Exhibit 27A: Detailed Discussion of Alternative 27—Reuse Treated Effluent

Acknowledgements: This discussion, which follows the same basic format as the fact sheet it accompanies, provides additional details and information that support the conclusions presented in the fact sheet. It was written by Sue E. Umshler, Esq., P.E. as part of the "Evaluation of Alternative Actions for Technical, Physical, Hydrological, Environmental, Economic, Social, Cultural, and Legal Feasibility and Water Quality Issues and Legal Overview" contracted to Daniel B. Stephens & Associates, Inc.

1. Alternative Evaluation

1.1 Technical Feasibility

Enabling New Technologies and Status

No new technologies are required for this alternative as the wastewater treatment and piping distribution systems exist today. Current technologies can collect and treat wastewater to quality standards required to reuse water for nonpotable demands and to distribute such recycled water to the reuse locations. However, such infrastructure is expensive and requires a positive benefit/cost ratio for constructing and operating the facilities in return for reduced water pumping requirements, delayed procurement of new water supplies and new water rights, and/or revenues from the reuse locations.

Water reuse has been practiced in the United States for over forty years (Asano, 2001). The Irvine Ranch Water District in California has reused treated effluent for irrigation, industrial, and such domestic uses as toilet flushing in high-rise buildings since 1961 (Asano, 2001). The Montebello Forebay project consisting of spreading basins to accomplish groundwater recharge from the Los Angeles Area began in 1962 (Asano, 2001). In 1976, Orange County California implemented the Water Factory 21 project which uses treated effluent to recharge groundwater aquifers by direct injection (Asano, 2001). St. Petersburg, Florida has reused its treated wastewater to irrigate parks, golf courses, schoolyards, residential lawns, and cooling tower make-up water since 1977 (Asano, 2001). In 1985, El Paso implemented its direct injection groundwater recharge project and power plant cooling water from treated effluent (Asano, 2001). Studies began in 1987 for use of reclaimed wastewater for agricultural irrigation of food crops that are typically eaten raw, including artichoke, celery, broccoli, lettuce, and cauliflower (Asano, 2001).

The largest current water reuse application is agricultural irrigation. Landscape irrigation, including commercial, office, industrial, and single residence landscaped areas, employing dual pipe systems, is the second largest consumer of reclaimed water (Asano, 2001). Industrial activities represent the third major use of treated effluent, primarily for cooling and process needs, which vary greatly in water quality requirements (Asano, 2001). Groundwater recharge is the fourth largest user of reclaimed water and recreational and environmental uses constitute the fifth major use of reused water (Asano, 2001). The lowest uses are presently non-potable urban uses such as fire protection, air conditioning, toilet flushing, construction water, and cleaning system supplies. Potable reuse is the rarest form of water recycling in the United States today, although it has been practiced in Namibia since 1968 (Asano, 2001).

Infrastructure Development Requirements

To implement this alternative new or expanded treatment plants may be required to treat the wastewater to current federal and state reuse standards, which are becoming more stringent. California has adopted the most stringent requirements (Department of Health Services, 2001). New Mexico is considering regulations that would track the California requirements, commonly called “Title 22” standards. (Department of Health Services, 2001, NMED, 2000) Treatment standards involve actual technology and equipment operational requirements, specific numeric values for potential pollutant constituents (particularly pathogenic organisms), narrative standards regarding water quality, monitoring and reporting requirements, and limitations on the reuse opportunities for certain produced treated effluent. (U.S. EPA, 1992) The highest levels of treatment must be met for unrestricted use where it is very likely that humans will be in contact with the water, the water spray, or the product that results from the water reuse (U.S. EPA, 1992). Examples of such reuse are toilet flushing, irrigation of public parks and recreational areas, irrigation of food crops, and aesthetic uses like decorative ponds or fountains (U.S. EPA, 1992). Water uses that would require less rigorous treatment include industrial cooling and process water, cement production, construction dust control, and wetland augmentation (U.S. EPA, 1992). In some cases it is more economical to simplify the system by treating the water to the highest levels required for any of the uses.

Specific requirements that may be imposed by the New Mexico Environment Department (NMED) to assure protection of human health and the environment could add additional cost to the infrastructure. For example, Florida requires that reclamation facilities be manned while water is being transferred to users to assure quality standards are met and to implement immediate shut-down if the system experiences failures (Florida Reuse Regulations, Undated). This requires 24 hour, 7-day staffing to provide on-demand deliveries to an urban reuse system. The treatment plant must be operated by a Class C operator and must include back-flow prevention devices and automatic cut-off if quality declines. Such systems may be more costly than routine wastewater treatment facilities striving only to achieve NPDES limits before discharge.

Additional infrastructure requirements include pump stations to lift water if gravity flow is not available and pipelines to distribute wastewater from the plant to potential reuse locations, including residences if economically feasible. Such pipelines must be totally separate and are usually color-coded (often called purple pipe systems) to distinguish from normal plumbing systems. This practice protects potable water quality systems and reduces the possibility of dangerous cross-connections that could impair human health and safety. To assure such segregation of the reuse system, state regulations will often prohibit use in locations where inexperienced persons may unwittingly connect the pipe systems incorrectly. (Department of Health Services, 2001; Florida Reuse Regulations, Undated). Reuse is restricted to facilities where residents and guests do not have access to the plumbing systems for repairs. Individual homes are therefore excluded from permissible reuse applications. The water is diverted to motels, hotels, apartment, and condominium complexes for toilet flushing or landscape use. This addresses the health considerations and assures that the quantity of the demand is high enough to justify the reclaimed water treatment and distribution cost. Retrofitting existing facilities can be quite expensive because of the need for the dual pipe system. It may be more cost effective to implement dual pipe systems in new developments and subdivisions for landscape irrigation or toilet flushing, but this does not overcome the concerns about cross-connections. Thus, in most states, reuse water is being applied where it can be centrally controlled and monitored, such as golf courses, industrial parks, large city recreational facilities, etc. Albuquerque, Rio Rancho, and Santa Fe have all rejected consideration of existing, small and isolated urban parks because the cost of the piping network was too high for such distributed uses. These cities focused their proposal analysis of potential reuse customers on the larger recreational facilities, golf courses, wetland uses, and new common area developments. (Camp Dresser & McKee, 1998; COA et al., 2002)

Because of the changes in water demand from summer to winter, storage facilities may also be required. The storage unit may be a surface impoundment or tank. In either case it may have to be quite large to hold the winter reuse water production until the demand begins in the spring. If such storage facilities cannot be constructed because of land requirements and costs, the water must be released through NPDES outfalls. If this occurs, the reuse opportunities are limited to the excess flows available in the spring, summer and early fall seasons.

Finally, there would be significant administrative costs to support the infrastructure project, such as permitting, easement acquisition, sampling, monitoring, reporting, and public outreach and education.

Total Time to Implement

The total time to implement this alternative depends upon the potential reuse location(s), the wastewater treatment plant location in relation to reuse locations (pipeline length and location), acquisition time for funding (grants, loans, rate increases, etc.), easement acquisition, resource procurement such as design and construction personnel and materials, the length of the requisite public outreach and education campaign to gain acceptance of the concepts and specific projects, permit(s) acquisition, and the time required to amend local ordinances to permit and regulate installation and control of reuse facilities. Reuse projects require extensive coordination with the regulatory agencies including NMED and local health departments. If an environmental impact statement is required because of use of federal funds or location on federal or Native American properties, such a study could take from three to five years to complete with adequate public participation.

The actual project implementation could take several years depending upon the administrative and technical requirements for the project specifications. A reuse project must be implemented in complete phases which match capacity and demand to assure collection of the wastewater and provide adequate supplies to meet the demands. Emergency alternatives should be provided to meet the water demand and/or to dispose of wastewater if the system fails. A reasonable total time to implement a new comprehensive reuse program, given the most complex scenario, which would include a National Environmental Policy Act (NEPA) analysis for use of federal funds, would be five to ten years.

Successful implementation in five to ten years depends upon many factors. The time could be extended if a detailed NEPA analysis is required to secure federal funds or the necessary public outreach and education is extensive. Initial implementation of any reuse program takes time because of the complexity of the issues involved in developing a reliable and safe new supply of water derived from wastewater flows.

1.1.1 Physical and Hydrological Impacts

Effect on Water Demand

There would be no effect on overall water demand with this alternative. It could result in more efficient utilization of water withdrawn by recycling to meet consumptive purposes, thus supplying another source of water to meet demand. This could result in delaying the need for procurement and development of new supply sources such as pumping or diversions to meet growing demand. If the reuse system had to be cutoff because of water quality failure, pipeline failure, or other disruptions, the water demand would have to be met from another source, probably the fresh water supply. The wastewater would then be discharged to an NPDES outfall. If the disruption occurred over an extended period of time, water demand from basic supplies would resume at its normal levels. Often, fresh water is needed for blending to meet reuse water quality requirements.

If water conservation programs are effective in reducing indoor water demand, then the quantity of water available for reuse would be decreased and the strength of the sewage that must be treated at the wastewater reclamation plant would increase. On-site recycling systems for industrial users can reduce the water supply demand, but they also reduce the flow and increase the wastewater strength flowing to the wastewater treatment facilities. This occurred when Intel implemented its recycling program, dropping the flow to the Albuquerque plant by about 3 mgd (**COA et al.**, 2002). If significant flow reductions occur, the amount of water available for reuse may be too limited to justify the treatment and distribution costs. This was the experience of Santa Fe when its call for reduction in water use was effective and reduced the flow to the wastewater treatment plant enough to impair the treatment processes. Reduced wastewater flows also cause anaerobic conditions in pipes and lift stations, which can be a public nuisance. Thus, the available quantity of treated wastewater available for reuse must also consider the long-term conservation goals and other programs of a community.

Finally, the water returned to the river and surface water courses may be necessary to meet return flow credit requirements or historical water use offset debts of the users' water rights permits. If this is the case, the quantity of water available for a reuse system is significantly reduced. This factor must be considered in the planning and development of a reuse system.

Effect on Water Supply (surface and groundwater)

If the reuse offsets current consumptive demands, this alternative could result in short-term reduction in water pumped or diverted and potential long-term reduction in per capita demands on the potable water supply for the entity deploying the reuse system. It would provide an alternative source of water to meet nonpotable consumptive demands. Reuse can result in complete consumption of the recycled water or, if applied to nonconsumptive as well as consumptive uses, can produce some return flow (i.e. about 50 percent is returned to the system, thus requiring some input of new water sources). These estimates are highly system-dependent, so exact values are inappropriate for this level of study, but the concept of return flow is relevant to determining water volumes available for planning purposes. For this paper, 100 percent consumption for the first recycling event is assumed.

If water that is currently returned to surface water systems is being used as a water supply for other uses, such as agriculture, down-stream water supplies, or environmental uses in riparian areas and river flows, it would be removed for those purposes and could result in a water supply deficit for downstream users. Thus, while this alternative could extend the water supply for one community, it might result in a decrease of supply for other water needs in the region.

Water reclamation and reuse can provide a viable opportunity for a particular community to augment traditional water supplies, but requires integration of water supply and wastewater treatment functions (Asano, 2001).

To estimate the amount of reuse water that would be available to supply water demand (approximated at 15 percent and 30 percent of plant production), a current effluent use and maximum capacity is utilized for 2003, adjusted for an assumed 15 percent indoor conservation rate. In 2050, using projected population figures from MRCOG (15), effluent production is estimated and again demand is set at a range of 15 to 30 percent. Figures are presented with and without a 15 percent conservation on indoor use (see Table 27A-1).

Table 27A-1. Reuse Conservation Estimates

Reuse Type	200 Day Demand					
	10% Losses		15% Losses		20% Losses	
	15% demand	30% demand	15% demand	30% demand	15% demand	30% demand
2003						
Without conservation (mg/y)	1,620	3,240	1,530	3,060	1,440	2,880
Without conservation (ac-ft/yr)	(4,957)	(9,914)	(4,682)	(9,364)	(4,406)	(8,813)
With conservation (mg/y)	1,377	2,754	1,301	2,601	1,224	2,448
With conservation (ac-ft/yr)	(4,214)	(8,427)	(3,980)	(7,959)	(3,745)	(7,491)
2050 [a]						
Without conservation (mg/y)	3.1 to 4.6	6.2 to 9.1	2.9 to 4.3	5.9 to 8.6	2.8 to 4.1	5.5 to 8.1
Without conservation (ac-ft/yr)	(9.5 to 14)	(19 to 27.9)	(9 to 13.2)	(18 to 26.4)	(8.5 to 12.4)	(16.9 to 24.8)
With conservation (mg/y)	2.6 to 3.9	5.3 to 7.8	2.5 to 3.7	5 to 7.3	2.3 to 3.5	4.7 to 6.9
With conservation (ac-ft/yr)	(8.1 to 11.9)	(16.2 to 23.7)	(7.6 to 11.2)	(15.3 to 22.4)	(7.2 to 10.5)	(14.4 to 21.1)

mg/y = Million gallon per year ac-ft/yr = Acre-feet per year

[a] 1,000 million gallon and 1,000 acre-feet; range reflects a low flow of 75 gallons per day and a high flow of 110 gallons per day.

Water Saved/Lost (consumption and depletions)

Water is not saved or lost in this alternative, it is just put to a different use in the water cycle, i.e. it provides a new source to meet water demand, but does cut off return flows to the river. Water may be saved from groundwater pumping but would be lost to the riparian and river systems when effluent is diverted back to the urban and suburban area for consumptive uses. This does not alter the total amount of available water in the system. The treatment and pipelines required would result in some additional evaporative and leakage losses that may not occur from present systems that simply discharge at an NPDES outfall. If water is treated for aquifer replenishment, then a greater potential exists for water being saved from evaporation, but it would still be lost to downstream surface systems.

Impacts to Water Quality (and mitigations)

“The acceptability of reclaimed water for any particular use is dependent on the physical, chemical, and microbiological quality of the water” (Crook, 1998). Assurance of treatment reliability is an important quality control measure for a reuse system (Crook, 1998). The distribution system must be designed, constructed, and operated to assure the reclaimed water is not degraded prior to use. The reuse system must not become a source of pollution to existing surface streams or potable groundwater aquifers (Crook, 1998). Open storage of the water can degrade the treated water quality by growth of algae and microorganisms, or introduction of particulates. It can also cause objectionable odor or color in reclaimed water, and result in significant evaporative losses. (Crook, 1998).

The water would be treated to reuse standards, however, any recycling results in concentration of salts and metals, which are then loaded in the soils or recycled to undergo treatment again (U.S. EPA, 1992). Such concentration must be offset by fresh water inputs for the use called "leaching requirement."

There are two types of reuse classifications depending on water quality required: Unrestricted Urban Reuse (UUR), which has a high likelihood of human contact with the reclaimed water, necessitating strict pathogen control, or Restricted Urban Reuse (RUR), where human contact is prohibited or unlikely (U.S. EPA, 1992). The potential nonpotable reuse possibilities in the region, with applicable classification include (U.S. EPA, 1992).

- Landscape irrigation
  - Golf courses (UUR where golfers are present, RUU if watered when humans not present)
  - Parks, schoolyards, play areas, and other turf recreation facilities (UUR)
  - Commercial and industrial open areas (UUR)
  - Single-family homes (UUR)
  - Cemeteries (RUR if watered when humans are not present)
  - Roadway medians (RUR)
- Aesthetic uses
  - Decorative ponds (UUR)
  - Decorative fountains (UUR)
- Industrial uses (all OSHA worker protection requirements apply)
  - Cooling water (RUR)
  - Process water (RUR, but can have higher water quality standards)
  - Construction dust control, aggregate washing, and mix water (RUR)

  - Road cleaning, sidewalk and outdoor work area cleaning (RUR)

- Other municipal uses

  - Toilet flushing (UUR)
  - Car and equipment washing (UUR)
  - Air conditioning (UUR)
  - Fire protection (UUR)
  - Commercial laundry (UUR)

- Agriculture

  - Non-food crop production (RUR, but quality depends on crops)
  - Food crop production (UUR and depends on crop)

- Groundwater recharge (UUR if can affect potable aquifers)

- Environmental enhancement

  - Wetland creation or maintenance (meet NPDES requirements)
  - Surface water augmentation (meet NPDES requirements)

In the region, surface water augmentation and wetland uses are already implemented by returning the treated wastewater effluent to the river system. The water thus returned is also being used for agricultural purposes down-stream as the water is mixed with native river flows.

Groundwater recharge requires the highest level of treatment—probably better than current drinking water standards—and will not be discussed in this alternative.

The opportunities for altering effluent uses in the region by more direct reuse are:

- Landscape irrigation
- Aesthetic ponds and fountains
- Industrial uses

The water quality requirements for the effluent and its potential impacts to groundwater or surface water quality depend upon the reuse application. Municipal uses, aesthetic facilities, and most landscape irrigation require the highest levels of treatment because of potential human contact. Industrial uses also require high levels of treatment and/or extensive worker education and protection systems. Some industrial processes require extremely clean water that would exceed treatment levels for irrigation systems.

The economic evaluation of the reuse project makes replumbing existing systems for fire protection, toilet flushing, car washing and air conditioning too expensive unless there is a dense concentration of demand, such as an industrial park. Distribution costs to single residences are much too expensive, again, unless the water can be applied in dense population centers such as apartment complexes. The final project conceptual designs would determine if such chemical reuse centers are available. After the nonpotable water demands are located, the most economic treatment and distribution system plans to supply these demands can be evaluated.

Turf irrigation with treated wastewater can result in adverse impacts if the soil loading for certain constituents is exceeded, resulting in potential pollutant migration through the vadose zone to the groundwater (National Academy of Science, 1996). Certain source constituents in municipal wastewater such as nutrients (potassium, nitrates, iron, calcium), salts, cadmium, copper, cesium, nickel, lead, selenium, molybdenum, arsenic, and zinc could be phytotoxic if added to the soil in excess of critical levels, if the crop uptake levels are exceeded and the elements are not immobilized in the surface soil, they may escape the root zone and leach to groundwater (National Academy of Science, 1996). The best mitigation is to design the system for site specific adsorption capabilities, to meet regulatory loading limits with vigilant monitoring systems, to dilute the recycled water with fresh supplies, and/or to meet higher treatment levels at the treatment plant, which are more costly (National Academy of Science, 1996).

In Florida, excess water that cannot be used in citrus groves is diverted to rapid infiltration basins for disposal. Overall, salts in reclaimed wastewater must be managed to preserve productivity of the soil for whatever is being grown. Thus, golf courses, recreational facilities, and other turf applications cannot rely totally on reuse water as the "leaching requirement" must be met with fresh water dilution of this resource. As water is recycled numerous times, the salt concentration continues to accumulate and finally reaches a level that prevents growth in all but the most tolerant plants (National Academy of Science, 1996). Even in ideal conditions, plants remove less than 10 percent of these constituents. This is also true in constructed wetlands, and the problem is exacerbated in arid or semi-arid soil systems, which contain higher initial salt concentrations (National Academy of Science, 1996). Repeated applications of reused effluent without fresh water dilution can result in the accumulation of metals to levels toxic to plants and soil organisms. (National Academy of Science, 1996). Eventually, the levels could become toxic to humans, domestic animals, and wildlife if the water is applied to crops consumed by them or if the toxic constituents migrate to drinking water supply wells (National Academy of Science, 1996). Thus, the U.S. Environmental Protection Agency (EPA) has established soil concentration limits in Part 503 of its sludge rule. The rules set out specific application rates, monitoring requirements, and leaching requirement recommendations.

Other constituents of concern are trace organics, including new potential contaminants such as endocrine disrupters (hormones), and pathogens such as bacteria, viruses, and parasites (National Academy of Science, 1996). Wastewater irrigation can potentially transport pathogens to groundwater under certain conditions and certainly to surface water if the pathogens are not removed in the treatment process (National Academy of Science, 1996). Disinfection and rigorous monitoring are necessary to minimize this risk. (National Academy of Science, 1996). This is a limitation of constructed wetlands, which do not provide adequate disinfection and filtration, and thus could not be used as stand alone treatment units for reuse applications. Constructed wetlands would not meet the proposed New Mexico minimum reuse standards for Unrestricted Urban Reuse (U.S. EPA, 1992). They could be used for aesthetic ponds, but there is some concern about exposure to pathogens by individuals who may contact that water (U.S. EPA, 2000; Thompson et al., 1996)

Public health concerns and public acceptance of the reuse system, are critical elements in studying and designing a proposed project. The results of this public outreach program will ultimately determine how much and where reclaimed wastewater can be applied (Asano et al., 1992).

For industrial reuse and some municipal reuse options such as toilet flushing, fire protection, and air conditioning, quality concerns include potential scaling, erosion, biological growth and fouling, and public health concerns, especially for workers (Asano et al., 1992). Recreational and aesthetic impoundments present issues related to health concerns, eutrophication and algal blooms as well as the need to dechlorinate the treated effluent to protect fish and plants if chlorine was used as the disinfection agent. (Crook, 1998; Asano et al., 1992)

Sludges and brines from the treatment plant must be properly handled to avoid simply moving the impurities to landfills, thus creating a different pollution source.

Available engineering knowledge and technology can address all of these issues and provide reclaimed water of the desired quality for use in landscape irrigation, groundwater recharge, and other nonpotable uses. Tertiary treatment can reduce pathogen concentrations to levels suitable for direct contact with the reuse water. Care must be taken in the system design to assure protection of water quality throughout the treatment and distribution cycle. In California, landscape irrigation and groundwater recharge have been the most rapidly growing categories of reclaimed water use and that state has the most stringent reuse water quality requirements (Crook, 1998).

Watershed/Geologic Impacts

There would be no change to the watershed. The geologic formation of the aquifer could be positively impacted if groundwater withdrawals were reduced or extended over time by recycling pumped water back to non-potable uses. However, this would be a per capita reduction and as long-term population increases, the benefits may be offset by new demand. Thus, the benefit is a delay, not an absolute protection of the watershed or the aquifer structure.

1.1.2 Environmental Impacts

Impact to Ecosystems

The treated effluent that is currently being released to the river from municipal treatment plants would not go into the river or other surface water courses where it is currently being discharged. This reduction in surface flows from these sources could affect the minimum flow levels in the river or the water levels in the riparian areas immediately adjacent to the current outfalls. The reuse water would contain concentrations of salts and metals which could change the ecosystems where it would be reused. See above discussion for potential impact to plants and soil organisms if the water is repeatedly used without dilution with fresh water supplies.

Implications to Endangered Species

If the river flow is decreased by reductions in treated wastewater discharges, there could be an impact to the silvery minnow if reduced flow is not offset by native or other surface flows.

If the riparian areas are changed adjacent to the surface water courses there could be an impact on Willow Flycatcher habitat. The addition or deletion of current NPDES outfalls could affect the riparian areas in the region upon which this species depends. Additional erosion or changes in the location of the outfalls should be evaluated to determine potential positive or negative benefits to this species.

1.2 Financial Feasibility

1.2.1 Initial cost to implement

In development of Reuse concepts, several factors need to be considered. Public input is an absolute necessity to evaluate options, determine locations for treatment facilities, potential reuse applications, and pipeline locations. The amount of effluent for reuse must be determined by consideration of return flow requirements, success of conservation programs, costs to treat and distribute, and impacts of reuse system development to the river and the regional environment. Nonpotable demands must be located and the costs to distribute the treated effluent to demand clusters must be determined, along with timing of new sources to match available effluent supply. The successful development of this dependable water resource depends upon close examination and synthesis of all elements of infrastructure and facilities planning, treatment plant siting, treatment process reliability, economic and financial analyses, and water utility management (Asano, 2001, COA et al., 2002). In this paper there is no attempt to do the critical analysis and water balance calculations necessary for an actual project.

The cost estimates below do not reflect a "real project scenario" and should not be used for such a purpose. The attempt here is to quantify volumes and costs based upon a range of potential values and an assumption that water users can be identified and economically served. Indoor conservation effects cannot be evaluated, but the initial computations for the three system losses of 10 percent, 15 percent, and 20 percent are repeated using an assumed reduction of 15 percent to provide a range of potential reduction to the reuse water supply if conservation occurred.

"A common misconception in planning for water reclamation and reuse is that reclaimed water represents a low-cost new water supply" (Asano, 2001). This could be true, but only where water reclamation facilities are conveniently located near large agricultural or industrial users and when no additional treatment is required beyond the typical secondary levels achieved at most central facilities (Asano, 2001). When the water has to be treated to higher quality levels, new plants or expansions to existing treatment facilities are required. Sometimes, this can improve the economics of a specific proposal because new satellite facilities can be located near potential nonpotable water users (COA et al., 2002). The conveyance, distribution, and potential storage facilities represent the principal cost of most reuse projects with recent California experiences indicating that $8 million dollars in capital costs are required to reclaim and reuse 1 million gallons per year(Asano, 2001). Many reuse projects result in water costs that are higher than delivered potable water from conventional systems (Asano, 2001). Such reclaimed water is probably too expensive for traditional agriculture, but urban irrigation systems can afford to pay the price if the cost of finding other water supplies is even higher (Asano, 2001). As an area becomes more urbanized, reclaimed water prices can compete with new water resources to provide nonpotable uses such as toilet flushing and irrigation of common areas, because the distribution network is more affordable in densely developed areas (Asano, 2001).

A critical factor affecting costs is the degree of utilization of the available capacity of existing wastewater treatment facilities (Asano, 2001). To maximize this utilization, storage units can be constructed to compensate for seasonal slack water reuse demands, mixing reuse water with fresh supplies to reduce seasonal peaks that exceed production capacity, and using alternative supplies to meet peak demands (Asano, 2001). The current demands in the Middle Rio Grande region are limited because of the low industrial demand and distance from effluent production plants to large agricultural demands. For example, the City of Albuquerque is planning for a maximum of about 15 percent of the effluent production being economically applied to nonpotable irrigation and industrial demands, while the Rio Rancho planning outlook is closer to 30 percent. The Rio Rancho figures reflect a newer and faster developing community providing opportunities to implement reuse at project initiation as well as lower effluent production quantities.

For the following calculations, a 15 percent and 30 percent estimate of the range of reuse demand was used to determine the effluent volume requiring higher treatment costs. These costs are estimated to provide additional treatment required and do not reflect basic wastewater treatment costs to meet NPDES permit requirements. In the analysis, the reuse volume never exceeded the present wastewater treatment capacity of about 80 mgd in the region. However, it is expected that some new treatment facilities would be needed and desirable to more economically meet reuse demands. Thus, for the 2050 estimates, a blended cost of expansion and new treatment facilities was used.

Only three days of storage was allowed, which would not be adequate to collect winter effluent to save for application in the spring. Because of the high cost of storage, it is assumed that excess winter production would be discharged. This could change if industrial uses with winter reuse demand were identified or if toilet flushing in new areas or buildings could be developed. Another potential use for the winter overage or surplus effluent production from the remainder of the year would be an aquifer injection program, but that is not considered in this alternative.

Planning, design, and construction of a reuse project require professional expertise and resources along with careful integration of a public education and sensitivity program. For purposes of cost estimation, it is assumed that the reuse program treats, distributes and stores all of the reuse water simultaneously, thus requiring treatment plant construction and/or expansion, pipeline installation, some lift stations, administration costs, and storage facilities. All of these values are highly dependent upon source and demand locations. For ease of comparison, median assumptions have been used and values listed in dollars per gallon. Extreme caution must be used before projecting these costs to any real project, which will present unique requirements that could make these costs higher or lower. The variables are too numerous to make specific project assumptions at this planning stage. More realistic costs would be determined during the feasibility and conceptual design stages of actual proposed projects.

For instance, pipeline costs would be based upon length of pipe and variability of elevations and terrain, not in dollars per gallon. If a satellite treatment plant is constructed near the reuse application, pipeline, lift and storage costs would be reduced. If gravity flow is obtainable, no lift station would be required. If new easements must be obtained, administrative costs could be higher depending upon the cost and location of the land. Therefore, these cost estimates should only be used for relative planning comparisons and not to project actual costs of any specific reuse proposal.

The 2050 figures are based upon an escalation rate of 3 percent for the cost values and a population projection of 1,536,100 persons actually connected to centralized treatment facilities. The 2050 values also assume that no reuse systems are implemented before that date. This assumption may be unrealistic, but should present a cost that would exceed real project costs, particularly if reuse programs are implemented at specific sites throughout the region over the projected timeframe as they become economically feasible.

To expand current treatment facilities with additional treatment processes the estimated 2003 dollars could range as follows (no adjustment is made for conservation as design and construction of treatment facilities, pipeline collection, administrative costs, and storage would be based upon maximum potential volumes) and (new plant construction is not considered here as the current facilities have excess capacity to meet projected reuse demands with expansion costs assumed to be 50 percent of new construction costs):

- Treatment Plant expansion (**COA et al., 2002;** New Mexico Heritage Preservation Alliance, 2002; ENR, 2002)
  - Current effluent production, 9-18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $20.25 million to $47.25 million
  - Current treatment plant capacity, 12.5-24.9 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $28.01 million to $65.36 million
- Interceptor Collection Pipeline(s) (**COA et al., 2002;** New Mexico Heritage Preservation Alliance, 2002; ENR, 2002)
  - Current effluent production, 9-18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $0.68 million to $1.35 million
  - Current treatment plant capacity, 12.5-24.9 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $0.93 million to $1.87 million

- Lift Costs and Administrative, such as permits, easements, etc. (10,11,12)

  - Current effluent production, 9-18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $0.68 million to $1.35 million

  - Current treatment plant capacity, 12.5-24.9 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $0.93 million to $1.87 million

- Storage Costs for 3 days of production (10,11,12)

  - Current effluent production, 9-18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $32.4 million to $44.6 million

  - Current treatment plant capacity, 12.5-24.9 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $44.8 million to $61.6 million

The total initial capital cost could range from a low of $54.0 million to a high of $130.7 million dollars to implement this alternative in 2003.

If implementation of the alternative is delayed to the end of the planning period, initial costs, 2050 dollars are estimated using a 3 percent escalation and a population of 1,536,100 persons connected to central facilities results in the following ranges:

- Treatment plant expansion

  - Low flow effluent production (75 gallons per day [gpd]), 17.3-34.6 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation and assume blend of new construction and expansion for unit costs: $511.4 million to $681.8 million

- High flow effluent production (110 gpd), 25.3-50.7 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $750.0 million to $1,000.0 million

- Interceptor collection pipeline(s)
  - Low flow effluent production (75 gpd), 17.3-34.6 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $5.7 million to $11.4 million
  - High flow effluent production (110 gpd), 25.3-50.7 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $8.3 million to $16.7 million

- Lift costs and administrative, such as permits, easements, etc.
  - Low flow effluent production (75 gpd), 17.3-34.6 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $5.7 million to $11.4 million
  - High flow effluent production (110 gpd), 25.3-50.7 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $8.3 million to $16.7 million

- Storage costs for three days of production
  - Current effluent production, 9-18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $272.7 million to $375.0 million
  - High flow effluent production (110 gpd), 25.3-50.7 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $400.0 million to $550.0 million

The total initial capital cost could range from a low of $795.5 million to a high of $1,583.4 million dollars to implement this alternative if action were delayed to 2050.

1.2.2 Potential funding source

- Rate increase

- Bureau of Reclamation Title XVI program, Reclamation, Recycling and Water Conservation. This funding is available for projects that include reclamation and reuse of municipal wastewater, other wastewater, or naturally impaired waters. Thus, the program could be a potential source of funds if the collection and treatment system were linked to a reuse program. The maximum federal cost share is 50 percent for planning, 25 percent for design, and 25 percent for construction, with an overall cap of $20 million for construction of a single project, regardless of total project cost. Often the federal share is non-reimbursable, resulting in a de facto grant, however, projects are funded by specific congressional appropriations, which require advance planning and requests that can be delayed depending upon the federal budget process and its shifting priorities. Matching local funds are essential to obtain and maintain these grants and state programs are designed to leverage such federal funding programs through vehicles such as the Water Project Fund administered by the Water Trust Board.

- State/federal grants

  - USDA Rural Utilities Service (RUS) has water and waste disposal loans and grants in rural areas and towns with 10,000 or fewer residents, up to 75 percent of eligible project costs and RUS guarantees loans made by banks and other institutions (New Mexico Heritage Preservation Alliance, 2002).

  - The U.S. Department of Housing and Urban Development (HUD) provides community development block grant programs to construct public facilities and improve water and sewer facilities (New Mexico Heritage Preservation Alliance, 2002).

  - For Tribes, HUD has resources for Native Americans, EPA has American Indian Environmental Office tribal grants, and the U.S. Department of Health & Human

Services also has grant programs for such projects (New Mexico Heritage Preservation Alliance, 2002).

- The Water and Wastewater Grant Fund (W/WWGF) was created for the purpose of awarding grants to qualified entities for water and wastewater projects. In FY02 77 projects were authorized grants statewide and with 27.6 million in grants and emergency requests being obligated. The fund balance is $13.3 million, with some funds obligated, but not spent. The NM Finance Authority has received 65 applications by October 2002, totally $99.1 million for consideration of funding in FY02-03 (New Mexico Heritage Preservation Alliance, 2002).

- State/federal loans

  - Clean Water State Revolving Fund provides $1 billion annually to the states which manage individual revolving loan funds for wastewater and other water quality projects (Camp Dresser & McKee, 1998). The program provides loans at low or zero interest with repayment periods up to 20 years. Terms vary by state, but typically the money goes to capital costs and not to O&M expenses. There is a lot of competition for these funds (New Mexico Heritage Preservation Alliance, 2002).

  - The Wastewater Facility Construction Revolving Loan program is administered by the NMED. It is capitalized by federal grants, state matching and other funds accrued from construction loans. The program is restricted to low-interest loans and eligible entities include municipalities, counties, sanitation districts, and Native American tribes or pueblos with resources to repay loans. The current unobligated balance in the fund is $52.2 million with pending applications for $40.8 million (New Mexico Heritage Preservation Alliance, 2002).

  - The Public Project Revolving Loan Fund (PPRLF) is administered by the NM Finance authority and provides low-cost financing for long-term capital projects such as sewerage and waste disposal systems. The program is capitalized with 75 percent of annual government gross receipts tax revenue combined with federal state and local funds. Each project financed for the PPRLF must be authorized by the legislature by way of a statute. The loan capacity at current market rates from the PPRLF is about $500 million (New Mexico Heritage Preservation Alliance, 2002).

- Private loans

- Revenue bonds

- Effluent sales income would be a primary source of income, particularly for operation and maintenance costs of a reuse project.

1.2.3 Ongoing cost for operation and maintenance

Operating and maintenance costs include power for the pumps, repair and replacement of mechanical parts, including pipeline systems, chemical acquisition, waste management, sampling and monitoring, and reporting (Camp Dresser & McKee, 1998). Sampling can be quite expensive, as high as $30,000 per year just for the daily fecal coliform tests (Florida Department of Environmental Protection, Undated). Considering all of the monitoring costs in total, the sampling budget alone is quite significant and a 25 percent increase above standard O&M costs are used for the following estimates.

Generally operation and maintenance costs are not included in the grant programs and in many of the loan programs, particularly those from the federal government. Thus, the community or project authority must normally have sufficient rate base or other funds to pay the O&M costs by itself. Moreover, these costs increase as the system complexity increases. For centralized wastewater treatment facilities and pipeline system maintenance, qualified management, operation, and maintenance staff must be provided to keep the system functional and protective of human health and the environment, especially to assure the reliability and consistent quality demanded in a reuse program. Sharing of resources via a central authority or joint agreement could maximize these resources, thereby reducing competition for the scarce resources and personnel and related costs.

Using cost estimates from current treatment facilities, the following range of values for the first operation year can be predicted in 2003 dollars to be: (COA et al., 2002; New Mexico Heritage Preservation Alliance, 2002; ENR, 2002)

- Current effluent production, 9 to 18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $6.75 million to $10.13 million

- Current treatment plant capacity, 12.5 to 24.9 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $9.34 million to $14.01 million

If a conservation program is effective in reducing indoor use and thence wastewater discharges, the O&M costs could be reduced because of the reduced volumes that would require treatment. Based upon an assumed reduction of indoor use by 15 percent the following reduced initial year O&M cost estimates can be made:

- Current effluent production, 9-18 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $5.74 million to $8.61 million

- Current treatment plant capacity, 12.5-24.9 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $7.94 million to $11.91 million per year

The estimated initial year O&M costs could range from a low of $5.74 million to a high of $14.01 million dollars per year if this alternative was implemented in 2003.

Estimated O&M values for 2050, using a 3 percent escalation results in the following ranges:

- Low flow effluent production (75 gpd), 17.3-34.6 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $56.82 million to $85.23 million

- High flow effluent production (110 gpd), 25.3-50.7 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $83.33 million to $125.00 million

With implementation of a conservation program and based upon an assumed reduction of indoor use by 15 percent the following reduced 2050 O&M initial year cost estimates can be made:

- Low flow effluent production (75 gpd), 17.3-34.6 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $48.30 million to $72.44 million

- High flow effluent production (110 gpd), 25.3-50.7 mgd (15 to 30 percent demand proportions), average flow estimates for cost computation: $70.83 million to $106.25 million

The estimated O&M costs could range from a low of $48.30 million to a high of $125.00 million dollars for the first year if implementation of this alternative were delayed to 2050.

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