Supporting Document J

19 Alternatives Analyzed by the Alternatives Working Team

2003

Middle Rio Grande Regional Water Plan
Abbreviated Evaluation of Alternative Actions

Metering Water Supply Wells (A-8)

Alternative Action Statement

Meter all water supply wells, including domestic wells, throughout the water-planning region.

Alternative Action Description

Under the current system, domestic well owners are allowed to withdraw up to 3 acre-feet of water per year. Metering is not required so there is no way to account for actual water use. However, once the amount of water being used is monitored, there may be an incentive for the consumer to use less water. In addition, if the amount of water withdrawn becomes known and it is considered excessive, legislation might be justified in order to reduce the amount of water pumped to something less than 3 acre-feet per year.

It is important to note that the State Engineer does not have accurate information on the number, location, and characteristics of all domestic wells in the State. Consequently, it is difficult to determine if the cumulative effects of domestic wells represents a serious water consumption problem or even if they consume a proportionately large amount of water. Although personnel in the Office of the State Engineer have provided rough estimates of the amount of water consumed by domestic wells in the Middle Rio Grande region, the estimates are not supported by definitive data or statistical evidence.

Funds should be appropriated to conduct definitive studies and obtain sufficient data to determine the actual consumption and impact of domestic wells. However, until such time as definitive studies and data become available, existing data should be used and action should be taken only to aid in identifying and regulating critical management areas and assuring that domestic wells are drilled and maintained in a manner that protects the underlying aquifer from pollution. Further regulation of domestic wells should not be attempted until sufficient data is available to support the basis for such regulation.

General Findings and Conclusions (as appropriate)

1. Technical Issues.

a. Initial Cost to Implement
   - Depending on how metering is performed, there may be significant cost factors involved in metering all domestic wells including the cost to individuals for the purchase and installation of meters
   - It is estimated that a meter will cost approximately $400 including installation.

b. Ongoing Cost for Operations and Maintenance

- The cost to the taxpayers for the bureaucracy to inspect and read the meters could be significant.
- Possible cost savings in meter reading might result if a “post card” system were instituted whereby owners would read their own meters and report consumption.
- Radio transmission and remote receipt of well meter readings might be another possibility; however, specialized meters could be costly.
- As in any permitted public use there are violations which should be reduced or eliminated through enforcement. Unfortunately, the State Engineer has no enforcement authority. This could be remedied through legislation.

c. Potential Funding Sources

- In order to accomplish domestic well metering fairly and adequately, the State Legislature would have to appropriate funds for the purpose.
- Legislation could require that meter purchase and installation be borne by the well owner. Consideration of this possibility might doom such proposed legislation.

d. Implementation Time

- If the cost of meter installation is borne by State appropriation, completion of metering throughout the MRG would probably take 20 or 30 years.
- If the cost of meter installation is borne by individual well owners completion of metering could be accomplished sooner.

2. Physical, Hydrological and Environmental Issues.

- Even If metering of domestic wells revealed widespread and substantial consumption exceeding 3 acre-feet per year and the pumping limit was reduced, considering that most water consumed in-doors is eventually returned to the aquifer via septic systems, there would be no long term impact on the water supply.
- If metering of domestic wells revealed excessive consumption to the individual owners, an incentive to use less water might result.

3. Social or Cultural Issues. None.

4. Economic Issues. Purchase of meters for installation by individual well owners would benefit local suppliers. Purchase and installation by others would benefit local suppliers as well as well drillers and/or plumbers.

5. Legal Issues. Regardless of the grounds but in view of the considerable public objection to changing the domestic well statues, legal action might be expected.

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Vegetation Removal Products (A-2)

Alternative Action Statement

Develop the economic potential of non-native species removal, harvesting, and output of products by local industries.

Alternative Action Description

Non-native species of vegetation often dramatically affect the biomes into which they are introduced. In the southwestern U.S., the salt cedar or tamarisk is a prolific halophytic phreatophyte or salt tolerant "well plant" found along riparian zones that consumes vast quantities of water in comparison with native vegetation. As such, active removal or elimination of this invasive species is considered desirable. The proposed alternative is designed to explore the economic potential of utilizing harvested materials to offset the costs of an ongoing exotic vegetation control program.

General Findings and Conclusions (as appropriate)

Estimates state that an individual mature tamarisk tree may consume more than 200 gallons of water per day, and that heavily colonized stands may consume between 202 and 785 acre-feet of water per acre annually. Estimates of 1.5 million acres of land in the Southwest have salt cedar infestation. It is unclear what the average density of trees occurring on this acreage is, and it most likely varies widely. Mature tamarisk trees are 4 inches in diameter at the trunk and reach 16 feet in height. According to Keith Duncan, a brush and weed control specialist with the N.M. State University Cooperative Extension Service, "Along the Pecos, stands of salt cedar will reach 3,000 to 4,000 per acre. Cottonwood and willow populations, by comparison, will be nearer 200 per acre."

1. Technical Issues. Various biomass-to-energy generation systems currently exist, including the patented biomass gasification system of Thermogenics Inc., an Albuquerque based company. This will be explored in the current review. Other uses of the harvesting products include furniture manufacture and pulpwood and may warrant further investigation.

Installation of either fixed or mobile processing facilities to convert harvested biomass into clean burning gas is a viable alternative. The model 103 Gasifier from Thermogenics Inc. can process 1,000 pounds of biomass per hour and generate 400 kWe. This equates to harvesting about 135 acres of salt cedar per year, at a density of 900 trees per acre. Each model 103 Gasifier with generator will take approximately six months to one year for manufacture, assembly, delivery and installation. Harvesting of salt cedar biomass can begin immediately to begin stockpiling biomass to provide continuous feed supply to the Gasifier.

2. Physical, Hydrological and Environmental Issues. This action will have no effect upon water demand by humans, but will cause significantly reduced water demand by riparian vegetation. Elimination of non-native phreatophytic vegetation will lead to reduced evapotranspiration from riparian zones, slow the process of soil surface salinization, and will allow native vegetation to reclaim and repopulate traditional habitats. In many cases this will allow streams and springs to flow year round, where currently the tamarisk has dried up such hydrologic features. The actual process of converting the harvested biomass into energy or other products should have no impact on the water supply.

With tamarisk trees consuming over 200 gallons of water per tree per day, and densities of 900 to 3,500 trees per acre, this amounts to an annual savings of 202 to 785 acre-feet of water per acre of salt cedar removed. This is very significant. With one Gasifier on line, and removal efforts of 135 acres per year, this would save an additional 27,270 acre-feet of water every year the program operates.

Neither the process of harvesting nor utilization of the biomass will impact the water quality measurably. Many marginal streams, springs, and wells will experience a dramatic localized increase in the water table. By employing a more economically sustainable non-native vegetation removal program, a dramatic reduction in salinization of riparian soils can be achieved along with the reduction of the potential for frequent damaging wildfire. This in turn allows reestablishment of native vegetation that is more conducive to supporting native fauna and will provide a more diverse biome.

Many species of birds, reptiles, amphibians, and mammals are currently threatened by the monoculture imposed by tamarisk invasion. In areas where removal programs have been ongoing, native species have returned and thrived. The endangered Southwestern Willow Flycatcher sometimes lives near or nests in stands of salt cedar, though only the white winged dove is known to nest regularly in them. Removal programs may be tailored to accommodate periods during the non-nesting season to minimize potential impact.

3. Social or Cultural Issues. None.

4. Economic Issues. One Thermogenics model 103 Gasifier (1,000 lbs/hr capacity) coupled with a Jenbacher high performance spark ignited 400 kWe engine/generator set with catalytic converter will cost $800,000. This will accommodate the biomass from 135 acres per year. Additional or larger capacity units can be purchased to facilitate more aggressive removal programs.

Estimates for the costs of salt cedar clearing, a combination of herbicide, burning, and mechanical control techniques, ranges from $750 to $1,300/ha (Taylor and McDaniel 1998). This equates to a range of roughly $300 to $525/acre. The City of Albuquerque estimates the cost of clearing salt cedar and other non-native plants such as Russian olive at $500 to $1,000/acre.

Each acre with a density of roughly 900 tamarisk trees can yield approximately 13 cords of wood which can be converted into gasified fuel with energy content of 20 million

BTUs, which when burned in a high efficiency generator will yield about 2100 kilowatt-hours of electrical power and 10.8 million BTUs of heat. At current PNM rates this electricity would be worth $0.05-$0.085 per kWh, or from $105 to $178.50 per acre. If the gasification facility was collocated to utilize the additional heat of 10.8 million BTUs (equivalent to 108 therms of natural gas), at current PNM industrial rates of $0.70, this would be worth $75.60. Total energy production value would thus be $180.60 to $254.10.

High-density stands of salt cedar can yield 3500 trees per acre, or roughly 38 cords of wood. This would yield electric and heat energy worth $527.90 to $742.75. Based upon these numbers, the energy produced from harvested biomass would range from a low of $180.60 to a high of $742.75 per acre. In the worst case, removal and biomass-to-energy conversion would cost a net amount of $819.40 per acre. In the best case the eradication and removal program could generate operating revenue of $442.75 per acre. An actual cost of removal for different tree densities needs to be established in order to ascertain accurate cost/revenue potential. But in all cases the use of biomass as a fuel can be significant.

5. Legal Issues. None.

Preserve Deep Water for Drinking (A-15)

Alternative Action Statement

Preserve, but continue to draw deep-well water for drinking purposes only.

Alternative Action Description

Removing vast quantities of water from the aquifer is lowering the water table and creating various surface water problems. Proposal is to limit consumption of aquifer waters for drinking purposes only and obtain water for other purposes from other sources. As treated surface water may be added to groundwater systems, the drinking water quality will be significantly affected, possible affecting public health.

General Findings and Conclusions (as appropriate)

1. Technical Issues. The technical issue is how to deliver two grades of water to urban users. Installation of dual piping systems is a possible solution. Producing bottled water from deep well sources is another solution.

2. Physical, Hydrological and Environmental Issues. Maintaining water quality to comply with public health and drinking water standards is a key objective in this alternative. Treated surface and waste water should be provided for the non-potable water uses. Deep well water would have to be isolated and reserved for drinking and cooking purposes.

3. Social or Cultural Issues. Drinking water supplies would have to be strictly controlled through special infrastructure systems and regulatory enforcement. Historically, multiple uses of tap water have been the standard practice among consumers. Major changes in drinking water habits may or may not be acceptable to the public as a whole.

4. Economic Issues. There are costs associated with new and expanded water treatment and distribution systems. An entirely separate piping system would be extremely expensive. Although economically feasible, a bottled water distribution system would require significant public support, particularly if there is a tap water alternative of potable water.

5. Legal Issues. Imposition of variable water quality standards might have legal implications. Regulation and enforcement must be stringent in order to ensure appropriate water quality.

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Soil & Vegetation Management (A-33)

Alternative Action Statement

Establish erosion prevention measures and use soil and vegetation management techniques to reduce runoff and increase infiltration throughout the watershed, including forested mountains and uplands.

Alternative Action Description

Promote and expand watershed management programs. These programs could include a variety of conservation practices intended to slow runoff and reduce soil erosion. Examples of structural practices include earthen diversions in gullies and arroyos to slow the velocity of storm runoff, rock and brush or gabion baskets to protect stream banks, and installing livestock water in areas to improve grazing distribution. Management practices for ranchers could include planned grazing systems that encourage pasture deferment, and limited use of recreation areas on public land to minimize impacts to the soil and plant life.

Improve vegetation management by thinning forests to minimize fuel load and allow understory plants and native grasses to be established to improve infiltration and reduce runoff. This can be promoted on high elevation forests, upland sites that are experiencing an encroachment of piñon and juniper, as well as bosque forests that are dense with non-native phreatophyte species.

General Findings and Conclusions (as appropriate)

1. Technical Issues. .

Locally, there are on-going studies that attempt to measure the increase in water yield from the removal of dense vegetation. The Bosque Ecosystem Monitoring Program (BEMP) is one that is quantifying the change in groundwater levels in the shallow aquifer of the Rio Grande Valley. With efforts to remove the non-native phreatophytes, it is anticipated that consumptive use will be reduced and there will be an increase in water levels.

A project in Gallegos Canyon (a small drainage in the East Mountains that flows into the Estancia Basin) is measuring groundwater and surface water yields following the removal of piñon and juniper trees from upland and hilly sites. These trees were historically controlled by regular fires, but have encroached areas that were traditionally grasslands, due to fire suppression and overgrazing of native grasses. These trees take up much of the precipitation that falls on a site and the bare ground underneath them allows for greater erosion and runoff during intense storms. With the re-introduction and establishment of native grasses, more precipitation will infiltrate the soil profile and replenish the aquifer and less will flow down the slopes as runoff. This is one example of improving watershed health.

2. Physical, Hydrological and Environmental Issues.

In natural plant communities, the hydrologic condition of a site is the result of complex interactions between soil and vegetation factors. The interaction of these factors determines how water is partitioned into the hydrologic cycle. Research has shown correlations between kinds of vegetation, amount of plant cover, and soils to erosion, infiltration, and runoff.

Improved watershed health will have a long term, positive impact to the environment. A potential adverse impact may include changes to wildlife habitat as plant communities are managed to reduce densities. It is imperative that restoration and maintenance considerations are included in all vegetation management plans so as to minimize any adverse impacts that may exist to the natural resources of the area.

3. Social or Cultural Issues.

The significance of livestock operations to the history of the Southwest may bring about a variety of issues and concerns with respect to grazing management. Pueblos within the planning region have traditionally allowed grazing of livestock on both riparian and upland sites, with minimal management or controls. By improving education and focusing on grazing systems that include rest and rotation of pastures, the ranchers should be encouraged by the ultimate goals to improve grass production and reduce erosion on rangeland.

4. Economic Issues.

The cost of vegetative management varies significantly given the ecology of the site. High elevation forest thinning costs run anywhere from $1500 to $2500 per acre, depending on slope, access, and degree of infestation. Upland sites with piñon/juniper densities can be treated for as little as $100 per acre and rarely need to be re-seeded as native grasses have a tendency to naturally return over time. Riparian vegetative control has shown to cost $250 per acre in the Pecos River Valley where aerial applications are made to control salt cedar monocultures, to $3000 per acre in the middle Rio Grande Valley where mechanical treatment is needed to hand cut the non-native trees that are mixed in with native cottonwoods.

The resulting wood products have economic values such as firewood, construction materials, landscape mulch, and furniture or other decorative home products. PNM Signs, in Mountainair, has received a grant to utilize juniper wood chips to press and form into signs. A carpenter and artist in Edgewood utilizes thin salt cedar branches to decorate cabinets, shutters, and lamps. Wood chips utilized in residential landscaping will reduce the need for irrigation and also minimizes soil blowing.

As more attention is brought to the problems associated with dense vegetation, more financial opportunities through grants and state or federal programs could augment the cost to the landowner or manager.

5. Legal Issues.

Land ownership, federal and state authorities, and other legal jurisdictions may impede progress on a large scale management program. Ultimately, by coordinating with all owners and operators in a watershed, educating everyone as to the need to make improvements, and providing incentives for land managers to incorporate soil and vegetation management, these legal issues can be minimized.

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Storm Water Management (A-34)

Alternative Action Statement

Enhance and expand local government storm water plans and programs to control runoff using swales, terraces, and retention structures to minimize erosion, enhance infiltration and recharge, and prevent pollution of surface and ground water.

Alternative Action Description

Storm water discharges are generated by runoff from land and impervious areas such as paved streets, parking lots, and building rooftops during rainfall and snow events. Although such runoff waters may be harvested for localized use, storm waters often contain pollutants in quantities that could adversely affect water quality. Storm water management is a program comprised of two principal components: 1) minimizing the physically damaging effects of high volume storm water runoff, and 2) alleviating the contamination of land and water resources from pollutants carried and deposited by storm waters. In both cases, it is normally the responsibility of local governments to control storm water runoff and reduce any potential damage to the built environment while protecting the local water supply available to the community. Many local governments throughout the water planning region do not have adopted policies and plans for storm water management within their respective jurisdictions. This alternative action proposes that all local governments prepare, adopt, and implement storm water management programs to the maximum extent possible within the bounds of local financial capability.

General Findings and Conclusions (as appropriate)

1. Technical Issues. The technology required to channel, divert, contain, or otherwise control flooding due to storm water runoff is well developed and extensive. Flood control structures can be readily designed and built given adequate resources. Techniques for storm water pollution control design are commonly known but are not prevalent in this region.

2. Physical, Hydrological and Environmental Issues. There is a significant problem in mitigating storm water pollution as an element of the flood and runoff control structures in a community. Infiltration of storm waters may conduct pollutants from surface to ground waters. Vegetation can be used as a natural filtering system for polluted runoff as it moves through swales and natural channels built to convey storm water. Vegetation, however, is seasonal and is less effective during dormant periods.

3. Social or Cultural Issues. There are no significant social or cultural issues associated with this alternative action.

4. Economic Issues. Drainage control facilities are relatively expensive to build and maintain. Flood control structures are a long term investment to a community and typically require acquisition of property, large scale technical design and construction, and ongoing costs of operation and maintenance. Many of the local governments in this region lack financial resources for construction of flood control works and would require outside assistance to some extent. Both structural and regulatory control techniques to implement a storm water management program may affect the local cost of development.

5. Legal Issues. The City of Albuquerque is currently mandated under the USEPA Water Quality Act (Phase I of the NPDES storm water permit program) to implement a storm water pollution prevention plan which includes a description of pollutant sources and control measures. Phase II of this program will soon affect some of the smaller municipalities in this metropolitan region. The focus of such a program is control of pollutants at the source (i.e., gas station spills) which can be regulated through local government ordinances. There are also standard legal issues (i.e., liabilities) involved with the development and construction of a publicly-owned flood control system in the community.

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Wetlands (A-36)

Alternative Action Statement

Create constructed wetlands where feasible for groundwater recharge, water harvesting, and habitat improvement, and hydrological management of the Rio Grande.

Alternative Action Description

Use constructed wetlands as an alternative method for treatment of sewage and other forms of greywater. Technical considerations include the difficulty of protecting the wetland plants from destruction by heavy downpour and floods. In addition, a significant amount of water is lost to evaporation and evapotranspiration.

General Findings and Conclusions

In the Middle Rio Grande, they are rarely used today. The City of Albuquerque undertook a substantial wetlands study in the 1990s to determine if their large wastewater treatment plant should be modified to include them. They determined them to be unfeasible. Other municipalities have also examined their use as alternatives in studies to replace, upgrade, or expand their M&I wastewater treatment systems but the larger entities that treat wastewater have not employed them. There is a small wetlands system functioning very well in Corrales at a school. The Sandia Pueblo used one to treat wastewater from their earlier casino but it is now abandoned.

In the state, there are constructed wetlands in some communities, resorts, and some schools. There are some excellent examples in northern New Mexico and Arizona. They find greater acceptance and use in smaller installations, with wastewater that is relatively more easily managed, and at sites where the promotion of perceived environmental friendliness is a positive influence.

Wastewater treatment is normally paid for by user charges and includes significant private and/or public infrastructure. This infrastructure is part of an entity's public or private service program that is costly, requires professional management, and involves compliance with complicated federal, state, and local laws. The selection of wetlands as a treatment option should mainly be influenced by technical and cost criteria in a formal selection process that considers other wastewater collection, treatment and disposal options. Failure to make the right choices in these types of exercises can result in wasting large sums of public and/or private money, public health threats, public nuisances, and federal, state and local fines and penalties associated with costly legal and punitive action.

Generally speaking, they are infrequently used for municipal and/or private wastewater treatment in the region however some examples do exist on a smaller scale. Their main drawback in the region is their inability to deal with effluent discharge requirements and the fact that higher rates of evaporation result in their use when compared to conventional wastewater treatment processes.

1. Technical Issues. There are four major technical issues associated with this alternative:

- Treatment Efficiency: Constructed wetlands are indeed used to treat M&I wastewater in the US today. They are used as primary treatment processes and secondary and tertiary treatment steps. Their use is predicated by the type and strength of wastewater as well as its temporal constancy in terms of biological, chemical and physical characteristics, hydraulic considerations of the waste-stream, and the effluent standards of receiving waters. Their design can be tailored to fit influent wastewater characteristics and effluent discharge requirements. They are not however cost effective in some applications and in others they cannot meet stream discharge requirements in terms of finished water quality without significant conventional mechanical and chemical wastewater treatment processes associated with them.
- Evaporation: Perhaps a major drawback to the use of wetlands as municipal or private wastewater treatment systems in the southwest is high evaporation rates. While submerged wetlands maintain a water surface that is mainly just below the surface of constructed sand and gravel beds, considerable evaporation still occurs. Evaporation of significant amounts of wastewater that is in the wetland means lower return flow credits, and this therefore means that an entity that uses wetlands must have more diversion or withdrawal water rights. It also means that reuse opportunities are reduced as well as that water which evaporates is out of the hydrologic system.
- Land Requirements: Wetlands require larger site footprints than traditional smaller industrial type plant operations. Sometimes for larger flows, this land requirement can be in the several hundreds of acres, where a traditional system might only use 20 to 50 acres. Land cost and more importantly land availability is an issue.
- Operation and Maintenance (O&M): Wetlands do not operate by themselves. Qualified O&M staff is needed and daily attention to their operations is required. Failure to operate wetlands properly can result in public health hazards, nuisances, and eyesores, not to mention failure to meet discharge standards.

2. Physical, Hydrological and Environmental Issues. As noted above, constructed wetlands can sometimes require large land areas. This can be a problem in urban areas for larger applications. They also can be major environmental showpieces that can be used as educational tools and aesthetic centerpieces. Also as noted, from a hydrological perspective, they usually are characterized by higher total evaporation than conventional wastewater systems, thereby removing more water from local and regional hydrological systems.

Constructed wetlands can be refuges for terrestrial and aquatic wildlife and plants. This is sometimes a key factor in their use.

3. Social or Cultural Issues. The use of constructed wetlands can be seen by the public in a positive environmental light. Many environmental advocates actively promote constructed wetlands as an environmentally friendly method of dealing with wastewater treatment. Their successful use can be a very positive way to educate the public and specially children about several important issues such as municipal wastewater treatment and disposal, wildlife and plant habitat, and ecology. They also can be used as highly beneficial public walking areas and even nature parks.

However, there are no social and cultural issues associated with their use in the middle Rio Grande planning region today other than nobody wants a wastewater facility of any type to be sited near them.

4. Economic Issues. Constructed wetlands may or may not be the most cost effective choice when selecting wastewater treatment and disposal systems. Normally when they are being considered for use they are being compared to other conventional and in some cases other non-conventional treatment systems. Factors which are used to determine and rank cost effectiveness in these selection studies include:

- Capital cost of equipment;
- Capital cost of land;
- Estimated useful life;
- Annual cost of operations and maintenance; and
- Cost of system overall withdrawal and consumptive water rights as affected by return flows.

5. Legal Issues. The selection of constructed wetlands as municipal and/or private wastewater treatment/disposal systems is allowable under federal and state law. As with any wastewater treatment/disposal system employed publicly or privately, they are regulated by complex and stringent federal, state and in the case of the Middle Rio Grande, by Pueblo effluent discharge requirements.

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Vegetation Management (A-40)

Alternative Action Statement

Continue evapotranspiration studies and apply findings to vegetation management programs in the water planning region.

Alternative Action Description

Evapotranspiration is the water given off by plants. More research is needed to understand how much water comes from which types of plants and under what conditions. Use of this information may lead to further actions that minimize overall water loss. Evapotranspiration studies are one aspect of the surface water system interactions. Water is mainly lost to three factors: evapotranspiration, seepage, and evaporation.

The vegetation under consideration includes all types of vegetation found in the region, including riparian, grasslands, forest, agricultural, and urban. Research into the relative evapotranspiration (hereafter e.t.) of various types of plants will make it possible to modify the plant mix in order to reduce the amount of water lost to e.t. The savings can then be applied to other uses.

At the current time, research is underway to determine how much water is released from various types of plants and under various climactic conditions, including temperature, wind, humidity, solar radiation, and precipitation fluctuations. The challenge is to be able to accurately assess how much water is lost to e.t. during its downstream passage. There is still a lot that is unknown about what factors affect water loss and how. The amount of water a plant uses varies from year to year according to the specific climactic conditions.

Researchers know enough to make educated guesses about riparian e.t. rates, but there are still surprises. It is now known that e.t. from the bosque is about the same as that of land planted with alfalfa, about 4 a-f per acre. Removal of salt cedar alone may save 20-30 percent of the water currently being lost.

Crop water usage rates have been studied extensively over the past 100 years and the e.t. rates are much better known. Ongoing research takes place at the Ag Extension at NM State in Las Cruces. What is still to be worked out is whether alternative plants can be found that will be economically viable alternatives to what is currently in use. For instance, is there a low-water alternative to alfalfa that will serve equally well as animal fodder? Amaranth and quinoa are currently under consideration as alternatives.

Riparian water usage is roughly equivalent to crop water usage. Farmland along the Rio Grande floodplain, if returned to a riparian use, will continue to use the same amount of water. Therefore, it would be more effective to identify low-water crops than to stop farming.

A closely related issue is how land use affects natural recharge. Agricultural and riparian land allows water to be absorbed into the groundwater system; by contrast, residential and municipal land provides very little recharge. Therefore, water planning must take into consideration land use.

Upland watershed management is another area that can benefit from e.t. research. What are the water effects of junipers encroaching on range land? What are the relative e.t. rates of juniper and piñon areas versus grassland? Although changes to municipal, forest, and range land vegetation can result in some water savings, the bulk of the potential savings comes from riparian and agricultural areas.

A number of projects are underway related to vegetation management. Following are a few:

- Several agencies have partnered to develop the Upper Rio Grande Water Operations Model (URGWOM), a computer model of surface water behavior for the Rio Grande from its headwaters in Colorado, to Fort Quitman, Texas. This model simulates both e.t. and open water evaporation, and is based on actual weather station data and 3 hour forecasts of some conditions. The data is modeled in a decision support system known as the E. T. Toolbox.
- At the Plant Material Center near Los Lunas, the USDA and New Mexico County Extension Service are conducting research into drought-tolerant plants and alternative plants for agriculture and range land.
- The UNM Biology department is currently utilizing a network of towers that monitor groundwater levels, vegetation, and soil along the Rio Grande to collect e.t. data.
- At the Bosque del Apache, experiments are underway to measure e.t. of the bosque.
- Dr. Ian Hendricks of New Mexico Tech is using satellite information to characterize all kinds of e.t. in the Middle Rio Grande region.

General Findings and Conclusions (as appropriate)

1. Technical Issues. The E.T. Toolbox is the decision support tool being used by many who study e.t. It was developed by the Interagency E. T. Workgroup and is maintained by the Bureau of Reclamation using federal and other funding. The E. T. Toolbox uses real-time data from weather stations, and hydrological and land use monitoring networks. Algorithms for predicting water usage are derived from the real-time data. Currently the E.T. Toolbox is able to generate accurate *annual* numbers on e.t. in various locations. The goal is to get to the point where it can make accurate monthly, weekly, or even daily predictions. The expectation at the Bureau of Reclamation is that in 10-20 years they will be able to make direct measures of depletions using a kind of radar combined with satellite imagery.

The E. T. Toolbox has a number of practical applications. It is intended for:

- Estimating how much water is available to divert from the river for irrigation;
- Identifying how much water is needed in areas to preserve endangered species;
- Pinpointing areas of highest water use.

It could also be used to:

- Help parks and golf courses make more efficient use of water;
- Manage water use on farms (starting to do this in 2003);
- During droughts, could accurately estimate amount of water “saved” by temporarily ceasing to farm certain areas.

2. Physical, Hydrological and Environmental Issues. If all riparian vegetation were changed to low-water plants, it has been estimated that the total savings would be on the order of 70,000 a-f per year. The questions is, how will changes in crop, e.g. going from a cover crop to a shrub or row crop, affect erosion and soil quality long-term?

3. Social or Cultural Issues. New water management practices may encounter resistance, which might be overcome by showing how current usages can be maintained while using less water. Residents in riparian areas often resist ditch lining and vegetation removal initiatives. Sometimes the fiercest resistance comes, not from the farmers, but from their neighbors.

Some Pueblo communities make an annual festival of the ditch cleaning efforts. On the other hand, several pueblos, including Santa Ana, Sandia, Isleta, San Felipe, and Cochiti, are currently working to remove non-native species from their floodplains.

4. Economic Issues. Cost estimates for riparian restoration vary according to the source and the degree of infestation by non-native plants. One expert quoted an average of $2,000 per acre for mechanical tree removal and $500 per acre for restoration. One way to prevent recurrence of salt-cedar and other water-guzzling non-native species is to mow the affected areas annually. Cost per acre is estimated at $8-10 per year.

Research that has been going on for more than 5 years is in danger of losing funding. This applies to several of the research activities underway, including, notably, the E. T. Toolbox. The applied development cost to create and run the e.t. monitoring network is, roughly speaking, $500,000 per year. Currently this is federally funded. Once the research is completed, ongoing costs are estimated to be around $250,000 per year.

5. Legal Issues.

- Rio Grande Compact
  The amount of water New Mexico owes downstream depends on the total water supply. If changes to vegetation result in more water in the river, who is credited with the water that is saved?
- Endangered Species Act

If plant species are changed out to reduce e.t, how will that affect the animals, especially endangered species that currently inhabit that area? Will they lose their habitats? According to some experts, removal of non-native plants from riparian areas has actually been shown to improve the quality of life of the inhabiting species.

- Water Savings
  Who has rights to the water that is "saved" from e.t. by enhanced vegetation management? Who gets credit for saving the water, and what is the payoff?

Sources of Information

James Cleverly, Research Assistant Professor, Department of Biology, UNM. Professor Cleverly is involved in research of e.t. rates of salt-cedar.

Corinne Brooks, District Conservationist, Natural Resources Conservation Service, USDA.

Sterling Grogan, MRG Conservancy District. Mr. Grogan is a biologist and planner with experience as a landscape ecologist.

Steve Hansen, Deputy Area Manager for the Albuquerque Area Office (AAO) of the Upper Colorado Region, Bureau of Reclamation.

Other Resources

Video "Pulsing the Bosque", available from the Bureau of Reclamation, describes how e.t. data is collected and used.

The Value of Water: A Report to the City of Albuquerque in Response to RSP95-101-SV. Prepared by F. Lee Brown, et al, Albuquerque, New Mexico: the City 1996. Available at UNM.

"Year 2002 Progress Report of Activities", April 2003 issue, New Mexico Plant Material Center, 1036 Miller Street SW, Los Lunas, NM 87031 Tel: (505) 865-4684, FAX (505) 865-5163, Web Site: Plant-Materials.nrcs.usda.gov.

The USDA web site, nm.nrcs.usda.gov. Click on Field Office Technical Guide. The technological notes, by category, cover a wide range of information dealing with natural resources. The standards and specifications for a lot of the practices that they recommend (e.g. concrete ditches or water control structures) are in Section IV.

Middle Rio Grande Regional Water Plan
Abbreviated Evaluation of Alternative Actions

Weather Modification (A-42)

Alternative Action Statement

Conduct research on innovative water supply enhancement techniques such as weather modification.

Alternative Action Description

Implementation of weather modification projects could yield increases in precipitation in suitable locations within the region. Conducting research will not get water; however, “on-the-ground” projects could result in essentially new water falling into the region. Sufficient research exists to support a pilot project in this area.

General Findings and Conclusions (as appropriate)

1. Technical Issues. Basically a cloud seeding operation, weather modification programs can be conducted on both airborne and ground-based equipment. The key ingredient for success is a moist air mass moving into the region (which is infrequent in this area). Even though there might be a strong probability in generating precipitation, weather modification often leads to unpredictable results.

2. Physical, Hydrological and Environmental Issues. A cloud seeding program may lead to an increase in localized precipitation. Based on numerous cloud seeding operations around the country, it may be anticipated that there would be a 10 to 20 percent gain in precipitation in experimental target areas.

3. Social or Cultural Issues. None.

4. Economic Issues. Weather modification programs require staff meteorologists, weather radar systems, support aircraft, computers, and specialized equipment. Annual operating costs could range from $200,000 to $500,000, based on knowledge of programs in Texas, North Dakota, Kansas, California, and Oklahoma.

5. Legal Issues. It is not clear what legal issues would arise from a weather modification program. There may be an aggrieved party, for instance, if localized flooding is caused by a cloud seeding operation, or if someone feels that rainfall was diminished in one area by changing the natural pattern of rain storms in another area.

Middle Rio Grande Regional Water Plan
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Water Harvesting (A-44)

Alternative Action Statement

Encourage on-site rainwater harvesting.

Alternative Action Description

Rain averages 8 inches per year in this region. The vast majority of rainfall is lost to evaporation. If a percentage of this rain could be collected, it would provide a significant additional source of water.

General Findings and Conclusions (as appropriate)

1. Technical Issues. The technology to capture and use rooftop water already exists. However, the most effective ways to install such systems has not been worked out. Individual systems are currently implemented on a trial and error basis.

Rooftop water can be collected, stored, and distributed in several ways. For existing facilities, water may be collected in storage tanks placed under downspouts. However, due to the volume of water during a rain, the size of the storage tanks may become a problem. A better solution is to retrofit existing buildings to pass water by gravity into an underground cistern. Water should be filtered to prevent introduction of dirt and contaminants. A pumping system is needed to retrieve water from the cistern. Rooftop water may be used directly, without purification, for outdoor watering. A purification system would be needed to make the water available for non-potable indoor use, say, for flushing toilets, washing clothing, etc. For new construction, water collection and distribution systems can be built into the design.

Some study of best methods for implementing these water collection systems would be required. Once the approach is known, implementation could be accomplished in a short period of time if funds were available.

2. Physical, Hydrological and Environmental Issues. By enhancing water consciousness, this option might reduce overall demand. The figures provided by the Bernalillo County Assessor's Office indicate an estimated total of 298,646,312 square feet of residential rooftop space and 115,648, 406 square feet of commercial rooftop space in Bernalillo County west of the mountains. Assuming 8 inches of average annual rainfall, potential increased water supply is 5,704.45 acre-feet per year. Rooftop figures are not available for the rest of the region.

In order to realize the full savings possible here, water collection systems must have a large enough capacity to capture water during sporadic storms. Estimated total water available from a 1000 square foot rooftop would be 4937 gallons per year. Anecdotal evidence suggests that this could be enough water for all outdoor watering on a typical house lot set up for low-water usage. If outdoor watering were done primarily with rooftop water, it might reduce the depletion rate of the aquifer by nearly 5 percent.

The harvested water is generally believed to be safe for outdoor watering. In many cases, rainwater is cleaner and softer than surface water. Although there is contact with building materials, rainwater has not yet picked up many of the minerals found in soil and rocks or the pollutants that exist in streams and rivers. Quality of rainwater may also vary based on the air pollution in the region.

3. Social or Cultural Issues. None.

4. Economic Issues. Exact costs for each of the water collection, storage, and distribution options are not available at this time. Special tanks for storing water cost about $1 per gallon. Filters, pumps, cisterns, and retrofitting would entail additional cost. Installation costs can vary from a few hundred dollars to tens of thousands of dollars. Operational costs would include electricity required for pumping and replacement costs over time.

5. Legal Issues. There may legal issues concerning impoundment of storm water and impairment of water rights as well as issues bearing on the quality of harvested water.

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Well Head Protection (A-50)

Alternative Action Statement

Enforce well head protection programs on all public water supply wells within local government jurisdictions.

Alternative Action Description

Nearly all public water supply systems in the region withdraw water from underlying aquifers. Generally, multiple wells pump water into a storage and distribution system with connections to individual consumers in the water service area. The groundwater capture zone around public water supply wells (i.e., well heads) is by definition a vulnerable area. Well head protection programs are essential to protect the quality and safety of the water supply.

The federal Safe Drinking Water Act requires all states to develop well head protection programs. The New Mexico Environment Department (NMED) administers a program to identify and monitor all public water systems, including well heads, in the state. Well head protection areas (WHPA) typically define the groundwater capture zone that is vulnerable to pollution. The delineation of WHPAs can be defined through the use of computer models, calculated fixed radius, or arbitrary fixed radius (1,000 ft. radius in N.M.). Following the delineation of the WHPA for each public water supply well, a local zoning authority must identify potential sources of contaminants within the WHPA and manage the land use activities to prevent pollution of groundwater in the capture zone of the well. The well head protection program should also include a contingency plan for alternate water supplies in the event that pollutants are detected in water produced by the well.

General Findings and Conclusions (as appropriate)

1. Technical Issues. The optimum delineation of well head protection areas requires a detailed hydrogeologic investigation, contaminant transport research, and water system evaluation. However, a well head protection program can be implemented with the application of a fixed radius WHPA as the area for land use management and monitoring of pollutants.

2. Physical, Hydrological and Environmental Issues. The vulnerability of groundwater is extreme in well head protection areas. In the event that a pollutant gets into the capture zone and is detected in the water supply well, public health may be at risk and the well would have to be shut down until it is determined if the contamination can be mitigated. Ground water pollution affecting any public water supply well may be difficult or impossible to trace because the pollution might have occurred in the distant past. Of major concern are abandoned wells and underground storage tanks located in a WHPA.

3. Social or Cultural Issues. With the exception of restrictions placed on property owners on lands within a well head protection zone, there should few, if any, social or cultural issues associated with this program.

4. Economic Issues. There are administrative costs associated with enforcing this program. Generally, this will put a burden on the planning and zoning operations of a local government.

5. Legal Issues. Restrictions or prohibitions on land use activities within the WHPA can lead to claims of "constitutional takings" by land owners. Some well head protections ordinances include an amortization process for nonconforming (i.e., prohibited) uses

Middle Rio Grande Regional Water Plan
Abbreviated Evaluation of Alternative Actions

Evaporative Loss Accounting (A-51)

Alternative Action Statement

New Mexico should attempt to establish a more equitable accounting for evaporative losses of Rio Grande compact water in Elephant Butte Reservoir.

Alternative Action Description

It appears that evaporation from Elephant Butte reservoir, as it pertains to the Middle Rio Grande, was accounted for and accommodated when the former gaging station at San Marcial was abandoned and moved to Elephant Butte Dam by resolution of the Rio Grande Compact Commissioners in February 1948. It would likely be very difficult to obtain unanimous consent of the commissioners to reopen the Compact to address this issue alone. However, if this matter was tied to sharing the benefits accruing to all compact signatories if large volumes of Elephant Butte water were stored upstream at higher elevations where significantly less evaporation occurs, it might be introduced as part of the deliberations.

General Findings and conclusions

1. **Technical issues.** None, except as it pertains to equitable division of any saved Elephant Butte water as a result of less evaporation.

2. **Physical, Hydrological and Environmental issues.** None.

3. **Social or Cultural Issues.** None, except those associated with a smaller Elephant Butte lake if significant storage is moved elsewhere.

4. **Economic Issues.** Any change in the compact that results in more water in the Middle Rio Grande would have a favorable economic impact.

5. **Legal Issues.** It is likely that any change in the compact would precipitate legal challenges.

Comment: 1. There is no provision in the RG Compact that requires NM to keep a certain amount of water in Elephant Butte Reservoir. 2. Why leave Colorado out? 3. Unless it's handled elsewhere as an Alternative, this might be the place to add TX and CO sharing the Federal Court ordered Silvery Minnow water requirements, also

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I'm not sure it would be in NM's best interests to attempt to gain a more equitable sharing of EB evaporation. The original RG Compact, when deliveries to EB reservoir were measured at San Marcial, let NM (MRG) consume a maximum of 261K acre feet (exclusive of and permitting NM to ignore and not have to account for Otowi flows during July, August and September). This maximum occurred when the gaged supply at Otowi was 1,100K and 1,200K af. When the Otowi supply was less than 1,100K af or more than 1,200K af, use of compact water in the MRG was severely curtailed. For instance, if the gaged Otowi supply was 500K af, we had to pass on to EB 300K af and could deplete 200K af. When the Otowi gaged supply reached 2,300K af, NM was required to deliver 2,253K af, retaining only 47K af compact water for the MRG. Perhaps the assumption then was that if there was that much more runoff than normal (1,100K - 1,200K af) at Otowi, especially since this volume didn't include the "monsoon" months of July, August and September, it must be an exceptionally wet year and the MRG could get by on rainfall and tributary runoff. In an average irrigation water year, the excluded months could be expected to produce 150-250K af (that would be added to the maximum 261K af permitted by the compact).

Because the river gages at San Marcial and San Acacia became inoperative and unreliable, the Compact Commission, at a meeting in El Paso February 22-24, 1948, passed a resolution that acknowledged and approved the abandonment of the San Acacia and San Marcial gages and established a new gaging station at Elephant Butte Dam. Sub paragraph (c) of the Resolution reads, "(Therefore be it resolved) That it is desirable and necessary that the obligations of New Mexico under the Compact to deliver water in the months of July, August and September, should be scheduled," thus eliminating NM's ability to ignore summer flows for accounting purposes. Subparagraph (d) reads: "That the change in gaging stations and substitution of the new measurements as hereinafter set forth will result in substantially the same results so far as the rights and obligations to deliver water are concerned, and would have existed if such substitutions of stations and measurements had not been so made." All the RG Commissioners and the AG's of all 3 states agreed to the changes and that they constituted no significant departure in compact water deliveries.

The new schedule for Elephant Butte deliveries implemented by this resolution "tops off" MRG consumption at 405K af when 1,200K or more af are gaged at Otowi.

It would appear that when the compact was changed to its latest accounting system that the EB evaporation factor was taken into consideration and that the MRG was not shortchanged. According to USBOR records, balance in compact deliveries is achieved when, in an average irrigation water year, 707K af are made available to southern NM, TX and Mexico. This condition is met when 1,300K or more af flow past Otowi and the MRG takes no more than its allotted 405K af. If there is more volume, NM gets a credit. If there is less, we run a deficit if we take more than the MRG compact's scheduled deliveries.

This is a lot more than you want, but it helps explain why I have felt throughout all these deliberations that EB evaporation is not a significant factor and is a non-issue in the MRG's water plan.

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Public Involvement in Water Planning (A-53)

Alternative Action Statement

Through open and inclusive processes, ensure public involvement in water planning by continuing regular public information/dissemination programs, public outreach campaigns and citizen planning committees. Keep the public engaged in this process.

Alternative Action Description

As the public becomes better informed on the scale and complexity of the region's water problems there will be more pressure for change, because that understanding will motivate people to take the individual and collective actions necessary to solve them. And by promoting the participation of people representing a wide variety of interests, the public involvement program also will demonstrate the broad-based support needed to implement the plan's other alternative actions.

Public involvement should include education programs in public and private schools about the social, cultural, economic and environmental importance of water in New Mexico, and the imperative for conserving and using this resource as efficiently as possible. It also should include local and regional education programs for the general public to foster greater awareness of water issues and to promote water conservation.

Liberal use of both print and electronic media should be employed in conducting public involvement programs.

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Regional Water Planning Program (A-58)

Alternative Action Statement

Establish dedicated and continuing funding for Regional Water Planning as an ongoing process and as a basis for water management at local, regional and state levels.

Alternative Action Description

The New Mexico Interstate Stream Commission was authorized by the N.M. Legislature in 1987 to provide funding for regional water planning. Limited funding has been provided for nearly all of the succeeding years. All regional plans are anticipated to be completed by the end of 2003; however, ongoing funding for implementation of regional plans is anticipated.

Regional water planning requires coordination and collaboration by multiple governmental jurisdictions in a regional setting. Implementation can be achieved through the combined actions of numerous governmental entities working together to achieve the goals and objectives stated in this Regional Water Plan. Nevertheless, there needs to be a regional organizational structure to ensure planning progress oversight, development and implementation of consistent local water management programs, provision of a central forum for multi-jurisdictional collaboration, and public outreach and education programs.

General Findings and Conclusions (as appropriate)

1. **Technical Issues.** There are no significant technical issues involved in implementing this alternative.

2. **Physical, Hydrological and Environmental Issues.** There are no significant physical, hydrological, or environmental issues involved in implementing this alternative.

3. **Social or Cultural Issues.** In order for the regional planning process to succeed, public participation is necessary to provide input to the plan components. Social and cultural issues need to be identified and considered in the preparation, update, and implementation of the regional water plan. There is a potential for incompatible and contentious local water management activities without consensus on regional water policy.

4. **Economic Issues.** The State Legislature has not appropriated adequate funding over the years to complete regional water plans in a timely manner. Ultimately, 16 regional plans need to be maintained, up-dated, and implemented, and integrated into the State water plan in order to provide for a coordinated and

cooperative local and regional perspective in long-term water resource management. Dedicated funding assistance would allow regional water planning agencies to achieve the goals of the water plan and ensure successful implementation. Most local governments do not have sufficient resources or technical capabilities to carry out the recommendations of the regional water plan.

5. Legal Issues. Regional water management authority is limited by statute. Thus regional water plans must be implemented through local government collaboration, joint powers agreements, and other means of multi-jurisdictional cooperation.

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Acequia Conservation Programs (A-60)

Alternative Action Statement

Fund irrigation organizations to develop and implement water conservation programs.

Alternative Action Description

There are two types of irrigation organizations in the Middle Rio Grande planning region: traditional acequias and Conservancy District ditches. Currently, all of the NM Office of the State Engineer (OSE) recognized acequias in the planning region are located in Sandoval County. (See Alternative Fact Sheets 7, 9, and 10). The MRG Conservancy District MRGCD was originally some 70 to 80 acequias located along the Rio Grande in the planning region. They are now part of a larger irrigation system although there are still several MRGCD units that very much resemble traditional acequias.

Conservation in irrigation and efficiency in irrigation are two different subjects. Conservation involves reducing consumptive use. Efficiency improvements deliver less withdrawal or diversion but do not reduce consumptive use; therefore technically, they would not necessarily be part of any irrigation conservation program. There are three ways to conserve irrigation water in the middle Rio Grande:

- Grow less crops and thereby consumptively use less water;
- Induce the existing quantity of crops to produce the same yield while at the same time reducing their consumptive use of water; and
- Change high water use crops like alfalfa to lower water use crops like some of the other field crops or high value crops.

While each of these is possible none are particularly promising without a considered program that would include willing and active acequia *parcientes* participation. A fourth way to reduce irrigation water consumptive use involves *water banking*. If a farmer decided not to plant crops in a given year and allowed the water not used to be leased, through a water bank, to another farmer or to another non-farm user this would be a form of conservation as consumptive use would be reduced.

General Findings and Conclusions (as appropriate)

The chief organizations that could develop and implement such programs if they would be possible would be the NM Department of Agriculture through their experimental stations and Officers and the USDA National Resource Conservation Service (NRCS).

1. Technical Issues. There are few technical issues, but they are formidable and they are listed below. However, while they would appear to discourage this as an alternative there are opportunities to carry out programs that would result in irrigation water conservation.

- Measurement: The acequia diversions in the planning region are not metered. They do not keep records of water diversion, drainage, and/or return flow. Without metering of these flows at the ditch and the farm level there is no way to know how effective any program can be. If a program was in fact agreed upon, this could however be overcome in terms of estimating how much water has been diverted historically at the main ditch level and at the farm level. However, meters should be installed on any acequia that would participate in such a program in order to gauge future results.
- Reduction of consumptive use through advanced irrigation systems: At this time most *parcientes* farming their land employ flood or furrow irrigation. They also mainly grow alfalfa. Experiments are being conducted in New Mexico using sprinkler irrigation for alfalfa. Perhaps this is a method to reduce the consumptive use of water in existing fields. This needs further study.
- Reduction of consumptive use through crop substitution: It is fashionable to suggest that MRG farmers should substitute their existing alfalfa and filed crops with other field crops and high value crops that will bring a higher economic return and use less water. IF this was a good idea, local farmers would already be doing it as they farm to create income. There are formidable constraints to this approach to reducing the consumptive use of irrigation water. They include, lack of farm labor, risk of crop failure, additional soil additives, additional herbicides and pesticides, additional pre-planting monies needed to start such crops, and the need to plant every year as alfalfa is only planted once every five years. And last but certainly not least, where are the markets for such high value crops? Farmers would have to find and understand how to work the market for such new crops: not an easy task. Today in the MRG planning region, there is a healthy market for alfalfa.

2. Physical, Hydrological and Environmental Issues. Reduction of the consumptive use of irrigation water is indeed physically constrained by the types of farms that are now found in the planning region's acequias. While some farms are larger than others, there are more and more smaller farms due to the sub-division of the farm land among farmer families. As farms grow smaller, their options to employ creative solutions to farming and conserving farm water can decrease and become more expensive per unit of farm area. Also from a physical perspective, one must realize that smaller farms means the lass able a farmer is to own their own farm mechanical equipment. This could be a constraint. Also, the smaller the farm, the less money a farmer might have to implement such a program on his/her own, even if it was subsidized.

From a hydrological perspective, reducing consumptive use on farms would result in reduced diversions. This would mean that more water could stay either upstream in reservoirs or in the water course enabling that saved water to be perhaps used for other irrigation or some other beneficial or non-beneficial use. It should be noted that irrigation system conveyance efficiency improvements will also result in much less diversion but also less seepage or return flow. This is not conservation.

There would be no apparent negative environmental effects to promoting farm water consumptive use conservation.

3. Social or Cultural Issues. Farming on acequias or in the MRGCD system is a major cultural activity in the planning region. There are many farmers who feel threatened by the growing urban areas in the planning region and they see this growth competing for the limited water resources that exist in New Mexico. They rightly argue that they hold senior water rights and as such they are entitled to the water. Meanwhile, their access to water and water availability is negatively affected by junior water rights holders use and conjunctive use effects.

Other residents in the planning region see the reduction of farmland through the retirement and sale of farmland for residential, commercial and industrial sites as a blow to the character of the region. They argue vociferously that growth should be controlled so that farmland can remain. Ironically, these same people call for infill residential and commercial development in the planning area which in fact adds pressure to the sale and conversion of urban farmland. This is a serious issue in the planning region that has more argument and ill-feelings attached to it than potential solutions at this time.

4. Economic Issues. As noted above, as farmland becomes more valuable to land developers, most farmers will more readily sell their land as it makes more sense from an economic standpoint.

In terms of developing and implementing an acequia or even a small farm conservation program that could be accessed by farmers served by the MRGCD, see Alternative 10. An On-Farm Water Management (OFWM) program is outlined therein. Something like this could be modified to include acequia water conservation. External funding could also be sought from federal and state sources.

Note that there is already federal and state funds available to assist acequias improve their efficiency. Federal funds are available through the US Army corps of Engineers Acequia Improvement project. State funds are also available through a similar program administered by the NM Interstate stream Commission.

5. Legal Issues. According to NMOSE water rights permits for irrigation, seepage is a return flow. Thus, reducing seepage through on-farm efficiency improvements is not conservation. If this were changed then conveyance and on-farm efficiency improvements would indeed *reduce losses* instead of *reducing return flows* and thereby be conservation improvements.

Water banking represents a possible way to conserve farm water within acequias. *Water banking* regulation is starting to be developed within the legislature.

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Domestic Well Controls (A-61)

Alternative Action Statement

Reduce the allowed pumping from domestic wells and restrict drilling of domestic wells where surface waters or the aquifer could be impaired.

Alternative Action Description

This Alternative Action consists of two separate and distinct actions; therefore they will be discussed and analyzed separately.

1. Reduce the allowed pumping from domestic wells.

In accordance with existing law, the State Engineer is obliged to issue a permit to individual homeowners to drill a well and pump up to three acre-feet of water per year for domestic use.

It is important to note that the State Engineer does not have accurate information on the number, location, and characteristics of all domestic wells in the State. Consequently, it is difficult to determine if the cumulative effects of domestic wells represents a serious water consumption problem or even if they consume a proportionately large amount of water. Although personnel in the Office of the State Engineer have provided rough estimates of the amount of water consumed by domestic wells in the Middle Rio Grande region, the estimates are not supported by definitive data or statistical evidence.

Funds should be appropriated to conduct definitive studies and obtain sufficient data to determine the actual consumption and impact of domestic wells. However, until such time as definitive studies and data become available, existing data should be used and action should be taken only to aid in identifying and regulating critical management areas and assuring that domestic wells are drilled and maintained in a manner that protects the underlying aquifer from pollution. Further regulation of domestic wells should not be attempted until sufficient data is available to support the basis for such regulation.

2. Restrict drilling of domestic wells where surface waters or the aquifer could be impaired.

There are areas where individual or community domestic wells have been drilled causing severe drawdown of the aquifer and resulting in impairment to surrounding existing domestic wells and surface water sources as well as the condition of the aquifer. These areas may be designated as “critical management areas." The State Engineer should continue to identify and regulate critical management areas and assure that domestic wells are drilled and maintained in a manner that protects the underlying aquifer from pollution. The installation of meters on the domestic wells drilled in critical management areas should be required.

Although the State Engineer and others have recognized actual and potential critical areas of domestic well use, the criteria for defining these "critical management areas" should be standardized. Furthermore, the existence of critical management areas should not be cause for widespread restrictions on domestic wells.

There is also need for subdivision development legislation that (1) would require that any proposed new development clearly identify the source of water; (2) assure that the source will be adequate in the future; (3) require the acquisition of sufficient water rights; and, (4) assure that the development will not deplete surrounding water user's water sources.

General Findings and Conclusions (as appropriate)

In order to assure that domestic well owners comply with the reduction in permitted pumping rates, metering of domestic wells will also have to take place. Accordingly, these findings and conclusions include those that are presented in Alternative Action A-8 (Meter all supply wells), including domestic wells, throughout the water planning region.

1. Technical Issues.

a. Initial Cost to Implement

- Depending how metering is performed, there may be significant cost factors involved in metering all domestic wells including the cost to individuals for the purchase and installation of meters.
- It is estimated that a meter will cost approximately $400 including installation.
- Based on the foregoing, it would cost approximately $60,000,000 to install meters on all domestic wells in the MRG.

b. Ongoing Cost for Operations and Maintenance

- The cost to the taxpayers for the bureaucracy to read the meters could be significant.
- Possible cost savings in meter reading might result if a "post card" system were instituted whereby owners would read their meters and report consumption.
- Radio transmission and remote receipt of well meter readings might be another possibility; however, meter purchase cost could be substantial.

- As in any permitted public use there are violations which should be reduced or eliminated through enforcement. Unfortunately, the State Engineer has no enforcement authority. This should be remedied through legislation.

c. Potential Funding Sources

- In order to accomplish domestic well metering fairly and adequately the State Legislature would have to appropriate funds for the purpose.
- Legislation could require that meter purchase and installation be borne by the well owner. Consideration of this possibility might doom such proposed legislation.

d. Implementation Time

- If the cost of meter installation is borne by State appropriation completion of metering throughout the MRG would probably take 20 or 30 years.
- If the cost of meter installation is borne by individual well owners completion of metering could be accomplished sooner.

2. Physical, Hydrological and Environmental Issues.

Effect on Water Supply

- Even If metering of domestic wells revealed widespread and substantial consumption exceeding three acre feet per year and the pumping limit was reduced, considering that most water consumed in-doors is eventually returned to the aquifer via septic systems, the long term impact on the water supply would only result from outdoor use.
- If metering of domestic wells revealed excessive consumption to the individual owners an incentive to use less water might result.

3. Social or Cultural Issues.

Before the law was passed limiting the pumping from domestic wells, it was a tradition in New Mexico for rural residents to use sufficient water from wells to provide for family live stock and gardens. There is reason to believe that when the limit for pumping from domestic wells was established at three acre feet per year, this tradition was being observed.

4. Economic Issues.

There could be a significant economic impact on properties that lie within a State declared Critical Management Area. In other circumstances, purchase of meters for installation by individual well owners would benefit local suppliers. Purchase and installation by others would benefit local suppliers as well as well drillers and/or plumbers.

5. **Legal Issues.**

Regardless of the grounds, but in view of the considerable public objection to changing the domestic well statutes, legal action might be expected. In particular, if a well permit is denied, there may be legal claims for compensation as a constitutional taking issue.

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Importation of Water (A-69)

Alternative Action Statement

Acquire additional water rights without condemnation from various sources from within or outside the water planning region, and import water from other basins where possible.

Alternative Action Description

Under NM law, water rights are regarded for most practical purposes as a property right and they can therefore be sold, leased, transferred and/or condemned if it is in the public and/or private interest to appropriate and/or transfer water rights to other users and/or for another beneficial and/or non-beneficial use. Further, there are some who say that it is becoming increasingly difficult to find water rights sellers and the cost to purchase and transfer water from place to place can be high or is increasing. Certainly the sale of water rights occurs frequently in New Mexico and in the region and is referred to as *water marketing*. The *water market* in the region and the state is active. There are state rules and regulations that govern the sale, lease and transfer of water rights.

General Findings and Conclusions

Water rights can be acquired from surface- and/or ground-water sources that have already been developed and those that are undeveloped today; from public and private water rights holders; and locally or state wide in the same watershed in which their future use is planned or from other basins. Their sale and or lease are regulated by specific state laws and are overseen by the NM Office of the state Engineer (OSE). Water rights sale and/or lease are complicated by:

- The apparent fact that most if not all surface water bodies and ground water basins are over-appropriated;
- Conjunctive use issues between ground- and surface-water withdrawals and return flows; and
- Most watersheds have not been adjudicated.

There is a body of literature on water marketing throughout the southwest and in New Mexico. Water rights purchase and or lease can and probably will play an important part in the MRG planning region's ability to add additional water that will be needed for future population growth and economic development.

1. Technical Issues. There are several technical issues that will dictate how and from where water rights can and will be transferred into the planning region. They are:

- Study and Planning for the Capture of Available Alternative Water Sources[1]: These water sources fall into the categories of new water and salvaged water, and the water supply entities in the MRG planning region and the OSE should use all means available to evaluate, establish and pursue water supplies that are currently un-appropriated or available. These water supplies include:
    - Inter-basin transfers;
    - Acquiring new water, through exchange, lease or purchase;
    - Moving water from other states;
    - Purchasing compact water;
    - Leasing tribal water;
    - Using or leasing additional groundwater or surface water not currently in use, such as the Ute Pipeline, Navajo-Gallup, North Plains aquifer, Gila River water, SE San Juan Basin aquifer, Central AZ Project Water;
    - Exploring the possibility of using abandoned oil pipelines that exist all over the US to bring water in to the state from other regions, keeping in mind that other states have greater financial resources and thus exercising caution in negotiations;
    - Implementing a study of extracting water from air;
    - Cloud seeding (precipitation augmentation);
    - Investing in research and development for new technology;
    - Genetically engineered plants with lower water needs;
    - Investigating tax credits to fund research/implementation for technology transfers;
    - Investigating aquifer storage and recovery and wastewater recharge;
    - Creating infrastructure for water storage;
    - Flood control aquifer recovery;
    - Reusing potable water or re-injecting it into groundwater;
    - Land management of bare soil;
    - Restoring and maintaining watersheds and riparian areas, including forest management on federally controlled lands;
    - Constructing wetlands/recharge projects;

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[1] New Mexico First, ***Interstate Stream Commission New Mexico First Town Hall Corrected Draft Consensus Report: Developing A Comprehensive State Water Plan***, Albuquerque, New Mexico, September 23-25, 2003 (Much of this section has been taken from this document and modified slightly)

- Controlling non-native phreatophytes as long as there is re-vegetation and restoration of ecosystem function;
- Aggressive clean-up of contaminated water;
- Reclaiming brackish, uranium mining, and high-saline ground water; and
- Desalinization (including the construction of desalinization plants) and the quantification of saline water resources.

The state should also explore interstate and international cooperation in the development of a high-saline treatment facility located at the mouth of the Rio Grande, which would provide freshwater to be piped upstream to Chihuahua, Texas, and New Mexico. Further, the state and the entities in the region should study:

- Expediting the present statute that allows treatment and use of water produced from oil and gas operations;
- Extracting water from oil/mineral development;
- Reducing evaporation losses;
- Evaporation suppression on surface water reservoirs and minimizing evaporation through such ways as storage upstream, underground, floating solar panels on Elephant Butte, keeping Elephant Butte at lower level; and
- Recovered losses from reservoir evaporation through groundwater storage and retrieval and storage at higher elevations. However, salvaged water projects must be assessed for their impacts on downstream users and compact deliveries (e.g. significant increases in use of salvaged water will result in declines in return flows that may require offsets to meet downstream obligations).

In the area of salvaged water (that which is reused and conserved), projects recommended for consideration include:

- Rain water harvesting and catchments;
- Re-use or piggybacking;
- Using geothermal water for energy and re-injection;
- Re-circulation of hot water;
- Gray water use;
- Water reclaimed through better more efficient treatment of sewer effluent; and
- Recycling water where economically feasible.

In addition to projects to increase supplies through new and salvaged water, the MRG planning region water entities and the OSE should pursue policy initiatives aimed at closing the gap between supply and demand, including:

- Developing a regulatory framework for intrastate water banking;
- Offering tax incentives to encourage use of produced water (especially water associated with coal-bed methane production);
- Sharing the burden of federal mandates, such as ESA and Indian water requirements, with other states; the state should pressure the federal government to make this a reality;
- Tax credits for xeriscaping;
- Requiring some users (such as golf courses) to look into using alternative water instead of depleting municipal water; and
- Tax incentives and new regulations to encourage domestic use of gray water.

A more complete list of promising initiatives and technologies that may be applicable to the MRG planning region water entities can be found in the regional water plans for Tularosa Basin Salt Basin, Lower Pecos River Basin, and the Carlsbad River Operation EIS.

- Implementation: With regard to the development of alternative water supplies and obtaining additional water rights, the water supply entities in the planning region and the OSE should actively pursue strategic partnerships to encourage development of new water supplies. The State also should finance research on alternative water sources, as well as practices and technologies that reduce residential demand support, and consider establishing a clearinghouse for the development of alternative water supplies. Mechanisms for funneling capital into research and development should include funding demonstration projects' procuring federal grants; and cost-sharing with municipalities or other government entities. All of these activities or those selected can result in additional water rights being transferred into the planning region.

2. Physical, Hydrological and Environmental Issues. All of the possible initiatives that could result in new water or salvaged water accruing to the water supply entities in the region have a myriad of local, regional and state physical issues such as topography, distance from the planning region, and water quality issues.

Hydrologically speaking, any development of new water sources, salvaging water, or acquiring and/or transferring water rights must make sense on a hydrological basis in terms of wet water transferability to the region.

There could be both positive and negative environmental issues that arise from any water rights acquisition. Each new possible project needs to look at the environmental effects of any transfer separately.

3. Social or Cultural Issues. There are no direct social or cultural issues however; there are special interest groups and residents of the MRG planning region who see the ability of water supply entities in the region to acquire new water rights as a potential way to fuel population growth and economic development. They believe that any growth that does occur must be sustainable and planned to the exclusion of acquiring water rights.

4. Economic Issues. Any water rights acquisition or development of other sources will be expensive. Monies to pay for simple acquisition of water rights will be significant. Using the City of Rio Rancho for example, if the City wishes to purchase say 12,000 AF of consumptive water rights at $5,000 per AF, this would mean that the City needs to have $60 million for this purpose. Such a sum can be obtained through a General Obligation Bond but would certainly mean an increase in water and sewer rates for existing and new utility customers. Such issues will be complex and politically charged.

In the case of developing water sources, similar magnitude expenditures will be required for any entity contemplating such a project. Needless to say, the development of new water and/or the acquisition of new water rights will be costly for any entity in the region. It will be also bound to have cost increasing effects on utility bills in the future: not only for new customers but for existing customers as well.

5. Legal Issues. Each of the possible water source development projects noted earlier will have a raft of legal issues to be dealt with during study, implementation, water rights acquisition, and reviews and approvals. These issues will be at the federal, state and local level. In some cases, laws will have to be changed and/or amended.

Middle Rio Grande Regional Water Plan
Abbreviated Evaluation of Alternative Actions

Adjudicate Water Rights (A-71)

Alternative Action Statement

Identify, quantify, and adjudicate all water rights and all wet water quantities in the water planning region.

Alternative Action Description

Adjudication of water rights is the legal process for establishing a right to use certain waters, determining a priority date, and quantifying the extent of the water right. Adjudications are essentially quiet title lawsuits, the parties to which are all water owners and claimants sharing the same source of water. An adjudicated water right is a final binding determination of a water right. An adjudicated water right supercedes any permit, license, declaration affecting that same water right.

General Findings and Conclusions (as appropriate)

1. Technical Issues.

Hydrographic Surveys Are a Needed Prerequisite to Adjudications. By law, the State Engineer "shall make hydrographic surveys and investigations of each stream system and source of water supply in the state . . . ." § 72-4-13 NMSA 1978. It is "[u]pon the completion of the hydrographic survey of any stream system" that the State may file and prosecute an adjudication." § 72-4-5 NMSA 1978. While it is possible for non-State parties to file an adjudication lawsuit, once "any such suit has been filed the court shall, by its order duly entered, direct the state engineer to make or furnish a complete hydrographic survey of such stream system . . . in order to obtain all data necessary to the determination of the rights involved." § 72-4-17 NMSA 1978. For this reason, the first step toward adjudicating this region is completing hydrographic surveys of this region.

2. Physical, Hydrological and Environmental Issues.

Adjudications Enable Quantification of Water and Better Management of Water. Courts have the sole authority to make the final determination of the amount of water supply within a stream system and who may use what amount of water, in what location, and under what priority date. <u>Public Service Company v. Reynolds</u>, 68 N.M. 54, 59, 358 P.2d 621 (1960) (The State Engineer does not have the power or the authority to adjudicate water rights; only courts have this power and authority).

In the past, lack of adjudication has practically precluded the State Engineer from strictly managing water rights under the priority system, both in time of shortage and for enforcement purposes. In 2003, the legislature enabled the State Engineer to adopt rules for priority administration in the absence of adjudicated water rights. § 72-2-9.1 NMSA 1978. However, it remains to be seen how the State Engineer will accomplish this task.

For these reasons, adjudications are important prerequisites to better water management in this region– both for purposes of a person's right to lawfully use the full extent of his, her, or its water in accord with the priority system, and for purposes of meeting the State's compact obligations on the Rio Grande.

3. Social or Cultural Issues.

Adjudications Include Indian Water Rights. Adjudications necessarily involve all water users in a stream system. § 72-4-17 NMSA 1978. This includes water use by Indian tribes and pueblos. Adjudication is therefore a means of addressing how the Indian water rights in the region fit together with the non-Indian water rights in the region.

4. Economic Issues.

However, Adjudications Cost Money. From a state perspective, the State Engineer's Office needs appropriate funding to prepare hydrographic surveys (and other technical information) and to prosecute adjudications. While the State is able to settle many water rights claims within on-going adjudications without litigation (see below), some private parties will incur significant legal expenses in the course of an adjudication.

5. Legal Issues.

Adjudications Take Forever. New Mexico adjudications can take years if not decades to complete. The adjudication process involves: first, the State identifying and surveying every water right claim; second, the State making a written offer to each claimant defining the characteristics of his, her, or its final water right; third, the claimant may accept the offer; or fourth, if the claimant rejects the State's offer, the claimant litigates the characteristics of the water right; and, following hearings, the Court issues a final decree defining the water rights of each claimant on the stream system. Some options for speeding up the adjudication process may be developing a special water court system or increasing alternative dispute resolution methods.

Middle Rio Grande Regional Water Plan
Abbreviated Evaluation of Alternative Actions

Maintain Water Resource Database (A-73)

Alternative Action Statement

Establish and integrate a regional Geographical Information System (GIS) database of publicly accessible information on water resources and photo imagery covering the water planning region.

Alternative Action Description

A regional water resource database needs to be maintained within the region and made accessible to any water management entity as well as the general public. The regional data should be compiled and organized according to State-approved standards to allow for ready exchange of information between this region, adjacent regions, and the Office of the State Engineer. This regional data and information can be available as a basis for historical trend analysis, current conditions profile, and future projections of water supply and demand.

There are various governmental agencies and educational institutions that compile and maintain geologic, hydrologic, and geohydrologic information pertaining to this water planning region. Critical water resource areas will need to be delineated throughout the region for purposes of aquifer protection, groundwater quality, and watershed management. Regional mapping establishes a common base for multi-jurisdictional and multiple service area agreements concerning the protection and preservation of water resources. All of these data need to be identified and filed with easy access for purposes of regional and local water planning.

General Findings and Conclusions (as appropriate)

1. Technical Issues. A significant portion of the regional water resource database has been and will be input to GIS files. There are numerous agencies and companies that have GIS capability. In a practical sense, a regional database will likely be carried out through a network of entities working in combination and cooperation to produce and maintain comprehensive information on the region's water resources. The problem will be providing for linkages and accountability for decentralized data banks.

2. Physical, Hydrological and Environmental Issues. Such issues will be defined, characterized, and supported by a regional water resource database.

3. Social or Cultural Issues. Such issues will be defined, characterized, and supported by a regional water resource database.

4. **Economic Issues.** Although the cost of computerized mapping and data management can be high, there would be benefits in terms of regional and local water management efficiencies, less duplication of effort, standardization of water-related information, pooling of local resources, and incentives for cooperation in water programs.

5. **Legal Issues.** None.

Middle Rio Grande Regional Water Plan
Abbreviated Evaluation of Alternative Actions

Active Resource Management (A-143)

Alternative Action Statement

Support the concept of pro-actively managing the state's water resources.

Alternative Action Description

This is the current policy of the New Mexico Office of the State Engineer. It is actively supported by this regional plan. Active water management by the state was first introduced as "Active River Management" a few years ago by then state engineer Tom Turney, replacing the former policy of simply administering water rights. In New Mexico's physical and hydrological environment, groundwater and surface-water water resources are fixed (though surface water varies markedly from year to year) but the demand for water will continue to increase, as it has in the past. Optimum and equitable future distribution of water can only be assured by an active and efficient management program. That program should be aimed at efficient use of the water to protect New Mexico's ambience, to maximize public welfare, to protect property rights, and to prevent outside appropriation of state waters. The state's management plan should be based on fundamental principles embodied in state law; inconsistences and conflicting guidance within the law should be resolved within the state political system.