information regarding water supply problems and current and potential water conservation measures are included. Most of the water conservation measures cited in Table 2.5 could be implemented in the two major publicly supplied water systems in the planning region (city of Socorro and Truth or Consequences). In Section 3, we take a hard look at the applicability of the various measures to the Socorro-Sierra region, and estimate the amount of water savings that could be realized from their implementation.

Table 2.5 – Per capita water use in publically-supplied water systems in the southwestern and intermountain western US, together with per capita use estimates by publicly supplied systems in the planning region (planning region data is *italicized*).

Publicly Supplied System	***Current Estimated Per Capita Water Use (gallons per capita per day, or gpcd)***
Alamo Reservation, NM	*56*
Santa Barbara, CA	90
Tucson, AZ	100
Santa Fe, NM	120
El Paso, TX	136
Grand Junction, CO	190
Socorro, NM	*203*
Truth or Consequences, NM	*219*
Albuquerque, NM	220
Salt Lake City	290
Las Vegas, NV	310

Table 2.5 - Examples of Water Utility Conservation Programs in New Mexico

City (Population)	Water Source	Water Supply Issues	Current Water Conservation Measures	Future Water Conservation Measures
Rio Rancho (54,000)	Groundwater	• High population growth rate (54% between 1990 and 1999) • 25% of residences are new homes and comply with federal standards for low-flow toilets, showerheads and faucets (i.e. 75% don't comply) • Groundwater mining and land subsidence • Water rights applications pending	• Water conservation program launched in 1998 • High water rates provide cost incentives • Promotion of efficient irrigation (Water Wise Landscaping Contest; Demonstration garden exhibiting irrigation systems, mulches and drought-tolerant plants) • Toilet Rebate Program: replacement of high-flow toilets with 1.6-gallon-per-flush toilets • Promotion of water conservation programs during community events • "Every Drop Counts" water education kits for 7th-grade students	• Marketing/education campaign • Development of a water conservation ordinance by an advisory group comprised of representatives from industry, local landscaping companies, developers, community leaders and other stakeholders concerned about water use.
Las Vegas, NM (18,000)	Gallinas River and leased water from Storrie Lake	• Drought • Competition with upstream irrigators • Annual population growth rate of 2% • Impacts of a forest fire on Las Vegas' watershed • Long history of water use restrictions	• Water conservation ordinance • Educational campaign • Aggressive attitude towards finding and fixing leaks	• Toilet exchange program or toilet rebate program
Roswell (50,000)	Artesian Basin	• Past water conservation measures in the agriculture sector, responsible for using between 90 and 95% of water, reduce need for water conservation	• Public service announcements • Use of building and plumbing inspectors to suggest the use of water efficient landscape plants and the use of low-flow devices	• In the event of a serious water shortage, the City of Roswell would apply its water rationing ordinance

Table 2.5 - Examples of Water Utility Conservation Programs in New Mexico (continuation)

City (Population)	Water Source	Water Supply Issues	Current Water Conservation Measures	Future Water Conservation Measures
Albuquerque (480,000)	Middle Rio Grande Aquifer	• High population growth • Dry weather conditions • Groundwater mining and land subsidence	• Water Conservation program was initiated in the early 1990s • Water Conservation Landscaping and Water Waste Ordinance • 1999 Water Watch program provides information about weather conditions and watering needs. • Marketing and public information • Informative internet site • Changes in bill format to accommodate for information about water savings and conservation tips or announcements. • "Every Drop Counts" water education kits for students • Toilet, xeriscaping, and clothes washer rebate, and audit/retrofit incentive programs (a) • Newsletters, mailings, seminars, toilet rebates, and free water use audits for nonresidential customers	• Collection of wastewater from industry to supply process water to neighboring industries and irrigation water for the Balloon Fiesta Field and city parks • Treatment of municipal wastewater effluent and delivery to the golf course at the University of New Mexico and Public Service Company of New Mexico generation facility for irrigation • Injection of excess treated water into the aquifer and pumping of that water during droughts or to meet peak demands in the summer • Construction of the San Juan-Chama River Project to deliver water from southwestern Colorado to the Rio Grande Basin
Alamogordo (30,000)	Surface (74%) and wells (26%)	• Most of water supply relies on springs that are very vulnerable to changes in rainfall and snowfall	• Improvement of delivery structures • Covering and lining of two raw storage reservoirs with plastic to prevent evaporation and percolation • Irrigation of city parks and baseball fields with effluent water • 1995 Mandatory water conservation ordinance • Promotion of water conservation through the "Keep Alamogordo Beautiful" campaign • Free xeriscape seminars, xeriscape demonstration garden	• Covering and lining of third raw storage reservoir • Aquifer storage and recovery

Table 2.5 - Examples of Water Utility Conservation Programs in New Mexico (continuation)

City (Population)	Water Source	Water Supply Issues	Current Water Conservation Measures	Future Water Conservation Measures
Las Cruces (83,000)	Mesilla Bolson Aquifer	• Absence of an unique person to coordinate the city's water conservation program • Population growth	• 1996 Water Conservation Ordinance • Inclining block rate structure • Public information and education • Free water audit survey kits • Xeriscaping of municipal buildings, xeriscape demonstration garden and xeriscape brochures	•
Santa Fe (70,000)	Santa Fe River (40%) and wells (60%)	• dry conditions, especially 1996 and 2000 • Important tourist destination • High population growth rate • Groundwater mining and land subsidence • Surface water supply vulnerable to droughts	• 1997 City of Santa Fe Water Conservation Ordinance, which includes: toilets, showerheads and faucets retrofitting, landscape watering restrictions, fugitive water and water waste prohibitions. • Water conservation tips and ordinance information offered through the website and in billing insets • Public xeriscape demonstration gardens, free xeriscape advice, and xeriscape/irrigation efficiency training workshops • Free audits for residential costumers • Water conservation education in schools • Rate structure provides cost incentive to conserve • Reuse of effluent on golf courses and parks • Artificial turf	• Development and implementation of a 40-year water management plan that includes: - Continuing (and possibly expanding) the reclaimed water program to include irrigating landscaping with treated effluent -

Table 2.5 - Examples of Water Utility Conservation Programs in New Mexico (continuation)

City (Population)	Water Source	Water Supply Issues	Current Water Conservation Measures	Future Water Conservation Measures
Gallup (21,000)	Gallup Sandstone and Dakota West Water Formation Aquifers	• Because of extremely dry conditions (Gallup sits on a high desert plateau), many people do not attempt to grow lawns, and the municipal water use is relatively low • Important tourist destination • High population growth rate	• 1983 Conservation and water waste ordinances • Early 1990s Utility's inclining rate structure • Public education • "Water Hot Line" in the City of Gallup to report excess water use in the community • 2000 commercial ordinance to ban single-pass cooling systems in new or retrofitted establishments • Reuse of sewage effluent to irrigate a golf course and two sports facilities. • Delivery of nonpotable water to irrigate systems on medians and landscapes in 25 locations.	• Aquifer storage and recovery in the city's wastewater treatment plant • Improvement of municipal wastewater system by increasing treatment and hydraulic capacity • Improvement of residential irrigation conservation • Promotion of conservation by emphasizing that it reduces the money required for wastewater treatment, and implementation of a more formal and comprehensive program

(a) The Conservation Current Newsletter (Spring 2001) reports the conversion of 35,472 high-water-use toilets to water-saving 1.6 gallon-toilets, conversion of 1,231 high-water-use clothes washers to water-saving models, conversion 711 traditional landscapes to xeriscapes, and performance of 18,562 home water audits.

2.3.3 Commercial, Institutional, Industrial, Power Generation, and Mining Users

Currently, aside from New Mexico Tech, water use in the Commercial, Industrial, and the Mining industries is quite limited in the planning region (Hydrosphere, 2000). Examples of existing and future water conservation measures and quantification of water savings in the commercial, institutional, and industrial sectors were found in the publicly available literatures. Many of those examples are described in detail below. Given the relatively high water use associated with New Mexico Tech, the actions taken at University of New Mexico (first item below) may be particularly helpful in identifying conservation opportunities at NM Tech.

- The University of New Mexico (Albuquerque) implemented a series of water conservation measures that resulted in 39% water savings in 5 years (1994 to 1998). Over-seeding of Kentucky bluegrass turf with fescue reduced water use by 10%. Preparation of high-granular soils with an Agri-soak type of material that retains moisture helped reduce water percolation. The installation of a central, computerized irrigation system has also a high water conservation potential that will be maximized once the entire campus' landscape is converted to computer controls. The installation of gravel borders adjacent to parking areas has contributed to the reduction of runoff into streets and parking lots. The university also partially converted landscape to xeriscaping and plans to build a xeriscape demonstration garden for public education. Important water use reductions were achiever at the university's golf courses through modifications in the irrigation system and application of fertilizers that promote root growth and therefore require less water. Future projects (chill water system for cooling, low-flow faucets and toilets) will contribute to further reductions in the water use at the university.
- The Presbyterian Healthcare Services, located in Albuquerque, is the 3rd largest water user (private sector) in the Albuquerque area. Since 1995, implemented conservation actions that allow a reduction of water use by 30%, as suggested by the city of Albuquerque. Water conservation measures included: installation of timers on the medical vacuum pumps (savings of 1.4 MG per year); installation of new medical vacuum pumps (savings of 1.8 MG per year); shutting down x-ray developers at night (savings of 1.8 MG per year); installation of condensate return pumps to reuse water (savings of 0.5 MG per year); replacing 130 high-water-using toilets with low-flow models (savings of 3.2 MG per year); installation of pressure-reducing valves; and in-house water conservation education program to PHS employees.
- Intel, the largest private employer in the Albuquerque metropolitan area (Rio Rancho), has reduced its water consumption by 61.4% between 1993 and 1998. Reduction of Intel's manufacturing water use was achieved through the increase of the system's efficiency, optimization of production processes, and by the reuse of outgoing water in cooling systems.
- Sandia National Laboratories, (Albuquerque) has reduced its water use by 19% between 1995 and 1998 and expects to achieve a 30% water conservation goal by 2004. Several water conservation measures were applied, with an emphasis on the most water-consumptive operations: production of ultra pure water used in the microelectronics

facility and the water used for cooling and steam generation. Existing and future water conservation measures included:

- o more efficient larger-surface-area reverse osmosis membranes and better valves were installed, and improvements were made to the reverse osmosis pump. The total cost of the investment in these conservation measures ($107,113) was recovered in less than one year, and resulted in water use reduction by 30-38 million gallons a year (annual savings of $78,000) and energy annual savings of $22,000.
- o reuse and recycle of wastewater, which costs $35,000 and will be paid back in 3.5 years, will save 8-12 million gallons of water and $20,000 per year.
- o Reduction of water consumption at the steam plant by 15 to 25 million gallons a year and reduction of wastewater by 11.5 million gallons a year, saving $100,000a year.
- o Other water saving measures that contributed or will contribute to the reduction of energy and chemical costs: replacement of aging dealkylizer and improvement of synthetic resin (savings of 1.2 million gallons a year), leaks repaired in the condensate return lines (12 million gallons a year of water savings), reduced frequency of boiler blowdown (savings of 2.7 million gallons a year), recycling cooling water (6 to 10 million gallons a year of water savings), cooling towers (savings of $10,000 a year in energy costs), and water savings through water conservation in the domestic water use at the plant (a Transit Time flow meter will be used to identify possible sources of waste and leaks).

- Tuscarora Inc. (Las Cruces), one of the largest manufacturers of custom molded foam packaging, has reduced its water use by 12.4% between 1994 and 1998. These water savings resulted from discontinuing the production of high water consuming products (expanded polypropylene), and several water conservation measures, including recycling of cooling water, installation of a reverse osmosis unit and wastewater metering.

- Honeywell (Albuquerque), a worldwide producer of heaters, fans, humidifiers, vaporizers, electronic air cleaners, water filtration products, thermostats, and home security systems, reduced its water use by 62% in 1995 by eliminating the need for process water as a result of requiring the circuit board manufacturer to supply cleaner boards, by changing the type of flux used, and by improving its soldering process. Additional water savings (50%) between 1994 and 1998 led to a total water use reduction of 82% and resulted from the installation of low-flow toilets, installation of more water-efficient temperature and humidity control system, and several landscaping alterations: reduced the landscaped area, redesigned the irrigation system, and installed an electronic rain sensor and timer.

- Water savings at Los Alamos National Laboratories (Los Alamos) reached 7% between 1994 and 1997, representing savings of about 36.55 million gallons per year. Despite considerable water savings as result of several water conservation measures, the increased demand for cooling as new products come on line results in increased water demands along the years. About 20 million gallons a year were saved by reusing treated sanitary wastewater in the power plant cooling towers. Planned or underway water saving projects include the cooling tower water efficiency project, the leakage repair project, and low-flow domestic fixtures.

- Ethicon Endo-Surgery (Albuquerque), a Johnson & Johnson company, implemented various water conservation measures that resulted in water savings of about 49% between 1991 and 1998. Removal of grass around parking areas, installation of drought-tolerant plants and native grasses among other measures resulted in water savings of 81% (representing about 26 million gallons a year of savings). Reuse of cooling water, recovery of condensate, optimization of blend of scale and corrosion inhibitors and system metering (to detect leaks) were the main water and energy conservation measures implemented in the facility's plant. Finally, faucets with infrared sensors for automatic on-off control were installed for the 900 employees, thus generating important water savings as well.
- Border Foods (Deming), one of the largest processors of green chiles and jalapeno peppers in the world, has reduced its process water use by 27% between 1992 and 1995. This was achieved through the recycling of water in two stages of the production line (recycling of the pepper's wash water is not allowed by law). In addition, Border also reuses the cooling water after treatment, and recycles 47 million gallons of wastewater each year, using it to irrigate its nearby 100 acres of alfalfa and grass farms.
- Ponderosa Products (Albuquerque), a wood recycling facility, implemented a series of measures to conserve water use in its facility. Those measures included capture and reuse of steam condensate from the boilers, reuse of water in the scrubbers, and the replacement of a web scrubber with a baghouse (which doesn't use water). The total water savings resulting from these conservation efforts achieved 57% between 1989 and 1998.
- The Summer 2001 Conservation Current Newsletter reports that a Santa Fe plant nursery (Santa Fe Greenhouses), known for xeric and water-wise plants, plans to collect and reuse approximately 370,000 gallons of water per year and cut onsite water use by 20%. These savings will result from the installation of a state-of-the-art rainwater collection and reuse system. This system collects rainwater from 38,000 sq feet of greenhouse and coldframe roof area and diverts it to a 36,000-gallon underground cistern. The water stored is then pumped to irrigate plants in newly constructed coldframes.
- Water conservation measures implemented in the potash producing cycle at Mississippi Potash (Carlsbad), resulted in water savings of about 52%. Those savings are a result of the use of recycled water in the wash down process, air pollution control equipment and wet scrubbers. Also, the plant achieved reduction in water use through the installation of low-flow toilets.
- El Rey Inn (Santa Fe) followed the City of Santa Fe's Water Conservation Ordinance that requires that a water conservation sign be posted in every public restroom and, together with the installation of 1.5 gallon-per-minute showerheads and low-flow toilets, was able to save 16% of water use between 1995 and 1997.
- Marriot Hotel (Albuquerque) water savings of 36.5% between 1994 and 1998 resulted from water conservation measures such as: monitoring and repairing the irrigation systems; replacement of high-water-use plants with drought-tolerant varieties; conversion of sprinkler systems to drip irrigation; use of efficiency timing tests to determine optimal watering times; installation of water-displacement devices in the existing toilets and installation of new, more efficient aerators; re-circulation of water in the ice machines;

installation of more efficient washers; and reuse of swimming pool water after major maintenance operations. Other conservation measures are planned, including recycling laundry gray water, which is expected to save approximately 230,000 gallons a year.

- La Vida Llena, one of Albuquerque's largest retirement communities, has saved 83% of its water use between 1994 and 1998, mainly through the elimination of water leaks. Partial conversion of landscaping to xeriscaping, installation of new sprinklers, adjustment of watering times, more efficient management of cooling towers, installation of low-flow toilets and showerheads, and water conservation education through the in-house TV station are examples of other water conservation measures that contributed to reduction of water use at La Vida Llena.
- Water savings in the condominiums at Hillcrest Park (Albuquerque) reached 31% between 1994 and 1998 as a result of a 10-year plan to improve the property while saving water and energy. Water conservation measures included: installation of low-flow showerheads; installation of ultra-low-flow toilets, through the City of Albuquerque's rebate program; landscape modifications such as replacement of blue-grass with bark, rocks, trees, and drought-tolerant grass, modification of the irrigation system, and replacement of sprinklers with water-efficient bubblers and misters; and changes in the swimming pool maintenance and equipment, which included the installation of efficient skimmer, pump, and filter system.
- The Deming Energy Facility (Deming) under construction by Duke Energy North America[1] will features combined-cycle, natural gas technology, which is environmentally superior and much more efficient than the technology used in older plants. It is called a combined-cycle facility because it will use two natural gas turbines and one steam turbine to produce electricity, with the steam turbine utilizes the exhaust heat from the gas turbines to produce additional power. This recycling process makes the plant more efficient and helps to conserve valuable resources. To save water more power generation facilities in the USA are installing and relying on air-cooled steam condensers, a decision often driven by water supply restrictions or circulating water discharge restraints. Air-cooled condensers (ACCs) have the following advantages: (i) minimization of water make-up requirements; (ii) elimination of cooling tower blowdown disposal issues; (iii) elimination of tower vapour plume; and (iv) elimination of circulating water pollution restrictions. The traditional once-through cooling method is more fuel efficient, but uses enormous amounts of water. In addition, drought conditions or the danger of drought conditions have generated local, regional, and state regulations encouraging water conservation in power plants, including a bill introduced in the 2003 session of the New Mexico legislature.

2.3.4 Livestock Water Use

Two broad categories of livestock water use occur in the planning region, water use by: (1) livestock grazing on the open range, and (2) livestock in confined conditions. The second category, confined livestock watering, can be broken down into livestock confined on

[1] Construction on the project began in October 2001, but construction activities were indefinitely suspended in October 2002 due to current market conditions for electricity in the western US.

individual properties for private use and small-scale commercial production, and concentrated animal feeding operations (CAFOs). For both rangeland livestock grazing and confined livestock on individual and small-scale commercial properties, livestock water is supplied in a relatively conservative fashion such as with float valves on a stock tank or earthen tanks that capture surface runoff, and there are thus relatively limited water savings that can be achieved for these type of livestock operations. Thus the primary water conservation opportunities are associated with CAFOs.

Table 2.6 shows typical per capita water use rates for various livestock species (Wilson and Lucero, 1997; Texas A&M University, 2000). The much higher water use for Dairy Cattle compared to Beef Cattle relates to both the more intensive water needs for heifers producing milk, and more importantly to the water used in processing operations on the dairy. A milking dairy heifer typically consumes on the order of 25 gpd, and the remaining 25 to 75 gpd listed in Table 2.6 goes toward wash down, waste management, and processing operations. In particular, waste management procedures employed in CAFOs can used huge volumes of water. Otherwise, it should be recognized that the demands listed in Table 2.6 apply to depletions. Thus, any water savings opportunities would require either: reducing diversions to increase efficiency, or cutting livestock populations to reduce depletions.

Table 2.6. Typical per capita water demand by various livestock species (gallons/animal/day).

Livestock Species	***Typical Per Capita Use (gpd)***
Beef Cattle	10 – 15
Dairy Cattle	50 - 100
Hogs	3 – 5
Horses	13 – 20
Sheep	2 – 3
Chickens	0.08 – 0.12

CAFOs are defined by the EPA as livestock operations confining and feeding:

- Cattle: 300 to 999 head, in a dairy or feedlot, if waste water discharges into a "navigable water of the state," or 1,000 or more head of cattle otherwise.
- Swine: 750 to 2,499 head of pork weighing 55 pouinds or more, if waste water discharges into a "navigable water of the state," or 2,500 or more head of swine otherwise.
- Sheep: 3,000 to 9,999 head of sheep if waste water discharges into a "navigable water of the state," or 10,000 or more head of sheep otherwise.
- Poultry: 15,000 to 149,999 head of chicken, if waste water discharges into a "navigable water of the state," or 150,000 or more chicken otherwise.

In the planning region, by these definitions, there are estimated to be 12 CAFOs, with eight of them being dairies. These operations are widely recognized by state and federal environmental regulatory agencies as significant potential sources of surface and groundwater contamination. As described above, the largest water use in any CAFO is in the animal waste management operation. Water is generally used to help convey animal wastes from feeding and processing areas to on-site wastewater treatment ponds and lagoons. A practice that manages waste on confinement areas and on cropland where wastes are ultimately deposited and utilized with the intent of maintaining surface and groundwater quality at acceptable levels is considered a Best Management Practice (BMP). A BMP is the most effective way to prevent or reduce pollution generated by CAFOs. Because of unique site characteristics in conjunction with CAFO operation management, each site will possess unique BMPs.

Conservation measures that can be adopted by CAFOs have been identified and investigated by the USDA, EPA, as well as state regulatory agencies (e.g., Idaho Dept. of Environmental Quality, 1993). Again, since animal waste management potentially generates huge volumes of waste water, any practice that helps to minimize waste water volumes and isolate wastes from the natural hydrosphere can be considered a BMP. There are two primary components to reducing wastewater volumes: minimizing the volume of water used in animal waste management, and preventing clean water that intercepts the site (e.g., precipitation) from becoming contaminated by animal wastes (and thus becoming part of the wastewater stream). Both of these actions are generally employed by Socorro county dairies (see below). Possible conservation measures on a CAFO include:

- Reducing water use for cooling, cleaning, flushing, and washing animals;
- Reuse and recycling of wastewater for flushing manure from barns and feeding/milking parlors;
- Maintain clean, dry bedding for animals (cleaner animals have reduced washwater volume requirements);
- Installing timers on any automatics wash-down equipment;
- Diversion of "clean" roof and ground runoff from areas contaminated by animal wastes; and
- Maximizing the opportunities for the animals to feed directly in open fields and pastures (e.g., grass-based dairies and free-range pastured poultry operations)

Based on studies by NRCS personnel in the planning region (Reasner, personal communication, May 2003), the dairies in Socorro county have an average per capita water use of roughly 35 gpcd. In other words, these dairies use only approximately 10 gpcd in the processing and waste management operations, much less than 1/3 of what is typical for dairies. These estimates were developed by the NRCS Socorro District Conservationist, who currently is working closely with several dairies in the region and monitoring their actual water use. Based on his investigation, there is very little opportunity for further reductions in water use. These exceptionally low water use rates by dairies in the planning region are due to two simple facts, and both of them relate to costs:

- due to the high cost of water, water rights in the region sell for between $4,000 and $5,000 per af, which is quite high compared to many milk producing regions in the country, including in the lower Pecos Basin in southeast New Mexico, and
- almost all wastewater generated by these dairies is treated by evaporation (as opposed to land spreading disposal); evaporation lagoons cost approximately $20,000 - $25,000 per surface acre, at the current use rate of 10 gpcd for processing and waste management operations this equates to approximately 1 surface acre / 400-500 head of dairy cattle. If

the local dairies generated wastewater volumes more typical of other regions, their waste disposal costs would increase roughly 2 to 4 fold.

2.3.5 Open Water Evaporation and Riparian-Vegetation Water Use

Open water evaporation (EVAP) includes evaporation from man-made and natural channels, and man made and natural reservoirs. It does not, however, include ephemeral channels, and current OSE estimates do it include reservoirs with a storage capacity less than 5,000 acre-feet. As discussed in Section 6, estimates for reservoir evaporation for the planning region indicate very large depletions, comprised mostly of Elephant Butte Reservoir and Caballo Reservoir evaporation in Sierra County. Evaporation off of Elephant Butte reservoir is computed using pan evaporation rates, times a lake depth correction factor, times reservoir surface water area. This evaporation has exhibited large variability over the years, primarily due to large changes in reservoir surface water area as lake levels rise and fall. Thus one major conservation opportunity associated with Open Water Evaporation is by attempting to maintain lower lake levels in Elephant Butte (constrained by / balanced against minimum pools to provide for lake recreation).

Riparian evapotranspiration (RPET) is comprised of water consumed by riverine (non-agricultural) plant communities in the vicinity of surface water features and areas with very shallow water tables. Table 2.7 presents RPET estimates for the planning region. We employed the RPET results presented by SSPA (2003), updated from values provided in their Middle Rio Grande Water Supply Study (MRG WSS). These RPET estimates include direct evaporation from the Rio Grande floodway channel, as well as from canals and drains that make up the MRGCD irrigation system.

Table 2.7: Riparian acreage and consumptive use by planning region (MRG and Socorro-Sierra planning regions).

Reach	Riparian Acreage (acres)	Total riparian acreage in planning region	Riparian CU (af/y) from ET Toolbox Jan 2003	Total Riparian CU by planning region (af/y)
Northern Socorro County Line to Bernardo*	4,719	46,951	18,215	184,690
Bernardo to Elephant Butte Reservoir	42,232		166,475	
Elephant Butte Res. To Southern Sierra County Line	NA		NA	

* Consumptive Use based on ET Toolbox Jan 2003 CU per acre of 3.86 acre-feet for Reach 4.
NA - Data not included in SSPA study

Recent research indicates that the non-native plant salt cedar (tamarisk) consumes water at a rate of approximately 4 acre-feet per acre of monotypic salt cedar stand, which is typically characterized by a stand density on the order of 1,000 to 2,000 tree per acre. On the other hand, native cottonwood - willow forest (with stand densities on the order of a few hundred trees per acre) consumes water at a rate closer to 3 ft/ac. Thus there is potential to save on the order of 1 af/ac if salt cedar stands were replaced with native cottonwood – willow – salt grass vegetation.

We take a closer look at the magnitude of potential water savings from EVAP and RPET in section 3.5 and in Section 8 of the regional water plan.

2.4 Water Conservation Funding Programs in New Mexico

Similarly to other western states, New Mexico has grant and loan programs that promote water conservation. The table below (Table 2.7) summarizes some water conservation programs, indicating, where available, examples of measures implemented and resulting water savings. Federal initiatives that address water conservation are also included. In many cases, it is the local Soil & Water Conservation Districts teamed with local NRCS staff that provide the knowledge and human resources to access the programs listed in Table 2.7

In addition to these existing programs listed in Table 2.8, one potentially germane approach toward funding irrigated agricultural system conservation measures (both off-farm diversion, conveyance, and delivery system, as well as on-farm improvements) can be found in the collaborative relationship between the urban San Diego County Water Authority and the Imperial Irrigation District in southern California. Under the proposed Quantification Settlement Agreement, over $100 million in irrigation system improvements would be paid for by the municipal water district in exchange for municipal acquisition of the water salvaged from the agricultural system improvements (e.g., see article at http://www.iid.com/pressbox/press.read.php3?which=386).

These programs represent potential funding opportunities to help in the implementation of the measures discussed in general above, and the most relevant targeted measures identified and discussed in Section 3 below.

Table 2.8 – Examples of Water Conservation Funding Programs

NEW MEXICO PROGRAMS		
Entity (Fund)	**Loan/Grant Program**	**Examples**
Interstate Stream Commission/State Engineer Office (Irrigation Works Construction Fund); administered locally by the SWCDs	Loan Program to community ditches; irrigation works loan program (cooperative arrangement with Soil & Water Conservation Districts)	Lining ditches, meter installation, drilling and equipping wells, installing sprinkler and drip irrigation systems, repairing headgate diversions, and irrigation scheduling improvements.
	Corps of Engineers/IWCF Grant Program to Acequias (Grant/cost share program for ditch rehabilitation)	Concrete ditch lining, headgate repair, construction of diversion structures and wasteways, and irrigation scheduling.
	Ditch Rehabilitation Grant Program (Flood damage grant/cost share program for ditch rehabilitation)	Repair of headgate diversion structures, repair or leaky ditches, improvement of efficiency of irrigation systems, rehabilitation work and repair of flood-damaged irrigation systems.
	Phreatophyte Control in the Pecos and Rio Grande Basins	Clearing salt cedars (Note: the results of studies conducted in the lower Pecos Basin in the 1970s and 1980s indicate that this is not a cost-effective method of increasing discharge in the Pecos River. Nonetheless, in 2002 the state legislature funded a large herbicide-spraying program for salt cedar eradication, and this is ongoing)
NMSU Cooperative Extension Service (NM Department of Agriculture, WRRI, county governments)	Technical and Educational Assistance	Workshops, demonstrations, field visits, consultations and educational programs in water conservation, including water quality and irrigation improvement, and irrigation scheduling; Demonstration and research projects for water conservation: drip irrigation systems for vineyards and lawn irrigation conservation methods.
Soil & Water Conservation Districts (SWCD)	Water conservation programs, local administration of ISC Irrigation Works Loan Program; Cost Share Programs, Salt Cedar Eradication Projects, Watershed Health Projects	Water conservation measures include land leveling, ditch lining, irrigation water management, and water quality improvements; Demonstration of soil and water conservation practices, tree planting and groundwater pollution prevention; Watershed improvements via brush and woody species control.
Environment Department Programs	Community Water System Protection (Wellhead protection program)	Community water systems pay a fee per unit of water use for water quality testing and a "contamination vulnerability" analysis.
	Nonpoint Source Pollution Control Program	Reduction of sedimentation in water courses and reservoirs and control of inflow of other pollutants from diffuse land use activities. Water conservation benefits include reduced flood peaks, higher baseflows during low flow periods, and increased reservoir capacities through reduction of erosion and sedimentation.
Energy, Minerals and Natural Resources Department	Conservation Planting Fund	Installation of watering systems (drip irrigation), planting of low-water using trees.
	Re-Leaf Program	Trees, mulching, wetland rehab, slope stabilization and water-saving irrigation systems.
	Energy Conservation Program	Water conservation through energy conservation practices.

Table 2.8 – Examples of Water Conservation Funding Programs (Continuation)

FEDERAL PROGRAMS		
Entity (Fund)	**Loan/Grant Program**	**Examples**
Natural Resource Conservation Service (NRCS)	EQIP, Environmental Quality Incentives Program; NRCS Agricultural Conservation Program (cooperative arrangement with Soil & Water Conservation Districts)	Water conservation measures include land leveling, ditch lining, irrigation water management, and water quality improvements.
USDA/NRCS	Conservation Incentives Program	Part of 2002 Farm Bill, details of implementation and rules still being developed
Army Corps of Engineers	Acequia Restoration Program (cooperative arrangement with ISC)	Repair of diversion dams and headwork, ditch lining.
New Mexico Environment Department (NMED)	Small Watershed Projects; EPA 319 Program	Improvement in water use efficiency, recharge of groundwater reservoirs, watershed rehabilitation and management.
Local Resource Conservation and Development Councils	Resource Conservation and Development	Water conservation schemes to reduce ditch leakage, improve water quality and schedule irrigation for improved efficiency.
U.S. Bureau of Reclamation	Water Conservation Demonstration Project Fund	Water conserving demonstration gardens, school education projects on water conservation, and community education programs.

- several of the programs listed above are administered locally and/or facilitated by the local Soil & Water Conservation Districts and NRCS offices

Sources: Fleming and Hall, 1996; Socorro Soil & Water Conservation District website (www.socorroswcd.org); NRCS website (www/nrcs.usda.gov/programs)

3. APPLICABILITY OF CONSERVATION MEASURES TO PLANNING REGION, ESTIMATED WATER SAVINGS, AND EXISTING CONSERVATION MEASURES

In this section, we evaluate their applicability of the conservation measures discussed in Section 2 to water systems in the study area, and we estimate the range of water savings that may be possible and at what cost. To build on the information provided above, we further analyze the water conservation measures identified in Section 2.3 that are applicable to the planning region, provide water savings estimates, and show the expected costs associated with implementing each measure. Again, we organize the discussion based on water-use categories.

3.1. Water Conservation Opportunities for in Irrigated Agriculture

As discussed in Section 2.3.1, irrigated agriculture is the human water-use category associated with the largest diversions and depletions in the planning region, by far. We previously identified a broad suite of possible water conservation measures related to agriculture (Table 2.3), and here we consider the applicability and feasibility of each measure, and estimate potential water savings and costs associated with the measures.

Many of the measures identified and discussed in Section 2.3.1 have already been implemented in the irrigated lands in the planning region that are supplied by Elephant Butte Irrigation District (EBID). In fact, as described in the "EBID Factbook" (see http://www.ebid-nm.org//static/PDF/EBIDBOOK-1.pdf; see also EBIDBOOK-2 and EBIDBOOK-3), as a result of these accomplishments, EBID received the Distinguished Water Conservation Award for outstanding water conservation achievement from the Bureau of Reclamation in1998. There are only 10 such awards given each year across the nation. Some of the EBID conservation measures include (1) replacement of older irrigation facilities, (2) canal and drain cleaning and restoration, (3) reduction of seepage losses through concrete lining of piping of earthen canals, (4) reduction of delivery time of water through replacement of older check structures and the replacement of undersized turnouts with high-flow turnouts, (5) the implementation of computerized data acquisition and dissemination of information, (6) ongoing training of personnel, and (7) the ongoing and future research and development of water conservation overall. Agricultural lands in the region within EBID, however, account for only roughly 10% of approximately 30,000 irrigated acres in the planning region.

In addition to the approximately 2,970 acres within EBID, estimates of irrigated acreage in the planning region include:

- 23,763 acres in Socorro county irrigated via the MRGCD and La Joya Acequia surface water diversion and conveyance systems (including Bosque del Apache Refuge),
- 2,418 acres irrigated by surface water diversions for five incorporated ditch associations in Sierra county,
- 200 acres irrigated by miscellaneous surface diversions in Sierra county, and

- 2,700 acres irrigated by miscellaneous groundwater diversions in Sierra county.

These acreage estimates were developed based on data and information provided by the NM OSE (Wilson, 2003), MRGCD (Dave Gensler and Doug Stretch, MRGCD staff, personal communication), Socorro NRCS staff (Darrel Reasner, District Conservationist, personal communication), Sierra NRCS staff (Gene Adkins, District Conservationist, personal communication), and personal communications with representatives of the 5 ditch associations in Sierra county.

Based on interviews with Sierra NRCS staff and ditch association representatives, agricultural production on lands supplied by the ditch associations is characterized by generally deficient water supplies relative to amount of irrigated acreage. Thus any water savings that can be achieved through conservation should help firm up system supplies.

3.1.1 Feasibility, Water Savings, and Costs of Conservation Measures

Our findings related to the feasibility, expected water savings, and estimated costs for implementing the conservation options discussed in Section 2.3.1 are summarized in Tables 3.1 and 3.2. The values presented for water savings and costs in Socorro county (Table 3.1) was developed based on information from publicly available literature and recent hydrological calculations, as well as phone conferences and meetings with NRCS staff, Soil & Water Conservation District staff and board, and MRGCD staff and board. Most of the water savings values in Table 3.1 were based on hydrological calculations by SS Papadopulos & Associates (SSPA), using their "water budget model" developed as part of the Middle Rio Grande Water Supply Study performed on contract to the OSE and the US ACOE (SSPA, 2001). In performing our analysis, we found it particularly valuable to screen the water salvage values estimated by SSPA against the best professional and expert judgement afforded by a team of agricultural professionals composed of John Carangelo (Socorro SWCD and La Joya Acequia), Gary Perry (MRGCD Vice Chairman), Darrel Reasner (NRCS, Socorro District Conservationist), and Gene Adkins (NRCS, Sierra District Conservationist). These reviewers feel that the values generated by SSPA are based on an "academic" understanding of the MRGCD diversion, conveyance, and delivery systems, as well as associated on-farm irrigation systems. This professional agriculturalist team helped us critically evaluate each measure both in terms of feasibility and also SSPA's quantitative estimates of water savings potential, and refine those estimates as necessary. For the irrigated lands in Sierra county (Table 3.2), the water savings and cost estimates were developed from our understanding of the systems based on information provided by Gene Adkins (Sierra County NRCS District Conservationist) and discussions with ditch association representatives.

Cost estimates presented in Tables 3.1 and 3.2 were obtained by synthesizing information provided by SSPA, MRGCD, and the Socorro and Sierra NRCS offices.

To help the reader understand the rationale behind our estimates of water savings and costs, we provide brief footnotes for many of the entries in Tables 3.1 and 3.2. In addition to these footnotes, there are a couple key points that we wish to emphasize:

- Installation of on-farm improvements does not guarantee water savings. Only if these physical improvements are accompanied by improved on-farm water management by the farmer can the full water savings potential be realized. The objective of the physical improvements and associated improved on-farm water management is to deliver precisely the amount of water needed by the crops, and no more. For example, poor water management typically involves supplying water to a field too slowly, which results in ponding water at a field's upstream end for far too long while the farmer waits for the water to arrive to the field's bottom end; the net result is supplying too much water at the upper end of the field (this "extra" water percolates past the root zone and ultimately becomes subsurface return flow).

- Generally, diversion reductions occur due to improved on-farm efficiencies (see preceding bullet), whereas significant depletion reductions do not occur unless planted acreage is reduced or crop types changed to lower water use varieties. This is due to the fact that crops receiving their full water supply generally consume a fixed amount of water for any given climatic regime (as computed by the Blaney-Criddle crop consumptive-irrigation-requirement equation).
- The exceptions to the preceding bullet are on-farm incidental depletions, such as water consumption by Johnson grass and weeds that grow along earthen ditches; which is why lining on-farm ditches results in small depletion reductions, and evaporation losses on poorly leveled fields.
- To achieve the reduced diversions made possible through on-farm improvements, it is necessary to install check structures in the main and lateral supply ditches. The checks are needed to maintain heads at the farm headgates high enough to ensure rapid water delivery to the farm fields and so maintain high on-farm efficiencies,
- The allotment system for projecting each season's water supply is of low- to medium feasibility due to the lack of storage capacity on the main stem of the Rio Grande. Nontheless, water managers can employ NRCS snow-pack data to project expected spring runoff quantities and timing for the Rio Grande.
- Land retirement and forebearance are considered of low feasibility for a variety of reasons. For one thing, it is common for abandoned farm land to become infested with salt cedar and/or other water thirsty species which results in no reduction in water depletions. Furthermore, while it is recognized that retirement of land from agricultural production is occurring, and will continue to occur, in relation to changing demographics in the region, the stated preference (from public input for this planning effort) is to maintain traditional agriculture. Given this preference, this region will seek to avoid creating further incentives for converting land out of agriculture. Consistent with these desires, forebearance programs are not considered in this water conservation plan, since one of the practical outcomes of such a program is accelerated conversion from agriculture to alternative development.
- Conversion to crops that use less water is considered of low to medium feasibility as markets for the alternative crops currently do not exist. Furthermore, we would not expect those markets to develop unless the NMDA and the state's economic development agencies (or local economic development professionals) work closely with the farmers to help develop markets for those crops.
- Switching to alternative irrigations systems such as drip can be a very expensive capital investment for the farmer, and generally will not occur in a significant way unless financial incentives are offered to the farmer (EBID, 2002).

- Finally, New Mexico water law creates institutional disincentives to convert to lower water use crops and perform other improvements to reduce depletions. Current water law dictates that savings on depletions reduce a farmer's water right (a bill passed in the 2003 session of the New Mexico legislature attempted to address this concern).

Summarizing the estimates provided in Tables 3.1, we see that for Socorro County:
- If all high-feasibility water conservation measures for irrigated agriculture are implemented, we could expect to conserve on the order of 30,000 af/yr in diversions and approximately 800 af/yr in depletions,
- If the medium feasibility measure, conversion to lower water use crops, is implemented on approximately 10% of the irrigated acreage, we could expect to conserve on the order of 3,000 af/yr in diversions and approximately 1,500 af/yr in depletions, and finally
- Despite the region's stated goal of maintaining traditional irrigated agriculture, there is bound to be some conversion of water from agriculture to commercial, municipal, and domestic uses; this will result in a reduction of agricultural diversions and depletions of approximately 4.8 af/acre and 2.4 af per acre converted, respectively. On this particular issue, a key concern for the region is the possibility that out-of-planning-region interests will acquire these converted water rights. This issue is being addressed separately in Section 8 of the regional water plan.

Summarizing the estimates provided in Tables 3.2, we see that for the Sierra County ditch associations:
- If all high-feasibility water conservation measures for irrigated agriculture are implemented, we could expect to conserve on the order of 8,000 af/yr in diversions and approximately 3,000 af/yr in depletions; these values represent roughly one-third of the water diverted and depleted on the acequias. This is a significant volume of water that could be used to improve the annual reliability of the existing water supplies, since the same acequia systems are generally characterized by poor efficiency and growing crops under water-deficit conditions.
- If the medium feasibility measure, conversion to lower water use crops is implemented on approximately 10% of the irrigated acreage, we could expect to conserve on the order of 1,400 af/yr in diversions and approximately 700 af/yr in depletions.
- Again, despite the region's stated goal of maintaining traditional irrigated agriculture, there is bound to be some conversion of water from agriculture to commercial, municipal, and domestic uses; this will result in a reduction of agricultural diversions and depletions of approximately 5 af/acre and 2.5 af per acre converted, respectively.
- On this particular issue, a key concern for the region is the possibility that out-of-planning region interests will acquire these converted water rights. This issue is being addressed separately in the regional water plan.

Table 3.1 – Estimated water savings and costs associated with applicable of Water Conservation Measures for Irrigated Agriculture in Socorro county.

Water Conservation Measure	Est. Diversion Reduction (af/yr)	Est. Depletion Red.[1] (af/yr)	Est. Unit Cost ($/unit)	Estimated Total Cost ($)	Feasibility (high, med, or low)	Currently Being Implemented?
Flexible water delivery rotations / improved delivery scheduling	<13,000[a]	0	0	$50,000	High	In part
Allotment system of water supply allocation	0	0	0	0	Low - Medium	No
Water metering flow on ditch conveyance system and at farm headgates	<13,000[a]	0	$10,000	$800,000	High	In part
Weed and brush control along delivery ditches and laterals[b]	0	0	0	0	High	Yes
Concrete lining and/or pipelining of on-farm ditches	<13,000[a]	600	$15/linear ft	$10,624,000	High	In part
Laser-leveling of fields	<13,000[a]	0	$250/ac	$3,026,000	High	In part
Conversion of land out of agricultural production, permanent or forbearance[c]	5.0 af/ac[c]	2.5 af/ac[c]	$12,000/ac	NA	Low	In part
Alternative irrigation systems, such as drip irrigation and sprinklers	1 – 2 af/ac/yr[d]	0.1-1.0 af/ac	$200 - $1,000/ac	$4,000,000[d]	Medium	In part[d]
Conversion to lower-water-use crops	1 - 2 af/ac/yr[c]	0.5 - 1 af/ac/yr [c,e]	NA	NA	Low to Medium	In part[f]
Conjunctive management of surface and groundwater supplies	2.4 af/ac/yr[g]	0	$20,000 / farm [h]	$4,000,000[h]	High	No
Concrete lining of 20% of MRGCD's conveyance ditches in planning region	4,400	200[i]	$50- $200/linear ft	$3,000,000[j]	High	No
On-farm irrigation water management	26,000[k]	0	0	0	High	In part

Footnotes:

1. Depletion savings realized only when vegetation changed, as plants will use a relatively fixed amount of water as estimated by Blaney-Criddle eqn.

a. Estimated by SSPA to save up to 10% from historical diversions.

b. No savings realized because MRGCD already mows ditches regularly.

c. Depletion based on average of current crops, and diversion savings assume 50% conveyance efficiency.

d. Diversion savings from significantly reduced on-farm losses. Total cost assumes alternative systems installed on approximately 20% of acreage in region. To date, only demonstration research projects have been implemented on less than 100 acres.
e. Based on Blaney-Criddle estimates of crop consumptive uses for alfalfa for current conditions vs speciality vegetables as "low-water-use" crops.
f. We estimate low-water-use crops are grown on less than 100 acres in region.
g. Based on avoiding estimated off-farm conveyance losses.
h. Based on estimated cost of installing an irrigation well on 200 farms
i. From eliminated riparian vegetation losses on lined portions.
j. From MRGCD estimates of ditch lining costs.
k. On-farm irrigation management is a key step to realize potential savings from physical improvements. Diversion savings obtained by compounding 10% savings from physical on-farm improvements (laser leveling and lining on-farm ditches)

Table 3.2 – Estimated water savings and costs associated with applicable of Water Conservation Measures for Irrigated Agriculture in Sierra county.

Water Conservation Measure	Est. Diversion Reduction (af/y)	Est. Depletion Red.[1] (af/yr)	Estimated Unit Cost ($/unit)	Estimated Total Cost ($)	Feasibility (high, med, or low)	Currently Being Implemented?
Flexible water delivery rotations / improved delivery scheduling	<1,661[a]	0	0	$50,000	High	In part
Allotment system of water supply allocation	0	0	0	0	Low - Medium	No
Water metering flow on ditch conveyance system and at farm headgates	<1,661[a]	0	$1,500	$225,000	High	In part
Weed and brush control along delivery ditches and laterals	<1,661[a]	830	$2,000/yr/acequia	$10,000/yr	High	Yes
Concrete lining and/or pipelining of on-farm ditches	<1,661[a]	830	$15/linear ft	$656,250	High	In part
Laser-leveling of fields	<830[b]	0	$200/ac	$2.4 million	Medium	In part
Conversion of land out of agricultural production, permanent or forbearance[c]	5.0 af/ac[c]	2.5 af/ac[c]	$12,000/ac	NA	Low	In part
Alternative irrigation systems, such as drip irrigation and sprinklers	1 – 2 af/ac/yr[d]	0	$200 - $1,000/ac	$277,000[d]	High	In part[d]
Conversion to lower-water-use crops	1 - 2 af/ac/yr[c]	0.5 - 1 af/ac/yr [c,e]	NA	NA	Low to Medium	In part[f]
Conjunctive management of surface and groundwater supplies	2.4 af/ac/yr[g]	0	$20,000 / farm [h]	$1,000,000[h]	High	No
Concrete lining and pipelining conveyance ditches, and increasing crossing capacity	4,400	200[i]	$50-$200/linear ft	$4,600,000[j]	High	No
On-farm irrigation water management	3,950[k]	1,144	0	0	High	In part

Footnotes:
1. Depletion savings realized only when vegetation changed, as plants will use a relatively fixed amount of water as estimated by Blaney-Criddle equation.
a. Estimated to save up to 10% from historical diversions.
b. Estimated to save up to 5% from historical diversions.
c. Depletion based on average of current crops, and diversion savings assume 50% conveyance efficiency.

d. Diversion savings from significantly reduced on-farm losses. Total cost assumes alternative systems installed on approximately 25% of acreage in region, and $500/ac to install system.
e. Based on Blaney-Criddle estimates of crop consumptive uses for alfalfa for current conditions vs speciality vegetables as "low-water-use" crops.
f. We estimate low-water-use crops are grown on less than 100 acres in region.
g. Based on avoiding estimated off-farm conveyance losses.
h. Based on estimated cost of installing an irrigation well on 50 farms (10 farms/acequia)
i. From eliminated riparian vegetation losses on lined portions.
j. From NRCS and Hydrosphere estimates of ditch lining costs.
k. On-farm irrigation management is a key step to realize potential savings from physical improvements. Diversion savings obtained by summing on-farm improvements (laser leveling, lining on-farm ditches, alt. irr systems and crops)

3.1.2 Existing Irrigated Agricultural Conservation Measures in Region

As alluded to in the text above, and explicitly noted in Tables 3.1 and 3.2, most of the water conservation measures considered are already being implemented in the planning region. In fact, except for concrete lining and pipelining of the off-farm irrigation system conveyance ditches and explicit conjunctive (surface water – groundwater) management of irrigation supplies, all of the measures are already being implemented in the region to varying degrees.

- For example, in EBID in Sierra county most of the measures related the surface supplies conveyance system efficiency improvements have been adopted to a large degree.
- Also in Sierra county, the much smaller ditch associations currently have only limited off-farm conveyance system measures in place, although plans are being made to adopt most of the identified high feasibility conservation measures.
- In Socorro county, on the other hand, MRGCD is only beginning to adopt and implement many of the measures; nonetheless, MRGCD currently has long-term plans and budget requests to fully implement all of the high-feasibility measures (Subhas Shah, personal communication, April 2003).
- La Joya acequia in Socorro County is well on its way to fully implementing the listed conveyance system improvements.
- With regard to on-farm conservation actions, the NRCS and SWCD offices in Socorro and Sierra County are working closely with landowners to aggressively implement the farm improvement listed in Tables 3.1 and 3.2. The Socorro NRCS District Conservationist estimates that currently approximately 20 to 25% of the irrigated lands in Socorro County have already been improved with the identified conservation measures. For Sierra County, the estimate of lands with listed conservation measures in place is approximately 20%.
- For future on-farm improvements in Socorro county, the NRCS office has developed a long-range plan that includes estimated water savings and cost estimates required to fully implement the on-farm improvements across their district (many of the cost estimates and water savings values listed in Table 3.1 were derived from the Socorro NRCS EQIP program Geographic Priority Area 2003 funding proposal to the USDA). The Sierra county NRCS office has developed similar plans.

The only high-feasibility conservation action currently not included in any firm plans is conjunctive management of surface and groundwater resources. To fully realize potential savings from this action, the Office of the State Engineer (OSE) needs to recognize the value of conjunctive management and develop policies and administrative procedures to encourage conjunctive use. Such a policy and associated procedures are not foreign to the OSE; for example, the OSE does have in place a conjunctive management policy and procedures for Carlsbad Irrigation District (CID) where supplemental irrigation wells are administered jointly with surface water diversions to help ensure that CID farmers receive a reliable water supply annually. In the MRGCD, on the other hand, the OSE currently has an irrigation well moratorium in place which presents an obstacle to effective conjunctive management of the irrigators' water supplies.

The medium-feasibility actions identified in Tables 3.1 and 3.2, alternative irrigation systems and conversion to higher-value lower-water-use crops, are currently in place on a very small fraction of the irrigated lands in the region. To realize potential savings from these measures will take significant investment of resources by state and federal agriculture agencies to increase the economic feasibility of these conservation actions.

3.2. Water Conservation Opportunities in Publicly-Supplied and Domestic Water Use

The local municipalities and public water suppliers currently have implemented limited conservation actions and policies. In any such public supply water system, there are three components of the system where conservation can be accomplished:

1. the water diversion and delivery system,
2. the water uses directly controlled by municipal authorities, and
3. the water uses by metered customers to the water system.

All public systems can conserve water by closely monitoring diversions and deliveries, and any discrepancy between those two values can help the water provider ensure that any system losses (leaks and/or illegal diversions from the system) can be found and eliminated. In addition, all public systems can directly control their own water use, and thus ensure that their use is in accordance with their water conservation goals. As described below, water use by system customers can be more strictly controlled in incorporated villages, towns, and cities than in public water systems in unincorporated areas (e.g., areas served by MDWCAs).

3.2.1 Mutual Domestic Water Consumer Associations

As described above, all public systems including MDWCAs can conserve water by closely monitoring diversions and deliveries to ensure that any system losses (leaks and/or illegal diversions from the system) can be found and eliminated. State water laws related to conservation and prevention of water waste, and the fact that "willful waste of water" is a misdemeanor crime (Fleming and Hall, 1996) provides significant incentive for MDWCAs to closely monitor for system losses and to use water conservatively. This system loss monitoring is accomplished on a monthly basis, by accounting for all diversions and comparing those values to recorded water deliveries at customer meters.

With regard to MDWCA water users, the primary conservation tool utilized by MDWCAs in the planning region has been adoption of water pricing structures that penalize higher water use (e.g., Polvadera MDWCA). Given the MDWCA's limited regulatory authority, pricing is probably the only viable tool they can employ to achieve their conservation goals.

3.2.2 Municipalities: City of Socorro

The city of Socorro does not have a current 40-year water plan in place, and they have no written policies related to water conservation. They do, however, closely monitor their system losses via monthly accounting of diversions and deliveries. They are currently in the process of upgrading the system of customer meters which will improve their ability to monitor for system losses.

With regard to water use by city facilities, in the past decade they have also aggressively converted much of the (non-turf grass) landscaping in city parks to xeric plants that are generally irrigated by automated drip systems. To date, the city has not had an opportunity to analyze water use data to quantify savings achieved through this conversion to more efficient irrigation systems.

With regard to customers to their water system, the City has not implemented a fee structure that provides a water conservation incentive.

Again, other than these measures, they have no written plan of hard policies / regulations in place that would provide a strong basis for water conservation. They are currently planning on pursuing an update of their 40-year water plan in the near future, and in that plan they will need to explicitly address water conservation goals and propose methods / policies to achieve those goals.

When addressing conservation in the 40-year water plan, the city would need to take a three-pronged approach to addressing conservation:

1. Identify uses
2. Review and evaluate comparable water conservation programs in small southwestern cities, and
3. Quantitatively evaluate the comparable conservation measures.

As part of the regional water planning effort, water use / demand figures for the city were compiled, but those values have not been disaggregated into distinct water use categories (e.g., water used in city parks). In section 2.3.2, we provided a high-level summary to address question 2 (see Table 2.4). Without a more complete understanding the publicly supplied water use components, it is difficult to provide a precise quantitative evaluation of the candidate conservation measures and compare / contrast the relative preference of one measure over another for the City of Socorro.

Despite this data gap, we can provide a rough outline of a conservation plan for the City and estimate potential water savings under such a conservation plan. Table 3.3 summarizes 10 broad areas of conservation practices, and expected water savings (in terms of percent reduction is use) that can be achieved from each of these practices. Given the lack of hard data on water use by various customer categories, we emphasize that the water savings values in Table 3.3 should be considered our best engineering estimates.

If all measures listed in Table 3.3 are implemented, the net savings (obtained by compounding, not summing, the percent changes) would be on the order of 35% over current uses. Given the city of Socorro's current per capita use rate of approximately 205 gpcd, this amount of savings would reduce Socorro's per capita use to 135 gpcd, a value similar to the more water-wise municipalities in the southwestern US (Table 2.5).

Table 3.3. Evaluation of key water conservation practices for the city of Socorro.

Conservation Practice	*Description of Practice*	*Quantity of Water Impacted by Practice (af/yr)*	*Percent Savings that can be Achieved through Practice*	*Quantity of Water Saved Through Practice [a] (af/yr)*
Water Accounting	Close accounting of water diversions and deliveries	1498 af [1]	5%	75 af
Surveys	Survey water use by city and customers	1498 [1]	0	0
Public Conservation	Meter and implement conservation practices for all public facilities	100 [2]	10%	20 af
Recycling	Evaluate effluent reuse and use of poor quality water for certain non-potable uses	100 [2]	100%	100 af
Universal Metering	All water uses supplied by the city are metered	1498 [1]	10%	150 af
Conservation Rates	Rate structure to encourage conservation	1398 [3]	15%	156 af
Prohibit Waste	Develop regulations and fines against waste	1398 [3]	10%	54 af
Plumbing Code	Adopt requirements for water-efficient fixtures	1000 [4]	15%	150 af
Landscape Code	Require major new developments to address conservation	1000 [4]	25%	250 af
Education and Outreach	Develop and implement an education / outreach program on conservation	2398 [5]	5%	240 af

Footnotes:

a. Estimate if the particular conservation practice were adopted by itself is computed as the percent expected savings times the quantity of water impacted. If a combination of measures were to be implemented, once could not simply add the savings from this column. In most cases, one would need to compound (multiply) the expected % savings to arrive at a net expected savings if a combination of measures were implemented.
1. Total depletion by city of Socorro in the year 2000.
2. Estimated as a total of 25 acres of city parkland times 4 af/acre depletion.
3. Total water use less public water use is the quantity that can be affected by this measure.
4. Quantity of water associated with the expected population growth in Socorro in the next 40 years (population projections from Sites Southwest, 2002).
5. Will impact current (year 2000) water use plus expected growth in water use over the next 40 years.

3.2.3 Municipalities: City of Truth or Consequences

The city of Truth of Consequences (T or C) has developed a 40-year water plan, which includes a description of anticipated conservation measures and expected savings. They have also adopted a water conservation ordinance (City Utility Ordinance Section 14-44, Water Conservation) that addresses the following issues:

- April-September outdoor water use
- Penalties for willful waste of water
- Drought emergency measures
- Low-flow toilets and fixtures in new construction
- Sliding water rate structures to encourage conservation

In addition, the 40-year plan identifies treated wastewater re-use as a possible conservation measure, and it provides an outline for drought contingency planning.

The city closely monitors for system losses via monthly accounting of diversions and deliveries. They estimate that unaccounted for water use, or system losses, currently account for approximately 26% of the total water diversions by the city. Sources of the unaccounted for uses included leaks in distribution system, fire hydrant diversions for fire fighting and annual system flushing, cleanup water for street sweeping and hazardous waste spills, public park land and roadway median landscaping irrigation, and flushing and washdown operations at the city's wastewater treatment plant. All of these uses are unmetered. They are currently in the process of upgrading the system of customer meters, subject to city budgetary constraints, which will improve their ability to monitor for system losses. They plan to carefully examine the various potential causes of these system losses, and have set a goal to reduce the total unaccounted for water use to less than 15% of total diversions.

With regard to water use by city facilities, water use for public purposes is currently unmetered. T or C city managers, however, the need to meter these uses, and plan to install meters in the future at locations of public water use. Until such metering is in place, actual water savings that can be achieved through these public water use conservation initiatives can only be estimated.

Per capita water use for T or C is estimated to range from 183 to 204 gpcd, depending on whether temporary winter and summer residents are included in the per capita use calculation. This value is in near the middle of the range for arid southwestern cities (e.g., Las Vegas uses roughly 300 gpcd, Albuquerque uses approximately 200 gpcd, and Los Angeles and Santa Fe use less than 150 gpcd).

In addition to the conservation measures already outlined by the existing conservation ordinance, the city may be able to achieve additional water savings through some of the same measures described above in our discussion of the city of Socorro. Again, the 3-step process discussed for the city of Socorro (identifying existing uses, identifying possible new measures, and evaluating the water savings and costs associated with those measures) should be employed for T or C. Table 3.4 lists existing measures and possible new measure that the city of T or C may be able to implement to enhance it existing water conservation program, along with estimates of water savings for each measure.

Table 3.4. Evaluation of key water conservation practices for the city of Truth or Consequences.

Conservation Practice	*Description of Practice*	*Quantity of Water Impacted by Practice (af/yr)*	*Percent Savings that can be Achieved through Practice*	*Quantity of Water Saved Through Practice* [a] *(af/yr)*
Water Accounting	Close accounting of water diversions and deliveries	1839 [1]	5%	92 af
Surveys	Survey water use by city and customers	1839 [1]	0	0
Public Conservation	Meter and implement conservation practices for all public facilities	545 [2]	20%	109 af
Recycling	Evaluate effluent reuse and use of poor quality water for certain uses	545 [2]	100%	545 af
Universal Metering	All water uses supplied by the city are metered	1839 [1]	10%	184 af
Conservation Rates	Rate structure to encourage conservation	1294 [3]	15%	194 af
Prohibit Waste	Develop regulations and fines against waste	1294 [3]	10%	129 af
Plumbing Code	Adopt requirements for water-efficient fixtures	2585 [4]	25%	646 af
Landscape Code	Require major new developments to address conservation	2585 [4]	25%	646 af
Education and Outreach	Develop and implement an education / outreach program on conservation	4424 [5]	10%	442 af

Footnotes:

a. Estimate if the particular conservation practice were adopted by itself is computed as the percent expected savings times the quantity of water impacted. If a combination of measures were to be implemented, once could not simply add the savings from this column. In most cases, one would need to compound (multiply) the expected % savings to arrive at a net expected savings if a combination of measures were implemented.
1. Total depletion by city of T or C in the year 1999.
2. From T or C 40-year water development plan (T or C, 2001).
3. Total water use less public water use is the quantity that can be affected by this measure.
4. Quantity of water associated with the expected population growth in Socorro in the next 40 years (T or C, 2001).
5. Will impact current (year 2000) water use plus expected growth in water use over the next 40 years.

3.3. Water Conservation Opportunities in Commercial, Institutional, Industrial, Power Generation, and Mining Use

As stated in section 2.2.3, New Mexico Tech accounts for over 95% of water use in this category for the planning region. Visitors to the New Mexico Tech campus frequently note the "oasis-like" appearance, which visually implies significant water use. We interviewed Mr. Jim McLain of the university's physical plant to determine current and planned conservation measures for New Mexico Tech.

Over the past decade, New Mexico Tech has been in an aggressive growth trend, both in terms of the college as well as the associated existing and new research institutions on campus. While the university has historically developed large areas of bluegrass turf on campus and an 18-hole golf course, they are moving into the future with a more conservation-minded approach to water use. Among the actions taken to improve the water use efficiency on campus are:

- 4 out of 5 new buildings constructed in the past decade have employed xeriscape (low water use native plant) landscaping; in one case (the Altimirano residence hall built in 2001) building construction included removal of existing turf.
- The new SUB (Student Union Building, construction beginning in 2003) will take up large turf area, and the building will be xeriscaped.
- Although there has been no formally adopted written policy, Mr. McLain indicates that in general, all new buildings and landscaping will use xeriscaping.
- Beginning in the early-1990s, the university began changing all turf irrigation from a manual to a fully-automatic system. While there is no hard water use data, Mr. McLain noted that this changeover "resulted in huge water savings." The automated system includes adaptive scheduling based on monitoring data form an on-campus weather station. This system currently controls approximately 90% of the turf irrigation, and by end of 2003 they estimate the entire campus will be on system.
- Intermediate-term (~ 3 year horizon) include plan for new buildings that will result in moving 3 holes on the golf course. The new holes will employ a Bermuda grass turf, while the holes that will be replaced have a 70%bluegrass/30% Bermuda mix.

Even though there are currently no major commercial, institutional, industrial, or mining water users besides New Mexico Tech, it would be prudent to anticipate that new such water users in this category may develop in the future. Local governments therefore should work toward developing water conservation standards for a variety of potential uses that can be reasonably anticipated. Another approach would be to wait for any potential industries to apply for a water rights, and be prepared to hire water resource engineers to perform water conservation analysis on any proposed new commercial, institutional, or mining use.

3.4. Water Conservation Opportunities in Livestock Water Use

As described in Section 2.2.4, livestock water use in the Socorro-Sierra planning region offers only limited water conservation opportunities, in the category of confined livestock watering on concentrated animal feeding operations (CAFOs). For both rangeland livestock grazing and confined livestock on individual and small-scale commercial properties, livestock water is supplied in a relatively conservative fashion such as with float valves on a stock tank or earthen tanks that capture surface runoff, and there are thus relatively limited water savings that can be achieved for these type of livestock operations.

Furthermore, as pointed out in Section 2.2.4, the CAFOs in the planning region (8 dairies plus 4 miscellaneous feeding operations in Socorro county, and less than 4 in Sierra county) use water in a very conservative fashion, at a rate estimated to be from 50% to 25% of typical water use rates of dairies across the country and in southeast New Mexico. In addition, most of the dairies in Socorro County are currently working with the local NRCS office to monitor and improve their already highly efficient current water use practices.

In summary, based on our reviews of current water uses by livestock in the planning region, we see very few opportunities for significant water savings.

3.5. Water Conservation Opportunities in Open Water Evaporation and Riparian Habitat Water Use

As discussed previously in Section 2.3.5, open water evaporation (EVAP) off of Elephant Butte Reservoir is one of the largest water depletions that occurs in the planning region. Thus one major conservation opportunity associated with Open Water Evaporation is by attempting to maintain lower lake levels in Elephant Butte (constrained by / balanced against minimum pools to provide for lake recreation). There are at least two conservation measures that could help reduce this depletion:

1. re-allocate storage of water from Elephant Butte to reservoirs further north in the state, where evaporation rates would be lower.
2. evaporation control through reduced water surface areas in engineered and natural areas; this has two components, reduction in open water evaporation and riparian colonization in the Elephant Butte delta through drainage, and reduction in small ponds outside the delta region.
3. removal of exotic vegetation, primarily salt cedar, from riparian areas in the Rio Grande basin

We address each of the conservation measures below in terms of potential water savings. The following quantifications of water savings were developed by SSPA using their water Middle Rio Grande Water Supply Study (MRGWSS) budget model on contract to the NM ISC in support of the Socorro-Sierra planning effort (SSPA, 2003a, 2003b). Table 3.5 summarizes potential water savings for each of the conservation measures, as well as rough cost estimates to implement the measures. Details on how these estimates were derived are provided below.

With regard to conservation measures 2 and 3 above, the costs are in the millions-of-dollars range. These costs and the complexities of implementing these measures are likely beyond the ability of the local governments. However, both the state and federal water management agencies also are highly motivated to deal with these essentially non-beneficial-use water depletions in order for them to meet their various agency obligations. As such, the planning region needs to aggressively lobby and work closely with state and federal water management agencies to ensure that some or all of these measures could be implemented.

Table 3.5. Summary of potential water savings associated with open water evaporation and riparian vegetation conservation measures. Details on how estimates were obtained can be found in text.

Conservation Measure	*Potential Water Savings*	*Comments*
Re-allocate Elephant Butte storage to low-evap reservoirs	0 af/yr (-2,000 to 2,000)	Significant agency effort in Compact and other issues; the Water Planning Steering Committee has indicated it would be opposed to any reduction in the current minimum pool (prescribed in the Rio Grande Compact) of 400,000 af
Evap reduction, EB Delta	0 – 80,000 af/yr	Low value if LFCC maintenance stalls
Evap reduction, other open water	525 – 1,320 af/yr	Reduce open water at state and federal riparian wildlife refuges
Eradicate exotic phreatophyte vegetation	0 – 22,000 af/yr	Water savings depends on concurrent LFCC / delta drainage actions

Finally, with regard to removal of exotic vegetation (e.g., salt cedar), the 2002 New Mexico legislature allocated $2.5 million to manage the exotic vegetation. The management program has since proceeded, and approximately 30 acres in the planning region already have been treated, and approximately 9,000 acres have been signed-up for treatment this coming eradication season (generally beginning in late fall). As described below in the detailed discussion of exotic vegetation removal, for the program to be effective over the long term, killing the trees represents only the first step in the concerted effort that would require a commitment to ongoing active management to ensure that water-thirsty exotic vegetation could not re-establish itself in the areas subject to eradication. Perhaps the best way to prevent re-colonization by exotic vegetation is to establish native vegetation.

1. Re-allocate storage of water from Elephant Butte to reservoirs further north in the state. The concept behind this conservation measure is that Elephant Butte reservoir's location at a low elevation in south-central New Mexico experiences much higher evaporation rates than reservoirs located northern New Mexico (i.e., Abiquiu and Cochiti reservoirs) where water potentially could be alternatively stored. While it is certainly theoretically possible to store water in these northern reservoirs, there are institutional issues associated with the Rio Grande Compact that would require agreement among the Compact signatories (New Mexico, Colorado, Texas, and the US federal government) to allow for storage re-allocation.

Neglecting this potential legal roadblock and assuming that storage re-allocation would be approved, SSPA performed an analysis to quantify potential water savings if this alternative were to be implemented. Surprisingly, the net effect of this proposed storage re-allocation is negligible water savings. The reason for the lack of water savings is that the water saved through reduced evaporation may be offset, at least in part, by increased depletions and conveyance losses when the water is released on a different schedule than that now applied. Increases in conveyance loss, if water were released slowly during the summer rather than routed to Elephant Butte during the spring flood wave, could potentially exceed the water savings, resulting in a net water consumption rather than a water savings. In addition, areas exposed to the atmosphere due to lower lake levels can be colonized by exotic riparian vegetation such as salt cedar which could lead to significant new depletions, with the net difference between the reduced evaporation and the increased riparian ET being negligible.

The planning region will support this conservation measure only to the extent that it does not result in the drawing down of the Elephant Butte pool level below 400,000 af in storage. This level is consistent with storage thresholds identified in the Rio Grande Compact, and more importantly for Sierra county businesses, is deemed a minimum level required to maintain a viable recreation industry associated with Elephant Butte Reservoir. A plan that involves a water level below the 400,000 af in storage would likely be protested by the City of Santa Fe, because a stage below this amount place's Santa Fe's water supply subject to a call by Texas, and the City is not allowed to increase the amount of water in storage.

2. Evaporation control through reduced water surface areas in engineered and natural areas. Reduction of water surface areas, such as a reduction in the wetted area of the Elephant Butte delta and reduction of ponded areas between San Marcial and the reservoir, is important for efficient delivery of water to Elephant Butte Reservoir for meeting New

Mexico's delivery obligations under the Rio Grande Compact. In the late 1950s, the Low Flow Conveyance Channel (LFCC) was constructed to drain swampy areas along the reach from San Antonio to the reservoir, and thus enhance New Mexico's ability to make required Compact deliveries. In the high flow years in the mid-1980s, the lower portions of the LFCC became inundated and clogged with sediments, leading to a recurrence of the swampy conditions and associated high riparian and open-water-evaporation water depletions. Today, water in the shallow subsurface of the delta area has the following disposition, with relative quantities unknown: evaporation from wetted soils, riparian evapotranspiration, subsurface flow to the reservoir, interception by portions of the LFCC in places where the LFCC water surface lies below the shallow groundwater elevation.

A pilot channel is currently under construction to reconnect the river and the LFCC to the reservoir. This channel also intercepts a main area of spreading LFCC drainage in its planned downstream reach. The lower portion of the channel is on schedule for completion in May 2003. The upper portion of the channel is partially complete, but the schedule for full completion is unclear. The intent of these channel maintenance activities is to provide a channel that can effectively carry spring run-off to the reservoir, thus, avoiding the spreading of floodwaters into the delta area. At present, the depth of the channel has not been designed to drain subsurface water to an elevation beyond the reach of riparian vegetation. SSPA's analysis of potential water savings for this action range from zero, if LFCC reconstruction and maintenance stall, up to 80,000 af per year should the LFCC rehabilitation proceed with channel lowering to drain water logged sediments in the delta and it is maintained on a regular basis. It is important to note that this water savings does not represent new water available for depletion in the planning region; rather it allows the hydrologic budget to return to baseline conditions consistent with the period from the 1960s through the mid-1980s and thus improves New Mexico's ability to make Compact deliveries. This will indirectly "firm-up" the region's water supply by reducing the likelihood of the state needing to make a call for Compact obligation purposes.

In addition to the swamps in the Elephant Butte delta area, there are also many open water areas in state and federal wildlife and game refuges within the Socorro-Sierra region. Reduction in these open water areas could also reduce water lost to evaporation. SSPA (2003a) estimates water savings ranging from 525 to 1,320 af per year, depending on the mix of replacement vegetation that would move into drained areas.

3. Removal of exotic vegetation, primarily salt cedar, from riparian areas in the Rio Grande basin in the planning region.

Based on SSPA's analysis of this alternative, removal of exotic vegetation has the potential to result in either significant consumptive use reduction or consumptive use increase depending on how it is implemented, with or without Low Flow Conveyance Channel (LFCC) maintenance. If vegetation is removed from areas of slightly higher elevation within the floodplain and the LFCC maintenance occurs contemporaneously with vegetation removal, the area will become scrub or grass land with little or no direct evaporative loss. In this case, the evaporative savings will be on the order of 4 acre-feet per acre, the average evapotranspirative loss from salt-cedar (King and Bawazir, 2000). If, on the other hand, the maintenance activities associated with the LFCC stall but the exotic riparian vegetation is removed, water tables could rise to the land surface and result in water depletions by direct evaporation, expected to be on the order of 6 af per acre.

SSPA (2003a) reports riparian acreage between Bernardo and Elephant Butte as 30,400 acres total. Note: This updates acreage reported in the August 2000 MRGWSS study of 31,934 acres). Average consumptive use from 1985 to 1998 was estimated at 3.71 acre-feet per acre for San Acacia to San Marcial, whereas established native cottonwood – willow bosque uses about 3 acre-feet per acre per year of water (King and Bawazir, 2000). Based on these values, if salt cedar were removed and replaced with native bosque, the potential reduced depletion is 0.71 acre-feet per acre resulting in a total reduced depletion of approximately 22,000 acre-feet per year. If we consider controlling salt-cedar on only a portion of these lands, which might be more realistic, re-establishing native bosque on 10% of the lands (3,000 acres) would resulting in a reduced depletions of about 2,200 acre-feet of water per year.

Alternately, the region could focus on areas where salt cedar habitat can be eliminated. The benefit of eliminating habitat is that salt-cedar is replaced by native desert scrub, rather than bosque, further reduces depletions. A potential area where this might work is on the east side of the Rio Grande below San Acacia, particularly from Escondida to Bosque del Apache. This area is a roughly 1 to 2 mile wide stretch of land that was once used for agriculture. This area was abandoned by the MRGCD when it became too waterlogged to plant. This area is cut off from the Rio Grande by a continuous levee, and is also the outlet for multiple arroyos, which, because of the levee, no longer connect to the river. The result is that significant amounts of water are released into this former farmland on a regular basis, maintaining a high water table and providing excellent conditions for salt cedar growth. If this land were drained such that some portion of it became inhospitable to riparian growth, the resulting water usage on the drained land would drop to roughly the effective precipitation, reducing depletions by roughly 3 to 3.5 acre-feet of water per acre annually. There are approximately 7,300 acres of riparian vegetation in this area, with approximately 50% of that being non-native (Earth Reflections, 2003), suggesting potential water savings in this area ranging between 2,000 and 10,000 af per year (depending on the type of replacement vegetation. Maintenance of the drainage system would be required to prevent salt-cedar from re-vegetating the area.

Finally, there is a developing area of riparian vegetation is in the now-exposed Elephant Butte northern basin. As mentioned in the preceding discussion related to "reducing open water depletions in engineered and natural environments," successful completion of the pilot channel for the LFCC is a critical step to reduce this encroachment of water-depleting riparian vegetation. However, additional drainage and maintenance would be required to substantially reduce the potential for riparian re-colonization.

As pointed out by SSPA (2003a = appendix E) here are several potential complications to controlling non-native vegetation:

- First, the removal of exotic vegetation may potentially conflict with Endangered Species Act over Southwestern Willow-Flycatcher habitat.

- Second, once non-native vegetation is removed, it will need to be maintained on a regular basis, or the area will need to be returned to more "natural" conditions such that non-natives have less advantage over native vegetation. Cost of on-going maintenance, in the former scenario, or the potential for increased water use resulting from re-engineering the area to recreate "natural" conditions, should be figured into the planning.
- Third, because non-native riparian vegetation, such as salt cedar, consume large quantities of shallow groundwater, to some extent they control shallow groundwater levels. Reconstruction and maintenance of the LFCC to ensure adequate drainage will be important to ensure that water-logging and evaporative losses are not exacerbated upon removal of salt cedar. Water table response and alternatives for water table elevation management should be built in to any vegetation removal plan.

4. APPLICABLE CONSERVATION MEASURES, OBSTACLES TO THEIR IMPLEMENTATION, AND IMPLEMENTING A CONSERVATION PROGRAM

In Section 3, we identified a suite of conservation measures for each major water-use category that are applicable to the planning region. For the livestock and institutional-industrial categories, we found that there are minimal opportunities for water savings. The primary conservation opportunities in the planning region are in;

- Irrigated agriculture,
- Publicly supplied domestic and commercial water systems, and
- Open water evaporation and riparian evapotranspiration.

Based on the existing programs/funds in Sierra and Socorro Counties, and taking into consideration the relative importance of water use in the agricultural sector, it is expected that future conservation efforts will continue to focus on this sector. In addition, with the ongoing drought tightening supplies at the same time that demand in the middle Rio Grande valley grows in the municipal sector as well as for environmental requirements (e.g., the silvery minnow), there is a large and growing focus on the potential large scale water savings associated with riparian vegetation depletions, particularly by non-native phreatophytes such as salt cedar.

Finally, when designing an overall water conservation program, besides cost, engineering, and physical/biological technical considerations, one must factor in existing legal and institution constraints to conservation in New Mexico and/or may consider changes to current statutes in order to promote further conservation. Section 4.1 summarizes information about statutes in New Mexico and their incentives and/or limitations to water conservation, and section 4.2 presents some recommendations that do not require statutory changes. Section 4.3 includes a brief discussion of overall conservation potential in the Socorro/Sierra Region.

4.1. Institutional/legal issues

4.1.1 Water Conservation Statutes in New Mexico

Water conservation statutes in New Mexico determine the legal or institutional potential for water conservation. The prior appropriation doctrine, in which the "first in time equals first in right" and the New Mexico Constitution, in which "beneficial use shall be the basis, the measure, and the limit of the right to the use of the water," do not promote conservation and efficient use of water. New Mexico water users are thus motivated to "use it or lose it" and to put to beneficial use as much water as possible to prevent it to be appropriated by someone else.

The main obstacles to conservation are: first, the vast majority of the water rights confirmed in Section 1 of the state constitution were pre-1907 rights, and constitute most of the surface water rights in New Mexico. Because they were not formally defined in adjudicating suits, they are not subject to the jurisdiction of the State Engineer. Secondly, prior appropriation does not mandate efficient beneficial use, only full beneficial use. Thirdly, "beneficial use" as the basis of a water right has been largely undefined.

Fleming and Hall (1996) present a comprehensive analysis of New Mexico statutes and how they impact the legal/institutional baseline for conservation practices. Highlights of that analysis are presented in table 4.1.

Table 4.1 – New Mexico Statutes and Water Conservation

Statute	Provisions for Water Conservation	Incentives / Limitations to Conservation
Water Conservation Program [72-5-28(G), 72-12-8(D)]	"Periods of nonuse when water rights are acquired and placed in a water conservation program, which has been approved by the state engineer, by a conservancy district… or by an acequia or community ditch association or the interstate stream commission shall not be computed as part of the four-year forfeiture period."	Under the conservation provision, if a user does not use a full water right for extended periods of time during full supply, saved water is exempt from forfeiture. However, the saved water could be appropriated if considered as water that had been wasted.
Conservation and Public Welfare [72-5-6; 72-5-7; 72-5-5.1; 72-12-3(D) & (E)]	A new application for water can be denied by the state engineer if the "approval of the application would be contrary to the conservation of water within the state or detrimental to the public welfare of the state".	These statutes are limited to new appropriations and therefore the state engineer is limited when trying to conserve surface water. They provide an avenue for private citizens to introduce evidence about conservation concerns.
Transfer of Water Rights [72-5-23]	Transfers of surface water rights "are not contrary to conservation of water within the state and not detrimental to public welfare" (supplement to 72-5-7)	Allows the state engineer to address conservation measures in the context of water transfers.
Prevention of Water Waste [72-5-18, 72-8-4]	[72-5-18] The SEO has the authority to determine the amount of water needed "consistent with good agricultural practices and…will result in the most effective use of water in order to prevent waste". The standard for determining effective use of water is the amount that can be put to "beneficial use". [72-8-4] This statute makes it a misdemeanor to waste water	The statute could be useful in the definition of part of the meaning of conservation for agriculture use in New Mexico. The statute doesn't specify what "waste" is.
Forfeiture: Failure to Use Water [72-5-28; 72-12-8]	(Same as "Water Conservation Program")	It provides municipalities and counties exemption from forfeiture. In the case of groundwater forfeiture, water conservation programs adopted by artesian conservancy districts are exempt. This allows these entities to enact conservation measures, but does not require conservation. SEO needs data on actual water use in order to quantify conservation efforts.

Table 4.1 – New Mexico Statutes and Water Conservation (Continuation)

Statute	Provisions for Water Conservation	Incentives / Limitations to Conservation
Requirement for Metering [72-12-27]	This statute gives the state engineer authority to require water meters to monitor the amount of water use from wells.	This statute gives the SEO an effective tool in administering water rights but it is limited to groundwater extraction and doesn't impact surface rights
Use of Water Outside the State [72-12B-1]	This statute provides a statutory scheme for the use of New Mexico water in other states.	The Commerce Clause of the Constitution can impact the SEO in determining conservation concerns.
Right to Use Water: Beneficial Use [72-12-2]	"Beneficial use shall be the basis, the measure, and the limit of the right to the use of water"	The "beneficial use" standard may not authorize conservation requirements because it doesn't expressly mandate efficient uses of water.
Conservation to Prevent Erosion, Waste and Floods [72-5-29]	This statute recognizes that water "may be conserved and utilized so as to prevent erosion, waste and damage caused by torrential floods, and in order that the benefits of such waters may be distributed among the inhabitants and landowners of the country along said stream as equitable as possible without interfering with vested rights"	This statute recognizes the relationship between "conservation" and the prevention of "waste". Also, it helps to establish a relationship between water conservation and watershed management. Benefits of upstream watershed management include soil and water conservation to prevent downstream erosion and flooding. Water conservation benefits of watershed management include higher baseflows during low flow periods and increased reservoir capacities through a reduction in sedimentation rates.
Permits, Hearing, Approval Process [72-5-6, 72-12-3(D) & (E)]	The surface water statute ensures that, after determining whether there is any unappropriated water, the SEO shall approve the application unless the proposed use is detrimental to the public welfare or is contrary to the conservation of water. The groundwater statute specifies the procedures for approving new appropriations of groundwater permits.	The two statutes only apply to new appropriations, which limits the SEO's power to affect conservation of existing water users. There is no general statutory definition of what constitutes "conservation".
Water Waste a Misdemeanor [72-5-4]	This statute makes the "willful" waste of surface or underground water a misdemeanor if it is "to the detriment of another or the public"	Limitations include: it may be difficult for the administrative agency to prove a "willful" waste of water; and it may be impractical to enforce this law because of lack of resources and will power.
Interstate Stream Commission Conservation Duties [72-14-31]	This statute empowers the ISC to negotiate compacts with other states for common waters. ISC is authorized " to investigate water supply, to develop, to conserve, to protect and to do any and all other things necessary to protect, conserve and develop the waters and stream systems of this state, interstate or otherwise…"	Although the ISC has no regulatory authority and therefore cannot require water conservation measures, it can encourage water conservation actions through its assistance and planning programs. It is unclear whether ISC's authority is limited to reactive conservation measures, in response to compact restrictions, or whether it includes proactive conservation measures.

Table 4.1 – New Mexico Statutes and Water Conservation (Continuation)

Statute	Provisions for Water Conservation	Incentives / Limitations to Conservation
Regional Water Plans and Conservation Criteria [72-14-44(C)]	This statute gives the ISC authority to establish regional water planning which would include an adequate review of water conservation.	The ISC Regional Water Planning Handbook [ISC, 1994] requires that "water conservation should be the first item considered among feasible water supply alternatives in the management of water t meet current and future water demands".
Artesian Conservancy Districts [73-1-1, 73-1-20]	These statutes provide for the organization of artesian conservancy districts to conserve the waters of the district and directs the district board to outline a yearly water conservation plan.	Any conservation measures affecting individual users must be voluntary rather than mandatory. The SEO allowed irrigators that have increased their efficiency in water use to re-capture the savings by increasing the crop area. However, that practice was stopped to prevent increased consumptive use and to promote overall water conservation. In addition, the Pecos Valley Artesian Conservation District has purchased and retired water rights within the basin to promote reduction in water use.
Conservancy District Powers [73-14-47 (B) & (F)]	This statute gives conservancy districts the authority to conserve water within the district, allowing them to retain water rights.	The conservation districts are not subject to the forfeiture for non-use. Also, only the "consumptive irrigation requirement" portion of the conserved water can be sold or leased outside district boundaries.
Irrigation District Powers [73-9-14, 73-10-16]	These statutes give irrigation districts broad powers over the limit subject of the delivery of water for irrigation purposes to lands within duly constituted districts	The irrigation district statutes do not specifically mention any power to conserve water and do not provide for the disposition of conserved water. However, state statutes do authorize irrigation district boards to rent and lease water rights within the district and these powers may imply the right to conserve water within the district.
Artesian Conservancy Districts [73-1-27]	This statute automatically adds to the duty of water for irrigation within any artesian conservancy district two acre inches of water per year per acre-foot of an established water right to compensate for carriage losses between the point of appropriation and the point of beneficial use.	To the extent that the statute fixes the quantity of carriage loss irrespective of actual loss, it does not promote the efficient use of water. However, if the SEO determines that carriage losses can be reduced, the court may impose those reduced limits on a water right.
Community Irrigation Ditch Powers [73-2-22.1]	Community irrigation ditches own all aspects of water rights	Community irrigation ditches have the capacity to hold unused water for the benefit of the ditch.

Table 4.1 – New Mexico Statutes and Water Conservation (Continuation)

Statute	Provisions for Water Conservation	Incentives / Limitations to Conservation
Adjudication Suits [72-4-19]	In an adjudication suit, the court decree " shall in every instance declare, as to the water right adjudged to each party, the priority, amount, purpose, periods and place of use, and as to water used for irrigation, the specific tracts of land to which it shall be appurtenant, together with such other conditions as may be necessary to define the right and its priority"	This statute creates an important niche for including conservation concerns in adjudication decrees.

4.1.2 New Mexico Return Flow Policies

Current New Mexico Return Flow policies protect downstream and other water right holders by not allowing any additional depletions in the river system, and thus may not encourage water reuse Use of effluent is not a conservation measure unless that effluent is presently being evaporated as a means of disposal.

In the case of Santa Fe, the high cost of water rights constitute an incentive to return as much sewage effluent as possible to the river for return flow credits in addition to reusing the effluent to water parks and golf courses. Likewise, the city of Albuquerque receives credit for return flows to the Rio Grande and may purchase fewer water rights in exchange for the amount that is returned to the river. This practice does not constitute an incentive for effluent reuse as groundwater recharge or on parks and golf courses.

Agriculture return flows are not always easy to measure, and return flows to the aquifers are not necessarily considered by the OSE. However, if it is possible to demonstrate water returns to the aquifer, through metering or hydrologic calculations, then return flow credits are awarded. This is an incentive for water conservation through on-site reuse of septic tank effluent for outdoor watering.

A policy change that, as referred in Fleming et al (1996), would encourage conservation involves the "banking" of water by a city. The forfeiture statute [72-5-28] exempts municipalities and counties from losing not-used water and therefore provides incentive to conservation.

4.1.3 New Mexico Water Quality Management

The management of water quality and water quantity and the adoption of water quality regulations are done by different agencies in New Mexico. Water quality must be considered in the areas of water reuse and use of low quality water for applications that do not require drinking water quality. Therefore, the different agencies in New Mexico should work closely to address conservation projects.

4.2. Recommendations

Fleming and Hall (1996) provide a list of options for encouraging municipal, industrial, and agricultural water conservation for New Mexico. These options were designed to be implemented under existing institutional and legal framework, and do not require statutory changes by the OSE and the ISC. Major recommendations are:

[The following list was taken directly from Fleming and Hall (1996); preliminary research indicates that few of these recommendations have been formally adopted as of yet]

1. Definitions of water conservation and beneficial use should be adopted, with emphasis on efficiency and economic feasibility

2. A "water conservation policy handbook" should be developed, with guidelines for preparing conservation plans and information on available conservation grants and water banking opportunities.
3. Additional funding for water conservation activities should be pursued through the establishment of a "water conservation grants" program, following examples in Colorado, Texas, and Arizona. Projects currently funded by the Interstate Stream Commission should document the amount of water conserved.
4. Return flow policies should encourage groundwater reuse and recharge, account for lower quality water in assigning credits, and recognize that a water right includes a diversion amount, farm delivery amount, a consumptive irrigation requirement, a return flow amount and conveyance losses.
5. A policy statement should be prepared stating that conserved or banked water depletions can be sold or leased by acequia associations, conservation districts or municipalities.
6. Policy statements need to be prepared and publicized which recognize the conservation advantages of protecting water from quality degradation and the potential for using and reusing poor quality water for appropriate uses. In cooperation with the Environment Department, a system of water credits for using poor quality water and other reuse procedures should be established.
7. A system of withdrawal fees should be adopted, through regulation, to pay for administering the water conservation program, which would include water conservation grants.
8. Methodologies for calculating the economic benefits of water conservation should be included in a "water conservation handbook"
9. All water rights applicants should be required to prepare a conservation plan, with guidelines for preparation published in a "water conservation handbook". Metering should be mandatory.
10. The OSE should recognize in a policy statement that integrated resource management plans for watersheds provide rational bases for statewide water planning.

4.3. Summary and Recommendations

Following a brief summary of the water supply and demand characteristics of the Socorro – Sierra water planning region (Section 1.2), this document first reviewed case histories of water conservation measures that have a proven track record for saving water in a wide range of water use sectors and categories (e.g., agriculture, industrial, municipal) (Section 2); and secondly evaluated their applicability to water systems in the study area, providing estimates of the amount of water that may be saved and at what cost, and identify existing measures in place (Section 3).

Finally, based on the findings from Sections 2 and 3, here we want to recommend actions to improve the likelihood that the conservation measures most applicable for the planning region will be successfully implemented. These recommendations are based on the physical, biological, hydrological, societal, engineering, institutional and regulatory situation within which the planning region exists.

To achieve efficient water use that will help stretch supplies for the benefit of water users in the planning region, we recommend:

- The local (Socorro County and Sierra County) USDA and Soil and Water Conservation District offices should continue to work closely together and with agricultural and owners to aggressively identify and address water conservation needs for on-farm irrigation system improvements, including land leveling, concrete ditch lining, pipelining, and adaptive on-farm water management. This should happen with the explicit support of local, state, and federal elected government officials to ensure that sufficient funds are provided to help landowners implement high-feasibility conservation measures identified in Section 3.1.
- The MRGCD, as well as the independent ditch and acequia water providers, should work aggressively to implement conveyance system conservation measures identified as effective and feasible in Section 3. Again, this should happen with the explicit support of local, state, and federal elected government officials to ensure that sufficient funds are provided to these irrigation water providers to implement these measures.
- The municipal water systems of Socorro, T or C, and Magadalena should adopt and implement actions and measures that improve the efficiency of the water use. All these communities should develop water conservation plans, and should adopt cost structures and regulations to help ensure that conservation goals are met.
- The smaller MDWCA water providers should each develop and adopt their own water conservation plans.
- Local, state, and federal government officials (both elected and government employees) should work to develop funding sources and to implement the large-scale engineering and on-the-ground watershed/habitat restoration efforts aimed at reducing water depletions associated with open water evaporation and riparian plant evapotranspiration as discussed in Section 3.5.
- NM Tech should develop a written conservation plan and policy
- County governments should consider adoption of water conservation guidelines for new industry, or for new residential development.

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