THE NEW MEXICO LOWER RIO GRANDE REGIONAL WATER PLAN

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LIST OF ABBREVIATIONS AND ACRONYMS

ac-ft	acre-feet
ac-ft/acre	acre-feet per acre
ac-ft/day	acre-feet per day
ac-ft/yr	acre-feet per year
ac-ft/acre/yr	acre-feet per acre per year
AGI	American Geological Institute
ASR	Aquifer Storage and Recovery
bgl	below ground level
BLM	Bureau of Land Management
BoR	Bureau of Reclamation
cfs	cubic feet per second
CWA	Clean Water Act
EBID	Elephant Butte Irrigation District
EPCWID#1	El Paso County Water Improvement District No. 1
EWUA	Environmental Water Users Association
Fm	Formation
ft bgl	feet below ground level
ft/day	feet per day
ft^2/day	feet squared per day
FWPCA	Federal Water Pollution Control Act
GPCD	daily per-capita water consumption
gpm	gallons per minute
gpm/ft	gallons per minute per foot
HIA	High Impact Area
IBWC	International Boundary and Water Commission
ISC	Interstate Stream Commission
Jornada	Jornada del Muerto Basin
JSAI	John Shomaker & Associates, Inc.
LRGWUO	Lower Rio Grande Water Users Organization
LUST	leaking underground storage tank
MCL	maximum contaminant level
MGD	million gallons per day
MVAA	Mesilla Valley Administrative Area
mg/l	milligrams per liter
M&I	Muncipal and Industrial
MTBE	methyl-tert-butyl ether
NAWQA	National Water Quality Assessment
NMBMMR	New Mexico Bureau of Mines and Mineral Resources
NMED	New Mexico Environment Department
NMEIB	New Mexico Environmental Improvement Board
NMOSE	New Mexico Office of the State Engineer
NMSA	New Mexico Statutes Annotated
NMSU	New Mexico State University
NMWQCC	New Mexico Water Quality Control Commission
NPDES	National Pollution Discharge Elimination System

NTU	Nephelometric Turbidity Units
SWUA	Special Water User Associations
SWTP	Surface-water Treatment Plant
spec.	specific
TDS	total dissolved solids
USEPA	United State Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
WRA	water righted acreage
WRRI	Water Resource Research Institute
WWTP	waste water treatment plant
μS/cm	microSiemens per centimeter

DEFINITIONS

Definitions are from Fetter (1989), Gorelick et al. (1993), AGI (1976), and King (2003)

alluvium: Sediments deposited by flowing rivers.

aquifer: Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

aquifer, confined: An aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer.

aquifer, unconfined: An aquifer in which there are no confining beds between the zone of saturation and the surface. There will be a water table in an unconfined aquifer.

basin: An extensive depressed area into which the adjacent land drains, and having no surface outlet. However, in the case of this report basin also refers to the areas which have identifiable geologic boundaries, but there are surface outlets (Rincon and Mesilla Basins).

bolson: A basin, depression or valley having no outlet and which, geologically, as a closed basin has received great thicknesses of sediments (e.g., in the sense that it was geologically an undrained basin).

cone of depression: The area around a pumping well where the hydraulic head in the aquifer has been lowered by pumping.

contamination, point source: Contamination whose source area is localized in a large ground-water flow system. Includes: surface impoundments, landfills, injection wells, sewage treatment plants, accidental spills or leaks, illegal dumping, oil and gas production activities, mining and milling, sewage disposal, dairies, and miscellaneous industrial sources.

contamination, non-point or distributed: Contamination whose source area is spatially distributed and large relative to the ground-water flow system. Includes: pesticides and fertilizers in agricultural and urban settings, road chemicals such as paving byproducts and salt, leakage from septic systems and aging sewer systems, and storm-water runoff from urban areas.

consumptive use or depletion of water: Is the amount of water removed from the local hydrologic system, primarily through the process of evapotranspiration (ET), where water is vaporized into the atmosphere, and biomass production, where water is tied up in the formation of plant tissues. ET tends to be much larger than the water used in plant tissue formation, and the latter term is generally neglected in discussion of consumptive use. As water is applied to crop land or landscape vegetation, either by irrigation or precipitation, some water will evaporate directly from the water and soil surfaces during infiltration, and some will be stored in the root zone and be taken up by the crop as consumptive use.

deep percolation: Is water that infiltrates in excess of the water holding capacity in the root zone soil. It percolates beyond the reach of the crop's active roots, and is generally unavailable to the crop. Deep percolation is often considered a loss, since it is water not available for consumptive use by the crop. Deep percolation has both beneficial and detrimental effects on crop growth. It is absolutely necessary to apply excess water to a crop to leach salts from the root zone, but deep percolation also leaches nutrients from the root zone. Whether deep percolation is actually a loss to the system depends on the specific hydrology. If deep percolation percolates through the root zone and is captured by a drainage system or ground-water pumping, it is a return flow and remains part of the available water supply, and therefore is not a complete loss. If the ground water is not used because of quality of access constraints, then deep percolation is a loss to the system rather than a return flow.

delivery: Is the flow of water from the irrigation canals to farms through farm turnouts. The diversion of water at International Dam to the Republic of Mexico is also considered a delivery because in the terms of the Treaty of 1906, the diversion at International dam was considered as equivalent to the deliveries to U.S. Project lands, and diminished in the same proportion during shortages. Those small diversions that are pumped from the river are considered both diversion and delivery, since the diversion point is essentially the farm. In general, more water must be diverted than is delivered, because water seeps into unlined and, to a much lesser extent, lined canals. Some diverted water is also returned directly to the river through wasteways as operational spills. A relatively small amount of water is lost to evaporation from the water surface in canals. Operational spills and canal seepage may be recaptured by downstream users as return flows. Canal seepage in some areas is also an important source of ground-water recharge, where it can be recaptured by pumping.

demand: Is the amount of water required by water users. For irrigated agriculture, the key factor is crop water needs, but the process of delivering water has its losses as described above, so that the actual demand is higher than the crop water need. In municipal and domestic systems, demand is based on landscape irrigation requirements, other outdoor, and indoor uses that vary seasonally, diurnally, and with population growth and attitudes toward water use.

drawdown: A lowering of the water table of an unconfined aquifer caused by pumping of ground water from wells.

eolian: Wind-deposited (sand dunes are eolian deposits).

facies: Mappable stratigraphic body distinguishable from other bodies based on different grain size, mineralogy, and structure.

fault: A fracture or fracture zone along which there has been displacement of the sides relative to one another parallel to the fracture.

floodplain: The portion of a river valley, adjacent to the river channel, which is built of sediments during the present course of the stream and which is covered with water when the river overflows its banks at flood stages.

graben: A block, generally long compared to its width, that has been downthrown along faults relative to the rocks on either side.

ground water: The water contained in interconnected pores located below the water table in an unconfined or confined aquifer.

ground-water basin: A vague designation pertaining to a ground-water reservoir that is more or less separate from neighboring ground-water reservoirs. A ground-water basin could be separated from adjacent basins by geologic boundaries or hydrologic boundaries.

ground-water diversion: Is the withdrawal of ground water from the aquifers in which it occurs by pumping. Such ground-water diversions may be used at the location from which they are derived, or transported through pipelines or canals to another point of use.

hydraulic conductivity: A value describing the rate at which water can move through a permeable medium.

horst: A block of the earth's crust, generally long compared to its width, that has been uplifted along faults relative to the rocks on either side.

maximum contaminant level (MCL): The highest concentration of a solute permissible in a public water supply as specified by the National Interim Primary Drinking Water Standards for the U.S.

maximum contaminant level goal (MCLG): A non-enforceable health goal for solutes in drinking water; set at a level to prevent known or anticipated adverse effects with an adequate margin of safety.

observation well: A non-pumping well used to observe the elevation of the water table.

permeability: The permeability of rock or sediment is its capacity for transmitting a fluid.

playa: The shallow central basin of a desert plain, in which water generally gathers after a rain and is evaporated.

recharge area: An area in which there are downward components of hydraulic head in the aquifer. Infiltration moves downward into the deeper parts of an aquifer in a recharge area.

release: Is the flow of water from storage in Caballo Reservoir into the bed of the Rio Grande. The release is controlled by outlet works gates in Caballo Dam, and the releases are determined by the U.S. Bureau of Reclamation based on current flow in the river at each of the diversion points, orders for water from the irrigation districts and Mexico, and any special considerations for flood control or maintenance on the system. Currently, releases are made from February through October, though this season has historically and will likely continue to be shortened during water-short years. Adjustments to the release are generally made three times a week, but this will likely be more frequent during water-short years. There is also a small release made directly from Caballo into the Bonito Lateral, a small system that predates and is separate from the Rio Grande Project. In 2001, the release to the Bonito Lateral was 1,100 acre-feet, quite small compared to the 786,900 released to the Project irrigation districts.

specific capacity: An expression of the productivity of a well, obtained by dividing the rate of discharge of water from the well by the drawdown of the water level in the well.

specific conductance: A measure of the ability of a sample of water to conduct electricity and serves as a general measure of the concentration of dissolved solids. It is the reciprocal of the resistance in ohm measured between opposite faces of a 1 cm^3 cube of an aqueous solution at a specified temperature.

specific yield: The ratio of the volume of water a rock or soil will yield by gravity drainage to the volume of the rock or soil. Gravity drainage may take months to occur.

storage coefficient, storativity: The volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head. It is equal to the product of specific storage and aquifer thickness. In an unconfined aquifer, the storage coefficient is equal to the specific yield.

surface or project water diversion: Is the flow of water from the river into the canal systems. Diversion occurs primarily at Percha Dam at the northern end of the Rincon Valley, Leasburg Dam at the northern end of the Mesilla Valley, Mesilla Dam south of Las Cruces in the Mesilla Valley, American Dam at the head of the El Paso Valley in Texas, and International Dam just downstream of American Dam, where Mexico makes its diversion. Riverside Dam, south of El Paso in the El Paso Valley, was a diversion point until it was damaged by high flows in 1986 and 1987. Riverside Dam has been used only occasionally since then, and water diverted at American Dam can now be conveyed to the canal system formerly serviced by Riverside. The California Extension and the Del Rio Lateral are two small diversions from the river above Mesilla Dam, each diverting water for individual users that are constituents of EBID. A few individuals are also permitted to pump water directly from the river within EBID. Diversion tends to be larger than release, because some of the diverted water returns to the river through drains and wasteways, and is part of the downstream diversion supply. EPCWID has disputed the inclusion of drain water, which tends to be of lower quality than water directly from the reservoir, in their allocation. Local precipitation and other discharges into the river also increase the volume available for diversion.

surface Runoff: Is irrigation water or precipitation that is not captured on the watershed and does not infiltrate into the soil, and runs off the watershed. It is generally collected in drains or other watercourse returning to the river as a return flow, though some may be lost to evapotranspiration in the collection and return systems.

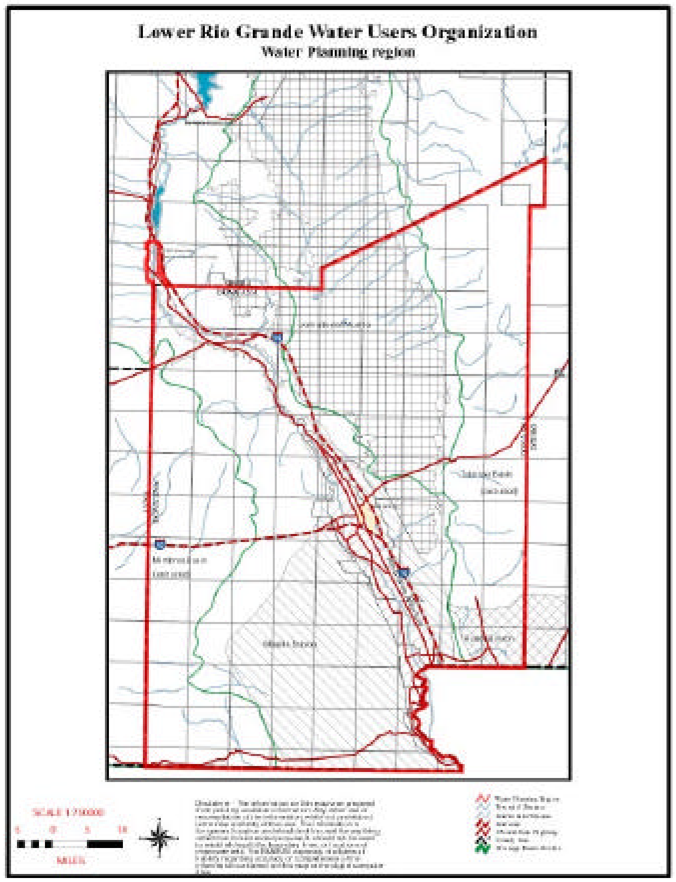
transmissivity: The rate at which water is transmitted through a unit width of an aquifer or confining bed under a unit hydraulic gradient. It is a function of the properties of the water, the aquifer, and the aquifer thickness.

vadose zone: The zone between the land surface and the water table. Saturated bodies, such as perched ground water, may exist in the vadose zone. Also known as the unsaturated zone.

water-level elevation: The elevation of the ground-water surface. In an unconfined aquifer the water-level elevation is the water table. In a confined aquifer (artesian), the water-level elevation is the elevation at which the water rises up in a well, and is often referred to as the potentiometric surface elevation.

EXECUTIVE SUMMARY

INTRODUCTION



Terracon, John Shomaker and Associates, Inc., Livingston Associates, LLC, Inc., Zia Engineering and Environmental, Inc., and Sites Southwest have completed the New Mexico Lower Rio Grande Regional Water Plan for the Lower Rio Grande Water Users Organization (LRGWUO). The Planning Region is located in south central New Mexico primarily within Doña Ana County.

The two year effort has built upon the previous water planning efforts in the region (1994), and was designed to bring the technical research up to the standards required by the Interstate Stream Commission (ISC) Regional Water Planning Template published December 1994 and modified June 1999. This report was completed in general accordance with the proposal dated June 4, 1999 (Terracon Proposal No. P99-048E, and LRGWUO Project No. 98-99-390), and the ISC Regional Water Planning Template.

The New Mexico Lower Rio Grande Regional Water Plan includes, but is not limited to the following items:

- Public Involvement;
- Legal Issues;
- Analysis of the surface and ground-water supply available in the region;
- Population projections to thru 2040;
- Current water use and projected water demand (2040); and
- Strategies for future management of the region’s water.

1.0 INTRODUCTION

1.1 Individuals Involved in the Water Plan Development

Table 1.1 lists the individuals involved in the preparation of Lower Rio Grande Regional Water Plan.

TABLE 1.1: INDIVIDUALS INVOLVED IN THE LOWER RIO GRANDE REGIONAL WATER PLAN DEVELOPMENT

Name	Affiliation	Title	Responsibilities
Eddie Martinez, P.E.	Zia Engineering and Environmental, Inc.	President / Principal Engineer	Surface-Water Supply
Mary Wells, P.E.	Terracon	Senior Engineer / Office Manager	Project Manager
Roger Perry, CPG	John Shomaker & Associates, Inc.	Senior Hydrogeologist	Ground Water Supply, Quality, Alternatives Assessment
Eddie Livingston, P.E.	Livingston Associates, LLC, Inc.	President	Water Demand, Alternatives, Budget
Phyllis Taylor	Sites Southwest	Vice President	Public Participation Plan & Public Meetings
Phil King	New Mexico State University	Associate Department Head; CAGE	Member of the LRGWUO Technical Committee/Review
Gene Paulk, P.E.	City of Las Cruces	Water Rights Manager	Member of the LRGWUO Technical Committee/Review
Jorge Garcia, P.E.	City of Las Cruces	Director/City Utilities	Member of the LRGWUO Technical Committee/Review
Bobby Creel	New Mexico Water Resources Research Institute	Assistant Director	Member of the LRGWUO Technical Committee/Review
Gary Esslinger	Elephant Butte Irrigation District	Director	Member of the LRGWUO Technical Committee/Review
Len Stokes	City of Las Cruces	Consultant	Member of the LRGWUO Technical

TABLE 1.1: INDIVIDUALS INVOLVED IN THE LOWER RIO GRANDE REGIONAL WATER PLAN DEVELOPMENT			
Name	**Affiliation**	**Title**	**Responsibilities**
			Committee/Review
Mariano Martinez	Doña Ana Mutual Domestic Water Consumers Association	General Manager	Member of the LRGWUO Technical Committee/Review
Arnie Castaneda	Village of Mesilla	Public Works Director	Member of the LRGWUO Technical Committee/Review
Cesario Alvillar, Jr.	Village of Mesilla	Trustee	Member of the LRGWUO Technical Committee/Review
Juan Fuentes	Village of Mesilla	Town Clerk	Member of the LRGWUO Technical Committee/Review
Minerva Rayos	Berino M.D.W.C.A.	Representative	Attended LRGWUO Technical Committee/ Review meetings
Robert Richardson, P.E.	Village of Hatch	Consultant	Member of the LRGWUO Technical Committee/Review

1.2 Previous Water Planning in the Region

The original impetus for regional water planning came in 1987, when a federal court ruled that New Mexico's prohibition against out-of-state transfer of New Mexico ground water was unconstitutional. As a result of this ruling, it became evident that New Mexico must actively plan for its water future. The resulting plans, with their forty-year horizon, will help to insure the continuity of the water supply. However, regional water plans that were prepared before the current Regional Water Planning Template was adopted followed a diversity of approaches and used a variety of different assumptions to produce projections of water use. Additionally, as has been done in other western states, New Mexico may decide to use the regional water plans as a basis for a State water plan, which can in turn influence litigation, water development, and legislation. For these reasons, regional water plans need to take a uniform approach and have a similar format. To achieve that end the Interstate Stream Commission (ISC) appointed a subcommittee and volunteer work group well versed in water management issues to develop the template to guide the development of regional water plans.

The Doña Ana County Regional Water Plan was completed in 1994. However, the 1994 plan did not contain all of the information required by the ISC Water Planning Template. Concurrently with water planning for the Lower Rio Grande in New Mexico, are planning efforts for the Tularosa Basin to the east, the Socorro-Sierra region to the north, the Mimbres and Gila to the west and the El Paso area in Texas.

1.3 Water Plan's Contents

The regional water plan is a two-year effort that builds upon previous water planning efforts in the region. The current effort is designed to bring the technical research up to the standards required by the ISC Regional Water Planning Template. This regional planning includes analysis of the surface and ground-water supply available to the region, demographic analysis, population projections to 2040, current water use and projected water demand, as well as strategies for future management of the region's water.

This report corresponds to the draft template designed by the ISC's "Template Subcommittee," which provides guidance to local water planning efforts. The ISC acknowledges the divergent regional water-use needs and interests in the state of New Mexico and therefore the template provides a useful checklist of items to consider when developing a water plan. The Lower Rio Grande Regional Water Plan contents follow the most recent update (June 24, 1999) of ISC Regional Water Planning Template.

2.0 DOCUMENTATION OF PUBLIC INVOLVEMENT IN PLANNING PROCESS

2.1 Interstate Stream Commission Sponsored Water Workshop

The Interstate Stream Commission did not sponsor a Water Workshop for the Lower Rio Grande Water Users Organization (LRGWUO).

2.2 Background Summary of Region Prepared for Public

The Planning Region is located in south central New Mexico and lies within the northern extreme of the Chihuahua Desert. The majority of the Planning Region is within Doña Ana County, which is the 16th largest county in the state, and has the second largest population (174,682 residents according to the 2000 Census). The Planning Region is bounded on the west, north, and east by Luna County, Sierra County, and Otero County, respectively, and to the south by the State of Texas and the Republic of Mexico. The Planning Region also includes a portion of Sierra County below Caballo Dam and a portion of Otero County that includes Chaparral. The Planning Region is shown on Figure 2.1. It should be noted that all of Sierra County is included in the Socorro Sierra Planning Region.

The climate of the Planning Region can be described as arid and semi-arid (depending on elevation) with elevations in the Planning Region that range from approximately 3700 to over 9000 feet. The average annual precipitation across the Planning Region varies from 7 to 9 inches. The average annual precipitation, mostly in the form of rain, in Las Cruces is approximately 8 to 8-1/2 inches. It is not uncommon for the temperatures to vary 30 degrees Fahrenheit within a 24-hour period.

The primary geographic feature in the Planning Region is the Rio Grande, flowing from the northwest corner to the southeast corner, creating a valley along the river between mountain ranges on either side. The Rio Grande’s fertile soil in the valley provides the basis for the region’s agriculture. Soils in the region range from loamy sands to loams and sandy, stony, very gravelly, sandy and silty clay loams. Soils near the mountains are generally formed on alluvial fans. Soils on the mesas and near the Rio Grande are formed on lacustrine (lake sediments), fluvial (water transported sediments) and eoline (wind blown sediments) deposits. A general soil map for the Planning Region is presented as Figure 2.2.

2.3 List of Stakeholders and Participants

Major stakeholders conducted the water planing process in the region, but many others with interest are involved. The LRGWUO is a public entity that was given the mandate to guide the regional planning effort in the Lower Rio Grande region. The LRGWUO is an organization made up of the City of Las Cruces, Doña Ana County, Doña Ana Mutual Domestic Water Consumers Association, the Town of Mesilla, the Anthony Water and Sanitation District, the Village of Hatch, New Mexico State University, and Elephant Butte Irrigation District. The Joint Powers Agreement (JPA 97-046) creating the LRGWUO was approved by Department of Finance and Administration on February 7, 1997.

Each of these groups has constituents, which they represent. LRGWUO participation on the New Mexico/Texas Water Commission has broadened the region to include Texas and El Paso participation and involvement of other federal and state agencies. Such governmental agencies include the International Boundary and Water Commission – U.S. Section, Rio Grande Compact Commission, NM State Engineer, NM Conservation Commission, Texas Water Development Board, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Services, and others. Additionally, special interest groups include Southwest Environment Center, Mesilla Valley Economic Development Alliance, and the League of Woman Voters. Through this planning process and those involved, every citizen in the region has a mechanism for input to the process.

3.0 STRATEGY CHOSEN TO MAXIMIZE PUBLIC INVOLVEMENT

The goal for public participation in the Lower Rio Grande Regional Water Plan was to maximum public involvement and input.

3.1 Water Plan Handout

A handout (see Appendix H) was developed summarizing water planning activities for the region. The objective of this handout was to summarize for the public the various elements key to the plan. This information was developed to give the public information prior to formal Public Meetings/Hearings so that they could be better prepared to provide ideas and/or additional information that would help in the overall development of the plan.

3.2 Press Releases/Web Page

3.2.1 Press Releases

Copies of the Press Releases are included in Appendix H.

3.2.2 Web Page

A web site (www.lrgwuo-waterplan.com) was established for the Public at the beginning of the planning process to provide information to the public. The web site includes a description of the project, opportunities for public participation, meeting notices, and draft documents that can be viewed on-line, printed out or downloaded. The web site allowed for public comments and questions via email. Information will also posted regarding Public Meeting/Hearing times and places and viewing locations of the Plan. A copy of the handout is also located on the web site.

3.3 Outreach Effort Tailored to Specific Communities

The core of the public involvement plan focused on three activities:

- Participation and guidance from representatives of the entities that make up the LRGWUO; serving as the volunteer Regional Water Planning Technical Committee;
- Monthly Technical Committee meetings that were open to the public;
- The consulting team for the LRGWUO gave formal presentation and informal talks to various public and technical organizations within the Planning Region (see Appendix

H); and

- Public meetings/hearings (August 25, 26 and 28, 2003 and September 4, 2003 and upon finalization of this Plan on December 17, 2003).

The goal of the public involvement effort was to make the citizens of the Planning Region aware of the progress of the regional water planning process and to offer them opportunities to comment and make suggestions.

The LRGUWO Board appointed a Technical Committee to hold meetings (open to the public) to deal with the daily, detailed issues of the planning process, on every third Thursday of each month from 1:30 to 3:30. The focus of the planning activities was to complete technical work and use the meetings to complete public involvement requirements of the Regional Water Planning Template. After quantitative information on the regional water supply and demand was gathered and analyzed, the consultants, the Technical Committee and the public began researching and discussing alternatives for the future use of the region's water. The Technical Committee also participated in the Public Meetings and Hearings.

3.4 Talks, Public Meetings/Public Hearings

Members of the LRGWUO Technical Committee presented portions of the Lower Rio Grande Regional Water Plan through formal presentation and informal talks to various public and technical organizations to get public input during stages of Plan development. Additionally, public meetings will be held in the region in the communities of Hatch, City of Las Cruces, Santa Teresa/Sunland Park and Chaparral. The goal was to obtain public input regarding the regional planning process and educate participants on water quality and water conservation issues. The meetings were held on August 25, 26, and 28, 2003 and September 4, 2003, Chaparral, Santa Teresa, City of Las Cruces, and in Hatch, respectively. A Public Hearing was held upon completion of this Plan at the City of Las Cruces City Council Chambers on December 17, 2003.

The LRGWUO was responsible for copying and distributing the press releases to the list of local media organizations. The radio stations included KRWG, KROL, KVLC, KSNM/ KXDA, KGRT, KPRR, KMVR, and KLAQ. Newspapers receiving press releases include the Albuquerque Journal, Las Cruces Sun News, Bulletin, Sierra County Sentinel, Desert Journal, Sun Country Senior Living, El Paso Times, and the Valley News. Television stations include KMAZ, KDBC, KRWG, KFOX, KTSM 9/ KKWB, and KVIA.

The LRGWUO also mailed meeting notices to the mailing list, which the Technical Committee members compiled during the planning phase. Furthermore, members of the LRGWUO posted notices in public locations within each jurisdiction in the region. The handout described above was distributed to LRGWUO member agencies prior to publication the draft Plan and at public meetings to increase public awareness of the project.

The majority of the public meeting time was devoted to answering questions from the public and recording their comments. The public meetings were in an "open house" format that allowed the public participants to view displays, ask questions and provide comments individually. The majority of the meetings included presentations of key information from the Lower Rio Grande Regional Water Plan. Comment sheets were available for written comments and all attendees were encouraged to identify themselves on sign-in sheets. Special arrangements were made to comply with the Americans with Disabilities Act.

4.0 BACKGROUND INFORMATION

4.1 Location and Boundaries of Planning Region

The study area is chiefly comprised of the area within Doña Ana County, excluding portions of the Tularosa and Mimbres Basins within in the County. The study area also includes the portion of Sierra County within the boundaries of the Elephant Butte Irrigation District (EBID) and the portion of the Hueco Bolson within Otero County (see Figure 2.1). It should be noted that all of Sierra County is included in the Socorro Sierra Planning Region.

4.2 Geography and Landscape

The Planning Region lies within the Basin and Range Province, and is characterized by "gently sloping plains broken by rugged mountain ranges and the Rio Grande Valley." Mountain ranges in this area are aligned generally in a north-south direction. A range of mountains including the San Andres, San Augustin, Organ and the Franklin forms the eastern boundary of Doña Ana County (Bullock and Neher, 1980).

Elevations within the Planning Region range between "3,730 feet in the Rio Grande Valley to about 5,000 feet on the upland plains. The Rio Grande Valley is nearly level to very gently sloping and varies in width from less than 1 mile to as much as 5 miles." The upland areas of the mountains are steep to extremely steep, with an elevation ranging between 4,800 to 6,500 feet. A number of individual peaks do exceed 7,000 feet. The highest point found within Planning Region is located in the Organ Mountains at the summit of the Organ Needle (9,012) feet (Bullock and Neher, 1980). The Rio Grande drains the areas adjacent to the river, while the rest of the Planning Region drains to closed basins or playas.

4.3 Climate and Drought History

The climate of the Planning Region is considered to be mild, arid to semi-arid continental type characterized by fairly hot summers and mild winters with warm spring and autumn seasons. The majority of the annual precipitation occurs in the form of summer or early fall thunderstorms. These storms are usually of short duration and result from an inflow of moist warm air originating in the Gulf of Mexico. Occasionally, precipitation occurs due to an intrusion of tropical pacific fronts entering from the Baja. Rain or snow of light intensity often accompanies frontal activity in the area.

The Planning Region is generally arid, with a small amount of semi-arid areas found in higher elevations where the temperatures are cooler and precipitation is greater. Low humidity and sunshine are characteristic of the Planning Region. January average minimum temperatures and July average maximum temperatures are shown on Figures 4.1 and 4.2.

Fall, winter, and spring are the dry seasons because much of the moisture is eastward circulation from the Pacific Ocean and is removed as the air passes over the mountains west of New Mexico. Summer is the rainy season when moisture-laden air from the Gulf of Mexico enters southern New Mexico. Strong surface heating and the upslope flow of the air cause brief, and often heavy, showers. South-central New Mexico mountains have a shielding effect on the southeasterly air flow, and the amount of precipitation received west of these mountains along the Rio Grande Valley is less, especially in Spring (Bullock and Neher, 1980).

The average annual precipitation across the Planning Region varies from 7 to 9 inches. Forty-two thunderstorms occur on average each year between April and October, with few hailstorms. Dust storms are frequent during the spring when "winds are strong and soils are dry, but soil blowing can occur briefly just before a thunderstorm" (Bullock and Neher, 1980).

The average annual snowfall for the Planning Region varies from 2.5 to 5 inches in the lower elevations, with an average "of less than 1 day in winter has 1 inch or more of snow. The average depth of snow cover on these days is 2 inches, but rarely does the snow cover last for 2 consecutive days" (Bullock and Neher, 1980).

The periods of drought in the region are 1907-1911 (based on New Mexico State University (NMSU) data only), and for all nineteen weather gage stations, from 1945-1956 and from 1963-1965. There are other isolated one or two year cycles of below normal precipitation, but not periods to be considered droughts. There were also localized differences in precipitation that caused some stations to be under drought conditions while others were not. One of these periods is 1968-1971, during which the Hatch and Caballo stations were below normal precipitation while the NMSU and Jornada stations were above or near normal for two years of the period. The periods of above normal precipitation for the study area were 1901-1905, 1912-1914, 1926-1929,1935-1942 and fairly consistently above normal from 1972 through 1998 with several years of near normal precipitation.

4.4 Demographics

The majority of the population within the Planning Region consists of individuals of

Hispanic or Caucasian backgrounds with an approximate 60-percent to 40-percent mix respectively between the two. According to the 2000 census 59.7-percent of the population are between 18 and 65 years of age. The ratio between male and female within the Region is approximately 1:1. The 2000 census report indicates that there are 59,556 households in the Planning Region with an average of 2.85 persons per household compared to an average of 2.92 in 1990 and 3.83 persons per household in 1960. Approximately 68 percent of residents own their own households.

4.5 Economic Picture

Within the Planning Region, government continues to be the predominant industry followed by services and trade. In general, the economy has experienced a slow but steady growth within each major industry group through the 1990's. Unemployment for the Planning Region area has typically been within the range of eight to ten percent through most of the 1990's. The metropolitan area of Las Cruces does have many high-income individuals working for facilities such as White Sands Missile Range and the New Mexico State University. The median household income for residents of Doña Ana County according to the census division was $26,379 in 2000.

The economic base of the Mesilla Valley has been very stable over the past several years and no great change is anticipated in the near future. The Planning Region appears to have some potential for attracting agriculture-related light industry for several reasons including the following: low cost of living, available land, available labor force, adequate water and systems, and good transportation facilities. There is also a potential for the development of a retirement-related industry due to the excellent year-round climate of the area and the relatively low cost of living.

4.6 Land Ownership and Land Use

The Planning Region has an area of approximately 3,807 square miles. The federal government controls well over 2,785-square miles of land in the county. Of this the Bureau of Land Management (BLM) administers 1,756-square miles (approximately 63-percent), and the military controls 856-square miles (approximately 31-percent). Approximately 908 square miles are used for agricultural purposes, most of which is in the EBID. Land Ownership in the Region is shown on Figure 4.3.

Land use statistics for developed lands in the county indicate that approximately 70 percent of land in the Planning Region is used for agricultural purposes, while only approximately 16 percent is residential (2000 Census), Doña Ana County Regional Water Plan (August 30, 1994). Land use in the Planning Region is shown on Figure 4.4.

In the Planning Region, there are approximately 46 persons per square mile. The City of Las Cruces is considered the only metropolitan area in the county. However, as shown on Figure 4.5, the Chaparral and Sunland Park/Santa Teresa areas have relatively high population densities. Current population and predicted growth for various areas within the Planning Region are presented in more detail in Section 7.3.1.

5.0 LEGAL ISSUES FOR THE REGION

This section will survey legal issues in the New Mexico Lower Rio Grande Planning Region.

5.1 Water Laws Relevant to the Region

Water laws relevant to the region may be grouped into three categories: New Mexico law, interstate law, and federal law. Issues within each category are present in pending lawsuits and new legislation, where the goals are:

- The quantification of New Mexico's rights to lower Rio Grande water;
- The development of an Operating Agreement between EBID and El Paso Water Improvement District No. 1 (EPCWID#1); and
- The creation of an efficient transfer mechanism to enable Rio Grande Project agricultural water to be used by municipalities and to enable ground water pumpers with junior priorities to purchase "offset water" to assist the State in meeting the needs of appropriators with senior priorities within the region.

5.1.1 New Mexico Law

A. In 1907, the New Mexico Territorial Legislature adopted the present Surface Water Code. See New Mexico Statutes Annotated (NMSA) 1978, Sec. 72-1-1 (1907) et. seq. The code expressly recognized existing surface-water rights evidenced through the filing of declarations with the Territorial Engineer and later the State Engineer. See NMSA 1978, Sec. 72-1-3 (1959). The Legislature extended the water code in 1931 to apply to underground waters. See NMSA 1978, Sec. 72-12-1 (1939), et seq. These waters are defined as underground streams, channels, artesian basins, lakes, and reservoirs having "reasonably ascertainable boundaries." By extending the water code to these waters, it made them subject to appropriation by the public and to administration and regulation by the State Engineer. The State Engineer declared the Lower Rio Grande Underground Water Basin, bringing its waters under his jurisdiction, on September 11, 1980.

B. Like most western states, New Mexico is governed by the doctrine of prior appropriation. Under Article XVI, Section 3 of the New Mexico Constitution, beneficial use is the "basis, the measure and the limit" of the right to use water. Under this doctrine, the first user in time of water (senior appropriator) has the right to take and use the water against subsequent users (junior appropriator) during periods of drought when there is not enough water to supply water for all appropriators. The priority date of a given right is the critical feature in any adjudication of water rights. The key priority in the lower Rio Grande is 1906 for all surface-water rights in the Rio Grande Project. Accordingly, a key issue in the lower Rio Grande will be the priority date assigned ground-water users in the pending adjudication as that will determine their requirement to obtain "offset water" for effects that they have on the Rio Grande in the event that they have priorities junior to 1906. The offset requirement arises from New Mexico's conjunctive management of related surface and ground water.

C. Surface and ground water are administered conjunctively in New Mexico requiring ground water pumpers who affect surface flows to acquire offsets to compensate for the effects of their pumping. The offset requirement derives from the principle of conjunctive management created in the case of City of Albuquerque v. Reynolds, 71 N.M. 428, 378 P.2d 73 (1962). Although the Water Code does not expressly contemplate conjunctive administration of surface water and ground water, the New Mexico Supreme Court has held that the surface and ground-water codes are substantively the same, with minor procedural differences, and that the State Engineer is obligated to administer the laws in such a way as to recognize the hydrologic interrelation between surface water and ground water. See City of Albuquerque v. Reynolds, supra.

In its key finding (71 N.M. 437) the Court held:

> Under the facts in this case, with the Rio Grande stream flow being fully appropriated, it would indeed be anomalous for the legislature to enact laws designed to permit water, which would otherwise reach the stream in substantial quantities, to be withdrawn by pumps and thereby attempt to deprive the prior appropriators of their vested rights.

D. As has been previously stated, the State Engineer now administers the Lower Rio Grande Underground Water Basin. This means that he has jurisdiction over all new appropriations, transfers, drilling of wells and changes of ownership of water rights. Approval of applications for new appropriations or for a change in point of diversion or purpose or place of use is governed by applicable provisions of the surface and ground-water codes. However, new legislation will allow expedited transfers of Rio Grande Project water to municipal purposes by EBID, with State Engineer streamlined hearings.

E. The State Engineer assumes jurisdiction over underground water basins when he declares a source of water to have reasonable ascertainable boundaries. This was done in the Lower Rio Grande Basin on September 11, 1980. The State Engineer has adopted administrative regulations for the Lower Rio Grande Underground Water Basin.

F. Although the State Engineer is given plenary authority over surface and ground water, he does not have the power to adjudicate water rights. The judiciary adjudicates the water rights. The stream adjudication has commenced for the Lower Rio Grande Basin, see State ex rel. Office of the State Engineer, EBID et al. See section 5.6.2 below. At issue in the adjudication are the elements necessary to quantify the water right of each water user in the basin, i.e., the "priority date, amount, diversion point, purpose and place of use. As to water used for irrigation … the specific tracts of land to which it shall be appurtenant…." See NMSA 1978, Sec. 72-4-19 (1907). Jurisdiction remains in issue by virtue of the United States' continuing efforts to remove its "Quiet Title" claims to federal court despite numerous rulings that the state court possessed jurisdiction over the United States under the McCarran Amendment, 43 U.S.C. 666, which waives the United States' sovereign immunity and allows joinder of the United States to general stream system adjudications.

G. Of particular importance to the adjudication of water rights, is the forfeiture statute (Section 72-5-28). Prior to 1965, an appropriator would automatically forfeit his water right if he failed to apply the water to beneficial use for four successive years. After 1965, the statute was amended to require the state engineer to give notice of the non-use. The water user then has one year to apply the water to beneficial use. Another doctrine, created by the courts, is the abandonment doctrine. Abandonment requires the intent to abandon along with the non-use. See State ex rel. Reynolds v. South Springs Co., 80 N.M. 144, 452 P.2d 478 (1969).

5.1.2 Interstate issues- Compact Obligations

The Rio Grande Compact ("Compact"), is a tri-state agreement between Colorado, New Mexico and Texas, which was approved by Congress in 1939. (53 Stat 785, NMSA 1978, Sec. 72-15-23-25 (1939)). The Compact divides the surface waters of the Rio Grande among the three states. The Compact is administered to include all of the territory drained by the Rio Grande and its tributaries in Colorado, New Mexico, and Texas above Fort Quitman, including a closed basin in Colorado that normally does not contribute to flows of the Rio Grande. Colorado's delivery obligation to New Mexico is measured at the Colorado-New Mexico state line at or near Lobatos. New Mexico's obligation to deliver water is measured at Otowi gage in north central New Mexico, as set forth in Article IV, and is composed of a percentage of the water flow at Otowi gage.

The apportionment in the Rio Grande Compact is an inflow-outflow apportionment, which requires scheduled deliveries based on the "index" inflow stations or gages described above. When the index inflow is a certain amount, the Compact apportions a certain outflow. The apportionment made by the Compact creates delivery obligations for Colorado and New Mexico as a percentage of the annual river flow. The delivery obligations of the two states progressively increase, measured against increased stream flow. For example, if the measured flow at Otowi is 100,000 acre-feet (ac-ft), then 57 percent or 57,000 ac-ft must be delivered below Elephant Butte Dam. If the measured flow is 1,000,000 ac-ft, then 62.1 percent or 621,000 ac-ft must be delivered. This percentage rises to 86.5 percent for water flows measured at Otowi of 3,000,000 ac-ft.

A recurrent legal question has been whether the State of Texas was apportioned a specific amount of water by the Rio Grande Compact through the division of water between the two districts on a 57%/ 43% basis. Courts have been divided on the issue. The first case to consider the issue was <u>El Paso County Water Imp. Dist. No. 1 v. City of El Paso</u>, 133 F. Supp. 894 (W.D. Texas 1955), a suit by a water improvement district, the United States, and others against the City of El Paso to determine rights to the use of Rio Grande water. The court found that such an apportionment had been made.

Subsequently, in <u>City of El Paso v. Reynolds</u>, 563 F. Supp. 379 (1983), a New Mexico district court considered the issue of ground water below Elephant Butte Dam, finding that it was not apportioned. More recently, <u>in Elephant Butte Irrigation Dist. v. Regents of New Mexico State University</u>, the New Mexico Court of Appeals held:

> The Rio Grande Compact is unique because Texas agreed to have water delivered at Elephant Butte Dam, approximately 100 miles north of the state border, rather than at the state line. As a result, the compact does not apportion a specific quantity of water between the two states. See City of El Paso ex rel. Public Serv. Bd. v. Reynolds, 563 F. Supp. 379 (D.N.M. 1983). Texas apparently believed that delivery at the dam was preferable because the Rio Grande Project contracts independently apportioned water below the dam for both New Mexico and Texas

users. Id. at 385-86; see also Raymond A. Hill, Development of the Rio Grande Compact of 1938, 14 Nat. Resources J. 163, 173-174 (1974).

5.1.3 1906 Treaty with Mexico

The International Boundary and Water Commission ensures that Mexico receives the 60,000 acre feet of water it is entitled to receive under the Treaty. The Mexican agency that has jurisdiction over municipal use of water in Juarez is the Junta Municipal de Agua y Saneamiento, an agency of the State of Chihuahua.

5.2 Federal Law Issues

A. United States of America v. Elephant Butte Irrigation District, et al., No. CIV 97-0803 MV-RLP. In the summer of 1997, the United States filed suit in Federal District Court for New Mexico to "quiet title" to the water rights for the Rio Grande Project. The United States claimed that the actions of the various defendants have clouded title of the United States to water rights for the Project. The United States argued that since it gave proper notice of its appropriation, the United States obtained and holds title to all the waters of the Rio Grande Project, including all return flows and all tributary inflows. The case was dismissed by the Tenth Circuit Court of Appeals and remanded to the district court where it has been stayed.

B. Counterclaim by El Paso County Water Improvement District #1.

As a result of the quiet title action, EPCWID#1 filed a counterclaim regarding the operation of the Rio Grande Project by the United States. During the mediation phase of the lawsuit, the United States, EBID, EPCWID#1, and other collateral parties attempted to negotiate an Operating Agreement regarding the allocation of water in the Rio Grande Project between the two districts. When the two irrigation districts in the Rio Grande Project took over operation of the Project works in the 1970s, they signed an agreement stating that they would enter into an Operating Agreement with each other and with the United States. To date, no Operating Agreement has been entered into between the parties and the United States continues to administer the Project without a written agreement on a day-to-day basis. The counterclaim was dismissed along with the quiet title action.

C. EBID vs. United States, et al.; U.S. District Court (New Mexico) No. CIV 00-1309. Upon dismissal of the quiet title action, EBID immediately filed this suit on September 18, 2000. The lawsuit seeks a judicial determination regarding the legal and contractual relationships between EBID, the United States, and EPCWID#1 regarding the management and day-to-day control of the operations of the Rio Grande Project (Operating Agreement). Plaintiff EBID requested a declaratory judgment to determine the rights, liabilities and privileges of the parties regarding the operation of the Project, and asked the Court to order an Operating Agreement after a hearing on the issues. Also at issue is the applicability of the 1920 Miscellaneous Purposes Act under which the United States asserts it has authority to regulate transfers of agricultural water to municipal/ industrial use. On July 2, 2003, Judge Black ruled that all claims would be dismissed, except the claim based on the applicability of the 1920 Miscellaneous Purposes Act to the Rio Grande project. The City of Las Cruces was also allowed to intervene. The court also reaffirmed that it would not create an Operating Agreement for the parties in the Project. However, "if the situation becomes such that the lack of an operating agreement causes violations of EBID's or EPCWID#1 from raising such violations as grounds for relief in a different case." In effect, the court is stating it will take jurisdiction of any claims, by either district, that they have that could arise from disagreements over not having an operating agreement, such as how the Project Supply is divided by the United States between the two districts.

D. Transfer of project drainage and distribution facilities. Ownership of the canals, laterals and drains in the Rio Grande Project that serve EBID was returned to EBID in 1992 under Title XXXIII of Public Law 102-575 (106 Stat 4600, 4705). Congress did not authorize the conveyance of the diversion dams or Elephant Butte or Caballo Reservoirs. Specifically, the legislation did not transfer any water rights. Since the conveyance, EBID has managed the canals, laterals and drains and permitted various uses through their special use permit process.

5.3 Water Quality Standards

Water quality for certain specific uses and for wastewater management is controlled by both state and federal laws and regulations. The two principal federal laws involved are the Federal Water Pollution Control Act (FWPCA), more commonly known as the Clean Water Act (CWA), Public Law 92-500 of 1972 and its many amendments over the past 30 years, and the Safe Drinking Water Act of 1974 (SDWA) and its amendments. For both the CWA and the SDWA, there are companion state laws that allow for state primacy over parts of the respective federal legislation. The state does not enjoy complete primacy. For example, the State of New Mexico does not have primacy (control) over the issuance of permits for the disposal of dredge and fill materials into navigable waters (Section 404 of the FWPCA), nor for discharge permits for wastewater effluents under the National Pollutant Discharge Elimination System (Section 402 of the CWA).

However, in most cases, state regulations provide the foundation for the control of water quality. In the sub-sections that follow, selected examples of state laws and rules are discussed as they apply to various regional water uses and wastewater discharges. There are other federal laws and comparable state acts of great importance to regional water uses and these laws will also be discussed briefly in sub-sections that follow.

5.4 Relevant Lawsuits.

A. United States of America v. Elephant Butte Irrigation District, et al., No. CIV 97-0803 MV-RLP. In the summer of 1997 the United States filed suit in Federal District Court for New Mexico to "quiet title" to the water rights for the Rio Grande Project. The United States claimed that the actions of the various defendants have clouded title of the United States to water rights for the Project. Simply put, the United States argued that since it gave proper notice of its appropriation in 1906 and 1908, it obtained and holds title to the waters of the lower Rio Grande, including all return flows and tributary inflows. The issues are the same as those in the stream adjudication brought by EBID in 1986 where ownership of water rights and the quantification of water rights claimed in the basin are at issue. EBID and other New Mexico parties have characterized the action as an attempt to circumvent state court jurisdiction because the United States was unable to have the case removed to federal court. The district court dismissed the lawsuit on August 22, 2000 on abstention grounds under Colorado River Water Conservation District v. United States, 424 U.S. 800 (1976) and Brillhart v. Excess Ins. Co. of America, 316 U.S. 491 (1942). The United States and the City of El Paso appealed to the Tenth Circuit Court of Appeals. In May 2002, the 10th Circuit Court affirmed the district court but remanded to the district court to determine whether the district court should dismiss the case without prejudice or enter a stay. (289 F.3rd 1170). The federal district court has decided to stay the case. In the future, the State of New Mexico will make an offer of judgment to the United States for its claims to storage and diversion of rights. The door remains open for the United States to seek review of actions taken in the State stream adjudication proceeding if it does not get what it believes it is entitled to.

B. Counterclaim by El Paso County Water Improvement District #1. As a result of the quiet title action, EPCWID#1 filed a counterclaim regarding the operation of the Rio Grande Project by the United States. During the mediation phase of the lawsuit, the United States, EBID, EPCWID#1, and other collateral parties attempted to negotiate an Operating Agreement regarding the allocation of water in the Rio Grande Project between the two districts. When the two irrigation districts in the Rio Grande Project took over operation of the Project works in the 1970s, they signed an agreement stating that they would enter into an Operating Agreement with each other and with the United States. To date, no Operating Agreement has been entered into between the parties and the United States continues to administer the Project without a written agreement on a day-to-day basis. The counterclaim was dismissed along with the quiet title action.

C. EBID vs. United States, et al.; U.S. District Court (New Mexico) No. CIV 00-1309. Upon dismissal of the quiet title action, EBID immediately filed this suit on September 18, 2000. The lawsuit seeks a judicial determination regarding the legal and contractual relationships between EBID, the United States, and the EPCWID#1 regarding the management and day-to-day control of the operations of the Rio Grande Project (Operating Agreement). This litigation concerns EBID's request for a declaratory judgment to determine the rights, liabilities and privileges of the parties regarding the operation of the Project, and asks the Court to order an Operating Agreement after a hearing of the issues. The litigation will require the Court to construe numerous contracts entered into over the past 80 years between EBID, the United States, and the EPCWID#1. The litigation also asks the Court to appoint a Special Master in lieu of the Bureau of Reclamation (BoR) to control the Project. The United States has created conflicts of interest in dealing with the Project water supply, and the District feels that the United States can no longer act impartially or fairly toward both the rights of the Plaintiff EBID and the Defendant EPCWID#1. The suit also requests the court to declare that the Act of February 25, 1920 is inapplicable to EBID. The suit was dismissed. However, the claim related to the applicability of the 1920 Reclamation Act, which relates to multiple uses of Project water, and to the transfer of agricultural rights in the Rio Grande Project to municipal purposes was dismissed without prejudice. The City of Las Cruces subsequently sought to intervene to seek a declaration of its interest on that issue, i.e., whether federal approval was necessary for transfers of project water to municipal use in the City of Las Cruces. On July 2, 2003, Judge Black ruled that all claims would be dismissed, except the claim based on the applicability of the 1920

Miscellaneous Purposes Act to the Rio Grande project. The City of Las Cruces was also allowed to intervene. The court also reaffirmed that it would not create an Operating Agreement for the parties in the Project. However, "if the situation becomes such that the lack of any operating agreement causes violations of EBID's or EPCWID#1's rights under the reclamation laws, or any other applicable statutes, the Court's decision in this case should not be construed as barring EBID or EPCWID#1 from raising such violation as grounds for relief in a different case." In effect, the court is stating that it will take jurisdiction of any claims by either district that they have, which could arise from disagreements over not having an operating agreement (e.g., such as how the Project Supply is divided by the United States between the two districts).

D. City of El Paso vs. El Paso County Water Improvement District No. 1 v. United States of America and Elephant Butte Irrigation District, (Western District of Texas) No. EP-01-CA-010-GTE. EBID was served with a 3rd Party Complaint in this case. This case attempted to bring EBID into Federal District Court in El Paso to litigate the Operating Agreement issues. EPCWID#1 has alleged that it is not getting its fair share of water from the Rio Grande Project because it is taking return flows from EBID. It wants all of its water to come from Elephant Butte and Caballo reservoirs. If this happens, an additional 100,000 acre feet of water could cross the state line without the New Mexico portion of the project getting credit. In addition, EPCWID#1 claims that pumping of ground water by farmers within EBID should be taken off of their surface-water allotment. This could reduce the ability of New Mexico to use its surface-water allotment from the Rio Grande Project from 30% to 60%. El Paso has purchased 800 acres of farmland within EBID. They claim that under a December 1, 1944 contract with the United States, EPCWID#1 and EBID, they are entitled to have water from 2,000 acres within EBID to be delivered to El Paso. El Paso notified EBID of its intention to have the water from their New Mexico farms delivered to El Paso. EBID replied by questioning the validity of the contract. The State Engineer also questioned the legality of the contract in the 1940s. EBID also responded that taking water outside the state would require an export permit by the New Mexico Office of the State Engineer (NMOSE) under NMSA Section 72-12b-1. The court has dismissed this action on jurisdictional grounds.

5.4.1 Court Decrees

There are no court decrees on the Rio Grande in this part of the river system.

5.4.2 Pending Adjudications

The stream adjudication has commenced for the Lower Rio Grande Basin. State ex rel. Office of the State Engineer v. EBID et al. The statutory stream adjudication was brought by EBID in 1986 in order to quantify all water rights in the Lower Rio Grande. The purpose of the lawsuit is to adjudicate all of the rights to use water from Elephant Butte Reservoir to the Texas state line. Numerous motions to dismiss the adjudication by the State of New Mexico and the United States were litigated for the first ten years. In 1997, State Engineer Tom Turney obtained funding from the legislature to fund the hydrographic survey. The State through an agreement with EBID was re-aligned as the Plaintiff. The hydrographic survey of the LRG was completed in three years. The State is now conducting a supplemental survey of domestic surface-water rights that will be completed in 2003. The adjudication will determine the elements necessary to quantify the water right of each water user in the basin, i.e., the "priority date, amount, purpose, diversion point and place of use. As to water used for irrigation … the specific tracts of land to which it shall be appurtenant…." See NMSA 1978, 72-4-19 (1907). An ongoing issue is the United States' efforts to have its "Quiet Title" claims determined in federal court despite several holdings that the McCarran Amendment waived federal sovereign immunity for the adjudication of those claims in state court.

5.5 Water Quality Policies Specific to the Region

5.5.1 Legal Responsibility for Ground Water Quality Management

While there are federal laws that authorize the issuance of ground-water standards and regulations that relate to water quality, basic responsibility for ground-water quality management rests with the State of New Mexico. There are two separate boards that have responsibility for adopting regulations and setting ground-water standards. These are the New Mexico Environmental Improvement Board (NMEIB) and the New Mexico Water Quality Control Commission (NMWQCC).

5.5.1.1 Responsibilities of the New Mexico Environmental Improvement Board

The responsibilities of the New Mexico Environment Improvement Board, to protect public health and welfare, do not differ much from those of the NMWQCC. However, the two boards are responsible for different aspects of ground-water quality. The NMEIB is assigned the establishment of safe drinking water standards for public and community water supplies in the state. Drinking water standards apply to water supplies derived from either or both surface and ground water. All of the public and community water supplies in the region use ground water as the sole source of supply. A sole-source aquifer is defined, in United States Environmental Protection Agency (USEPA) regulations, as an aquifer that is the only source of safe drinking water available to a community or region. The NMEIB sets conditions for the designation and special protection afforded sole-source aquifers.

The NMEIB also sets standards for the protection of ground-water quality from leaking underground storage tanks. Setting standards for hazardous waste, the disposal of radioactive materials, and septic tanks also is part of the responsibilities of the NMEIB.

5.5.1.2 Responsibilities of the New Mexico Water Quality Control Commission

Under the state's Water Quality Act, the NMWQCC must adopt standards for ground water that, at minimum, protect public health or welfare, and that enhance water quality. The Commission must adopt regulations that prevent or abate ground-water pollution. The NMWQCC regulations may not specify the methods used to prevent pollution but may set performance standards based on the best available technology. The Commission has broad permitting powers that it delegates to its constituent agencies. Those state agencies that have representation on the NMWQCC, and that have been delegated regulatory responsibility for ground-water protection under state laws are the Environment Department, the Oil Conservation Commission, the Office of the State Engineer, the Department of Agriculture, and the Bureau of Mines. The involvement of some of the constituent agencies in ground-water quality is limited. For example, the Office of the State Engineer has rules related to well drilling and well plugging after abandonment. The State Engineer may also disapprove of a request to appropriate ground water, if he finds that water quality will be impaired as a result of granting the request. The Oil Conservation Commission's responsibility is limited to prevention of pollution related directly to the petroleum industry.

With respect to ground-water quality management in the region, the authority of the NMWQCC exceeds that of the NMEIB. The NMWQCC sets ground-water standards to protect supplies from the discharge of wastewater effluents. Under the Water Quality Act, the NMWQCC also promulgates a complex set of regulations designed to prevent ground-water pollution. These regulations cover the submission of applications for ground-water discharge plans, for public notice of intent to make a discharge, for abatement plans, compliance plans, variances, monitoring, reporting, and a host of other technical and administrative details.

5.5.1.3 Administrative Responsibilities of the New Mexico Environment Department

Although two different boards are responsible for the adoption of ground-water standards and regulations, virtually all of the administrative responsibilities are assigned to New Mexico Environment Department (NMED). The exceptions, noted above, are the protection authority delegated by law to the constituent members of the NMWQCC. The NMED operates a number of ground water related programs of regional interest: the Safe Drinking Water Program, Groundwater Protection Bureau, the Hazardous Waste Program, the Super Fund Program, and the Petroleum Storage Tank Bureau.

The NMED is assigned the administration of a permit system to control wastewater discharges that may pollute ground water. Applicants for permits must fill out a comprehensive form and submit an initial filing fee of $100. Additional fees may be assessed depending on NMED investigative costs. An application must include plans and specifications for collection, transport, treatment, and storage of all wastewater flows, leachates, and sludges. Operational, monitoring, contingency, and closure plans are also required. Monitoring wells up the ground-water gradient and down-gradient are required for any discharge that involves ponds or lagoons. Departmental guidance sheets are available that describe recommended location, design and sampling of monitoring wells.

5.5.1.4 Ground-Water Quality Standards

Standards for ground-water quality, applicable to the region, are derived from at least three sources: ground-water standards adopted by the NMWQCC designed to prevent pollution, drinking water standards adopted by the NMEIB, and the USEPA drinking water standards and health advisories. The state drinking water standards are essentially the same as those promulgated by the USEPA. In the absence of a state standard, reliance is placed on USEPA's standards and health advisories. Between the three sets of standards, over 100 numeric limits, treatment technologies, or narrative standards exist for various organic, inorganic, biological, and radioactive contaminants. USEPA standards are the most comprehensive. The state's ground-water standards include fewer numeric values, particularly for organic contaminants where narrative standards are referenced. In the absence of a state standard, state regulators will look to USEPA standards for guidance.

5.5.1.4.1 Compliance with State Drinking Water Standards

A large number of public and community water supplies in the region are subject to the state's drinking water standards and regulations. Most of these are listed in tables in the demand sections of this report. By and large most of these supplies are able to meet the state's drinking water standards.

Of special concern in the region is meeting the USEPA revised standard for arsenic of 10 parts per billion. There are at least 15 public or community water supplies in the region that have exceeded the10-microgram level in at least one sample. Most of these water systems serve a limited number of homes. However, two larger community systems have been shown to exceed the 10-ppb limit in one sample: Anthony, New Mexico and Chaparral, New Mexico. Additional testing may show that these two public water supplies can meet the revised USEPA standard. With a few exceptions, there are no regional ground-water quality trends or conditions (other than pollution caused by man) that preclude meeting the standards. There are zones of naturally occurring, high-salinity, ground water in the region. Some are in the Radium Springs area, the alluvial fans on the east and west flanks of the Mesilla Valley south of Anthony, New Mexico, and the salt-water up-flows near the narrows in the Rio Grande just above International Dam at El Paso. Poorer quality geothermal waters are found in the Radium Springs area and in the hills to the east of New Mexico State University.

5.5.1.4.2 Regional Ground-Water Pollution

In a number of locations in the region, ground-water pollution precludes the use of the available supply. Three of these sites are at old Bureau of Land Management landfills (Mesilla Dam, La Mesa, and Las Cruces). There is an old mine site (Stephenson-Bennett mine) about a mile and a half south of Organ, NM where limited pollution has occurred due to water seepage through mineralized formations. Pollution problems have been discovered at two regional federal facilities: the NASA-White Sands Test Facility on the west side of the San Andres Mountains in the Jornada del Muerto basin.

A more serious ground-water quality problem is the pollution plume in the Walnut Street-Griggs Street area in Las Cruces. Discovered in 1997, a plume of perchloroethylene has been found to cover an area half a mile wide and almost a mile long. It has moved both horizontally and vertically, effecting wells at depths from 100 feet to over 700 feet. One Las Cruces municipal well has been shut down as a result of the plume. The source of the contamination is unknown, but is being monitored by 16 area wells. The Walnut-Griggs plume is a national Superfund site

5.5.1.4.3 Regional Ground-Water Discharge Permit Sites

At least 100 waste generating locations in the region have permits from the NMED Groundwater Bureau. Most are small facilities such as mobile homes, rural restaurants, and schools. Of the more significant classes of discharge holders are regional dairies with twenty locations. Other locations are ten chile or cheese processing plants, seven Department of Defense or NASA facilities, five sludge or septage disposal sites, and two manufacturing sites and the state prison on the West Mesa outside Las Cruces.

5.5.2 Legal Responsibility for Regional Surface-Water Quality Management

The New Mexico Water Quality Act assigns the NMWQCC the full responsibility for adopting regulations, setting stream standards, hearing water pollution cases, and directing abatement actions by one or more of its constituent agencies. The Commission is the official water pollution control agency for the state. The bulk of the duties of surface-water monitoring, data collection and analysis, investigating instances of water pollution, reporting, and reviewing National Pollution Discharge Elimination System (NPDES) permit applications is allocated to the NMED. The Water Quality Act gives the Commission the task of reviewing and revising the state stream standards every three years (a federal Clean Water Act and USEPA requirement), but the actual work is carried out by the Surface Water Bureau of the NMED.

The USEPA issues NPDES permits in New Mexico after NMED certification. Entities with NPDES permits in the region include the City of Las Cruces, Town of Hatch, Anthony Water and Sanitation District, Sunland Park, Santa Teresa, Alto de Las Flores, Gadsden School District, El Paso Electric, and Cervantes Enterprises.

The International Boundary and Water Commission (IBWC) has no direct water pollution control responsibilities in the region, but does have authority to investigate pollution and to seek abatement in the reach of the Rio Grande below the International Dam at El Paso where the river forms the international boundary. The IBWC has monitored the river and maintained water quality and stream flow records at El Paso for many years. The IBWC data constitutes the best surface-water quality record available in the region.

5.5.2.1 Elements of State and Federal Legislation of Regional Interest

Surface water in the region is primarily used for irrigated agriculture. The majority of the surface water is released from Elephant Butte Dam and Caballo Dam for irrigation in New Mexico, Texas, and Mexico. Water is diverted from the Rio Grande at three points into delivery canals along both sides of the river. Both the federal CWA and the state Water Quality Act contain provisions that give understanding to two aspects of irrigated agriculture in the southwest. First, that the right to use water for beneficial purposes is granted to water users, by the state, on a first come basis and that states have primacy for the administration of water use within their boundaries. Second, that inherent in the use of water for irrigation is the build up of salinity in the down-stream direction. The process of irrigation involves the evapotranspiration of a major part of the applied water and the leaching of the residual water from the root zone of the plant, along with the bulk of the dissolved solids originally present in the irrigation supply. In the region, roughly two-thirds of the surface water applied to a plant is lost to evapotranspiration and one-third is flushed to irrigation drains that parallel the Rio Grande. These irrigation return flows, along with the accumulated dissolved constituents, are returned to the Rio Grande along its route in New Mexico and re-diverted as a necessary part of the regional irrigation supply. This same process is repeated again and again as the Rio Grande is used for irrigation and makes its way south through the reach below El Paso, Texas.

In the Congressional declaration of goals and policies in the federal Clean Water Act (Section 101 (g)) there is a clear statement of state authority over water. This section mandates that each state has the right to allocate quantities of water within its own boundaries and that nothing in the CWA should be construed to supersede or abrogate that right.

Section 402 of the federal CWA deals with permits under NPDES and subsection (l) states that the USEPA may not require that a permit be obtained for “discharges composed entirely of return flows from irrigated agriculture”. This subsection also prohibits USEPA from requiring that states permit irrigation return flows. As a result, the NMWQCC and the state NMED tend to treat drains and irrigation return flows as “non-point” sources of pollution, but there is no language in statues or regulation that confer this designation.

The New Mexico Water Quality Act contains a similar provision. Section 74-6-4 (Duties and Powers of the Commission), subsection “K”, provides that the NMWQCC:

“shall not require a permit respecting the use of water in irrigated agriculture, except in the case of the employment of a specific practice in connection with such irrigation that documentation or actual case history has shown to be hazardous to public health or the environment."

5.5.2.2 New Mexico's Surface-Water Quality Standards

The New Mexico Water Quality Standards for Interstate and Intrastate Streams is a complex, comprehensive document that deals with a wide range of water quality issues of interest in the region. New Mexico adopted its original stream standards in 1968 and some elements of the first version remain in effect. A stream standard consists of two elements: a designated use and a narrative or numeric criterion to protect that use. In general, most of New Mexico's streams share some of the same designated uses: irrigation, wildlife habitat, livestock watering, some form of water recreation, and some level of a fishery. Numeric standards exist for each of these uses.

The federal CWA requires that states review their stream standards every three years. This triennial review process was started in New Mexico in late 1997 and the process continued until mid-2002. The problem rests with the USEPA over-sight on state standards. After revision in the triennial review process, the state must submit its revised standards to USEPA for approval. If the Administrator of the USEPA does not approve of a state standard, the Administrator may change the state standard. To prevent this, the NMWQCC has continued to make changes to the standards. The latest change was the NMWQCC adoption in the spring of 2002 of numeric limits for a large number of toxic chemicals.

A significant part of the NM standards is in direct response to requirements in the federal CWA, Section 303. Examples are sections on goals, an anti-degradation policy statement, and on use attainability analysis.

5.5.2.3 Water Quality Standards of Interest in the Region

Numeric standards and designated uses exist for Elephant Butte Reservoir, the Rio Grande downstream to the head-waters of Caballo Reservoir, Caballo Reservoir to Percha Diversion Dam, and the Rio Grande from Percha Diversion Dam to the International Dam at El Paso. Numerical standards are provided for bacterial quality, temperature, and pH. The bacterial standards are designed to permit primary water-contact recreation and are set at a maximum of 100 fecal coliform per 100-ml. sample for the monthly geometric mean count. The reach of the river from Percha dam to the International dam also contains limits for total dissolved solids, sulfates, and chlorides at times when irrigation releases are being made from Elephant Butte Reservoir. These numeric limits were agreed upon by the State of Texas and the State of New Mexico in 1968 and have been in effect since that time.

In 1999, the New Mexico legislature passed a change to the state Water Quality Act that provides for water quality impacts related to natural conditions and the reasonable operation of irrigation and flood control facilities. The legislative language below was incorporated into Section 1105 of the state stream standards:

When changes in dissolved oxygen, temperature, dissolved solids, sediment or turbidity in a water of the State is attributable to natural causes or to the reasonable operation of irrigation and flood control facilities that are not subject to state or federal pollution control permitting, numerical standards for temperature, dissolved solids content, dissolved oxygen, sediment, or turbidity adopted under the Water Quality Act do not apply.

The USEPA objected to this limitation in the stream standards. In April 2001, the NMWQCC resolved USEPA's concerns by submission of the following statement to USEPA:

The Commission interprets this provision to preclude enforcement of the specific numerical standards against listed activities; essentially non-point sources associated with the reasonable operation and maintenance of irrigation and flood control facilities. However, New Mexico measures and will continue to measure these numeric criteria for the purpose of assessing water quality in surface waters of the state affected by such activities. Any exceedances of these numeric criteria will be fully considered in assessing and reporting water quality.

5.6 Water Rights Administration Policies Specific to the Region

5.6.1 Mesilla Valley Administrative Area Guidelines for Review of Water Right Applications

The State Engineer has identified the following administrative objectives in the guidelines, which were adopted on January 5, 1999.

1. The Rio Grande stream system is fully allocated and existing rights may not be impaired by proposed appropriations. The system within the Mesilla Valley Administrative Area includes the Rio Grande, irrigation canals and laterals, and drains and wastes ways. The primary aquifer within the Mesilla Valley Administrative Area is recognized as a stream-connected system in which ground-

water withdrawals will ultimately result in depletions of surface-water sources.

2. Local water level decline rates resulting from proposed appropriations should not impair existing rights. Local water level declines refer to drawdown at nearby wells of other ownership.
3. The appropriation of water and/or a change in place of use, purpose of use and/or point of diversion shall not be contrary to water conservation within the state nor be detrimental to the public welfare of the state.
4. A ground-water appropriation may be granted to the extent that unappropriated water is available to the well from the aquifer at the proposed point of diversion.
5. Existing water quality for domestic, municipal, agricultural, industrial and other beneficial uses may not be impaired.
6. The existing drains system will not be impaired.

To achieve the above objectives, quantitative standards have been selected. These standards are provided below.

1. A surface-water depletion of less than 0.10 acre-foot in any year due to a proposed appropriation will be deemed acceptable and no offset of this impact will be required during that year.
2. An average annual local ground water level decline rate of 1.0 foot per year or less due to a proposed appropriation in combination with the exercise of existing water rights will be deemed acceptable when addressing impacts on existing wells of other ownership.
3. Wells completed into the flood plain alluvium or within one mile of any surface-water source can have large and immediate surface-water impacts. Depths to ground water within this area are generally less than 100 feet below land surface. This zone adjacent to the surface-water system is referred to as the High Impact Area (HIA) and is shown in Figure 2. The boundaries of the HIA are coincident with the area in which the depth to water is 100 feet or less (New Mexico State Engineer Technical Report No. 43, Plate 16, Wilson and others, 1981).

Administrative criteria have been developed to serve as agency guidelines on how to process and evaluate pending applications for surface and ground-water appropriations within the Mesilla Valley Administrative Area. Each application will be reviewed on a case-by-case basis.

1. OFFSET OF SURFACE WATER IMPACTS - Applications within the Mesilla Valley Administrative Area for ground-water appropriations that impact the surface waters beyond acceptable depletions (see B.1.) must offset 100% of the surface water depletions caused by the appropriation. All wells used to appropriate water, other than wells permitted under Mesilla Valley Administrative Area Section 72-12-1 (1998), must meet these requirements. An offset is achieved by acquiring a volume of water through a water right or other contractual obligation in the affected water source and releasing that water to replenish the affected volume in the source that results from exercise of the permitted ground-water appropriation. Offsets must be made before ground-water withdrawals commence tantamount to surface-water effects associated with the full exercise of the permit. Because of the uncertainty in hydrogeologic characteristics, the State Engineer will not require offsets of surface-water depletions when the proposed transfer of water rights results in an increased calculated depletion of less than 3% of the total amount of water diverted and consumed. If offset requirements are not achievable, the application will be denied.

2. APPLICATION REQUIRED FOR OFFSET - Offsets may be made by filing out an application to change the point of diversion and/or place and/or purpose of use of valid existing water rights. The State Engineer may alternatively consider other methods for offsetting as proposed by an applicant. The amount credited to offset the surface-water effect will be based on the historical use of the water right and the resulting surface-water impact.

3. APPLICATIONS FILED PRIOR TO IMPLEMENTATION OF THESE CRITERIA - These criteria are intended to allow the numerous applications currently on file with the Office of the State Engineer to be processed. These applications may be approved if the NMOSE staff requires, prior to pumping, sufficient water rights to be transferred by permit to offset the additional depletion on the Rio Grande, and the proposed application does not impair existing water rights, is not contrary to conservation of water within the state, and is not contrary to the public welfare of the State. The applicant shall proceed with due diligence in acquiring offsetting water rights and placing the water to beneficial use.

4. OPTION TO LEASE OFFSET RIGHTS FOR APPROPRIATIONS OUTSIDE OF

HIA - Ground-water appropriations located outside of the HIA may have delayed surface-water depletions. Due to these possible delays, the full amount of water rights acquired for offset purposes may not be needed for those purposes during early pumping time periods. Rights not immediately needed for offset purposes may be leased and used at a different location or for a different use as provided by statute and rules and regulations governing the appropriation and use of water. Alternately, the rights, if not immediately needed, can be left at the original place of use and may continue to be exercised pursuant to their original purpose.

5. CALCULATION OF SURFACE WATER DEPLETIONS - The calculation of surface-water depletions are necessary for the following situations:

a. Applications for new ground-water appropriations;

b. Applications to transfer water rights;

c. Applications to retire water rights for offset purposes;

d. Applications for supplemental wells that result in a shift of the pumping center.

Stream effects from discontinuing appropriations in b or c above may persist as surface-water impacts (residual impacts) associated with the recovery of the cone of depression. In the evaluation of the application, calculations will be performed to determine whether the residual impacts plus the impacts from the move-to well maintain an allowable level of surface-water depletion. The allowable surface-water depletion is the amount up to the surface-water depletions associated with the use of the retired water right if the water right had continued to be exercised at its original location (Figure 3). Surface water depletions will be estimated through the use of a superposition model based on a model presented in Frenzel-Kaehler (1992), using the procedures described in Barroll (1998), or such improved successor model and procedures as they become available. The calculated reduction in evapotranspiration (ET) will be treated as a surface-water depletion because of the uncertainty in ET behavior. Within the HIA, the aquifer depletion for irrigation is the product of the irrigated acreage and recognized average consumptive irrigation requirement. For HIA ground-water appropriations other than irrigation, and appropriations for all purposes outside of the HIA, the aquifer depletion is assumed to be equal to the diversion rate until a return flow plan has been accepted by the State Engineer.

6. CALCULATION ON LOCAL DRAWDOWN IMPACTS - Local drawdown effects that are due to a proposed appropriation will be evaluated on a case-by-case basis to ensure that impacts on the nearest wells of other ownership are maintained at an average annual rate of

decline of 1.0 foot or less (this includes drawdowns due to existing uses, criterion 7). It will be the applicant's burden to show that no impairment results when drawdowns exceed 1 foot per year. In the determination of whether local drawdowns are excessive, available water columns, impacts from existing and proposed uses, and the ability to deepen wells to sustain a freshwater supply will be considered as deemed necessary. Drawdown calculations may be performed using the superposition model, or the Theis equation. The method resulting in the greater impact will govern unless site specific information indicates that a particular method would be more realistic. Aquifer parameters used to calculate drawdowns on nearby wells may be obtained from available ground-water flow models or from site specific information as deemed reasonable. The pumping rate used in the calculations will be the aquifer depletion rate described in the last paragraph of criterion 5. Over 1 foot, average annual drawdown may be allowed based on the facts of the case and the applicant showing that there will be no impairment.

7. DRAWDOWNS DUE TO EXISTING WELLS - For the purpose of determining the water level decline due to existing rights, estimates included in Papadopulos (1987) or Lang and Maddock (1995) may be considered in addition to impacts from subsequently approved applications.

8. DIVERSION AND CONSUMPTIVE USE RATES FOR IRRIGATION WELLS [RESERVED]

9. RETURN FLOW CREDIT - Return flow credits, for other than irrigation uses, permit a water right owner to divert waters beyond the consumptive use amount to the extent that water diverted over and above the recognized consumptive use amount returns back to the system. Return flow credits are only allowed if specifically requested through application. The return flow credit that the State Engineer may grant will be based on demonstration that waters are actually returning to the system. For ground-water appropriations in which credit is sought for returns back to the aquifer, the applicant will be required to address location, timing and quantification of flows back to the aquifer of origination. For surface-water return flow credit, the location and amount measured by the applicant as return flows to the surface-water source per method approved by the State Engineer may be considered for credits. Surface water return flow credits accrued may not be carried over to the following year.

10. AVAILABLE TRANSFER AMOUNTS - For applications to change point of

diversion and/or place and/or purpose of use, the quantity of water that has been historically available and consumed for beneficial purposes will be taken as the amount which may be considered for transfer to the proposed use. For applications to transfer ground-water rights, the available offset amount will also be limited to the difference between the impacts resulting from the continued use of the move-from well and the residual impacts described in item 5. For applications to transfer rights from irrigation to other purposes, the historical consumptive use will be considered available for transfer. If surface-water rights are to be transferred long distances downstream or upstream, river losses or gains may be considered. Water uses developed from wells permitted under NMSA Section 72-12-1 (1998) shall not qualify as retirement rights.

11. SUPPLEMENTAL WELLS - Wells will be classified as supplemental only if the well is drilled in the same and only the same underground stream or channel, artesian basin, reservoir or lake and does not increase the appropriation of water to an amount above the existing water right. Application for supplemental well(s) may be granted if applicable criteria have been met. These include but are not limited to the issues of local drawdown effects, surface-water depletions, conservation and public welfare. Applications for supplemental well(s) for declared water rights may be approved, but only as provided for in criteria 14 and 16 below. Application for supplemental well(s) for permitted water rights that have been perfected, or are currently in development, may be approved for the total permitted water right.

12. CONSERVATION OF WATER - The State Engineer will determine whether an application is contrary to the conservation of water in the state. Water conservation issues will be addressed on a case-by-case basis. Applications and water conservation plans, if any, will be reviewed to ensure that highest and best technology practically available and economically feasible for the intended use will be utilized to ensure conservation of water.

13. PUBLIC WELFARE - The State Engineer will determine whether an application is detrimental to the public welfare of the state. The state water planning process, statewide and local issues of concern, water quality issues, and information submitted by parties in a protested application will be considered by the State Engineer in making the public welfare determination.

14. REASONABLE QUANTITY OF WATER SOUGHT - Each application will be reviewed to determine whether the well may reasonably obtain the quantity of water sought. A determination of the availability of water from a particular point in the aquifer will be based on

the transmissivity/storativity of the aquifer at that location, the proposed well casing diameter, the water column in the well, and the freshwater thickness. In addition, it will be assumed that a well capacity of at least 6 gallons per minute is required per irrigated acre and that a pump can not run more than 60% of the time, unless the applicant demonstrates that a higher percentage is reasonable.

15. 40 YEAR WATER PLAN - Municipalities, counties, public utilities supplying water to municipalities or counties, and universities must file a 40 YEAR WATER DEVELOPMENT PLAN pursuant to NMSA Section 72-1-9 (1997), when submitting application to appropriate water or an application to change place and/or purpose of use. The plan should support the applicant's request to acquire and hold, unused, water rights provided they can show reasonably projected additional needs within forty years. At a minimum, the plan should include a summary of water rights held by the applicant; quantities of water put to beneficial use; plan of development of water rights sought; conservation measures incorporated by the applicant; and public welfare issues. The State Engineer will review the plan to determine if the proposals appear reasonable.

16. APPLICATIONS ASSOCIATED WITH PRE-BASIN WATER RIGHTS - An application involving declared water rights for a supplemental well, replacement well, change of point of diversion, place of use, or purpose of use, may be filed by the applicant. The State Engineer will entertain a proposed change only to the extent that beneficial use has occurred. At the time of action on the application, the State Engineer may characterize the amount of declared water rights recognized. When characterizing the amount of declared water right recognized, considerations will be given to:

a. Date of commencement of works relative to date of declaration of the basin;

b. Capacities of diversion works and source of supply;

c. Existence of a water development plan, including feasibility of projected demands, in effect prior to declaration of the basin;

d. Adherence to and diligence in following that water development plan;

e. Amount of water beneficially used;

f. Continuity of actual beneficial use; and

g. Period of time since the basin was declared.

17. VERIFICATION OF OWNERSHIP OF TRANSFERRED WATER RIGHTS - Determination of ownership of water rights is not within the jurisdiction of the State Engineer. Unless otherwise notified in writing, the State Engineer will proceed with application processing as if an applicant is the owner or has authorization of the owner of the water right that the applicant proposes to transfer. If a question of water right ownership or owner authorization is raised before final action by the State Engineer, the State Engineer will suspend his decision until the question is resolved by a court of competent jurisdiction or other appropriate legal authority.

18. DECLARATIONS - Any person, firm or corporation claiming to be the owner of a vested water right from any of the underground sources of the Lower Rio Grande Basin, by application of waters therefrom to beneficial use, may make and file a declaration on a form prescribed by the State Engineer. The declaration shall set forth the beneficial use to which said water has been applied; the date of first application to beneficial use; the continuity thereof; the location of the well; if such water has been used for irrigation purposes, the description of the land upon which such water has been used for irrigation purposes; and the name of the owner. Such records or copies thereof officially certified are prima facie evidence of the truth of their contents. Declarations may be accompanied by affidavits of persons having personal knowledge of the history of the works or by other evidence tending to substantiate the claims and by copies of well logs, if available, but may be rebutted by other evidence. Beneficial uses cited in declarations will be inspected in the field by NMOSE staff and all works and beneficial uses will be documented.

19. 72-12-1 WELLS - The State Engineer will issue any qualified applicant a permit to drill and use a well as provided in NMSA Section 72-12-1 (1998). With the exception of wells for single household use or livestock use, all wells will be required to be metered and the permittee will be required to submit meter readings to the State Engineer. Permits issued for the drilling and use of wells pursuant to 72-12-1 are subject to such limitations as may be imposed by the courts and lawful municipal and county ordinances, which are more restrictive than applicable State Engineer regulations.

20. METERING - As a condition of approval on all permits, with the exception of single household domestic permits and/or livestock use, a measuring device or meter is required and the volume of water diverted must be reported to the State Engineer.

21. ADJUDICATION - Applications filed subsequent to the water rights being

adjudicated by a court will also be subject to these criteria.

22. MAPS - Filing maps, conforming to the State Engineer's latest rules and regulation, will accompany all applications.

23. STATE ENGINEER OPTION TO REVISE GUIDELINES - As new data become available, or as conditions warrant, the State Engineer may revise these guidelines to best achieve the administrative objectives above. If any part of these guidelines is found by a court to be invalid, the remainder shall remain valid and will continue to be used for evaluation purposes.

5.6.2 Jornada del Muerto Basin Criteria

The NMOSE has a draft of the recommended informal criteria for evaluating applications in the southern Jornada del Muerto Basin, Lower Rio Grande Underground Water Basin. A copy of the criteria is provided in Appendix J.

5.6.3 Hueco Bolson Criteria

At present, the State Engineer has not adopted criteria and guidelines for evaluating water rights applications in the Hueco Basin. Evaluations are conducted on a case-by-case basis, using a basin ground-water flow model as appropriate. Because conditions in the Hueco Basin are similar to those in the Tularosa Basin, effects may be compared to the Tularosa Basin criteria where appropriate.

5.7 Supplemental Well Pumping

The use of supplemental wells by water right holders with EBID surface-water rights mostly came about with the drought in the 1950s when EBID Project water allotments were in the inches. With the recent drought, many pumpers have once again initiated pumping of these wells and others have sought application to obtain supplemental well permits. At this time, the NMOSE has continued to grant permits for supplemental well use constrained with a beneficial use measurement dependent on the crop that is being grown. The actual limitation of the use of supplemental wells will be determined in the stream adjudication.

5.8 Special Districts

In the legislative session of 2003, an important new law was enacted to create Special Water User Associations under Section 73-10-48(A), which amended the Municipal Water User

Association Statues (MWUA). Special Water User Associations include municipalities, counties, state universities, member-owned water systems, and public utilities supplying water to municipalities or counties, which supply water to lands within the boundaries of Irrigation Districts organized pursuant to chapter, 73, Articles 10 and 11 NMSA 1978, and the ISC. The statute was passed to start the process whereby the City of Las Cruces and other water providers would be able to acquire Project water rights to eventually place in surface-water treatment plants. The statute has several provisions that will be instrumental in creating a streamlined transfer mechanism to provide for the use of agricultural water by municipalities. In a key provision, the statute provides for junior ground water pumpers to obtain offset water to compensate for the effects of their pumping on the Rio Grande and for the purpose of enabling the State to meet the needs of appropriators with senior priorities within New Mexico.

Under this statute, the irrigation district has authority to:

1. Assess the Association for total assessed acreage of participating members in the Association.
2. Coordinate delivery of annual allotment of project water for all assessed acreage participating in the Association.
3. Place the Association as record owner on the irrigation district tax statement for the duration of the participation by district constituents in an Association.

An Association has authority to lease the use of the entire annual allotment of project water for all assessed acreage participating in the Association.

EBID will adopt new regulations to implement the statute. It is anticipated that these regulations will closely resemble the MWUA regulations already in place. Among the more relevant parts that address some of the nuts and bolts problems of implementing the MWUA are:

1. An Association may lease the use of annual allotments of project water from owners of tracts of land within EBID boundaries that are concurrent with the Association service area. In all cases where there may be overlapping service areas, among two or more Associations, the EBID Board of Directors will have final approval as to which Association will be authorized to lease the annual allotments of project water within the disputed service area.
2. In cooperation with EBID, the Association shall take steps to insure that land from

which the water has been leased is not irrigated with any water from any source during the term of the lease.

3. All assessments, levies and administrative fees must be paid in full prior to February 1 of the current year for all assessed acreage included in the Association.
4. The Association must submit to EBID a map indicating its legal service area within EBID boundaries. If those boundaries should change, the Association shall revise the map and submit the revision within 60 days of the approved change.
5. The Association agrees that the annual allotment of water shall only be used for the placement of that water in a municipal water treatment plant, which serves an area within the boundaries of EBID. The Association will transfer into the EBID "Agricultural Pool" annual allotments of Project Water that it holds or may acquire. The water may be sold at a rate equal to or less than the assessment charge. This transfer shall occur until such time as the Association utilizes project water in a municipal water treatment plant.
6. The Association shall submit to EBID a recorded copy of the lease agreement with the EBID member by September 1 of each year.
7. Leases shall be for a minimum of 5 years and a maximum of 40 years and shall include only "water righted acres".
8. Partial leases of "water righted" acreage will be allowed if administratively feasible.
9. Leases shall be signed by all appropriate parties and recorded with the Office of the County Clerk and shall be binding on the current land owner and all future land owners for the term of the lease.
10. Leases shall stipulate that maintenance to the assessed acreage is to continue to insure that fallow land does not become a public nuisance, including but not limited to weed infestation, wind and soil erosion, etc.
11. Leased water may not be transferred outside of EBID boundaries. The Association shall be assessed a penalty in the amount of the current approved assessments for the farm or flat rate charges for the applicable tract of land and a deduction from the Association's water account for any unauthorized use of water outside of EBID boundaries, as determined by EBID.
12. In addition to administrative fees, the Association shall pay all costs incurred by

EBID associated with the approval of the transfer of water by the Association, including but not limited to the Municipal and Industrial charge for maintenance of Elephant Butte Dam which is charged annually to EBID by the United States.

13. EBID shall develop a procedure to analyze the effects of ground-water pumping on Project water supply. The analysis will examine the current effects of ground-water pumping and the effects caused by the use of water under this policy by the Association. Depletions of Project supply by the Association shall be accounted for by a reduction in the amount of Project water ultimately delivered to the Association or by other methods agreed to by EBID.
14. The Association may request a variance to any of the conditions in this policy, by written application to the Board. The Association will set forth the specific reason(s) for the variance request and attach whatever materials are necessary to evaluate and justify the variance. The Board, in its sole discretion, has the authority to grant the variance if they find a rational and/or statutory basis to do so.

5.9 The Role of the New Mexico Office of the State Engineer

The role of the NMOSE and state water administration has mainly been devoted to the quantification of water rights in the Lower Rio Grande through the stream adjudication. Recent activity has centered around how transfers of water use from agricultural to M&I will take place. The SWUA legislation was noted by the NMOSE as the first bill to meet all the major requirements for complex water banking to be successfully implemented. The bill was the result of a collaborative process to provide for expedited transfers of banked water rights from agricultural uses to M&I use. The legislation ensures that the state engineer has the statutory approval and oversight authority to determine that water banking within the district will be according to law and will not result in impairment or increases in net depletions in the stream system. The NMOSE is in the process of developing rules and regulations for the implementation of the SWUA legislation. The NMOSE and ISC also continue to play a role in providing funding for more precise measurement and metering of Project Supply. As more data is available, and ground-water models are refined, the administrative guidelines should be amended by the NMOSE.

5.10 Legal Issues Needing Resolution

The most pressing legal issues center around the quantification of existing surface and ground water rights within the Lower Rio Grande Basin and the ability to transfer water rights when most of the water rights in the Lower Rio Grande have not been adjudicated. Quantification of water rights is the subject of the ongoing Lower Rio Grande stream adjudication. In addition, the issue of the United States' ability to condition any transfer of Rio Grande Project water from agricultural to municipal and industrial uses must to be resolved.

The City of El Paso is proposing a bill in Congress that will exempt the Rio Grande Project from the 1920 Miscellaneous Purposes Act for municipal transfers. EBID and the City of Las Cruces will support the legislation if it exempts the entire Project from the 1920 Act.

Aside from the issues of quantification and transfer, the next set of issues that need resolution revolve around the Operating Agreement for the Rio Grande Project. Not having a written operating agreement in the Project between the United States, EPCWID#1 And EBID has led to numerous claims by Texas entities with respect to Project water. Issues of misallocation of Project supply, under delivery, return flow credits, water quality, year around delivery, carry over storage, supplemental well pumping, Canutillo Wellfield pumping, Project water use in Hudspeth County and credit for the lining of the American Canal have all been raised in the various lawsuits enumerated in section 5.4. It is clear that an Operating Agreement has the potential to resolve many of these issues or simply resolve the issue of project water allocation between the two irrigation districts. EBID continues to suggest that the two districts need to reach agreement on the major points in the operating agreement even if all of the issues are not resolved.

5.11 Local Conflicts

Aside from the conflicts that will arise among junior and senior water users, conflicts have revolved around claims to service area. Doña Ana County and the City of Sunland Park have litigated over the right to serve in the Southern part of Doña Ana County.

In January of 2002, Doña Ana Mutual Domestic Water Users Association filed suit against the City of Las Cruces in a Federal court to protect the Association's service area. Most recently, Doña Ana Mutual Domestic and the City of Las Cruces have settled their issues regarding service area.

5.12 Legal Limitations

Legal limitations on the water supply for the Lower Rio Grande will ultimately be determined in the ongoing stream adjudication. The actual amount of ground-water use in the Lower Rio Grande that can occur without damage to a senior water right holder will ultimately be determined by the court. In order for junior ground-water users to continue to pump, they will have to acquire more senior ground-water rights, switch to surface water and receive water through one of the regional surface-water treatment plants or acquire offsets to their effect on senior water right holders through a mechanism like a Special Water Users Association (SWUA). Surface water allocations in the Project between the two irrigation districts will ultimately be determined in some form of Operating Agreement. Texas entities have alleged that the New Mexico portion of the Project is taking more than their share and seek a larger portion of the allocation of Project supply. The United States may also pose a hurdle in the conversion of Project water to Municipal and Industrial (M&I) use. EBID has initiated litigation to have the court determine whether or not the United States will have a say in these transfers under the 1920 Act.

6.0 WATER RESOURCES ASSESSMENT FOR THE PLANNING REGION

6.1 Water Supply

6.1.1 Surface Water Supply

6.1.1.1 Precipitation

According to the environmental service records of the NMSU Climate Center, the average annual precipitation is approximately 8 to 8-1/2 inches for Las Cruces (NMSU Weather Bulletin 9) and varies from 7 to 9 inches across the Planning Region (Bullock and Neher, 1980). More than half of this annual precipitation usually occurs in the form of thunderstorms between April and October. The more intense of these storms often occur during the period of July through September.

Nineteen weather gage stations were located within the planning area. Of the nineteen stations located, only four had historic data for their period of record (based on discussions with the State Climatologist and the National Weather Service). Consistent data was not available for the remaining fifteen stations. The four stations listed in the planning area are Caballo Dam, Hatch, Jornada Experimental Range and NMSU. The tables below show the locations of the fifteen stations (Table 6.1) and the relevant data for the four stations which have historical data (Tables 6.2 through 6.5). The pan evaporation data available for the study area including the periods of record, monthly average evaporation and the total annual evaporation average are listed in Table 6.6. In addition, graphs of the precipitation and temperatures at each of the four stations listed in Tables 6.2 through 6.5 are included as Figures 6.1 through 6.4 and 6.5 through 6.8, respectively. A precipitation contour map of the study area is also included as Figure 6.9.

TABLE 6.1: IDENTIFIED PRECIPITATION GAGES, DOÑA ANA, SOUTHERN PORTION OF SIERRA AND WESTERN OTERO COUNTIES

Station	Latitude	Longitude	Elevation (ft)	Period of Record
Afton 6 NE	N32 07	W106 52	4187.9	07/1946-12/1999
Caballo	N32 54	W107 18	4190	11/1938-07/2000
Chaparral	N32 01	W106 25	4002.9	10/1997-Present
Garfield	N32 45	W107 16	4103.0	07/1946-10/1948

TABLE 6.1: IDENTIFIED PRECIPITATION GAGES, DOÑA ANA, SOUTHERN PORTION OF SIERRA AND WESTERN OTERO COUNTIES

Station	Latitude	Longitude	Elevation (ft)	Period of Record
Hatch	N32 40	W107 09	4039.0	07/1946-03/2000
Jornada Experimental Range	N32 37	W106 44	4265.0	12/1925-04/2000
La Mesa	N32 05	W106 34		07/1947-01/1951
Las Cruces KGRT Radio	N32 16	W106 44	3879.9	09/1975-04/1976
Las Cruces KGRT Radio	N32 49	W106 49	3895.0	04/1976-Present
Las Cruces Municipal Airport	N32 17	W106 55	4452.9	10/1948-Present

TABLE 6.2: CABALLO DAM, NM-STATION 291286, N32 54 W107 18, 4190 FT, 11/1938-07/2000, SOUTHERN PORTION OF SIERRA COUNTY

Month	Average Monthly Snow Fall (in)	Average Annual Total Snow Fall (in)	Average Total Monthly Precipitation (in)	Average Total Annual Precipitation (in)	Average Monthly Temperature (F) High	Low	Average Annual Temperature (F) High	Low
		1.0		**9.62**			**76.8**	**44.4**
Jan.	0.3		0.41		56.6	25.7		
Feb.	0.0		0.32		62.0	29.5		
Mar.	0.1		0.27		68.4	35.1		
Apr.	0.0		0.20		77.1	42.2		
May	0.0		0.33		85.4	50.3		
Jun.	0.0		0.70		94.9	59.7		
Jul.	0.0		1.79		95.4	65.6		
Aug.	0.0		2.06		92.8	63.9		
Sep.	0.0		1.54		87.5	56.7		
Oct.	0.0		0.93		78.1	44.7		
Nov.	0.2		0.44		66.1	33.2		
Dec.	0.3		0.61		56.8	26.5		

TABLE 6.3: HATCH, NM-STATION 293855, N32 40 W107 09, 4039.0 FT, 07/1946-03/2000, DOÑA ANA COUNTY

Month	Average Monthly Snow Fall (in)	Average Annual Total Snow Fall (in)	Average Total Monthly Precipitation (in)	Average Total Annual Precipitation (in)	Average Monthly Temperature (F) High	Low	Average Annual Temperature (F) High	Low
		2.6		**9.77**			**77.9**	**41.8**
Jan.	1.0		0.49		58.9	23.5		
Feb.	0.3		0.37		63.7	26.7		
Mar.	0.1		0.25		70.0	33.4		
Apr.	0.1		0.26		78.2	40.7		
May	0.0		0.34		86.4	48.5		
Jun.	0.0		0.56		95.2	56.9		
Jul.	0.0		1.87		95.2	63.0		
Aug.	0.0		2.08		92.8	61.2		
Sep.	0.0		1.47		87.9	53.7		
Oct.	0.0		1.00		79.1	41.1		
Nov.	0.3		0.40		68.0	29.6		
Dec.	0.6		0.68		59.2	23.6		

TABLE 6.4: JORNADA EXPERIMENTAL RANGE, NM-STATION 294426, N32 37 W106 44, 4265.0 FT, 12/1925-04/2000, DOÑA COUNTY

Month	Average Monthly Snow Fall (in)	Average Annual Total Snow Fall (in)	Average Total Monthly Precipitation (in)	Average Total Annual Precipitation (in)	Average Monthly Temperature (F) High	Low	Average Annual Temperature (F) High	Low
		2.3		**10.12**			**76.8**	**39.7**
Jan.	0.8		0.52		56.9	20.8		
Feb.	0.3		0.36		62.2	24.5		
Mar.	0.1		0.29		68.9	29.9		
Apr.	0.0		0.21		77.0	37.1		
May	0.0		0.41		85.4	45.2		
Jun.	0.0		0.60		94.6	55.2		
Jul.	0.0		1.94		95.5	62.2		
Aug.	0.0		2.13		92.3	60.4		
Sep.	0.0		1.52		87.0	52.7		
Oct.	0.0		0.93		78.0	40.1		

TABLE 6.4: JORNADA EXPERIMENTAL RANGE, NM-STATION 294426, N32 37 W106 44, 4265.0 FT, 12/1925-04/2000, DOÑA COUNTY								
Month	Average Monthly Snow Fall (in)	Average Annual Total Snow Fall (in)	Average Total Monthly Precipitation (in)	Average Total Annual Precipitation (in)	Average Monthly Temperature (F)		Average Annual Temperature (F)	
					High	Low	High	Low
Nov.	0.3		0.49		66.2	27.8		
Dec.	0.1		0.72		57.1	20.8		

TABLE 6.5: NEW MEXICO STATE UNIVERSITY, NM, STATION 290131-N32 17, W106 45-3910.0 FT-01/1892-03/1959, STATION 298535-N32 17, W106 45-3880.0 FT-04/1959-01/2001, DOÑA ANA COUNTY								
Month	Average Monthly Total Snow Fall (in)	Average Annual Total Snow Fall (in)	Average Total Monthly Precipitation (in)	Average Total Annual Precipitation (in)	Average Monthly Temperature (F)		Average Annual Temperature (F)	
					High	Low	High	Low
		3.1		**8.7**			**76.7**	**44.3**
Jan.	0.8		0.40		57.7	26.2		
Feb.	0.6		0.39		62.6	29.8		
Mar.	0.2		0.32		69.3	35.1		
Apr.	0.1		0.21		77.3	42.1		
May	0.0		0.32		85.5	50.0		
June	0.0		0.63		94.1	59.4		
July	0.0		1.50		94.1	65.7		
Aug.	0.0		1.89		91.7	63.9		
Sept.	0.0		1.26		86.8	56.8		
Oct.	0.0		0.79		77.9	44.2		
Nov.	0.5		0.45		66.2	32.1		
Dec.	1.0		0.58		57.6	26.7		

TABLE 6.6: AVERAGE EVAPORATION RATES (INCHES)													
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	TOTAL ANNUAL EVAPO-RATION
Caballo Dam Station 1948-1995	4.18	4.95	8.52	11.3	13.0	14.8	12.7	11.3	9.03	7.13	4.58	3.37	110.7
Jornada Exper. Range 1953-1979	2.44	4.10	7.24	10.1	11.8	12.8	10.7	9.46	7.64	5.63	3.61	2.50	87.9
NMSU Weather Station 1959-1995	3.00	4.19	7.24	9.86	12.1	13.0	12.1	10.4	8.03	6.12	3.58	2.79	93.6

Source: NMSU Weather Web Site Accessed June 28, 2001

6.1.1.2 Description of Physical Drainage Basins and Topography

The study area consists of four distinct drainage basins which are structurally depressed units that were displaced downward with respect to surrounding mountain uplifts (W.E. King, et al.). Upland watershed areas drain to the basins in the direction of the Rio Grande, which is the sole perennial surface-water source in the Plan area. A few of these watershed drainage systems reach the Rio Grande, while a significant number of them "dead-end" into the sandy bottoms of the main drainage basins. A topographic map of the study area showing the general watershed boundaries is included as Figure 6.10.

The Rio Grande flows through a valley that is part of a narrow structural depression that passes through three physiographic provinces. In the Basin and Range Province, the river flows from north to south through alternating series of broad and narrow valley segments that coincide with several series of structural basins each separated by uplifts of more resistant older rocks (Soils and Geomorphology in the Basin and Range Province area of Southern New Mexico – Guidebook to the Desert Project: New Mexico Bureau of Mines and Mineral Resources: Gile, Hawley, and Grossman, 1981). Most of the valley is incised in intermontane basin-fill and associated volcanics. A stepped sequence of valley-border surfaces, graded to successive lower levels of river incision, is inserted below basin-fill and piedmont-erosion surfaces.

A complete range of channel types can be seen traversing the basins, which trend approximately northwest to southeast. The channel types are influenced mainly by basin slopes, underlying bedrock units, and soil formation and cover. Basin slopes range from nearly level (less than one percent) on the flood plains to seventy percent on the uplands and mountainsides. On flood plains and stream terraces, slopes range from zero to one percent. The slopes on fans, terraces, ridges, valleys and basin floors, and higher flood plains and piedmonts range from one to forty percent. Surrounding mesas, plains, upper basin floors, fans, higher ridges, and some uplands and mountains have slopes ranging from one percent to seventy-five percent.

6.1.1.3 Stream Flow and Sources of Stream Flow

The primary source of surface-water flow within the Plan area is from the Rio Grande itself. Within the Plan area, stream flows from external sources are limited to intermittent (non-perennial) flows from arroyos during the summer months caused by infrequent large frontal activity storms. Finally, a smaller source of flows is from municipal and non-municipal wastewater treatment plant systems along the 100-mile river reach that utilize ground water and then treat the non-consumed ground water prior to discharge into the system.

6.1.1.3.1 Rio Grande Flow from Upstream

The Rio Grande Project is the major determinant in discussion of available surface-water supplies within the Plan region. The project, constructed in the early 1900's, developed all of the remaining flows of the Rio Grande and its tributaries from Elephant Butte Reservoir to Fort Quitman, Texas. Within the local region, the EBID administers the Project. The EBID Project boundaries are also shown on Figure 6.10.

Water supplies within the Rio Grande vary from year to year depending on annual precipitation within the system. Historical records indicate that the supply has consistently been above one-half of the normal capacity of the river system. This would equate to an available water supply of at least 790,000 ac-ft for about 25 percent of the time and a water supply of at least 600,000 ac-ft about 85 percent of the time (1994 Doña Ana County Regional Water Plan).

6.1.1.3.2 Surface Water Runoff

During the summer months, orographic lifting of warm air masses produces severe short-duration thunderstorms that generate significant volumes of stormwater runoff. Depending on the channel geology and slope of arroyos collecting and conveying the runoff, sometimes there are intermittent flows from these arroyos to the Rio Grande. However, most of the flows in the arroyos "dead-end" in sand beds in the respective basins and do not reach the river. There are no natural perennial surface-water flows within the study area that intersect the Rio Grande. The volume of surface runoff is included in identification of available surface-water resources for the Rio Grande itself. Thus, no additional credit is applied in discussion or identification of runoff volumes from within the Plan area. Major ephemeral surface-water features within the study area are listed in Table 6.7 and discussed below. This table is followed by a description of these ephemeral basins.

TABLE 6.7: MAJOR BASINS ALONG THE RIO GRANDE WITHIN THE PLANNING REGION

Basin Name	Basin Area/a (mi^2)	Basin Length/a (mi)	High Elevation/a (ft)	Low Elevation/a (ft)
Rincon Arroyo	78.3	22.0	5300	4030
Broad Canyon	65.0	15.7	5540	3990
Arroyo Cueruo	117.8	26.2	5840	4085
Berrenda Creek	90.5	32.3	7640	4110
Tierra Blanca Creek	37.1	19.6	8425	4120
Montoya Arroyo	17.2	15.1	5415	4135
Placitas Arroyo	34.8	12.2	6050	4055
Alameda Arroyo	15.6	8.6	5100	4270
Las Cruces Arroyo	9.7	7.1	4575	3905
Tortugas Arroyo	21.3	13.9	7220	3880
Mossman Arroyo	11.5	11.1	6490	3860
Pena Blanco Arroyo	24.5	10.4	5585	3850

/a - Values are approximations.

Rincon Arroyo is a large basin originating on the east side of the Caballo and Redhouse Mountains. The basin is relatively wide with gentle sloping arroyos combining to form the Rincon Arroyo.

Broad Canyon originates in the Sierra de Las Uvas mountain range and feeds the Rio Grande from the west. The majority of the runoff comes from Tailholt Mountain at a slope of 1.9 percent.

Arroyo Cueruo is a relatively small arroyo, however numerous intermittent streams connect to form this large basin. The basin drains into the Rio Grande on the west side between

Salem and Garfield.

Berrenda Creek originates in the Gila National Forrest at an approximate elevation of 7640 feet above mean sea level draining into the Rio Grande from the west between Derry and Garfield at a slope of 2.1 percent. The drainage basin is relatively narrow with few intermittent streams connection Berrenda Creek.

Tierra Blanca Creek originates in the Gila National Forrest south of Sawyers Peak on Seven Brothers Mountains. This basin is narrow with a moderate amount of intermittent streams connecting to the main creek. The creek originates at an approximate elevation of 8425 feet above mean sea level draining into the Rio Grande on the west between Arrey and Derry at a slope of 4.2 percent.

Montoya Arroyo originates just east of state highway 27 approximately 4.5 south of Hillsboro. The arroyo drains into the Rio Grande approximately 2 miles north of where Tierra Blanca Creeks drains. No intermittent streams combine to form this arroyo.

Placitas Arroyo is fed by a large amount of intermittent streams originating on the north side of the Sierra de Las Uvas at an approximate elevation of 6050 feet above mean sea level. The arroyo drains into the Rio Grande approximately 0.5 miles north of the bridge connecting Hatch and Interstate 25.

Tortugas Arroyo originates in the Organ Mountains through Filmore Canyon at an approximate elevation of 7220 feet above mean sea level. The arroyo enters into a drainage detention dam where the flow is regulated and then released into the Las Cruces lateral on the west side of Interstate 10.

Mossman and Pena Blanca Arroyos originate on the southern portion of the Organ Mountains in Archenback and Long Canyon on the Fort Bliss Military Reservation – McGregor Range. The arroyos both enter into a drainage detention dam and released where the flow is terminated on the west side of Interstate 25.

Alameda and Las Cruces arroyos both originate from runoff from the east side of the Organ Mountains. The Alameda arroyo enters the Alameda Dam with regulated flow resulting on the east side. The Las Cruces arroyo’s north and south fork enters drainage detention dams to regulate flow. Both of the arroyos terminate on the east side of the Army Corp of Engineers 500-year design storm detention dam.

6.1.1.3.3 Treated Water Discharges

Information obtained from the NMED Surface Water Bureau indicate that NPDES permits have been issued to six municipal and other wastewater treatment plants/systems along the river. These permits allow the plants to discharge treated wastewater to the Rio Grande. The treated wastewater is required to conform to USEPA regulatory standards. The six wastewater treatment plants and their NPDES permitted discharges as well as their estimated average daily discharges in million gallons per day (MGD) are tabulated below. Their locations are identified in Figure 6.11.

TABLE 6.8: LOCATION/POINTS OF TREATED WASTEWATER DISCHARGES, DOÑA ANA AND SOUTHERN PORTIONS OF SIERRA COUNTIES

Community/Location	NPDES Permitted Discharge (MGD)	Current Average Discharge (MGD)
Hatch	0.3	0.25
Las Cruces	15.0	7.5
Gadsden ISD	<0.1	<0.02
Anthony	0.8	0.6
Santa Teresa	0.8	0.53
Santa Teresa Border Crossing	N/A	0.3
Sunland Park	2.0	0.8
Total	**19.10**	**10.0**

The NMED Surface Water Bureau, Doña Ana County, and the wastewater treatment plants provided the above information. The total permitted discharge of approximately 19.1 MGD from the six plants represents a return flow from water diversions of approximately fifty-nine acre-feet per day (ac-ft/day) of treated wastewater to the Rio Grande. Currently however, only an average of about 9.7 MGD (30 ac-ft/day) is being discharged to the river. In addition to these current sources, there are plans to construct two new wastewater treatment plants in the near future in Salem and Santa Teresa. It is estimated that these plants will each discharge approximately 1 MGD of treated wastewater to the Rio Grande. The gain in volume of discharge to the Rio Grande from these wastewater treatment plants may, to some degree, be offset by a decrease in seepage into the river from septic tank discharges in the gaining reaches of the river.

Several commercial and industrial entities in the Plan area have ground-water discharge permits issued by the NMED Groundwater Division. These permits allow the industries to store their wastewater in lined ponds, utilize land-application and/or discharge to septic systems. The majority of these industries are either dairy, food processing facilities or rural smaller industrial/commercial operations. In addition, Doña Ana County operates a septage disposal facility in Mesquite, which consists of lined evaporation basins. These discharges however, do not directly discharge to the Rio Grande, or to any canals or drains. Therefore, they do not directly impact the available surface-water supplies within the Rio Grande.

6.1.1.3.4 Stream Gage Locations

Due to the extensive volume of irrigated lands within the study area and the EBID system, this portion of the Rio Grande in New Mexico is one of the most heavily monitored portions of the river system within New Mexico in terms of monitoring of stream flows. Both the United States Geological Society (USGS) and the EBID maintain an extensive array of flow gages along the Rio Grande, in canals, laterals, and drains within the bounds of the plan area. Identified locations are shown in the table shown below. Locations were obtained as part of this study through the EBID via use of a hand-held global positioning system (GPS) accurate to within (±) 15 meters. The gages are intended to monitor flow into and out of the EBID system as well as within the main channel of the Rio Grande itself. The stream gage locations are provided in Table 6.9 and shown on Figure 6.12.

TABLE 6.9: IDENTIFIED SURFACE WATER GAGES, DOÑA ANA COUNTY AND SOUTHERN PORTIONS OF SIERRA COUNTY

Station[1]	Latitude (Degrees Minutes)	Longitude (Degrees Minutes)	Period of Record	
Caballo Cable Section	N32 53 090	W107 17 565	1938	1995
Percha Private Lateral	N32 52 084	W107 18 177	1916	1995
Arrey Canal	N32 52 143	W107 18 312	1930	1995
Spillway #5 Hatch Main	N32 42 140	W107 14 823	1979	1995
Garfield Drain	N32 41 256	W107 11 613	1921	1995
Hatch Drain	N32 39 432	W107 07 841	1923	1995
Spillway # 16	N32 40 013	W107 01 233	1979	1995
Spillway # 18	N32 37 395	W107 01 470	1979	1995
Rincon Drain	N32 36 798	W107 00 275	1930	1995

TABLE 6.9: IDENTIFIED SURFACE WATER GAGES, DOÑA ANA COUNTY AND SOUTHERN PORTIONS OF SIERRA COUNTY

Station[1]	Latitude (Degrees Minutes)	Longitude (Degrees Minutes)	Period of Record	
Haynor	N32 36 806	W107 01 230	NA	1995
Leasburg Heading	N32 29 794	W106 55 322	1916	1995
Spillway # 1A	N32 28 789	W106 55 277	1989	1995
Leasburg Cable	N32 28 617	W106 55 107	1914	1995
Spillway # 5	N32 22 374	W106 49 993	1979	1995
Spillway # 8	N32 20 524	W106 49 529	1979	1995
Picacho Bridge	N32 17 779	W106 49 451	1991	1995
Spillway # 40	N32 16 090	W106 49 785	1991	1995
Three Saints East	N32 00 038	W106 37 136	1981	1991 (w/gaps)
Rio Grande @ Anthony Bridge	N31 59 970	W106 38 168	1986	1989
La Union West	N32 00 168	W106 39 250	1984	1995
West Drain	N31 51 203	W106 37 329	1930	1984
Nemexas Drain	N31 56 979	W106 37 994	1930	1985
Anthony Drain	N31 59 651	W106 37 368	1930	1969
East Drain	N32 00 132	W106 36 548	1921	1995
Del Rio Drain	N32 06 876	W106 39 942	1923	1995
Spillway # 18	N32 07 977	W106 48 623	1986	1995
Spillway # 25	N32 10 243	W106 43 206	1986	1995
Spillway # 15	N32 11 747	W106 44 005	1986	1995
La Mesa Drain	N32 02 584	W106 39 772	1921	1995
Spillway # 31	N32 02 231	W106 39 784	1981	1995
Spillway # 30	N32 03 912	W106 39 831	1986	1995
Spillway # 19	N32 05 395	W106 39 277	1982	1995
Mesquite Drain	N32 05 380	W106 38 537	NA	1995
Picacho Drain	N32 14 923	W106 49 333	1930	1995
Eastside Heading	N32 13 706	W106 47 770	1914	1995
Del Rio Lateral	N32 13 681	W106 47 822	1955	1995
Westside Heading	N32 13 534	W106 46 313	1914	1995
River Below Mesilla (sporadic data from 1980-1985)	N32 21 615	W106 47 823	1986	1995
Bonita Lateral	NA	NA	1938	1991
Rio Grande below Percha Dam	NA	NA	1930	1937

TABLE 6.9: IDENTIFIED SURFACE WATER GAGES, DOÑA ANA COUNTY AND SOUTHERN PORTIONS OF SIERRA COUNTY				
Station[1]	**Latitude** (Degrees Minutes)	**Longitude** (Degrees Minutes)	**Period of Record**	
Angostura Drain	NA	NA	1930	1995
Irrigation Above Leasburg Canal	NA	NA	1984	1988
Rio Grande Above Leasburg Dam	NA	NA	1930	1983
Spillway # 1	NA	NA	1992	1992
Selden Drain	NA	NA	1930	1971 (w/gaps)
Spillway #13	NA	NA	1984	1991
La Union East	NA	NA	1984	1991
Spillway # 26	NA	NA	1979	1995
Spillway # 16	NA	NA	1986	1990
Spillway # 20	NA	NA	1979	1987 (w/gaps)
Spillway # 21	NA	NA	1986	1991
Spillway # 23A	NA	NA	1986	1991
Spillway # 30	NA	NA	1986	1988
Spillway # 32	NA	NA	1979	1991
Spillway # 32A	NA	NA	1986	1988
Spillway # 32B	NA	NA	1986	1991
Spillway # 34	NA	NA	1986	1991
Spillway # 34A	NA	NA	1986	1987
Spillway # 35	NA	NA	1980	1991
Spillway # 35C	NA	NA	1986	1988
Spillway # 36	NA	NA	1986	1991
Spillway # 38	NA	NA	1986	1991
Vado Bridge	NA	NA	1986	1995
Vinton Bridge	NA	NA	1986	1990
Montoya Drain	NA	NA	1930	1991
Chamberino Drain	NA	NA	1930	1963
Mesilla Drain	NA	NA	1930	1963 (w/gaps)
Montoya Intercepting Drain	NA	NA	1986	1990
Santo Tomas Drain	**NA**	NA	1980	1985 (sporadic data)

TABLE 6.9: IDENTIFIED SURFACE WATER GAGES, DOÑA ANA COUNTY AND SOUTHERN PORTIONS OF SIERRA COUNTY				
Station[1]	**Latitude** (Degrees Minutes)	**Longitude** (Degrees Minutes)	**Period of Record**	
Santo Tomas River Drain	NA	NA	1986	1989

[1]Gages operated by EBID

6.1.1.3.5 Stream Flow from Ungaged Tributaries

As indicated previously, the primary water feature within the Plan area is the Rio Grande. The EBID gages the river system at several points within the Plan area including the northern/upstream portion of the Plan area (Caballo Dam), near the middle of the Plan area at the Leasburg Dam and canal, and the southern point of the Plan area (the approximate boundary between New Mexico and Texas). These gages measure all flows, which enter the system in between. There are no perennial streams/tributaries that flow into the Rio Grande within the Plan area. Therefore, there are no ungaged stream/tributary flows that are not taken into account within the gage records discussed previously.

6.1.1.3.6 Rio Grande Flows at Major Gage Stations

Three major gage stations within the plan area that have consistent data for an extended period are at Caballo Dam (Caballo Cable Section), Leasburg Dam (Leasburg Heading + Leasburg Cable Section) and Courschene Bridge. The annual average flows, minimum annual flow and maximum annual flow and the years these occurred at these gage stations are listed in Table 6.10 below and displayed graphically in Figure 6.13. The Rio Grande flows through the Plan area decrease from the head of the system at Caballo Dam to the tail at Courschene Bridge as shown in flows measured at the gaging stations at those two points and at Leasburg Dam. The average annual flow at Caballo Dam over the period from 1930-1995 was 693,000 ac-ft. while the flow at the southern boundary of the Plan area, Courschene Bridge, was 419,000 ac-ft.

TABLE 6.10 RIO GRANDE ANNUAL FLOW SUMMARY 1930-1995 (AC-FT/YR)					
Minimum Flow	**Minimum Flow**	**Year**	**Peak Flow**	**Year**	**Average Annual Flow**
Caballo Cable Section	206,000	1964	1,796,000	1942	693,000
Leasburg Cable and Leasburg Canal	144,000	1992	1,571,000	1942	637,000
Courschene Bridge	57,000	1956	1,559,000	1942	419,000

Source: EBID

6.1.1.3.7 Location and Description of Major Storage Reservoirs

Within the Plan area, there are no major storage reservoirs. The City of Las Cruces maintains a small recreational lake, Burn Lake, which is fed via irrigation/drain water. In addition, stormwater runoff from the low-lying west central section of Las Cruces drains to Burn Lake. This small lake is located within the boundaries of the City limits approximately 6500 feet east of the Rio Grande with an elevation of 3873 feet above mean sea level as reported by Robert Ebler of the City of Las Cruces Engineering Department. The approximate storage capacity of this recreational facility is 390 acre-ft.

There are also numerous stormwater dam facilities located within the Planning area. However, these are designed only as detention facilities and therefore, do not maintain a permanent pool behind them. For this reason, they only slow the surface-water runoff releases to the system and have minimal impacts on losses to surface-water volumes resulting from infiltration and evapotranspiration while the runoff flows are being detained.

Congress authorized the construction of Elephant Butte Dam on February 25, 1905, and on May 4, 1907, $1 million of nonreimbursable funds were appropriated as the State Department's share for allocation of 60,000 ac-ft of water annually to Mexico by treaty. Additional project works authorized under congressional action include Caballo Dam, a combined flood control and power regulating structure and the Elephant Butte power development. Surface water flows entering into the study area flows are controlled by the Caballo Reservoir located at the northern boundary of the area within southern Sierra County.

Caballo Dam and Reservoir was constructed in 1936-1938 to hold waters released from Elephant Butte Reservoir for power generation and to provide flood-storage capacity. The Caballo Dam and Reservoir are on the Rio Grande 25 miles downstream from Elephant Butte Dam and 17 miles south of Truth or Consequences.

Elephant Butte Dam is a concrete gravity dam 301 feet high and 1,674 feet long, including the spillway. It contains 618,785 cubic yards of concrete. The dam was completed in 1916, but storage operation began in 1915. The Caballo Reservoir has a surface area of 11,532 acres and a drainage area of approximately 1300 square miles. The Caballo Dam is an earthfill structure 96 feet high and 4,558 feet long, and has a storage capacity of 331,510 ac-ft of water. The spillway is located at the east end of the dam and consists of:

- A concrete-lined approach channel; two 50-foot-wide by 22.5-foot-high radial gates, which are automatically and mechanically float-operated; a concrete-lined discharge chute;
- A concrete stilling basin; and
- A concrete slab and girder bridge across the spillway at the upstream side of the gates.

The outlet works is a concrete-lined tunnel, 13.5 feet in diameter and 508 feet long, located in the left abutment. The concrete-lined tunnel is controlled by two 6-foot by 7.5-foot high-pressure slide gates. The IBWC and the BoR control the operation of the structure.

6.1.1.3.8 Minor Dams in Doña Ana County

The New Mexico Office of State Engineer maintains a database of flood control and other relatively minor dams in New Mexico. The database lists 53 of this type of dams in Doña Ana County including 48 flood control dams and 5 listed as recreational. The dams are listed in Table 6.11.

TABLE 6.11 FLOOD CONTROL AND OTHER MINOR DAMS IN THE PLANNING REGION

County	Dam Name	State ID	Purpose	Maximum Storage	Owner Name
Doña Ana	Alameda Arroyo Dam	Misc.	Flood control	394	Dept. of Interior-BLM

TABLE 6.11 FLOOD CONTROL AND OTHER MINOR DAMS IN THE PLANNING REGION					
County	**Dam Name**	**State ID**	**Purpose**	**Maximum Storage**	**Owner Name**
Doña Ana	Anthony Arroyo Dam No. 1	3284	Flood Control	1012	EBID
Doña Ana	Apache Brazito Mesquite Dam	3138	Flood Control	345	EBID
Doña Ana	Apache Brazito Mesquite Dam	3137	Flood Control	2400	EBID
Doña Ana	Apache Brazito Mesquite Dam	3135	Flood Control	925	EBID
Doña Ana	Apache Brazito Mesquite Dam	3136	Flood Control	603	EBID
Doña Ana	Apodaca Arroyo Dam	3035	Flood Control	193	Apodaca, J.F.
Doña Ana	Breedlove Flood Control Dam	4646	Flood Control	140	Doña Ana Flood Control Commission
Doña Ana	Caballo Arroyo Dam No. 1	2989	Flood Control	79	Caballo Soil & Water Conservation
Doña Ana	Caballo Arroyo Dam No. 2	2978	Flood Control	228	Caballo Soil & Water Conservation
Doña Ana	Caballo Arroyo Dam No. 3	2979	Flood Control	140	Caballo Soil & Water Conservation
Doña Ana	Caballo Arroyo Dam No. 4	3010	Flood Control	490	Caballo Soil & Water Conservation
Doña Ana	Caballo Arroyo Dam No. 5	3011	Flood Control	272	Caballo Soil & Water Conservation
Doña Ana	Crow Broad Placitas Dam #1	3231	Flood Control	6520	EBID
Doña Ana	Crow Broad Placitas Dam # 2	3246	Flood Control	14604	EBID
Doña Ana	Doña Ana Site 1	2918	Flood Control	856	EBID
Doña Ana	Doña Ana Site 2	2919	Flood Control	358	EBID
Doña Ana	Escondido Dam	Misc.	Flood Control	10	New Mexico State Land Office
Doña Ana	Fillmore Site 1 Dam	3075	Flood Control	1395	EBID
Doña Ana	Fillmore Site 2 Dam	3076	Flood Control	71	EBID
Doña Ana	Fillmore Site 3 Dam	3077	Flood Control	180	EBID
Doña Ana	Hatch Valley Arroyo Dam #1	2939	Flood Control	420	Caballo Soil & Water Conservation

TABLE 6.11 FLOOD CONTROL AND OTHER MINOR DAMS IN THE PLANNING REGION

County	Dam Name	State ID	Purpose	Maximum Storage	Owner Name
Doña Ana	Hatch Valley Arroyo Dam #2	2895	Flood Control	241	Caballo Soil & Water Conservation
Doña Ana	Hatch Valley Arroyo Dam #3	2948	Flood Control	281	Caballo Soil & Water Conservation
Doña Ana	Hatch Valley Arroyo Dam # 4	2945	Flood Control	255	Caballo Soil & Water Conservation
Doña Ana	Hatch Valley Arroyo Dam # 5	2907	Flood Control	326	Caballo Soil & Water Conservation
Doña Ana	Knight Flood Retard Dam	2765	Flood Control	232	Knight Flood Control Project
Doña Ana	Las Cruces Dam	4772	Flood Control	13200	City of Las Cruces
Doña Ana	Las Uvas Dam No. 1		Flood Control	177	Dept. Of Interior - BLM
Doña Ana	Las Uvas Dam No. 4		Flood Control	63	Dept. Of Interior - BLM
Doña Ana	Las Uvas Dam No. 5		Flood Control	113	Dept. Of Interior - BLM
Doña Ana	Las Uvas Dam No. 6		Flood Control	454	Dept. Of interior - BLM
Doña Ana	Lawson Arr. Fld.	4620	Flood Control	329	Doña Ana Flood Control
Doña Ana	Leasburg Arroyo Dam	2962	Flood Control	97	EBID
Doña Ana	Lucero Detention Dike	4686	Flood Control	480	EBID
Doña Ana	Mccleron Dam	Alph	Flood Control	60	New Mexico State Land Office
Doña Ana	Mclead Dam	2734	Flood Control	744	EBID
Doña Ana	Picacho North Dam	Misc.	Flood Control	680	EBID
Doña Ana	Picacho South Dam	Misc.	Flood Control	400	EBID
Doña Ana	Porter Whisenhunt Dam	2946	Flood Control	218	Porter, Ruth
Doña Ana	Redwood Dam	Alph	Flood Control	15	New Mexico State Land Office
Doña Ana	Rhodes Arroyo Retard Dam	2963	Flood Control	194	Tomlin, John
Doña Ana	Sandhill Arroyo Dam	2871	Flood Control	285	City of Las Cruces
Doña	Sandhill Arroyo	2871	Flood Control	285	City of Las Cruces

TABLE 6.11 FLOOD CONTROL AND OTHER MINOR DAMS IN THE PLANNING REGION					
County	**Dam Name**	**State ID**	**Purpose**	**Maximum Storage**	**Owner Name**
Ana	Camino Real				
Doña Ana	Santa Teresa Dam No. 1	3314-1	Recreation	34	Santa Teresa Development Co.
Doña Ana	Santa Teresa Dam No.3	3314-3	Recreation.	16	Santa Teresa Development Co.
Doña Ana	Santa Teresa Dam No. 4	3314-4	Recreation	24	Santa Teresa Development Co.
Doña Ana	Santa Teresa Dam No. 5	3314-5	Recreation	20	Santa Teresa Development Co.
Doña Ana	Santa Teresa Pond e 8	3314-e8	Recreation	60	Santa Teresa Development Co.
Doña Ana	South Fork Dam	Alph	Flood Control	125	New Mexico State Land Office
Doña Ana	Spring Canyon Dam	3313	Flood Control	800	Village of Hatch
Doña Ana	Tortugas Site 1 Dam	3063	Flood Control	2940	EBID
Doña Ana	Tortugas Site 2 Dam	3064	Flood Control	168	EBID

Source: NMOSE

6.1.1.3.9 Stream Connected Ground Water

Studies have shown that within the Plan area, there is a significant tie between the surface-water system of the Rio Grande and ground-water supplies. This generally results in recharge of the underlying ground-water aquifer system. Agriculture provides the major source of ground-water recharge in the plan area. Recharge occurs to the Rio Grande alluvium aquifer from the Rio Grande and associated irrigation and drainage canals. In return, the aquifer also provides water to the river under certain conditions. Thus, the relationship between these surface-water sources and the underlying shallow aquifer is very complex. Issues, which affect it, include irrigation practices, weather and precipitation patterns, releases of water from the reservoirs upstream, and pumping rates (Wilson et al., 1981).

In addition to the direct ties between the surface and ground-water systems along the Rio Grande, there is also recharge during precipitation events in general. A significant portion of the ground-water recharge in the lower elevations of the Plan area occurs along ephemeral stream channels (arroyos) during precipitation events (Frenzel and Kaehler 1990). In these flat low-lying areas, ephemeral streams flow out of the nearby steep hillsides into sand-laden channels that have relatively flat gradients. A significant amount of these surface-water flows infiltrate the channel sediments and enter the ground-water system before the surface waters reach the Rio Grande.

6.1.1.3.10 Extent of Irrigated Lands

Agriculture is the dominant use of land within the Rincon Valley, and Mesilla Valley. Irrigation consumes the largest amount of water. The total amount of irrigated acres in the Mesilla Valley has increased from approximately 29,000 acres around the turn of the century, to approximately 82,000 around 1955 and then fell to about 74,000 acres during 1960-1980. According to the NMOSE Technical Report 50 published in 1998 on studies done by the NMOSE and NMSU Department of Agriculture and Economics, EBID has a total of 90,640 water-right acres of land in Doña Ana and Sierra Counties. Sources of irrigation water are ground water (17,040 acres irrigated) and surface and ground water combined (78,480 acres irrigated). For an average year, EBID provides water to approximately 74,000 acres.

The major crops, in order of total acreage planted are cotton, pecans, alfalfa, cereal grains and vegetables (primarily chile, lettuce, and onions). The Rio Grande is the primary source of irrigation water, which is distributed by the EBID in the Mesilla Valley. Whenever needed, ground water is used to supplement the surface water.

Ground water came into widespread use during the drought period of the 1950s, but it has remained an important water supply component even in the subsequent full supply years. Unfortunately, data on quantities of ground water used by irrigators in the District has not been collected. Cost of using ground water is generally slightly higher that the cost of water from the conservation pool, roughly $25 per acre-foot. Well owners will presumably be required to meter their wells as their ground-water rights are adjudicated, and the District will require that all ground water pumped into District facilities – a common practice during drought – be metered. The District and the Interstate Stream Commission are collaborating to develop and install well meters and telemetry systems on all irrigation wells in the District, but it will likely take some years to completely meter the area's ground-water pumping.

Irrigators pump ground water to supplement surface water for a variety of reasons (the following is summarized from King, 2003):

1. The primary irrigation season generally runs from late February or early March through mid-October. The rest of the year, the District does not divert or deliver water. Farmers growing cool season crops or who need an early or late irrigation for primary season crops must rely on ground water during the winter months.
2. The market for most high-value crops such as vegetables are extremely dependent on quality of harvest, and the quality is very sensitive to timing of irrigations. Since an order for surface water must be made well in advance, and the exact delivery date is uncertain, high-value crop farmers rely on ground water for irrigation if surface water is not available when the crop needs it.
3. High use crops, particularly pecans and alfalfa, require a farm delivery of irrigation water in excess of the standard allotment of 3 acre-feet per acre (ac-ft/acre). Farmers may acquire water through the District's conservation pool if it is available, or they may pump ground water to make up the difference.
4. Vegetable crops are not generally high consumptive water users, but the quality requirement discussed in (2) above means that irritations must be frequent and small. This leads to low application efficiency due to high deep percolation losses and a higher farm delivery requirement than the normal allocation of 3 ac-ft/acre. Again, farmers may make up the difference through the conservation pool, but due to the timing requirements for high value crops, ground water is the more attractive alternative.
5. The most important function of ground-water pumping has been, and will undoubtedly be again, drought reserve. The District's survival through the drought of the 1950s through the 1970s was based on creative management of surface water and heavy reliance on ground water. The impending drought will induce many of the same strategies.

Most irrigation, municipal, industrial, and domestic wells are located in the valley where ground-water pumpage for irrigation of crops accounts for much of the annual ground-water withdrawal as shown in the table below. Stock and domestic wells are scattered throughout the western section of the Palomas Bolson, West Mesa, and Mesilla Valley to provide water for grazing livestock. Annual ground-water withdrawals may vary considerably, depending on the amount of surface water available from the river (Wilson, et al 1981). A review of current crop acreages is provided by crop type in Table 6.12.

TABLE 6.12: SUMMARY OF THE MAJOR CROPS PRODUCED THE PLANNING REGION		
Major Crops	**Harvested Acres**	**Production**
Pecans	20,500	29,663,500 Pounds
Chile	5,700	14,600 Tons*
Cotton	15,200	33,600 Bales
Onions	5,700	2,396,600 cwt
Lettuce	1,200	420,000 cwt
All Hay	18,100	24,600 Tons
Wheat	1,600	20,800 Bushels
Corn Silage	8,900	208,600 Tons

Source: Unpublished Data (2000) provided by EBID

6.1.1 Ground Water Supply

The Planning Region contains portions of four ground-water basins: Jornada del Muerto (Jornada), Mesilla, Hueco, and Rincon Valley (Figure 6.14). The shapes and sizes of these basins are controlled by the underlying geologic structure, which consists of a series of faulted blocks created by north-south trending normal faults as part of the Rio Grande Rift (Kelley, 1952, 1955; Chapin and Seager, 1975; Reiter et al., 1978; Hawley and Lozinsky, 1992). The main ground-water bearing formations in these areas consist of thick sequences of basin-fill deposits of the Santa Fe Group and deposits of the current Rio Grande. The following information for this regional water plan is presented in accordance with the ISC Regional Water Planning Template for the Jornada, Mesilla, Hueco, and Rincon Valley Basins:

1. A description of the geologic structure of each basin, the extent and thicknesses of water-bearing formations, and geologic cross-sections.
2. A description of aquifer characteristics, including specific yield and hydraulic conductivity, and the identification of ground-water flow patterns.
3. Identification of USGS observation wells in the region, maps of water-level elevations from three time periods intended to show predevelopment conditions,

interim conditions, and current conditions, and a discussion of the water-level changes through time.

4. Locations of recharge zones and rates of recharge.
5. Estimates of the quantity of usable remaining water for determining availability for future use.
6. Analysis of ground-water quality from USGS and other observation wells, for three different time periods, including: identification of aquifers with existing contamination, horizontal and vertical changes in water quality over three time periods (if available), salinity levels, total dissolved solids concentrations, and regions vulnerable to point and non-point sources of pollution.

The information presented here is summarized from previous geologic, geochemical, and hydrologic investigations. No new field mapping, water-quality testing, water-level measuring, or aquifer testing were performed for this regional water plan. Resources utilized include scientific publications of the USGS, New Mexico Bureau of Mines and Mineral Resources (NMBMMR), and NMOSE, as well as ground-water modeling and water-quality reports written by private consultant companies. We have also gathered current data from several different bureaus of the NMED, the City of Las Cruces, and Doña Ana County regarding water quality and potential contamination sources. Finally, many of the maps and figures included in this report were generated by the New Mexico Water Resource Research Institute (WRRI), which is affiliated with NMSU.

6.1.2.1 Hydrogeology

6.1.2.1.1 Mesilla Basin

The Mesilla Basin is an important hydrologic basin for economic development in southern New Mexico and, consequently, has been studied by many workers, including Conover, 1954; Leggat et al., 1962; King et al., 1971; Hawley, 1984; Wilson and White, 1984; Nickerson, 1986; Hawley and Lozinski, 1992; Weeden and Maddock, 1999. The Mesilla Basin occupies the central portion of Doña Ana County, covering approximately 1,110 square miles (Figure 6.14) (Weeden and Maddock, 1999). It is bounded to the southwest by the East and West Potrillo Mountains, to the northwest by the Robledo Mountains, to the northeast and east by the Doña Ana and Organ Mountains, and to the southeast by the Franklin Mountains and the Hueco

Bolson (Hawley, 1984). The Rio Grande flows through the Mesilla Basin, forming a floodplain 60 miles long and several hundred feet to 5 miles wide (Weeden and Maddock, 1999). A great deal of research has been done in the Mesilla Basin regarding its geology and hydrogeologic characteristics; the following sections contain summaries and quotes of large portions of reports written about this basin.

The Mesilla Basin contains thick, unconsolidated Santa Fe Group basin-fill sediments and Rio Grande floodplain alluvium, and is bounded by high-angle normal faults (Hawley and Lozinsky, 1992; Weeden and Maddock, 1999). Normal faults are places where one area of rock has moved down relative to the rock adjacent to it. These faults are related to the Rio Grande Rift, a narrow zone of extension that has been active over the last 30 million years (Hawley and Lozinsky, 1992). The East Robledo and East Potrillo Faults form the western edge of the Mesilla Basin (Frenzel and Kaehler, 1990). The eastern edge is loosely defined by a partly-buried horst, a block of rock bounded by normal faults that have moved rock lower on both sides, that separates the Mesilla Basin from the Jornada Basin to the east. Figure 6.15 is a regional geologic map of the study area. Figure 6.16 shows a geologic cross-section through the northern part of the Mesilla Basin. The cross-section shows the location of normal faults on the sides of the basin, and adjacent bedrock units.

Bedrock Units

The underlying and surrounding bedrock of the Mesilla Basin, as well as the other three basins, consists of Precambrian-age crystalline rock, Paleozoic-, Mesozoic-, and lower Tertiary-age sedimentary rocks, and mid-Tertiary-age volcanic rock (a simplified geologic time-scale can be found in Appendix A). Because these rock units are relatively consistent from basin to basin, the detailed geologic descriptions that follow will not be repeated in the sections of the other three basins. The following descriptions (in the order of oldest to youngest) of the local geologic units and their water-bearing properties are modified only slightly from Frenzel and Kaehler (1990).

Igneous-Intrusive and Metamorphic Rocks

The Organ Mountains and some parts of the Doña Ana Mountains and Robledo Mountains are composed of lower Tertiary-age igneous rocks (Dane and Bachman, 1965; Seager et al., 1976). The Organ Mountains also have Precambrian-age igneous and metamorphic rock. Goat Mountain and Picacho Peak also contain igneous rock. These igneous and metamorphic rocks may yield small quantities of water where they are weathered or fractured.

Paleozoic and Mesozoic Sedimentary Rocks

Sedimentary rocks of Paleozoic and Cretaceous-age occur in the mountains and beneath the basin-fill sediments in some parts of the study area. The Paleozoic-age rocks are mainly composed of carbonate with some shale, quartzite, quartzite conglomerate, gypsum, sandstone or siltstone, depending on the age (King and Hawley, 1975). Most of the San Andres and Robledo Mountains are composed of sedimentary rocks of possibly Upper Cambrian through Permian-age (Kottlowski, 1975).

The sedimentary rocks, when unweathered, have very low permeability. However, secondary permeability may result from weathering, fracturing, faulting, or dissolution of limestone and gypsum within the otherwise dense rock. The overall permeability of these rocks is probably much smaller than that of the basin-fill, and is therefore minor when compared to the basin-fill ground-water system. However, the permeability along fractures or dissolution channels may be large in places, allowing for the potential migration of water with substantially different chemical compositions.

Lower Tertiary Sedimentary and Volcanic Rocks

The oldest Tertiary-age rocks are the conglomerates of the Love Ranch Formation (Formation) (Kottlowski et al., 1956). The Love Ranch Formation crops out in the Rincon Hills and San Diego Mountains north of the Mesilla Basin. The Love Ranch Formation is overlain by the Palm Park Formation (Kelley and Silver, 1952), which is composed of various types of volcanic rocks and sedimentary rocks derived from the volcanics, in addition to spring deposits (travertine) (Seager et al., 1976, p. 6). The Palm Park Formation is found in the Western Selden Hills, Rincon Hills, and the southern Caballo Mountains. The Bell Top Formation (Kottlowski, 1953) and the Thurman Formation (Kelley and Silver, 1952) contain volcanic and sedimentary rocks of mainly Eocene to Miocene-age, and form the greater part of the Doña Ana Mountains, the southern Organ Mountains, and Picacho Peak. Some or all of these units probably underlie the Santa Fe Group in most parts of the Mesilla Basin (Frenzel and Kaehler, 1990).

Frenzel and Kaehler (1990) continue on to say that within the Mesilla Basin, there has not been much ground-water exploration in these igneous and sedimentary rocks, probably because their permeabilities are very low. Very few wells have been drilled into these units and those that have, provide only small quantities of water used mainly for watering stock (King and

Hawley, 1975; Conover, 1954; Wilson et al., 1981).

The major water bearing units in the Mesilla Basin are the unconsolidated basin-fill of the Santa Fe Group and the alluvium deposited in the channel and floodplain of the Rio Grande. In places, these two units have different abilities to transmit water, measured using concepts like hydraulic conductivity, transmissivity, and specific yield, which are based on the size and sorting of the material.

Santa Fe Group Deposits

Hawley (1984) splits the water-bearing deposits into a number of different subdivisions. These subdivisions are based on the different ways the sediments were deposited, and distinguish between units with different aquifer characteristics. Hawley and Lozinsky (1992) group these different subdivisions into four major units: post-Santa Fe Valley-fill deposits, Upper Santa Fe unit, Middle Santa Fe unit, and Lower Santa Fe unit.

The valley-fill deposits include the river channel and floodplain deposits (up to 100 feet thick) that form what has been referred to as the “shallow aquifer” by Leggat et al. (1962). Hill slope materials at the edges of the basin have progressively buried the floodplain and channel deposits; as a result, the highly transmissive, water-bearing river deposits now extend hundreds of feet beneath the hill slopes. Leggat et al. (1962) also identify the “valley-border alluvium,” as a post-Santa Fe Valley-fill deposit, consisting of channel and terrace deposits of tributaries of the Rio Grande. This valley-border alluvium is usually up high on the hill slopes and is so thin that it lies completely above the water table.

The Upper Santa Fe unit, which can be as much as 750 feet thick (Hawley and Lozinsky, 1992), was deposited during the Middle Pliocene to Middle Pleistocene, and consists of interbedded coarse- to medium-grained alluvial fan and ancestral Rio Grande deposits in the north. These grade into finer-grained lake and playa deposits to the south. There are also basalt and sandy eolian deposits present in some small areas (Hawley and Lozinsky, 1992).

The Middle Santa Fe unit is as much as 1,500 feet thick (Hawley and Lozinsky, 1992) and consists of a number of different facies, including alluvial, eolian, playa-lake, basin-floor, and alluvial fan. As in the Upper Santa Fe unit, there are also localized basalts and sandy dune deposits. The Middle Santa Fe unit was deposited between the Middle Pliocene and Middle Miocene (Hawley and Lozinsky, 1992).

The Lower Santa Fe unit may be as thick as 1,000 feet (Hawley and Lozinsky, 1992) and also consists of numerous kinds of sediments, including dunes, lake bed, alluvial, basin-floor, sandstones, and mudstones. These sediments were deposited during the Middle Miocene to late Oligocene (Hawley and Lozinsky, 1992).

6.1.2.1.2 Jornada Del Muerto Basin

The Jornada del Muerto Basin lies between the San Andres Mountains to the east and the Caballo, San Diego, and Doña Ana Mountains, and the Mesilla Basin to the west. The southern end of the Jornada del Muerto Basin is Fillmore Pass, southeast of Las Cruces. The Jornada del Muerto Basin (Jornada Basin) extends out of Doña Ana County to the north (Figure 6.14). The southern portion of the Jornada Basin is the focus of this report, and is defined as that portion of the basin extending from the southern-most portion of the basin north to the Doña Ana County boundary.

<u>Geologic Setting</u>

The Jornada Basin, like the others in the Planning Region, is a north-south trending valley resulting from extension related to the rifting of the Rio Grande Valley. While the San Andres and Organ Mountains lie to the east (where the boundary is a single, steeply-dipping normal fault), the western boundary of the Jornada Basin is a semi-buried volcanic horst, known as the Jornada Horst (Woodward and Myers, 1997). The effects of this horst on local ground-water movement has been studied by many, including: Hawley et al. (1969), King et al. (1971), Wilson et al. (1981), Mack (1985), Frenzel and Kaehler (1990), Hawley and Lozinsky (1992), and Woodward and Myers (1997).

Sediments from the Upper Santa Fe Group overlie the horst, which is composed of Tertiary-age volcanic rock at the top, with Permian-age sedimentary rocks beneath (Figure 6.17, Appendix G). This horst acts as a partial barrier to ground-water flow, resulting in a higher ground-water table in the Jornada Basin than in the Mesilla Basin to the west. The ground-water table is above the top of the horst south of U.S. Highway 70, but north of the highway, the ground-water table is below the top of the horst, largely restricting ground-water flow in that region (Woodward and Myers, 1997).

<u>Water-Bearing Units</u>

Again, basin-fill sediments from the Santa Fe Group form the aquifer in the Jornada Basin. The surrounding and underlying bedrock (the same units as described for the Mesilla Basin) is much less permeable, and therefore is not considered to be an aquifer (Figure 6.15). The sediments can be divided into three units with slightly different characteristics (Shomaker and Finch, 1996; Hawley, 1984). The upper unit, 100 to 160 feet of saturated sediments (corresponding to lithofacies I from Hawley, 1984), consists of interbedded sands and gravels and is relatively permeable. The middle layer, which is about 1,300 feet thick and corresponds to Hawley's lithofacies II through VII, is relatively permeable and consists mainly of sand and gravel (Hawley, 1984; Shomaker and Finch, 1996). The lowest unit (Hawley, 1984, lithofacies VII through X) consists of less-permeable sand and clay, with thicknesses ranging from 0 to over 1,000 feet. All of these layers are thickest in the south-central portion of the basin, reaching a total saturated thickness of over 2,000 feet (Shomaker and Finch, 1996).

6.1.2.1.3 Hueco Bolson

The Hueco Bolson covers about 255 square miles and is primarily in the far southeastern corner of Doña Ana County, and extends a short distance eastward into Otero County (Figure 6.14). Only about 2 to 5 percent of the Hueco Bolson lies within New Mexico; the Hueco Bolson extends many miles into Texas and Mexico where it forms the El Paso Valley. Like the other basins in the Planning Region, the Hueco Bolson is a graben that was created by the Rio Grande rifting process. The basin consists of a down-dropped fault block nestled between a set of north-south trending normal faults (Figure 6.18). The Hueco Basin is bounded to the west by the Franklin Mountains, to the north partly by the Organ Mountains, and to the east by the Jarilla and Hueco Mountains.

The geologic setting of the Hueco Bolson is essentially the same as those of the other basins in the Planning Region (see the section on the Mesilla Basin hydrogeology). The surrounding mountains are composed of Precambrian to Tertiary-age igneous, metamorphic, and sedimentary rocks, as is the rock that lies beneath the unconsolidated Santa Fe Group deposits (Orr and Risser, 1992) (Figures 6.15 and 6.18). These consolidated rocks have, in general, far lower permeabilities than the Santa Fe Group. Thus, despite some localized regions of higher permeability, the consolidated bedrock is generally not considered as part of the Hueco Bolson aquifer system.

Water-Bearing Units

Like the Jornada and Mesilla Basins, the main water bearing unit of the Hueco Bolson is the Tertiary to Pleistocene-age Santa Fe Group basin-fill. In places, the fill in the Hueco is as much as 8,000 feet thick (Figure 6.19). The Rio Grande does not flow through the New Mexico portion of the Hueco Basin, though fluvial and alluvial sediments have been deposited by other, older fluvial systems. According to Orr and Risser, 1992,

> Fluvial deposits of the Camp Rice Formation [Upper Santa Fe Group] of Strain (1966, 1969) of the Santa Fe Group (King et al., 1971) occur at or near land surface throughout much of the northern part of the Hueco Bolson (Seager et al., 1987). Geophysical and lithologic logs indicate that the thickness of these Tertiary and Quaternary deposits may be as much as 1,000 feet in places. Underlying the fluvial deposits are closed-basin deposits that include lacustrine clay and evaporites bordered by alluvial-fan sand, gravel, and clay. These typically fine grained deposits may comprise most of the lithologic sequence of the Hueco Bolson.

6.1.2.1.4 Rincon Valley Basin

The Rincon Valley Basin, occasionally referred to as the Palomas Basin, is located in south-central Sierra County and the northwestern corner of Doña Ana County (Figure 6.14). This basin is bounded by the Caballo Mountains to the northeast, the Sierra de las Uvas to the southwest, and the Black Range to the northwest. The Rio Grande flows through the Rincon Valley Basin in an entrenched floodplain on its way to the Mesilla Basin to the south. As opposed to the other basins, the Santa Fe Group deposits in the Rincon Valley Basin are very clay-rich and therefore do not form a very good aquifer. Instead, the main water-bearing formation in this valley is the alluvium in the Rio Grande Valley and other smaller tributaries (Wilson et al., 1981).

Pre-Santa Fe Group Igneous and Sedimentary Units

Like the other basins in the Planning Region, the Rincon Valley Basin is a down-dropped basin bounded by normal faults that has subsequently filled with sediments (Figure 6.20). The surrounding bedrock consists of Precambrian-age igneous rocks, which are found in the Caballo Mountains, and Pennsylvanian and Permian-age sedimentary rocks (Figure 6.15). A few stock wells are drilled into fractures, faults, and solution channels in the bedrock units, but these produce only a few gallons of water per minute. There are also many occurrences of Cenozoic-age rocks in and surrounding the Rincon Valley Basin, including the volcanic rocks of the Sierra de las Uvas. In general, all of these rocks have very low permeability and are considered barriers to ground-water flow (Wilson et al., 1981).

Santa Fe Group

As with the other basins, the Santa Fe Group in this area consists of basin-fill and alluvial deposits, layered with some basalt flows (Figure 6.20). Wilson et al. (1981) describes four distinct units within the Santa Fe Group. The oldest two units, one of which is unnamed and the other called the Hayner Ranch Formation, are transitional units that consist mainly of conglomerate and sandstone. The Hayner Ranch Formation also includes a significant amount of volcanic material. The third unit, called the Rincon Valley Formation, consists of beds of red clay and gypsum, with thin sand layers. The youngest formation, called the Camp Rice (or Palomas) Formation, "is composed of fluvial gravel, sand, and clay deposits that intertongue with alluvial-fan deposits derived from the adjacent mountains" (Wilson et al., 1981, p. 26). Among these four units are three distinct sedimentary facies, each with different water-bearing properties. The alluvial-fan facies consists of hillslope deposits that are coarse-grained on the mountain fronts and grade to fine-grained in the center of the basin. These fan deposits have from 30 to 300 feet of saturated thickness, and represent the only significant water-bearing unit within the Santa Fe Group in the Rincon Valley Basin. There is also a clay facies that consists of very fine-grained sediment, deposited in lakes in the basin centers. This clay facies acts as a barrier to ground-water flow and does not yield significant quantities of usable water. The total thickness of this clay facies is unknown, but according to Wilson et al. (1981), it is at least 1,200 feet thick in some areas. Finally, there is a fluvial facies that consists of coarse- to fine-grained sediment that was deposited by flowing water (Wilson et al., 1981).

Post-Santa Fe Group Alluvial Deposits

The Rio Grande floodplain in the Rincon Valley contains alluvial deposits ranging from about 50 to 125 feet thick. These deposits consist of a narrow (less than 2 mile wide) strip of well-rounded gravel, and lenses of sand and clay (Wilson et al., 1981). There are also alluvial deposits in tributaries to the Rio Grande, though these deposits are thin and usually lie above the water table.

6.1.2.2 Aquifer Characteristics

6.1.2.2.1 Mesilla Basin

As indicated before, the main aquifers of the Mesilla Basin consist of the Rio Grande deposits and Santa Fe Group basin-fill. A summary of aquifer test results, mainly from Wilson et al. (1981) is included in Appendix B.

Rio Grande Alluvium Aquifer

A summary of aquifer characteristics for the Rio Grande aquifer can be seen in Table 6.13. In general, the alluvium makes a fairly transmissive aquifer with high hydraulic conductivity and specific capacity. Many of the wells drilled into the alluvium are actually completed in both the alluvium and the upper part of the Santa Fe Group deposits, where the two are hydraulically connected and fairly similar in character (Wilson et al., 1981).

TABLE 6.13: SUMMARY OF AQUIFER CHARACTERISTICS OF THE RIO GRANDE ALLUVIUM IN THE MESILLA BASIN

Depth of Water Table (feet below ground level)	Well yield (gpm)	Hydraulic Conductivity (ft/day)	Specific Yield	Transmissivity (ft^2/day)	Specific Capacity (gpm/ft)
10-25[a]	2,500+[a]	100-350[b] 94[d]	20%[d]	12,600-15,200[a]	59[d] 10-217[a]

[a] Wilson et al., 1981
[b] Hamilton and Maddock, 1993
[c] Conover, 1954
[d] Frenzel and Kaehler, 1990

ft bgl feet below ground level
gpm/ft gallons per minute per foot
ft^2/day feet squared per day

The Santa Fe Group Aquifer

The main aquifer consists of the upper 1,500 feet of the saturated portion of the Santa Fe Group, though the sediments are, in places, up to 2,500 feet thick (Weeden and Maddock, 1999). According to Hawley and Lozinsky (1992), the thicknesses and areal extents of the more highly transmissive units within the Santa Fe Group are smaller than was originally thought. Hydraulic conductivities within the Santa Fe Group decrease with depth (Frenzel and Kaehler, 1990). Figure 6.21 is a diagram from Frenzel and Kaehler (1990) showing the distribution of hydraulic conductivity with depth for the Santa Fe Group. Median hydraulic conductivities for the Upper, Middle, and Lower Santa Fe Group units are 25, 13-14, and 11-14 feet per day (ft/day), respectively (Frenzel, 1992). Overall, the average hydraulic conductivity reported in Santa Fe Group deposits by Frenzel and Kaehler (1990) was 21 ft/day (Appendix B). In their regional ground-water flow model, Frenzel and Kaehler (1990) use a ratio of horizontal to vertical hydraulic conductivity of about 200 because the presence of many horizontal, thin clay layers impede the vertical movement of water.

According to Weeden and Maddock (1999), “Municipal wells in the Las Cruces east-side well field have transmissivity values ranging from 2,710 to 19,300 ft^2/day. Transmissivities in the Santa Teresa Well Field owned by El Paso, Texas (5 miles north of the Mexican border on the west valley slope and the West Mesa) range from 2,700 to 5,300 ft^2/day (Wilson et al., 1981)." The Weeden and Maddock (1999) ground-water flow model assigned hydraulic conductivity values ranging from 20 to 150 ft/day for layer 1 of the model, which is the upper 200 feet of aquifer. Weeden and Maddox (1999) assigned a 400-foot thickness for layer 2 and a transmissivity range of 800 to 10,500 ft^2/day, indicating a corresponding hydraulic conductivity range of 2 to 26.25 ft/day. Layer 3 of the model was assigned a thickness of 600 feet and a transmissivity range of 1,000 to 7,800 ft^2/day, indicating a corresponding hydraulic conductivity range of 1.7 to 13 ft/day. Layer 4 of the Weeden and Maddox model was assigned a variable thickness and a transmissivity range of 800 to 12,200 ft^2/day.

Nickerson (1989) estimated Santa Fe Group transmissivities in the upper intermediate and deep zones at the Canutillo well field of 2,600 to 4,700 ft^2/day and a storage coefficient of 0.00043 or less. A pumping test at a municipal supply well completed in 1999 for La Union indicated a transmissivity of 9,360 ft^2/day (JSAI, unpublished letter report, January 1999), and a hydraulic conductivity 67 ft/d. Pumping tests performed at Anthony municipal Wells 3 and 6 indicated a transmissivity near the wells of 5,350 ft^2/day and a hydraulic conductivity of 27 ft/d (JSAI, unpublished letter reports, December 1998).

6.1.2.2.2 Jonada Del Muerto Basin

Because the top two units of the Jornada Basin are composed of similar sediments, they have similar hydraulic conductivities. Aquifer tests from these units in the Jornada Basin resulted in hydraulic conductivities ranging from 10 to 54 ft/day and transmissivity ranging from 5,000 to 15,000 ft^2/day (Wilson et al., 1981) (Appendix B). Wilson et al. (1981) suggest that transmissivity and hydraulic conductivity are substantially lower in the region south of U.S. 70. There are no aquifer tests for the lowest, more clay-rich unit, but Shomaker and Finch (1996) estimate that its transmissivity ranges from 1.0 to 3,000 ft^2/day. As in the Mesilla Basin, the presence of horizontal clay layers in the Jornada Basin make the ratio of horizontal to vertical conductivity about 200. This ratio decreases towards the edges of the basin where clay layers are less prevalent.

The ground-water flow model developed by Shomaker and Finch (1996) for the southern Jornada Basin assumed the uppermost basin-fill unit, based on Hawley's valley fill (1984), was unconfined, with a specific yield of about 15 percent (Shomaker and Finch, 1996). Shomaker and Finch (1996) assumed the majority of the middle unit was confined, where it lies fully beneath the water table, and it was assumed to have a storage coefficient of 10^{-6} times the layer thickness (in feet) where confined and a specific yield of 15 percent where unconfined. It was also assumed that the lowest unit is a confined aquifer with a storage coefficient of 10^{-6} times the saturated thickness (Shomaker and Finch, 1996). Wilson et al. (1981) reports ground water is present under leaky confined conditions except for the upper portion of the aquifer where it is present under unconfined conditions.

6.1.2.2.3 Hueco Bolson

The aquifer characteristics of the Hueco Bolson vary greatly, depending on the grain-size and sorting of the sediments (Orr and Risser, 1992) (Table 6.14). Coarser-grained sediments (such as alluvial fan deposits) near the mountain fronts have higher hydraulic conductivity than do the finer-grained fan and lake deposits at the center of the basin. Also, like Santa Fe Group deposits elsewhere, there is a high ratio of horizontal to vertical hydraulic conductivity due to discontinuous clay layers throughout the sediments (Orr and Risser, 1992).

Several researchers have calculated hydraulic conductivity and transmissivity in different parts of the Hueco Basin. Most of these studies were done using wells that penetrate only the upper 1,000 feet or so of Santa Fe Group deposits. On the western side of the Texas portion of the basin, Knowles and Kennedy (1958) calculated a transmissivity of 5,000 to 22,000 ft^2/day with hydraulic conductivities of 15 to 43 feet per day. A pump test at a well in Township 26 South, Range 5 East, Section 4.312, also known as the Bell test well, indicated a transmissivity of 15,240 ft^2/d (Koogle & Pouls and Beaumont, 1964). Near El Paso, Texas, Meyer (1976) calculated transmissivities of 1,300 to 37,000 ft^2/day and hydraulic conductivities of 15 to 60 ft/day. Also in El Paso, Lee Wilson and Associates, Inc. (1986) calculated an average hydraulic conductivity of 31 ft/day, ranging from 6 to 130 ft/day. In the fine-grained sediments on the eastern side of the basin, the hydraulic conductivity is probably on the order of 2 ft/day (Orr and Risser, 1992).

In their ground-water flow model of the Hueco Bolson, Orr and Risser (1992), simulated the upper 600 to 800 feet of the aquifer as unconfined and assumed a specific yield range of 5 to 20 percent. Leggat and Davis (1966) estimated that the specific yield of the aquifer is 15 percent, and Meyer (1976) estimated a range of specific yields between 10 percent and 30 percent.

TABLE 6.14: SUMMARY OF AQUIFER CHARACTERISTICS OF THE HUECO BOLSON

Area	Hydraulic Conductivity (ft/day)	Transmissivity (ft^2/day)	Specific Yields
El Paso region	15 – 60[a] 6 – 130[b]	1,300 – 37,000[a]	10%-30%[a]
Eastern, Texas	2[c]	--	10%-30%[a]
Western, Texas	15 – 43[d]	5,000 – 22,000[d]	10%-30%[a]

[a] Meyer (1976)
[b] Lee Wilson and Associates, Inc. (1986)
[c] Orr and Risser (1992)
[d] Knowles and Kennedy (1958)

6.1.2.2.4 Rincon Valley Basin

The main aquifer in the Rincon Valley Basin is the post-Santa Fe Group alluvial deposits. Within these deposits, which are contained within the Rio Grande floodplain, the water level is about 8 to 15 feet below the surface and flows to the south with a gradient of about 5 feet per mile (Wilson et al., 1981). According to Wilson et al. (1981), the specific capacities for wells completed in the alluvium range from 17 to 79 gpm/ft, and average 50 gpm/ft. Assuming this aquifer is unconfined and has a specific yield of 20 percent, conservative transmissivity values calculated from these specific capacities range from 2,700 to 14,800 ft^2/day, averaging 9,200 ft^2/day. Based on this average transmissivity, and an average aquifer thickness of 55 feet, Wilson et al. (1981) estimated the hydraulic conductivity of the alluvial deposits to be about 170 ft/day (see Appendix B for aquifer data).

Yields in irrigation wells in the floodplain aquifer can be quite high. According to Wilson et al. (1981), 44 percent of these irrigation wells have yields higher than 1,000 gpm, and can have yields as high as 2,500 gpm. Yields in arroyo and tributary sediments are, in general, lower, and range from 100 to 1,000 gpm. Finally, yields in wells in the Santa Fe Group deposits range from zero in the clay facies to as high as 1,500 gpm in some areas with transmissive lineations.

6.1.2.3 Water Level

6.1.2.3.1 Mesilla Basin

Water levels in the Mesilla Basin range from only 10 to 25 feet below ground level (bgl) in the Rio Grande floodplain to 300 or more feet bgl in the western and east-central part of the basin (Figure 6.22) (Appendix C). Analysis of water-level elevation contours over several time periods shows that a cone of depression, or localized region of water-level decline, is developing beneath the City of Las Cruces (Figures 6.23, 6.24, and 6.25). A cone of depression indicates that water is being pumped out faster than water from other parts of the aquifer can flow in to replace it.

Hydrographs from 202 wells in the Mesilla Basin are included in Appendix D. Hydrographs were only produced for wells, which had at least 10 water-level measurements. Generally, wells in the valley having a depth to water of less than 50 feet have had water-level fluctuations of 1 to 5 feet. For shallow wells, which have data from the mid to late 1950s, a sharp decline in water level generally occurred in the mid to late 1950s. Water levels after this time generally increased for at least a short period of time, even for most wells where water levels subsequently continued to trend downward.

Hydrographs for wells having a water level ranging from 50 to 100 feet indicate that water levels have remained relatively stable and fluctuated from less than 1 to about 8 feet per year. Hydrographs for six wells having a water level ranging from 100 to 200 feet, indicate that water levels in two wells have increased at an average rate of 0.04 to 0.3 feet per year, water levels in two wells had declines ranging from about 0.13 to 1.09 feet per year, and water levels in two wells have remained relatively stable.

Hydrographs for 39 wells that have a water level exceeding 200 feet below ground surface show water levels in 56 percent of the wells remaining relatively stable and fluctuating from less than 1 to more than 20 feet, water levels in 36 percent of the wells decreased 0.03 to 0.41 feet per year with total declines ranging from 1 to 36 feet, and water levels increased slightly in 8 percent of the wells with average annual increases ranging from 0.1 to 0.2 feet per year.

Ground-Water Flow Patterns

Ground-water flow in the Mesilla Basin is, in general, to the southeast, parallel to the trend of the Rio Grande with ground water flowing from higher elevations to lower elevations (Figure 6.25). There is also a steep water-table gradient from the Organ Mountains and Aden Hills down into the Rio Grande Valley (Wilson et al., 1981; Frenzel and Kaehler, 1990). The average water-table gradient in the valley is about 25 feet per mile. The cone of depression created by City of Las Cruces municipal pumping wells interrupts the regional ground-water flow pattern by causing nearby water to flow towards the depression in the northwest portion of Township 23 South, Range 2 East.

Natural discharge from the basin occurs near El Paso at a bedrock high referred to as the El Paso Narrows, which is covered by 2 to 3 feet of saturated alluvium. The majority of ground water ultimately discharges as drain flow and evaporation (Wilson et al., 1981). It is difficult to quantify ground-water discharge from the basin because of the complex interaction between the shallow ground-water and surface-water systems which are annually and seasonally dependant on surface water releases from Caballo Reservoir (Weeden and Maddock, 1999, and Nickerson and Myers, 1993).

Water-level elevation maps for 1960 and before (referred to as 1960 data), 1978, and 1995 to 2000 are presented as Figures 6.23, 6.24, and 6.25. From 1960 to 1978, water-level elevations remained relatively unchanged. This is primarily due to the ability of the surface water to quickly recharge the shallow aquifer system. The water-level elevation in the study area is essentially the elevation of the water table above mean sea level. Some of the differences in the location of the elevation contours, particularly in the southern portion of the basin, may be due to a lack of 1960 data. The general direction of ground-water flow has remained essentially unchanged since the 1960s. As early as 1960, a cone of depression was present northeast of Las Cruces in the northwest portion of Township 23 South, Range 2 East. The cone of depression increased in size from 1960 to 1978.

From 1978 to 1995, water-level elevation contours indicate that ground-water pumping has lowered the water table in some areas, while in other areas the water table has risen, or remained essentially unchanged. When comparing the 1978 and 1995 contour maps, a southward shift in a given elevation contour from 1978 to 1995 indicates that the water table has risen, and a northward shift from 1978 to 1995 indicates the water table has declined. Examples representing water table rises are the southern movement of the 3,860-foot contour southwest of San Pablo in Township 24 South, Range 1 East and the southern movement of the 3,820-foot contour southwest of La Mesa in Townships 25 and 26 South, Range 2 East (Figures 6.24 and 6.25). Localized cones of depression on the order of 5 to 40 feet, indicating a lowering of the water table, developed in the basin during this time interval, including areas near the town of Doña Ana, west of Four Points, northeast of Vado, and west of the Canutillo well field in Texas. The cone of depression northeast of Las Cruces became larger, extending southward several miles. Figure 6.26 is a map showing the increases and decreases in the water table from 1978 to 1995. The map was developed by comparing the 1978 and 1995 water table elevation maps, and using data from the hydrographs for this period of record.

6.1.2.3.2 Jornada del Muerto Basin

Water levels in the Jornada Basin range from about 50 to over 500 feet bgl, averaging about 300 feet bgl (Figure 6.27, and Appendix C). Water levels in the Jornada del Muerto Basin have decreased the most in the U.S. 70 corridor between Las Cruces and Organ, where some of the major municipal wells for Las Cruces are located.

Hydrographs were made for wells in the Jornada Basin for which there were five or more measurements (Appendix D). A total of 14 hydrographs were made for this basin. Data for three of the wells are from a limited time interval during the 1970s. Data collected over a longer period of time from five wells in the basin indicate a decline in water levels ranging from about 0.2 to 1.2 feet per year, with total drawdowns ranging from 3.7 to 31 feet. Data presented on the remaining hydrographs indicate that the water levels have fluctuated from less than 1 to more than 25 feet, but have remained essentially the same.

Ground-Water Flow Patterns

The direction of ground-water flow in the Jornada Basin was historically to the west and southwest, towards the Rio Grande Valley. Currently, the ground-water flow direction is west to southwest throughout most of the basin, except in Township 22 South, Range 3 East where it is to the northwest, toward the Rincon Valley. The gradient is steepest in the mountains, and becomes very gradual in the flat part of the valley, only about 5 to 8 feet per mile. In the very southern end of the basin, the flow pattern is more to the southwest (Shomaker and Finch, 1996). As in the Mesilla Basin, the regional flow pattern is interrupted by cones of depression, this is the case in the U.S. 70 corridor between Organ and Las Cruces, New Mexico. Natural discharge from the basin occurs as ground-water flow along the western part of the basin and was simulated by Shomaker and Finch (1996) to be 2,860 acre-feet per year (ac-ft/yr).

Water-level elevation maps representing periods from pre-1970, 1978 to 1983, and 1995 to 2000 are presented as Figures 6.28, 6.29, and 6.30. The 1978 to 1983 data interval will be referred to as 1980 data and the 1995 to 2000 interval will be referred to as 2000 data. Water table declines occurred from pre-1970 to 1980, as indicated by a westward shift of a given water-table elevation contour. General differences can be seen when comparing the water-table elevation contours from 1980 data with 2000 data, particularly in the northwest portion of the basin, but the direction of ground-water flow is essentially the same for both time periods (Figures 6.29 and 6.30). Many of these differences appear to be due to the lack of data in 1980 data, compared to data available for the 2000 data map.

Water-level declines of 2 to more than 20 feet occurred from 1962 to 1999 in the southern portion of the basin (Figure 6.31). The greatest declines are present in Townships 21 and 22 South, Ranges 2 and 3 East, near Highway 70.

6.1.2.3.3 Hueco Bolson

The average water level in the New Mexico portion of the Hueco Bolson is about 350 feet below ground level (ft bgl), with almost all water levels between 300 and 400 ft bgl (Figure 6.32). Figure 6.33 shows predevelopment water-level elevation contours for the Hueco Bolson from 1954 (Knowles and Kennedy, 1958), Figure 6.34 shows 1978 to 1983 water-level elevation contours (Orr and Riser, 1992), and Figure 6.35 shows 1995 to 2000 water-level elevation contours.

Water levels in the Hueco Basin are affected largely by pumping in the El Paso/Ciudad Juarez region. According to the USGS water-level database, the average water level in the New Mexico portion of the Hueco Bolson has been steadily dropping since the 1960s, with about an 18.8 ft average water-level decline over the past 40 years (Table 6.15). According to Orr and Risser (1992), there has been between zero and 25 feet of water-level decline within the Hueco Bolson in Doña Ana County between 1905 and 1983, while up to 200 feet of water-level decline has occurred in El Paso, Texas, and Ciudad Juarez, Mexico in that same time period. Water-level declines in the basin based on a comparison of the 1978 to 1983 data with the 2000 data indicate declines of up to 20 feet along the New Mexico-Texas border. Water-level declines in this area will continue to decline, primarily as a result of the City of El Paso's pumping in the Texas portion of the Hueco aquifer.

TABLE 6.15: AVERAGE WATER LEVELS IN THE HUECO BOLSON, DOÑA ANA AND OTERO COUNTIES, NEW MEXICO	
Time Period	**Average Water Level (Feet Below Ground Level)**
pre-1960	335.4
1970-1979	344.0
1980-1989	349.7
1995-2000	354.2
Average Overall Decline	**18.8**

Source: USGS water-level database, 2000

Hydrographs of 11 wells in the Hueco Basin are included in Appendix D. Of these 11 wells, nine indicate the water level is declining, and two have fluctuated over a couple of feet but have remained essentially constant. Water-level decline rates range from about 0.2 to 1.0 feet per year. Total declines at wells that have been monitored since the early 1950s range from 9 feet at a well in Township 25 South, Range 4 East, Section 35.213, to more than 47 feet at a well in Township 26 South, Range 5 East, Section 33.244.

Ground-Water Flow Patterns

Ground-water flow in the New Mexico portion of the Hueco Basin is generally eastward along the northwestern portion of the basin. In the southern portion of the basin, the flow direction is eastward in the western portion of the basin, and south in the southeastern portion of the basin, apparently in response to pumping in Texas. The pre-development gradient was about 2.5 feet per mile, but heavy pumping in the El Paso/Ciudad Juarez region has resulted in a south-southwestward gradient of about 5 feet per mile. The gradient is steepest at the southern border of Doña Ana County, where the influence from Texas and Mexico pumping is strongest.

Natural discharge from the basin across the southern portion of the study area into Texas is estimated to be 4,640 ac-ft/yr for the portion of the aquifer having a total dissolved solids (TDS) concentration of 1,000 mg/l or less. This area includes the Hueco Basin in Doña Ana County eastward, several miles into Otero County. This estimate was derived using Darcy’s equation assuming the average saturated thickness are those reported by Orr and Riser (1992), an average hydraulic gradient of 5 feet per mile, and a hydraulic conductivity range of 23 to 35 ft/day (Orr and Riser, 1992). Natural discharge from the deeper portions of the aquifer which have a TDS exceeding 1,000 mg/l were not made due to the lack of hydraulic data for this portion of the aquifer

Water-level elevation maps showing data from 1978 to 1983, referred to as the 1980 data, and from 1995 to 2000, referred to as the 2000 data, are presented as Figures 6.34 and 6.35. Drawdowns in New Mexico resulting from Texas pumping in the Hueco to the south can be seen when comparing the 1980 data and the 2000 data, and are presented on Figure 6.36. Ground-water declines ranging from about 10 to 25 feet occurred in the south-central portion of Township 26 South, Range 5 East. This drawdown was primarily the result of pumping from Texas in the Hueco Basin south of the New Mexico–Texas state line.

Land Surface Subsidence

Severe water-level declines such as those in the El Paso area can irreversibly affect the water storage capability of an aquifer. When water is removed from an aquifer, the sediments can become permanently compacted, decreasing the amount of pore space. Land surface subsidence can cause damage to house foundations, underground pipelines, and other structures. Kernodle (1992) simulated land surface subsidence in the El Paso/Ciudad Juarez region, showing that between 1880 and 1984, approximately 0.4 feet of subsidence has occurred. Kernodle (1992) estimated an additional 0.2 feet of subsidence between 1984 and 1992 in the El Paso/Ciudad Juarez region. The greatest amount of subsidence has occurred in the El Paso/Ciudad Juarez region where water-level declines are greatest, and at this time does not appear to affected the land surface in Doña Ana County.

6.1.2.3.4 Rincon Valley Basin

Water levels in the Rincon Valley Basin vary widely. Water levels in the floodplain range between 0 and 25 ft bgl, while water levels up in the Caballo Mountains can be as much as 300 to 400 ft bgl (Wilson et al., 1981). Few data are available for the western portion of the basin in Sierra County. Along the Rio Grande in the Planning Region, depth to water is less than 20 feet, and increases to 40 to 60 feet along the eastern and western portions of the Valley (Figure 6.37). Average water levels within the valley do not appear to be decreasing over time, though a significant amount of seasonal fluctuation may occur. Water is replaced fairly quickly in the alluvial aquifer, due to its high transmissivity and proximity to the Rio Grande. Removing water from the floodplain aquifer probably has a larger effect on surface-water levels than ground-water levels.

Hydrographs of 29 wells in the Rincon Valley Basin are included in Appendix D. Based on data available from these hydrographs, water levels in wells completed along the river valley, where the depth to water is less than 20 feet, have either increased slightly or remained essentially constant during the 1970s. Increases during this period ranged from 0.2 to 0.7 feet per year. Overall, water levels in the shallow aquifer in the valley have fluctuated 2 to 3 feet, but remain essentially constant.

Hydrographs of wells, which have water levels exceeding 100 feet, indicate an overall decrease in water levels. Wells with water levels exceeding 100 feet, which have been monitored for more than 20 years, have experienced declines ranging from 1.9 to 3.3 feet per year, with total drawdowns ranging from 33 to 94 feet.

Ground-Water Flow Patterns

The direction of ground-water flow in the Rincon Valley Basin is northeast, from the mountains into the valley, and then toward the south and east down the river. Natural ground-water discharge from the basin in the shallow alluvial sediments was estimated to approximately equal recharge (Wilson et al., 1981), because of the hydraulic connection between the shallow ground water and the canals and the Rio Grande.

Water-level elevation maps representing periods from 1960 and before, 1978 to 1983, and 1995 to 2000 are presented as Figures 6.38, 6.39, and 6.40. The 1978 to 1983 data interval will be referred to as 1980 data, and the 1995 to 2000 interval will be referred to as 2000 data. From 1960 and before, to 1980, the water table decreased throughout most of the western portion of the basin. Evidence for this decrease is shown by the eastward movement of the water-table elevation contours, most notably shown by the eastward movement of the 4,000- and 4,050-foot elevation contours. The water table 4,050-foot elevation contour moved northward from 1980 to 2000, which may primarily be due to the availability of additional data rather than an actual rise in the water table. Declines of 5 to 15 feet did occur in the southeastern-most portion of the basin. Little water level change occurred from 1978 to 2000 (Figure 6.41), with one relatively small area having a decline of about 10 feet in Section 36, Township 17 South, Range 5 West.

6.1.2.4 Sources and Rates of Recharge

6.1.2.4.1 Mesilla Basin

According to Frenzel and Kaehler (1990), most of the ground-water recharge to the Santa Fe deposits in the Mesilla Basin occurs along ephemeral stream channels (arroyos) during precipitation events. In this region, ephemeral streams flow out of the steep hillsides into channels that have relatively flat gradients. A significant amount of water can infiltrate through these channel sediments into the ground-water system before ever reaching the main channel of the Rio Grande. This process is known as "slope-front recharge," if the steep hillsides are underlain by basin-fill, and "mountain-front recharge," if the steep slopes are underlain by bedrock. Slope-front recharge occurs on the west side of the Rio Grande within the Mesilla Basin. Mountain-front recharge occurs along the western boundary, off the East and West Potrillo Mountains, Aden Hills, and the Sleeping Lady Hills, and the eastern boundary off the Doña Ana Mountains, the Organ Mountains, and the Franklin Mountains. Figure 6.42 shows estimated mountain-front recharge in the basin. Some subsurface water also enters the Mesilla Basin from the Jornada del Muerto Basin to the east (Shomaker and Finch, 1996) and the Mimbres Basin to the west (Hawley et al., 2000). In addition, there is a source of upwelling geothermal water entering the basin from the bedrock-high separating the Jornada del Muerto Basin from the Mesilla Basin (Shomaker and Finch, 1996).

Using an empirical method based on mean annual runoff, drainage basin area, mean annual winter precipitation, and the slope of the basin, Frenzel and Kaehler (1990) estimate the total mountain- and slope-front recharge to be about 15.3 cubic feet per second (cfs) (11,084 ac-ft/yr). Most of the recharge occurs on the eastern side of the basin. Frenzel and Kaehler (1990) emphasize that their estimate has a potential error of plus 100 percent or minus 50 percent. Weeden and Maddock (1999) recalculated recharge, using the same equation, but different values for surface area and precipitation. They calculated a value of 17.9 cfs (12,967 ac-ft/yr) for the combination of slope- and mountain-front recharge.

Recharge also occurs to the Rio Grande alluvium aquifer from the Rio Grande and associated irrigation canals. The aquifer will also provide water to the river in return. There is a very complex relationship between these surface-water sources and the underlying shallow aquifer, which is tied into irrigation practices, weather and precipitation patterns, releases of water from the Caballo Reservoir upstream, and pumping rates (Wilson et al., 1981). Wilson et al. (1981) estimate that in the reach between Las Cruces and Anthony, the river loses between 1.0 to 4.8 cfs per mile of river to the aquifer. These river losses correspond to 20,300 to 97,400 ac-ft/yr, assuming a river length of 28 miles between Las Cruces and Anthony. A similar study by Nickerson (1995) catalogued gains and losses along the Rio Grande between Leasburg

Dam (in New Mexico) and El Paso, TX between 1988 and 1992. The results of this study showed a cumulative gain in streamflow of 15-25 cfs between Leasburg Dam and Las Cruces, NM followed by a rapid loss of 35-45 cfs between Las Cruces and Mesilla Dam (Nickerson, 1995). This loss was in turn followed by a gradual gain of 10-20 cfs between Mesilla Dam and Canutillo, NM, and finally, followed by a rapid loss in streamflow of 20-30 cfs between Canutillo, NM and El Paso, TX (Nickerson, 1995).

Return flow to an aquifer from irrigation practices is not considered recharge in this report. This is because return flow is not bringing new water into the system, it is simply changing, at least temporarily, the accounting of existing water in the system. Recharge is assumed to only occur from precipitation events when "new" water is added to the system, and from direct movement of water from streams or canals into an aquifer.

6.1.2.4.2 Jornada Del Muerto Basin

Recharge to the Jornada Basin occurs via mountain-front recharge, sub-surface ground-water flow, and from geothermal upwellings. Shomaker and Finch (1996) simulated recharge rates via these different processes between 1962 and 1994 as 171,200 ac-ft (about 5,200 ac-ft/yr). A significant portion of that recharge was simulated as inflow from the northern part of the Jornada Basin where much of it quickly flows into the Rio Grande and is removed from the aquifer before it reaches well fields near the southern portion of the basin near Organ and Butterfield Park, New Mexico. Recharge along about 50 miles of the eastern base of the San Andres Mountains was estimated through the model calibration process to occur at a rate of about 3,800 ac-ft/yr. This is equivalent to about 0.10 cubic feet per second, per mile of mountain front (about 76 ac-ft/an per mile). This is only slightly higher than the 1994 pumping rate of 3,463 ac-ft/yr (Shomaker and Finch, 1996). If pumping rates increase, as they are expected, the total volume of water removed from the aquifer will surpass the volume flowing into it. Ground-water flowing from the northern region of the Jornada Basin into the Doña Ana portion was estimated to occur at a rate of about 1,329 ac-ft/yr (Shomaker and Finch, 1996). A small amount of water (roughly 59 ac-ft/yr) was estimated to flow upward into the aquifer from geothermal vents at its base. Total estimated recharge to the southern part of the Jornada Basin, therefore, is just under 5,200 ac-ft/yr (Figure 6.43).

6.1.2.4.3 Hueco Bolson

According to Orr and Risser (1992), subsurface recharge to the New Mexico portion of the Hueco Basin comes mostly from the Tularosa Basin, with a small amount of flow from the Mesilla Basin. Surface recharge to the basin-fill comes from storm runoff percolating through the alluvial fans on the sides of the Organ and Franklin Mountains (Figure 6.44). Orr and Risser (1992) estimate that 3 percent of annual precipitation in the mountains (12 inches per year over 225 square miles) ends up in the aquifer, about 4,300 ac-ft/yr. Meyer (1976) estimates that an additional 5,600 ac-ft/yr enter the Hueco Basin from the Tularosa Basin. Recharge that occurs in Texas and Mexico (such as from the Rio Grande) probably does not have a large effect on the New Mexico portion of the basin.

6.1.2.4.4 Rincon Valley Basin

Much of the recharge to the floodplain aquifer in the Rincon Valley Basin is from seepage from the Rio Grande and irrigation canals (Wilson et al., 1981; King et al., 1971). Some recharge also occurs from subsurface flow through the coarse sediments in mountain-front tributaries and arroyos, especially during summer thunderstorm events and during spring run-off (Weeden and Maddock, 1999). Weeden and Maddock (1999) use the methods of Frenzel and Kaehler (1990) to estimate the steady-state recharge rate from mountain-front recharge. Their estimate for recharge in the Rincon Valley is about 6.27 cfs (4,542 ac-ft/yr). King et al. (1971) say that recharge to the shallow alluvium occurs fairly rapidly, as evidenced by the quick recovery of water levels after heavy pumping. No estimates of recharge to basin from surface-water inflows were available.

6.1.2.5 Water Availability

6.1.2.5.1 Mesilla Basin

According to Wilson et al. (1981), about "20 million ac-ft of freshwater and 2.7 million ac-ft of slightly-saline water are theoretically available to wells in the part of the Mesilla Valley north of Anthony." There may be an additional 34 million ac-ft of water in the Mesilla Basin in the West Mesa region (Wilson et al., 1981).

The quantity of ground water in storage having a TDS concentration of 1,000 mg/l or less was estimated for this report to be 31 million ac-ft. The estimate was made by planimetering the aquifer area and multiplying average saturated thickness by a specific yield value. The most productive aquifers in the basin were used to develop this estimate, and correspond to lithofacies I, II, III and V as described by Hawley (1984) and Hawley and Lozinsky (1992). The saturated thickness of lithofacies I through III, and lithofacies V having a TDS concentration less than 1,000 mg/l are presented as Figures 6.45 and 6.46, respectively. No estimates were made for the portion of the aquifers having a TDS concentration exceeding 1,000 mg/l. A specific yield of 15 percent was assumed for aquifer thickness to 750 feet, 10 percent for portions of the aquifer from 750 to 1,000 feet, and 5 percent for aquifer depths below 1,000 feet. Although deeper portions of the aquifer may currently be present under confined storage, it was assumed that the aquifers would have a specific yield of 5 percent after pumping removed the confined storage. This assumption would probably account for the larger estimate of water in storage using the above method than the estimate made by Wilson et al. (1981).

Not all water in storage is readily available to wells nor can it be economically pumped from an aquifer. This is because of drawdown effects from pumping wells and the rate at which water can be released from aquifer storage. The percent of water in an aquifer that can be recovered depends on the saturated thickness of the aquifer and the hydraulic characteristics of the aquifer, the proximity to which pumping wells are placed relative to each other, and recharge to the aquifer. A greater percentage of water can be recovered from aquifers that are dominated by coarse-grained material than from aquifers dominated by fine-grained material.

Estimating the quantity of water that can be pumped from an aquifer is difficult. This is because long-term pumping from an aquifer can create large-scale drawdowns in the aquifer as water is pumped from storage, and can reduce surface-water flows. Generally, estimates of recoverable water in storage have been made by assuming that some percentage of water in storage, such as 50 percent, or water in the aquifer to some arbitrary depth, such as 1,000 feet, could be recovered from the aquifer.

For this report, a different approach was taken in order to assess the recoverable ground water in storage in the Mesilla Basin. The approach consisted of assuming pumping from hypothetical well fields to assess not only the impacts to the ground-water and surface-water systems, but also the operational and maintenance costs of developing the ground water.

To better describe the costs, both financial and otherwise, of ground-water recovery in the Mesilla Basin, examples were prepared using a ground-water flow model, to simulate what might actually happen if and when ground water is recovered. A superposition model for the Mesilla Basin by John Shomaker & Associates, Inc., based on the report and model by Frenzel (1992), was used to evaluate possible costs and effects associated with pumping from hypothetical well fields. Each well field contains 6 wells, spaced about 0.5 mile apart, and each well field's annual production rate was 14,529 ac-ft (each well pumps a constant 1,500 gpm). All of the ground water pumped in this scenario was simulated to be completely depleted; in other words, return flow was not simulated. The wells were simulated to pump from the deep aquifer, represented by layer 3 in the model (700-1,300 feet). The well field locations were arbitrarily selected, but were evenly spaced throughout the basin, so that certain well fields were located closer to the Rio Grande, and other well fields were located farther away. Transmissivity at the pumping locations in the model ranged from 6,990 ft^2/d to 6,270 ft^2/d, and the storage coefficients at the pumping locations were about 0.0006.

To conduct the pumping scenarios, first, one well field was simulated to pump 14,529 ac-ft/yr for 40 years, and the costs and effects of that ground-water recovery were estimated. Then the model was simulated to pump from two well fields simultaneously for 40 years, and the costs and effects of pumping from both well fields were estimated. This approach continued for three well fields, then four well fields, then five well fields, until finally the approach was used to simulate the costs and effects of 40-year ground-water production from all six well fields, spread out evenly over the New Mexico portion of the basin, with a combined production rate of 87,174 ac-ft/yr.

Figure 6.47 shows the cumulative amount of water, as well as the model simulated water sources, that have supplied the ground-water production at 40 years. The inflow components balance with the amount of water being removed from the aquifer due to ground-water pumping. For this hypothetical pumping scenario, there are two basic sources of water for ground-water production (inflows): water that originates directly from ground-water storage, and water that essentially originates from the Rio Grande.

At first, whether one or six well fields are in production, the source of most of the ground-water production is stored ground water. At the end of 1 year of pumping from six well fields, the rate at which stored ground water is recovered equals about 73,000 ac-ft/yr, whereas the rate at which Rio Grande water is recovered equals about 14,000 ac-ft/yr. The contribution of Rio Grande water is at the expense of ground water that may have otherwise flowed into the river, or from river water moving directly into the aquifer, or both. However, at the end of forty years, these rates have changed considerably. The rate at which Rio Grande water is recovered at 40 years is about 47,000 ac-ft/yr and the rate at which stored ground water is recovered is about 40,200 ac-ft/yr. Therefore, as pumping time increases, more and more of the water pumped from the ground is supplied from the river, not from stored ground water.

Figure 6.47 also illustrates the annual operating and maintenance costs associated with the ground-water production of one through six well fields, based on pumping lifts at 40 years. Operating and maintenance costs increase fairly regularly (linearly) with additional well fields. If all six well fields were constructed, the average capital cost per hypothetical well field might be about $15,500,000.

Even when using this modeling approach to evaluate available ground-water resources, qualifying remarks are still needed. The results of the model scenarios are based on hypothetical well fields; if the well field locations, well field configuration, rate of pumping, and or duration of pumping were to change, there might be differences in the relative quantities of water produced from ground-water storage and from the Rio Grande, as well as the capital, and operating and maintenance costs associated with the well fields. And finally, the model used was a simplified ground-water flow model, which assumed that there was always a hydraulic connection between the ground-water system and the Rio Grande; if this were not to be the case, the amount of stream flow that would be depleted might change. In sum, the results or the model simulations and costs described in the above paragraphs should not be viewed as fixed, but as a possible scenarios that might arise if large volumes of ground water were to be developed.

While this hypothetical simulation does not directly indicate what the maximum amount of recoverable ground water is for the Mesilla Basin, it does point towards a important limiting factor for recovering Mesilla Basin ground water, which is the availability of surface-water rights to offset stream flow depletion. Currently, the Office of the State Engineer policy is moving toward a requirement that water rights must be under an applicant's control to offset the total ground-water production (minus the demonstrated return flow to the stream). Additional future studies will be needed to assess the potential for ground-water pumping to induce saline water intrusion. Saline water intrusion will affect the estimates of recoverable freshwater supply and the economics of desalination.

6.1.2.5.2 Jornada Del Muerto Basin

Water that is readily available to wells in the Jornada Basin is primarily limited to the more coarse-grained sediments, described by Hawley (1984) as lithofacies V, in the central portion of the basin, east of Highway 70. Saturated thickness of these sediments ranges from zero near the basin margins to more than 1,000 feet in Township 21 South, along the border of Ranges 2 and 3 East. Additional ground water exists below and adjacent to this portion of the aquifer; however, well yields would be much lower, and water quality would decrease with depth, with TDS concentrations exceeding 1,000 mg/l.

Shomaker and Finch (1996) calculated the amount of water in storage in the Jornada Basin using an assumed specific yield of 15 percent and estimates of the volume of water pumped between 1962 and 1994 (Table 6.16). Specific yield is a measure of how much water can be removed from saturated sediments. It is not likely that it will be economically feasible to pump water from the third unit (model layer 3), both because it is so far underground and because the water quality may be poor. The amount of usable, recoverable water, therefore, may be significantly less than indicated in the following table.

TABLE 6.16: ESTIMATED AMOUNT OF GROUND WATER IN STORAGE IN THE JORNADA BASIN

Model Units	Range in Thickness for Model Layer (feet)	Original Total Ground Water in Storage (ac-ft)	Volume Withdrawn, 1962-1994 (ac-ft)	Volume Remaining (ac-ft)
1 and 2	0 to 1,440	41,400,000	39,850	41,360,000
3	0 to >1,000	59,000,000	0	59,000,000
Total		**100,400,000**	**39,850**	**100,360,000**

As discussed in the Mesilla Basin portion of the report, not all water in storage is readily available to wells, nor can it be economically pumped from an aquifer due to drawdown effects and the rate at which water can be released from aquifer storage. In order to assess the economic costs from pumping water from the Jornada Basin, the ground-water flow model developed by Shomaker and Finch (1996) was used to simulate pumping from four hypothetical well fields from 2001 to 2041. Each well field contained six wells pumping at a constant rate of 1,549 gpm, with a combined annual pumping of 15,000 ac-ft. All of the water pumped was assumed to be depleted, that is, no return flow to the aquifer was simulated. The wells were simulated to pump from layer 2 in the model, which produces better water quality than the underlying layer 3. The well field locations were selected along a south to north segment of the basin center, where the aquifer has the best quality water and the highest yields.

To conduct the pumping scenarios, first, one well field was simulated to pump 15,000 ac-ft/yr for 40 years, and the costs and effects of that ground-water diversion were estimated. Then the model was simulated to pump from two well fields simultaneously for 40 years, and the costs and effects of pumping from both well fields were estimated. This approach continued for three well fields, then all four well fields to simulate the costs and effects of 40-year ground-water production.

Figure 6.48 shows the cumulative amount of water, as well as the model simulated water sources, that have supplied the ground production at 40 years. The inflow components balance with the amount of water being removed from the aquifer due to ground-water pumping. For this hypothetical pumping scenario there are essentially two sources of water. The primary source water pumped is ground water in storage and recharge. The second source of ground water pumped is either at the expense of the Rio Grande, in terms of ground water that would have otherwise flowed into the river, or water moving from the river into the aquifer, as the ground-water gradient is reversed due to long-term ground-water pumping.

Throughout the 40 year pumping simulation, the source of the majority of ground-water production is from stored ground water. The cumulative amount of ground water produced at the end of 40 years of pumping which is at the expense of the Rio Grande ranges from 9,760 ac-ft with one well field pumping, to 83,040 ac-ft with all four well fields in production (Figure 6.48).

Figure 6.48 also illustrates the annual operating and maintenance costs associated with the ground-water production of 1 through 4 well fields, based on pumping lifts at 40 years. Operating and maintenance costs increase fairly regularly (linearly) with additional well fields. If all four well fields were constructed, the average capital cost per hypothetical well field might be about $32,000,000, in 2001 dollars.

The results of the model scenarios are based on hypothetical well fields; if the well field locations, well field configuration, rate of pumping, and or duration of pumping were to change, there might be differences in the relative quantities of water produced from ground-water storage and from the Rio Grande, as well as the capital, and operating and maintenance costs associated with the well fields. The results or the model simulations and costs described in the above paragraphs should not be viewed as fixed, but as a possible scenarios that might arise if large volumes of ground water were to be developed.

6.1.2.5.3 Hueco Bolson

The quantity of ground water in storage having a TDS concentration of 1,000 mg/l or less, and that having a TDS concentration exceeding 1,000 mg/l in the Hueco Basin in New Mexico was estimated by planimetering the aquifer area and multiplying average saturated thickness by a specific yield value. Aquifer thickness values were taken from Orr and Risser (1992). For the portion of the aquifer having a TDS concentration of 1,000 mg/l or less, specific yield of 20 percent was used for areas where the aquifer thickness is 800 feet or less, and a specific yield value of 15 percent was used for areas where the aquifer thickness exceeds 800 feet. A specific yield of 10 percent was assumed for the lower portion of the aquifer having TDS concentrations exceeding 1,000 mg/l. Areas with the greatest saturated thickness are located on the Fort Bliss Military Reservation.

Ground-water flow modeling was not performed to assess the costs associated with pumping water from the Hueco Basin, primarily because a ground-water flow model was not readily available. Therefore, recoverable ground water in storage estimates are based on the assumption that 50 percent of the water in storage can be recovered by wells. The estimated quantity of water in storage and estimated recoverable water in storage in the Hueco Basin is shown in Table 6.17.

TABLE 6.17: ESTIMATED GROUND WATER IN STORAGE AND RECOVERABLE GROUND WATER IN STORAGE IN THE YEAR 2000 IN THE HUECO BASIN, NEW MEXICO

TDS Concentration, mg/l	Water in Storage (ac-ft)	Recoverable Water in Storage (ac-ft)
Less than 1,000 mg/l	13,264,544	6,632,272
Greater than 1,000 mg/l	20,900,000	10,450,000

6.1.2.5.4 Rincon Basin

Wilson et al. (1981) estimated the amount of fresh and slightly saline water in storage in the alluvial aquifer to be about 540,000 ac-ft. This number was calculated using an aquifer surface area of 51 square miles, an average saturated thickness of 55 feet, and an average porosity of 30 percent. Of the 540,000 ac-ft of water in the aquifer, approximately 44 percent, or

238,000 ac-ft are freshwater, and 302,000 ac-ft are slightly saline. Of the total amount of water (fresh and saline), only about 320,000 ac-ft, or 60 percent, are theoretically recoverable (Wilson et al., 1981).

Ground-water flow modeling was not performed to assess the costs associated with developing ground water. However, the shallow aquifer system in the Rincon Basin is very similar to that in the Mesilla Basin, and the shallow aquifer system is intimately connected to the surface water, pumping from relatively shallow wells can impact flow in the Rio Grande. Therefore, development of ground water in the Rincon Basin will be at the expense of surface-water flow in the Rio Grande, probably to a greater degree than was simulated to occur in the Mesilla Basin (Figure 6.47). This is because the Rincon Basin does not extend a great distance east and west of the Rio Grande, and large scale development of ground water would require some of the well fields to be placed relatively close to the river. In general, the closer the wells are placed to the river, the more readily ground water pumping will impact surface-water flows.

6.2 Water Quality

6.2.1 Surface Water Quality

6.2.1.1 Surface Water Quality Analysis

The Water Plan area lies in the Lower Rio Grande Valley in the southern section of the Basin and Range Province. The Rio Grande is the sole perennial surface-water drainage in the Plan area. The reach of the Rio Grande within the Plan area meanders approximately one hundred miles through fertile farm lands, near or through populated communities, and along the base of piedmont slopes.

In the flood plain of the lower Rio Grande valley there are complex interactions between the surface water and ground-water systems. Irrigation canals distribute surface water for agricultural purposes, while most drains and laterals intercept shallow ground water and return it to the Rio Grande (USGS Circular 1162). In turn, surface water from the Rio Grande and irrigation canals leak to recharge shallow ground-water systems. In some instances, deeper ground-water flows upward to recharge the shallow ground-water system and/or contribute water to the Rio Grande. Excess irrigation water also recharges the shallow ground-water systems.

Human activity along the river results in discharge of chemicals to the surface-water systems and subsequently to shallow ground water. Residues of fertilizers, herbicides, and pesticides are the main chemicals discharged from farms, while hazardous metals and organic and inorganic chemicals are leaked to the surface and ground-water systems by human activities in the more populated communities. Data from the USGS Water Resources Investigations (WRI) Report 94-4061 indicate that over twenty (20) tons of active herbicide ingredients were applied annually in the Plan area between 1987 and 1989.

In 1991 the U.S. Geological Survey implemented a full-scale National Water Quality Assessment (NAWQA) program. The long-term goals of the NAWQA program are to describe the status and trends in the quality of a large representative section of the Nation's surface-water and ground-water resources and to provide a sound scientific understanding of the primary natural and human factors affecting the quality of these resources (USGS Open-File Report 91-160: 1991).

The Rio Grande Valley study unit was one of twenty study areas throughout the U.S. to begin assessment activities (USGS WRI Report 94-4061). Since the inception of the NAWQA program the USGS and the BoR have published several reports on the Rio Grande Valley study unit in association with NMSU. The USGS WRI Report 94-4061 listed twenty-six surface-water stations for data collection and analysis in the Plan Area between Caballo Dam in New Mexico and El Paso in Texas. Data is collected for nutrients, suspended sediments and/or suspended solids, and/or pesticides.

Under the NAWQA program, each analyte is given a *parameter code*, a standard five-digit code that uniquely identifies the specific analyte. Both the U.S. Geological Survey Water-Data Storage and Retrieval System (WATSTORE) and the U.S. Environmental Protection Agency Data System (STORET) use the codes. For the WATSTORE, a letter code follows the five-digit code to identify the analytical method used or to be used.

Nitrogen in the form of organic nitrogen, ammonia, nitrite, and nitrate is the nutrient most frequently tested for. Sources of nitrogen in water include discharges from wastewater treatment plants, septic tank leachate, farm animal waste, fertilizers, atmospheric deposition, and natural sources including nitrogen-fixing algae.

Phosphorus and other nutrients such as calcium, magnesium, sodium, and potassium are also high on the list of elements analyzed. Suspended sediments affect water quality in several ways including adverse effects on recreational watercourses, and effectively adsorbing pesticides and nutrients and transporting them.

Results of the on-going Rio Grande Valley study under the NAWQA program is continually being updated and are published periodically by the USGS in their WRI Reports. The most recent available reports were published in 1997 and 1998; Water Quality Assessment of the Rio Grande Valley, Colorado, New Mexico, and Texas – Summary and Analysis of Water-Quality Data for the Basic-Fixed-Site Network, 1993-1995 (USGS WRI Report 97-4212); and Water Quality in the Rio Grande Valley, Colorado, New Mexico, and Texas, 1992-1995 (USGS Circular 1162), respectively.

The USGS WRI Report 97-4212 summarizes the three major elements of the study between 1993 and 1995. The Rio Grande Valley study area has seventeen (17) basic-fixed-network sites. Only two of these sites (# 16 and 17) are located in the Plan area. Site # 16 is located on the Rio Grande below Leasburg Dam, near Leasburg, and Site # 17 is located at/near El Paso, Texas. The three elements of the evaluation are: (1) Stream flow, physical properties, and water-quality analytes sampled monthly, (2) trace element and organic-carbon analytes analysis, and (3) pesticide and metabolite analytes analysis.

The USGS Circular 1162 reports on land-use studies conducted in the Rio Grande Valley study between 1992 and 1995. Two of the land-use studies were performed in the Plan area, namely, the Rincon Valley agricultural land-use study, and the Mesilla Valley pesticide synoptic study. The two studies focused on pesticide, volatile organics, nutrients, radon in ground water, and dissolved solids in surface water. The findings from the two studies in the Plan area indicated that no pesticide concentration detected in surface water exceeded USEPA drinking water standards or applicable Federal or State ambient criterion or guideline. The report further stated that in the Mesilla Valley, there were more detections of more different pesticides during the non-irrigation season than during the irrigation season; as many as 27 percent of the pesticide detections attributed to pesticide use in the Mesilla Valley may be from urban sources. This point is emphasized by the listing of two waste water treatment plant (WWTP) discharges among the eight highest concentrations of pesticide identified in testing of surface waters along the Rio Grande (Table 6.19). The report also concluded that in the Rincon Valley, more pesticide compounds were detected more frequently in agricultural drains in April than in October or January; some individual pesticides detected in agricultural drains were not detected in shallow ground water.

Results of the studies reported in the USGS Circular 1162 show that seven of the eight largest pesticide concentrations found in the Rio Grande Valley study were found at seven sampling locations in the Plan area. The eight pesticides, and their concentrations and locations (from USGS Circular 1162) are shown in Table 6.18. Dissolved nutrients including nitrite, ammonia, and phosphorus were also found in the surface water.

TABLE 6.18: EIGHT HIGHEST PESTICIDE CONCENTRATIONS DETECTED IN RIO GRANDE SURFACE WATER (ADOPTED FROM USGS CIRCULAR 1162: 1998) IN THE PLANNING REGION

Pesticide	Concentration (µg/l)	Date	Location	MCL (µg/L)
Carbofuran	E0.75	04/27/94	East Side Drain at levee road near Anthony, Texas	40
Metolachlor	0.41	01/04/95	Hatch Drain at Rio Grande, near Hatch, New Mexico	--
DCPA	0.21	10/26/94	Rincon Drain at Rio Grande, near Rincon, New Mexico	--
Diazinon	0.21	09/06/95	Santa Fe River above Cochiti Lake, New Mexico	--
Chlorpyrifos	0.19	04/26/94	Las Cruces WWTP outflow at levee road, Las Cruces, New Mexico	--
DCPA	0.17	04/22/94	Rincon Drain at Rio Grande, near Rincon, New Mexico	--
Diazinon	0.16	04/28/94	Sunland Park WWTP at Sunland Park, New Mexico	--
Carbofuran	E0.15	04/20/94	Garfield Drain at Road 391, near Salem, New Mexico	40

The results of the stream flow, physical properties, and water-quality data taken from the USGS Water-Resources Investigations Report 97-4212 are provided in Table 6.19 below. The summarized results of the analysis of the trace elements of maximum concentration found at the two sites in Plan area are given in Table 6.20. The results of the analysis of the organic carbon analytes are shown in Table 6.21. The USGS WRI Report 97-4212 indicates that eleven (11) pesticide analytes were found at Site 16, and ten (10) analytes at Site 17.

TABLE 6.19: WATER QUALITY DATA FOR TWO NAWQA SITES IN THE PLANNING REGION, SUMMARY OF STREAM FLOW, PHYSICAL PROPERTIES, AND WATER-QUALITY ANALYTES (SAMPLED MONTHLY)

Property/ Analyte	Parameter Code**	Unit	Range of Concentrations				Minimum Reporting Level
			Site 16		Site 17		
			Min	Max	Min	Max	
Stream Flow, Instantaneous	00061	cfs	58	3280	96	2520	0.01
Specific Conductance	00095	µS/cm	628	1450	835	2080	1
pH	00400	Standard units	7.8	8.7	7.4	8.7	0 – 14
Temperature, Water	00010	^{o}C	2.0	27.0	6.0	26.0	-5.00
Oxygen, Dissolved	00300	mg/L	6.3	12.1	6.2	10.9	0.05
Oxygen, Dissolved		% saturation	83	116	79	117	
Hardness		mg/L as $CaCO_3$	140	390	180	450	
Hardness, non-carbonate		mg/L as $CaCO_3$	24	170	36	190	
Alkalinity, it-field*	39086	mg/L as $CaCO_3$	113	220	145	267	0
Solids, Total Dissolved		mg/L	353	929	472	1350	
Solids, residue @ 180 ^{o}C	70300A	mg/L (TDS)	376	955	496	1390	1
Calcium, dissolved	00915D	mg/L as Ca	39	120	54	130	0.02
Magnesium, dissolved	00925C	mg/L as Mg	9.5	24	12	29	0.01
Sodium, dissolved	00930C	mg/L as Na	60	160	86	290	0.2
Sodium, percentage		%	44	52	48	59	
Sodium adsorption ratio			2	4	3	6	
Potassium, dissolved	00935B	mg/L as K	4.9	8.1	5.4	11	0.1
Bicarbonate, it-field*	00453	mg/L as HCO_3	135	268	176	326	0

TABLE 6.19: WATER QUALITY DATA FOR TWO NAWQA SITES IN THE PLANNING REGION, SUMMARY OF STREAM FLOW, PHYSICAL PROPERTIES, AND WATER-QUALITY ANALYTES (SAMPLED MONTHLY)

Property/ Analyte	Parameter Code**	Unit	Range of Concentrations				Minimum Reporting Level
			Site 16		Site 17		
			Min	Max	Min	Max	
Carbonate, it-field*	00452	mg/L as CO_3	0	11	0	16	0
Sulfate, dissolved	00945G	mg/L as SO_4	110	350	150	460	0.1
Chloride, dissolved	00940J	mg/L as Cl	40	140	62	240	0.1
Fluoride, dissolved	00950B	mg/L as F	0.5	0.7	0.2	0.8	0.1
Silica, dissolved	00955D	mg/L as SiO_2	1.4	16	5.5	29	0.01
Nitrogen, nitrite, dissolved	00613F	mg/L as N	<0.01	0.2	<0.01	0.08	0.01
Nitrogen, nitrite + nitrate, dissolved	00631E	mg/L as N	<0.05	0.37	0.09	0.97	0.05
Nitrogen, ammonia, dissolved	00608F	mg/L as N	<0.015	0.07	<0.015	0.30	0.015
Nitrogen, un-ionized ammonia, dissolved		mg/L as N	0.0002	0.004	0.0004	0.013	
Nitrogen, ammonia plus organic, dissolved	00623D	mg/L as N	<0.2	0.4	<0.2	0.5	0.2
Nitrogen, ammonia plus organic, total	00625D	mg/L as N	<0.02	0.8	0.3	1.5	0.2
Phosphorus, total	00665D	mg/L as P	<0.01	0.36	0.03	0.47	0.01
Phosphorus, dissolved	00666D	mg/L as P	<0.01	0.11	<0.01	0.10	0.01
Phosphorus, orthophosphate	00671H	mg/L as P	<0.01	0.05	<0.01	0.07	0.01

TABLE 6.19: WATER QUALITY DATA FOR TWO NAWQA SITES IN THE PLANNING REGION, SUMMARY OF STREAM FLOW, PHYSICAL PROPERTIES, AND WATER-QUALITY ANALYTES (SAMPLED MONTHLY)

Property/ Analyte	Parameter Code**	Unit	Range of Concentrations				Minimum Reporting Level
			Site 16		Site 17		
			Min	Max	Min	Max	
Iron, dissolved	01046D	µg/L as Fe	<3	13	<3	38	3
Manganese, dissolved	01056C	µg/L as Mn	<1	40	<1	50	1
Sediment, suspended	80154	mg/L	19	8920	38	1900	1
Sediment, suspended discharge		tons/day	3.3	43600	13	6280	

* it-field is incremental titration in the field.
** WATSTORE/ STORET parameter code
Site # 16 is located on the Rio Grande below Leasburg Dam and Site # 17 is located at/near El Paso, TX.

TABLE 6.20: SUMMARY OF TRACE ELEMENTS OF MAXIMUM CONCENTRATION IN THE PLANNING REGION

Analyte	Parameter Code*	No. of Samples	Range of Concentration (µg/l)				Minimum Reporting Level
			Site 16		Site 17		
			Min	Max	Min	Max	
Barium, dissolved	01005G	49	14	101	--	--	1
	01005C						2
Chromium, dissolved	01030I	41	--	--	<1	7	1
Lithium, dissolved	01130B	**45**	--	--	<4	220	4
Molybdenum, dissolved	01060G	59	--	--	<1	20	1

* WATSTORE/STORET Parameter Code

TABLE 6.21: SUMMARY OF ORGANIC CARBON ANALYSIS (MG/L) IN THE PLANNING REGION

Site No.	Total			Dissolved			Suspended		
	No. of Samples	Min	Max	No. of Samples	Min	Max	No. of Samples	Min	Max
16	2	4.1	7.4	12	3.1	7.5	11	0.2	1.5
17	2	5.0	7.3	11	3.2	5.7	11	0.7	2.9

6.2.1.2 Point Source Impacts

A point source is defined as, "any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged (excluding return flows from irrigated agriculture or agricultural storm-water runoff)." Point source impacts within the bounds of the project area are generally limited to those from the municipal and regional WWTPs discussed previously under the section on "Treated Water Discharges." Contributions of pollutants to the Rio Grande from WWTPs include sporadic discharges of pesticide as noted in Table 6.18 and consistent discharge of higher than background TDS concentrations. Other point source impacts not previously described consist of specific outfalls from municipal storm drain systems into the Rio Grande or, in rare instances, into EBID drain systems. Surface water quality for the Rio Grande and drains within the Mesilla Valley are shown in Table 6.22.

TABLE 6.22: SURFACE WATER QUALITY FOR THE RIO GRANDE AND DRAINS IN THE PLANNING REGION [1]				
Parameter, Concentrations in mg/l Unless Stated	**East Side Drain at Anthony, NM near State line**	**East Side Drain at Anthony, NM near State line**	**East Drain at County Road A62 near Bernino, NM**	**East Drain at County Road A62 near Bernino, NM**
Date	02/17/2000	02/25/2000	02/16/2000	02/24/2000
Discharge, cfs	3.7	30	3.2	26
Spec. Conductance, µs/cm	3,160	1780	3,150	1,860
Ph, standard (field)	8.3	8.0	8.5	8.0
Turbidity, NTU	9.1	120	7.8	150
Calcium	90	74	91	76
Magnesium	33	21	32	21
Sodium	530	260	560	270
Potassium	47	22	44	26
Bicarbonate	505	360	466	383
Alkalinity (field)	414	295	410	314
Sulfate	550	300	570	320
Chloride	430	200	420	200
Fluoride	1.6	1.0	1.4	1.1
Nitrate	0.728	1.50	0.877	2.07
Phosphorus, total	0.09	0.55	0.04	0.36
Boron	0.659	0.357	0.644	0.381

[1] USGS Water Resources Data, New Mexico, Water Year 1999
mg/l = milligrams per liter
NTU = Nephelometric turbidity units
field measurement made in the field
spec. = specific

Water quality from the domestic wastewater systems is tightly monitored and controlled and water quality impacts from these sources, other than those mentioned above, have generally been negligible or positive to the overall water quality within the river. Impacts from storm drain runoff are undefined as they are typically not monitored and may vary greatly depending upon volume of precipitation and time period between precipitation events. Additional investigation of this issue may be warranted beyond the scope of this study. In both instances, existing sampling data from the USGS and/or the EBID typically captures impacts from these sources.

6.2.1.3 Non Point Source Impacts

Non-point source impacts are a concern to water quality within the region. Uncontrolled stormwater runoff from municipal areas, commercial and industrial sites and agricultural farmlands and dairies can result in significant volumes of contaminants entering the surface-water system. In addition, there are numerous permits for non-point source dischargers within the study area. These generally fall into the following categories:

- private and commercial septic systems
- land application to crops from dairies, food processing facilities and other agricultural related operations
- evaporation lagoons for agricultural, commercial and industrial operations
- discharges from small domestic wastewater systems to leach fields, evaporation lagoons or land application

While the majority of these discharges are to the ground water, they provide an indication of the type of activities that can impact surface waters throughout the study area and also can result in significant short-term impacts to the surface-water system in the event of a failure of the treatment and/or disposal system/process. Direct sampling data for surface-water impacts is not available but such impacts can generally be monitored and inferred from data obtained from the existing EBID and USGS monitoring network within the river system.

6.2.2 Ground-Water Quality

6.2.2.1 Mesilla Basin

The following discussion of the water quality of the Mesilla Basin is largely extracted from Anderholm (1990), Wilson et al. (1981), and USGS water-quality data. Additional water-quality data comes from the NMED (Appendix E). The term, “water quality,” refers to both the natural chemical composition of the ground water as well as the extent of human-caused pollution. There is completely natural and technically unpolluted ground water in the Mesilla Basin, and other basins, that is unfit for human consumption simply due to its high amount of dissolved minerals. Water quality in the Mesilla Basin is dependent on several factors, such as irrigation within the Rio Grande corridor, the bedrock found in different recharge zones, and the presence of geothermal water. There are also leaking underground storage tank (LUST) sites and other point- and non-point source pollution that can have a detrimental effect on water quality (NMED UST web site).

6.2.2.1.1 Ground-Water Geochemistry

Wilson et al. (1981) and Nickerson and Myers (1993) describe distinct zones of fresh and saline water in the Mesilla Basin. In general, the shallow ground water in the alluvium is slightly saline due to the concentrating effects of evapotranspiration. This upper saline zone can range from 100 to 250 feet thick, and is usually thinnest near the Rio Grande. Beneath this upper slightly saline to saline zone, there is a relatively thick layer of freshwater, estimated to be as much as 2,000 feet thick in the Las Cruces and Mesquite regions. It is suspected that saline zones underlie the freshwater in some places. Tables of water quality in wells in the Mesilla Basin can be found in Appendix E.

Wilson et al. (1981) summarizes the geochemistry of the Mesilla Basin ground water as follows (pp. 45-46):

> In the northern part of the Mesilla Valley (from T. 24 S. northward), water quality is generally suitable for irrigation and municipal use. Dissolved-solids concentrations in 54 percent of all ground-water samples collected in the Mesilla Valley north of Mesquite were less than the recommended maximum of 500 milligrams per liter (National Safe Drinking Water Standards, 1974). Sulfate, chloride, boron, and nitrate concentrations were generally lower than the recommended limits. Fluoride concentrations were generally less than 1.4 milligrams per liter. Ground water in the northern part of the Mesilla Valley is very hard: the total hardness in most samples exceeded 120 milligrams per liter.
>
> [In] the southernmost Mesilla Valley and on the east side of the valley between Las Cruces and El Paso, ground water that meets drinking water standards may not be obtainable.... The dissolved-solids concentrations in ground water in the southern one-half of the Mesilla Valley (from T. 25 S. southward) were generally much greater than in the northern part.

The USEPA has established National Primary Drinking Water Regulations that are legally enforceable standards that apply to public water systems. As part of these regulations, the USEPA has established maximum contaminant levels (MCL) for many inorganic, organic, radionuclides, and microorganisms. The USEPA has also established National Secondary Drinking Water Regulations that are not legally enforceable standards, but that may have aesthetic effects such as taste and odor, or cosmetic effects such as tooth discoloration. The NMWQCC has also established drinking water standards for selected parameters. A copy of the USEPA Primary and Secondary Regulations and the NMWQCC standards are included in

Appendix E.

Ground water in the shallow alluvium has been saline for quite some time. From 1953 to 1956, and 1963 to 1965, the BoR conducted a study of water salinity in a large series of irrigation wells in the Mesilla Basin. Wilson et al. (1981) supplemented this study for the years 1972 to 1975. The results of these studies show that the average specific conductance in shallow wells in the Mesilla Basin is fairly high (between 1,740 and 2,150 μS/cm), varies only slightly from year to year, and during that time period did not seem to noticeably increase or decrease (Table 6.23).

TABLE 6.23. AVERAGE SPECIFIC CONDUCTANCE OF IRRIGATION WELLS IN THE MESILLA VALLEY (WILSON ET AL., 1981)

Year	Number of Irrigation Wells Sampled	Annual Average Specific Conductance (micromhos)
1953	266	1,930
1954	158	2,040
1955	294	1,820
1956	490	2,150
1963	347	1,910
1964	823	1,870
1965	63	2,020
1972	71	1,800
1973	58	2,040
1974	26	1,740
1975	76	1,900

For the purpose of analyzing ground water, Anderholm (1990) divides the Mesilla Basin into three separate regions: west of the Mesilla Valley, the Mesilla Valley itself (or Rio Grande corridor), and east of the Mesilla Valley. Ground water in the western and eastern margins of the Mesilla Basin has a significantly different geochemical signature than the ground water found in the river valley itself. Ground water inside the river valley has been significantly affected by the influx of excess water (return flow) from irrigation, which often brings with it high concentrations of dissolved ions flushed from the soils (Anderholm, 1990). The concentration of ions is highly variable, both horizontally and vertically.

Ground-water geochemistry in the region west of the Mesilla Valley is largely determined by the chemistry of the rocks in the recharge zone and presence of geothermally-influenced water. The water flowing into the basin from the northwest has a specific conductance between 1,400 and 2,310 μS/cm. Water flowing in from the southwestern margin generally has a specific conductance less than 1,940 μS/cm, except along faults where there can be geothermally influenced water with a specific conductance as high as 7,400 μS/cm. Ground water in the region just west of Las Cruces has a relatively low specific conductance, less than 900 μS/cm (Anderholm, 1990).

East of the Mesilla Valley, the ground water has two distinct chemical signatures, which are based on the different lithologies in their respective recharge zones (Anderholm, 1990). Water flowing from the Organ Mountains, which are composed of igneous rocks, tends to have a lower ion concentration than water flowing from the San Andres Mountains, which are composed of more soluble sedimentary rocks. There is also a significant source of geothermal water east of the Mesilla Valley, which is of low quality because of its high chloride concentration (Anderholm, 1990).

According to Wilson et al. (1981), there was little change in ground-water quality over time between the 1960s and 1970s, despite the significant amount of pumping during that time. Wilson et al. did predict in 1981, however, that water quality would deteriorate due to downward-moving saline water into the freshwater zone. No known studies have been performed to verify if this has actually occurred, nor do available data allow for an accurate assessment.

Maps showing specific conductance data for three different time periods are presented as Figures 6.49, 6.50, and 6.51. The time periods are 1960 and before, 1978 to 1983, which will be referred to as 1980 data, and 1995. Few data are available for any of the time periods, and, therefore, specific conductance contours for the basin could not be developed. Comparison of historic specific conductance changes in the basin could not be made due to the lack of comprehensive data.

Water-quality data from the USGS database were reviewed to assess selected reported parameters, which exceeded NMWQCC standards. The database included water-quality data from 1947 to 1995. Sulfate and chloride concentrations have exceeded the NMWQCC aesthetic standard of 600 and 250 mg/l respectively, in many wells in the basin USGS database, November 2000). Approximate areas where wells were reported to have both sulfate and chloride concentrations exceeding the NMWQCC standard are 2.9 miles northwest of Las Cruces, 1.5 miles east and southeast of Mesquite, 1 mile southeast of La Mesa, 2 miles southeast of Vado, 0.5 mile west of Berino, and 3.7 miles south of La Union. Nitrate concentrations exceeding the NMWQCC standard of 10 mg/l were reported in several wells east and southeast of Mesquite, and a well south of La Union. Specific concentrations of sulfate, chloride, nitrate and other parameters, some of which exceed water quality standards, for the aforementioned areas and other areas in the Mesilla Basin are included in Appendix E.

6.2.2.1.1 Ground-Water Pollution Sources

There are several main categories of ground-water contamination sources in the Mesilla Valley. These sources include LUST sites, septic tanks and cesspools, landfills, dairies, agricultural and municipal chemicals (including pesticides and herbicides), and other waste disposal practices.

Leaking underground storage tanks are a major source of ground-water contamination in New Mexico. Spills from these tanks can introduce different types of pollutants, such as gasoline, diesel, and fuel oil, as well as associated toxic chemicals like benzene and toluene into the ground-water system. There is also concern today about the gasoline additive methyl-terti-butyl ether (MTBE) though its possible health effects are not yet well understood. MTBE is extremely soluble in water and, therefore, can move very rapidly in an aquifer. There are 114 LUST sites located within the Mesilla Basin, the majority of which are in and around the City of Las Cruces. Of these sites, 48 do not currently require any further action, while the other 66 sites are undergoing investigation, remediation, or monitoring according to data available from the NMED Underground Storage Tank Bureau (Appendix E).

Nitrate contamination deserves a short discussion of its own. Nitrate forms as a byproduct of the degradation of ammonia and organic nitrogen compounds, which are found in animal and human waste products. Septic tanks, dairies, and feedlots are all potential nitrate contamination sources. The large number of dairies in the Planning Region, especially between the towns of Mesquite and Berino, are likely the main potential source of nitrate contamination in the Planning Region. Municipal wastewater treatment plants and fertilizers are also potential sources of nitrate. Nitrate can be toxic at high levels, especially to fetuses and infants. Ingestion of water containing more than 10 mg/l of nitrate can cause the rare but deadly disease methemoglobinemia, or “blue baby syndrome,” (Earp and Koschal, 1986). The average nitrate level in Doña Ana County municipal water supplies is low, about 0.10 mg/l; concentrations much higher than this may indicate some type of contaminant source impacting water quality. Levels higher than 5 mg/l are considered worrisome and investigation is encouraged (Earp and Koschal, 1986). Nitrate can travel relatively quickly through the subsurface and, if found at elevated levels, may be an early indicator of other types of contamination.

Seven closed landfills and Doña Ana County’s two active landfills are located in the Mesilla Basin. According to the 1994 Doña Ana County Regional Water Plan (NMSU et al., 1994), many of the landfill closures were due to violations of USEPA regulations. Contamination from landfills depends on many factors, including the character of the waste in the landfill, the patterns of ground-water flow through or under the landfill, and the character of the ground beneath the landfill.

In 1996, the New Mexico Border Health Office, located in Las Cruces, commissioned a study on water quality in domestic wells in the Mesilla Valley (Stephens & Assoc., 1996). Stephens & Assoc. analyzed the water from 135 wells, between the towns of Radium Springs and Sunland Park, for constituents such as nitrate, bacteria, viruses, organic compounds (including pesticides and herbicides), metals, and other inorganic parameters. In 31 domestic wells, they found concentrations exceeding USEPA MCL of one or more of the following: lead, arsenic, nickel, selenium, and uranium. They also found levels of bacteria exceeding USEPA MCL in 24 wells and nitrate exceeding USEPA MCL in 3 wells, and trace levels of toxic organic compounds in a few wells. The majority of nitrate-contaminated ground-water sites, according to Stephens & Assoc. (1996), are located east of the Rio Grande between Mesquite and Berino, with additional high-nitrate sites located throughout the valley. Dairies near Mesquite are reported to have contaminated the shallow ground with nitrate concentrations up to 200 mg/l (Texas Water Development Board and New Mexico Water Resources Research Institute 1997, and Jacques and Samani 1992). Fuel contamination sites are located throughout the valley, but, as one would expect from the list of LUST sites, most are in Las Cruces. There are very few ground-water contamination sites of any kind outside the Rio Grande floodplain region.

The New Mexico Border Health Office study concluded that, in general, water from shallow domestic wells was of moderate to poor quality, due to both natural TDS levels and the presence of pollution (Stephens & Assoc., 1996). The study recommended that owners having wells that produce low quality water either invest in a treatment system or use bottled water for drinking, though the study acknowledges that neither of those options are economically feasible for many of those with water-quality problems. Insuring that domestic wells have properly installed sanitary seals on the well heads and annular seals is another way to help reduce the opportunity for contamination to enter wells, especially from waste-borne pollutants like nitrate, fecal coliform bacteria, and viruses. Sanitary seals are placed on the wellhead and prevent dirt, insects, debris, and the like from entering the well. Annular seals should be installed at each well during well construction to limit the opportunity for contaminants to migrate down the well bore in the aquifer. Annular seals generally consist of cement, bentonite, or both, and are placed between the well casing and the borehole. A summary of Stephens & Associates findings can be seen in Appendix E, along with a list of contaminants in public water-supply wells as measured by the NMED.

6.2.2.1.2 Aquifer Sensitivity

Aquifers are susceptible to contamination from various types of surface and shallow subsurface pollution sources depending on factors such as depth to water, soil type, and the character of the vadose zone (the subsurface zone above the water table) sediments (Figure 6.52). Creel et. al (1998) used these factors to construct a model of aquifer sensitivity for the Mesilla Basin. Depending on how many of these factors were conducive to contamination transport, an intensity range from very slight to extreme was assigned. "Results indicated that of the 2,282 km^2 included in the study area, less than one percent was classified as *extreme*, slightly over 10 percent as *severe*, almost 19 percent as *moderate*, nearly 43 percent as *low*, about 16 percent as *slight*, and over 12 percent as *very slight*" (Creel et al., 1998; WRRI Figure 11 from Creel et al., 1994). The Rio Grande alluvial deposits are very susceptible to pollution because the aquifer consists of highly transmissive gravels and sands, and the water table is usually less than 20 feet below the ground surface. Water in the deeper Santa Fe deposits may be less likely to face contamination because the water table can be hundreds of feet below the surface. The presence of interfingered, horizontal clay layers are very effective in retarding downward flow of pollution from the surface. Regions where the water table is very deep also tend to be less populated (and therefore have less domestic-waste pollution potential) than the central river valley.

6.2.2.1 Jornada Del Muerto Basin

6.2.2.1.3 Ground-Water Geochemistry

According to Wilson et al. (1981), the southern portion of the Jornada del Muerto Basin has fairly low TDS levels (less than 500 mg/l) but relatively high concentrations of sodium, bicarbonate, and sulfate. Relative concentrations of silica and magnesium are higher in the Jornada Basin than in other basins within the Planning Region. Hardness concentrations range from 24 to 320 mg/l, and fluoride concentrations less than the NMWQCC standard of 1.6 mg/l. The USEPA aesthetic MCL for fluoride is 2.0 mg/l. Iron levels are often high and can exceed the USEPA MCL of 0.3 mg/l. Manganese concentrations in the Jornada Basin are lower than in the Mesilla Basin, and generally lower than NMWQCC standard of 0.2 mg/l. Water quality data from the USGS database are included in Appendix E.

There is a wide range of specific conductance levels in the Jornada Basin, and water in the south-central part of the basin is generally slightly saline (Appendix E). Pockets of more highly saline water tend to occur along faults where deep water can flow upward. There are also pockets of very fresh water, located along recharge zones near arroyos.

A map showing specific conductance data from 1948 to 1958 is referred to as pre-1960 data and is presented as Figure 6.53. Few data are available for pre-1960 or any other time period, and, therefore, specific conductance contours for the basin could not be developed. Pre-1960 data indicate specific conductance values range from 349 μS/cm in the southern portion of the basin near Highway 70 to 2,010 μS/cm in the north-central portion of the basin. Comparison of historic specific conductance changes in the basin could not be made due to the lack of comprehensive data.

In 1989, JSAI measured water quality at different discrete intervals in a new Las Cruces municipal well, located near Moongate. From the analyses on this well, it appears that deeper water has higher dissolved-solids concentration than water near the surface (Table 6.24). For example, in the interval between 730 and 750 ft bgl, TDS was 652 mg/l, but in the deepest interval of 1,850 to 1,870 ft bgl, TDS was 9,172 mg/l.

TABLE 6.24: WATER QUALITY IN LAS CRUCES WELL NO. 40, 22S.03E.6.4333, 1988						
Constituent	**Depth Interval of Discrete-Interval Sample (ft bgl)**					**Completed Well, End of 48-hr Test**
all measurements in mg/l	730-750	910-930	1,110-1,130	1,590-1,610	1,850-1,870	
sodium	77.7	62.4	102.7	485.8	1,261.8	33.7
potassium	<0.1	<0.1	<0.1	4.7	23.5	<0.1
total hardness	246	211	104	675	4,241	242
calcium	65.3	60.7	23.5	177	1,219.8	71.1
magnesium	20.2	14.4	11.0	56.6	291.1	15.7
iron, total	4.24	1.28	1.94	0.36	0.09	0.16
chloride	51.8	32.5	29.9	569.7	3,572.5	13.5
fluoride	0.64	0.53	0.87	1.46	0.91	0.42
nitrate	0.68	0.82	0.47	0.67	0.04	0.95
sulfate	155.7	139.6	67.1	796.1	1,712.5	138.5
TDS	652	514	450	2,509	9,187	395
arsenic	0.002	<0.001	0.004	0.003	<0.001	0.003
barium	0.06	0.05	0.03	0.25	0.14	0.03
cadmium	<0.005	<0.005	<0.005	<0.005	0.016	<0.005
chromium	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
lead	0.020	0.008	0.010	<0.005	0.034	<0.005
mercury	0.0002	<0.0002	<0.0002	0.0003	0.0003	0.0006
selenium	<0.001	<0.001	<0.001	0.001	0.002	<0.001
silver	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02

Source: Shomaker, 1989

6.2.2.1.4 Ground-Water Contamination

Sources of ground-water contamination in the Jornada Basin include septic tanks (concentrated in the vicinity of Butterfield Park), liquid waste disposal sites, and LUST sites. There are three LUST sites listed with the NMED in Organ, all of which have No Further Action status (Appendix F). In addition, elevated nitrate levels, in some cases exceeding the USEPA's maximum contamination levels of 10 mg/l, have been measured in the Organ water supply wells (Appendix E).

6.2.2.1.5 Aquifer Sensitivity

Because the water table is fairly deep in the Jornada Basin, and there is no highly-transmissive riverine floodplain, the aquifer may not be quite as sensitive to contamination from LUSTs, septic tanks, landfills, or agricultural operations as it is in either the Mesilla or Rincon Valley Basins (Figure 6.52). However, elevated nitrate levels, exceeding 10 mg/l, were found in several municipal supply wells, so some pollutants appear to be able to infiltrate the aquifer (Stephens, 1996; USGS water quality database).

6.2.2.2 Hueco Bolson

6.2.2.2.1 Ground-Water Geochemistry

Water quality in the Hueco Bolson is highly variable. According to the USGS Water Quality Database (2000), specific conductance in Hueco Bolson samples ranges from 400 to over 10,000 μS/cm (Figures 6.54 and 6.55), and TDS ranges from about 300 to 10,000 mg/l. Most of the wells with extremely high specific conductance and TDS values are located in the very northern edge of the Hueco Bolson, where it is hydraulically connected with the Tularosa Basin. Specific conductance and TDS values in deeper portions of the aquifer are also very high. Water in the Tularosa Basin, especially deep water, can have a TDS content as high as 35,000 mg/l (McLean, 1970). Not enough comprehensive data exist to assess historic specific conductance changes in the basin. Specific conductance data collected from two wells in 1997 and 1998 are shown in Table 6.25. Although unknown, the difference in the specific conductance in these wells from 1997 to 1999 is probably the results of differences in pumping, with increased pumping resulting in higher specific conductance values.

TABLE 6.25. SPECIFIC CONDUCTANCE VALUES FROM 1997 AND 1999 FOR TWO WELLS IN THE HUECO BASIN, NEW MEXICO

Date	Well Location	Specific Conductance (mS/cm)
09/04/97	25S.04E.12.121	415
08/11/99	25S.04E.12.121	706
09/04/97	25S.04E.11.123	665
08/11/99	25S.04E.11.123	495

In the Hueco Basin, hardness and chloride content can be very high, up to 2,040 and

1,770 mg/l, respectively. Sulfate concentrations are well below the USEPA secondary MCLs (Appendix E). The USGS database indicates that iron and manganese concentrations in some wells exceed the USEPA MCL (Appendix E).

According to Kernodle (1992) and Orr and Risser (1992), most of the fresh water is found in a wedge where recharge comes off the alluvial fans on the western side of the basin. Aquifer thickness, having a TDS concentration of less than 1,000 mg/l, ranges from about 2,000 feet along the east side of the Organ Mountains near Soledad Canyon, to about 400 feet at the Town of Chaparral (Orr and Riser, 1992) (Figure 6.56). The thickness of the fresh water decreases eastward, reaching only about 100 feet along the Doña Ana-Otero County line. In the very eastern part of the Hueco Basin, just a few miles east of the Doña Ana-Otero County line, there is no water with less than 1,000 mg/l TDS.

6.2.2.2.2 Ground-Water Contamination

There are two NMED-listed LUST sites in the Hueco Basin, both of which are located in the town of Chaparral and have the status of "No Further Action/Suspected Release," (Appendix F). There is one closed landfill in the town of Chaparral, but it is unknown whether it is a source of ground-water contamination. Two of Chaparral's water supply wells, the West and Greenwood Wells, had elevated nitrate levels of 5.62 and 8.31 mg/l, respectively, in 1981 (Appendix E). These nitrate levels do not exceed the New Mexico Ground-water Standards for nitrate, which is 10 mg/l, but are higher than nitrate levels in most other water supply wells (Earp and Koschal, 1986). The presence of elevated concentrations of nitrate is probably related to septic systems in the area. The NMED also measured high levels of chloride, barium, specific conductance, and TDS in Chaparral's Edna Well in 1997 (Appendix E).

6.2.2.2.3 Aquifer Sensitivity

The presence of elevated nitrate levels in some of the wells in Chaparral indicates that the aquifer is at least slightly sensitive to sub-surface contamination, unless the wells were contaminated due to improper well construction. As a whole, the Hueco Bolson aquifer in the Planning Region is probably not terribly sensitive to surface pollution due to the relatively great depth to water (Figure 6.52).

6.2.2.3 Rincon Valley Basin

6.2.2.2.4 Ground-Water Geochemistry

According to Wilson et al. (1981), water in the alluvial floodplain aquifer is very hard, exceeding the USEPA MCL of 250 mg/l in many wells, and contains significant amounts of dissolved solids. Over half of the wells in the floodplain alluvium have TDS levels higher than 1,000 mg/l, and specific conductance levels have been measured as high as 8,000 μS/cm. Specific conductance data collected by the USGS from 1947 to 1957 (pre-1960) in the southern portion of the basin ranged from 897 to 2,640 μS/cm. Pre-1960 specific conductance measurements are shown in Figure 6.57. No data were available from late 1970s to early 1980s. One specific conductance measurement was collected by the USGS in 1995 at a well near Hatch in Township 19 South, Range 3 West, Section 11.323, and the value was 1,270 μS/cm. This value is similar to those measured pre-1960. No basin wide comparison of specific conductance values can be made due to the lack of comprehensive data.

The major ions in the floodplain alluvium ground water are sodium, calcium, sulfate, and varying amounts of chloride. These same ions are found in the Rio Grande water, but at lower concentrations, indicating that the Rio Grande is probably the major recharge source for the aquifer. Other significant ions in the alluvial aquifer include iron and manganese, both of which sometimes exceed USEPA recommended maximum concentrations, and boron, which falls within USEPA MCL. Water pumped from wells in Township 18 South, Range 4 West (near the Town of Garfield) tends to have high specific conductivity due to a lack of subsurface drainage. This creates a situation where salts leached from the soil down into the ground water do not get flushed away. In addition to relatively high salinity, wells in the Town of Garfield tend to have high fluoride content, exceeding the NMWQCC standard of 1.6 mg/l in as many as six public wells. Manganese concentrations in the basin often exceed the USEPA MCL (Appendix D).

6.2.2.2.5 Contamination Sources

According to the NMED LUST database, there are 13 leaking underground storage tank sites in the Rincon Valley Basin, all of which are located in or near the town of Hatch. Of these 13 sites, two of them have no further action status. Seven sites are currently being monitored, and the remaining four sites are either being remediated or investigated (Appendix E). Other contamination sources in the Rincon Valley Basin include liquid waste disposal, septic tanks, and cesspools (NMED, personal communication).

6.2.2.2.6 Aquifer Sensitivity

The Rincon Valley Basin aquifer is quite susceptible to contamination because the water table is so close to the surface and the floodplain sediments tend to have a high transmissivity (Figure 6.52). According to several sources, including the recent USGS water-level database, water levels in the floodplain alluvium tend to be less than 25 feet below the ground surface (Wilson et al., 1981; Creel et al., 1998; Weeden and Maddock, 1999).

7.0 WATER DEMANDS

7.1 Present Regional Water Demands

Historically, there have been (and continue to be) two broad water-demand categories in the Planning Region: 1) the use of the surface-water supply developed under the BoR's Rio Grande Project, and 2) the use of the regional ground water supply as developed by private individuals, industrial-commercial interests, semi-public entities, and municipalities. Present and future demands from these two different sources will be treated separately as the surface supply is already fully allocated.

Although surface and ground water demands will be reported separately, the relationship between the two in the Rincon and Mesilla valleys should be kept in mind. The river, the irrigation canal system and on-farm irrigation all provide an avenue for recharge of the alluvial aquifers in the Rincon and Mesilla Valley. (Clyde A. Wilson, Robert White, Brennon Orr, and Gary Roybal, Water Resources of the Rincon and Mesilla Valleys and Adjacent Areas, New Mexico, Technical Report 43, New Mexico State Engineer, page 63).

During periods of low river-flow when releases are not being made from Elephant Butte Reservoir, the Rio Grande gains base-flow from the shallow aquifers. The NMOSE has recognized this inter-relationship between surface and ground water by providing guidelines for review of new applications for the appropriation of ground water in the Mesilla Valley. (Office of the State Engineer, Mesilla Valley Administrative Area Guidelines for Review of Water Right Applications, January 1999, pages 1-2). The objectives of NMOSE guidelines are to ensure orderly development of the water resources of the region, to prevent unacceptable depletions of the surface-water supply (more than 0.10 ac-ft/yr; see Administrative Standard B.1. in the NMOSE guidelines, page 3), to prevent impairment of existing rights, and to promote the conservation of water. All of these factors will have to be considered in meeting future water demands in the Mesilla Valley. These guidelines describe the administrative process that will be followed in reviewing permits for new ground water developments to meet future demands in the Mesilla Valley. The NMOSE has informal guidelines for the consideration of new wells in other basins in the region (for example the Jornada del Muerto Basin); however, these guidelines have not been through a public comment process, and have not been formally adopted by the State Engineer. It should be remembered that in Rio Grande valleys in the region, demands for ground water are in addition to the demands for surface water used for irrigation in New Mexico, Texas and Mexico.

7.1.1 Surface Water Demands

7.1.1.1 Surface Water Uses in the Region

Surface water demands for irrigation under the EBID are met by water delivered by the District, most of which originates as releases from storage in Elephant Butte and Caballo Reservoirs located 30 miles north of the Region in Sierra County. Not all of the releases from Elephant Butte Reservoir are used in the Region.

Some water is lost to evaporation in Caballo Reservoir (about 20,000 ac-ft/yr), some is lost to phreatophytic vegetation below the two dams, a part is ear-marked for delivery to Mexico (60,000 ac-ft/yr), and about 43 percent of the supply for the U.S. Districts is committed to the EPCWID#1 in Texas. A small part of the annual releases from the dam are used in Sierra County for irrigation, but because the volume is relatively small, these demands for surface water will be reported along with those for the Region. The Town of Truth or Consequences claims some rights to the use of Reservoir surface water, but these are not believed to be presently in use. There is also the non-consumptive use of Reservoir water for power generation. There is competition between these demands such that an increase in one tends to deplete the supply available to meet other demands. Adjudication of water rights in the Lower Rio Grande was started in 1986. No final date has been set for completion of the adjudication. The adjudication will ultimately determine how much ground water can be pumped without affecting surface-water flows that have seniority.

Table 7.1 provides a listing of all of the surface-water demands in the region and those uses met by diversions from the Rio Grande below Elephant Butte in Sierra County. Not included are a dozen or so small springs in the region that provide stock watering and limited irrigation near their point of origin. None of these springs lead to an ephemeral stream.

The consumptive use of the surface-water supply available to New Mexico from Elephant Butte Reservoir is now allocated exclusively for irrigated agriculture. Non-consumptive use of the flow of the Rio Grande is associated with recreation at State parks at Percha Dam and at Leasburg Dam. The City of Las Cruces has a river park at Picacho Bridge that offers scenic walking paths and picnic areas. The narrow green valley that extends from below Caballo Dam to the Texas-New Mexico state-line also provides esthetic values for area residents. There is a significant amount of consumptive use associated with the maintenance of the non-beneficial vegetation that grows along ditches and drains maintained by the irrigation district and in the bosque areas. This phreatophytic vegetation uses both surface water and shallow ground water, but as it principally uses ground water estimates of acreage and consumptive-use will be reported under the section on ground-water demands.

TABLE 7.1: SUMMARY BENEFICIAL SURFACE WATER USES IN THE PLANNING REGION

Name of Water User	Source of Supply	Quantity of Water	Location and Purpose of Use
Rio Grande Project	Rio Grande water stored in Elephant Butte Reservoir	730,000 ac-ft/yr	For use on the Rio Grande Project including irrigation in Texas and New Mexico, delivery of water to Mexico under the Treaty of 1907, municipal water supply, power generation, and recreation
Carrie Tingley Hospital	Rio Grande surface supply	97.14 ac-ft/yr	To irrigate lawns, trees, and gardens surrounding the hospital. Diversion may be made from the river or from a well.
Lawerence Horner	Diversion from the Rio Grande	Sufficient to irrigate 34.33 acres	Irrigation in Sec.25, T20S, R2W
Mary Ward	Diversion from the Rio Grande	Sufficient to irrigate 114 acres	Irrigation in Sec.13, T20S, R2W
James Brewster	Diversion from the Rio Grande	45 acre-ft per yr.	Irrigation in Sec.13, T20S, R2W
Parry Larsen and William Buhler	Diversion from the Rio Grande	Larsen-5.6 ac-ft per yr; Buhler 4.65 ac-ft per yr	Larsen- Irrigation in Sec 34, T13S, R4W; Buhler- recreational fishing pond Sec.33, T13S, R4W
Francis Stout	Diversion from the Rio Grande	10.5 ac-ft per yr	Irrigation in Sec.5, T14S, R4W
Robley Hedrick	Diversion from the Rio Grande	105 acre-feet/ yr	Irrigation in Sec.3, T14N, R4W
Robley Hedrick	Diversion from the Rio Grande	5.2 ac-ft per yr	Irrigation in Sec.34, T13S, R4W

TABLE 7.1: SUMMARY BENEFICIAL SURFACE WATER USES IN THE PLANNING REGION			
Name of Water User	**Source of Supply**	**Quantity of Water**	**Location and Purpose of Use**
D.F. Brungardt	Diversion from the Rio Grande	10.5 ac-ft per yr	Irrigation in Sec. 34, T13S, R4W
Bessie Arnold	Diversion from the Rio Grande	87.5 ac-ft per yr	Irrigation in Sec. 6, T14S, R4W
M.B. Doolittle	Diversion from the Rio Grande	38.5 ac-ft per yr	Irrigation in Sec. 4, T14S, R4W
Helen Doolittle	Diversion from the Rio Grande	35 ac-ft per yr	Irrigation in Sec. 4, T14S, R4W
James Stoval	Diversion from the Rio Grande	4.9 ac-ft per yr	Irrigation in Sec.34, T13S, R4W
Cain Brothers	Rio Grande	60 ac-ft per yr	Irrigation Sec.5, T14S, R4W
Arroyo Bonito Ditch	Rio Grande, direct diversion in Sec 30, T16S, R4W	515 ac-ft per yr.	Irrigation in various sections in T16S, R4W and R5W

* Information from (Department of Interior, Legal and Institutional Framework For Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995,Table III. 1 a.)

7.1.1.2 Surface Water Demands Exerted by the Rio Grande Project

7.1.1.2.1 Demands Established by the Reclamation Acts of 1902 and 1905

The primary source of the surface water in the region is from flows stored in Elephant Butte Reservoir, the basic storage unit for the Rio Grande Project. The Rio Grande Project was authorized by Congress under the Reclamation Act of 1902 to provide irrigation water to farms in Texas and New Mexico by capturing flood-flows and storing them in the Reservoir. The Project was to include diversion dams and a canal delivery system. The funds for these irrigation and storage works were to be reimbursed by the owners of the irrigated lands on the basis of a uniform per acre charge.

At the time of the 1902 Reclamation Act, Texas was not eligible for participation as there were no public lands in Texas to help underwrite the reclamation fund(Douglas R. Littlefield, Interstate Water Conflicts, Compromises, and Compacts, Ph.D. thesis, published by UMI Dissertation Services, Ann Arbor, Michigan, 1987, page 153.) Because farmers in the El Paso, Texas area claimed the right to use the flows of the Rio Grande for irrigation, as did farmers in

New Mexico, some accommodation was necessary. A division of the anticipated supply from Elephant Butte Reservoir between the two states was a necessity if the Project was to go forward. In 1904 an agreement between business people from El Paso and Las Cruces formed the basis for a Congressional act in 1905. The 1905 Reclamation Extension Act did the following:

- Extended the benefits of the Reclamation Act of 1902 to include the El Paso area;
- Provided that all irrigated lands in the Project would have the same standing with respect to priority dates and charges; and
- Established the guidelines for the division of the water supply above and below El Paso on the basis that New Mexico would be allowed to irrigate 88,000 acres, and 67,000 acres in Texas.

7.1.1.2.2 Demands Created by the U.S.-Mexico Treaty of 1906

Another primary objective of the Rio Grande Project was to ensure that the United States could deliver water to Mexico. For many years, Mexico had complained that excessive uses of Rio Grande water in Colorado were depriving Juarez farmers of their historic supply. In 1906 a treaty was negotiated with Mexico for the delivery of 60,000 ac-ft of "free" water annually to Mexico at the Acequia Madre ditch that headed below the principal diversion at El Paso, the Franklin Canal. The U.S. has delivered the amount of water to Mexico in most years, but has reduced these deliveries during periods of short supply from Elephant Butte Reservoir.

7.1.1.2.3 Demands Created by Contracts between BoR and the Districts

The acreage to be irrigated in Texas and New Mexico under the Rio Grande Project and municipal water-uses were arrived at by means of contracts between BoR and one of the irrigation districts and by three party contracts that included BoR and both of the districts. The most important of these joint agreements was signed in September 1937 when the districts were allowed to increase their authorized acreage: 90,640 acres in New Mexico and 69,010 in Texas. This increased the authorized Project acreage to 159,650 acres.

The 1937 contract is important as it provides for years when irrigation shortages occur as follows (Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995,page II-9):

….. in the event of a shortage of water for irrigation in any year, the distribution of the supply in such year, shall so far as practicable, be made in proportion of 67/155 thereof to the lands within the EPCWID#1, and 88/155 to the lands within the EBID.

7.1.1.2.4 The Rio Grande Compact of 1938 and Project Demands

Colorado, Texas and New Mexico entered into an interstate compact that divided the supply of the Rio Grande between the three states by providing sliding scale delivery tables. New Mexico's deliveries at Elephant Butte Dam were to "Texas", or in reality to the Rio Grande Project, as it was the "unit" beneficially using all of the surface water below that point. The Compact did not further divide the water supply between New Mexico users, the EBID, and the Texas Irrigation District. The Compact did include deliveries to Mexico. Article VIII of the Rio Grande Compact, defined the "normal release" of "usable water" for the Project from Elephant Butte Reservoir to be 790,000 ac-ft/yr (Hill, page 72). This amount coupled with the use of return flows and flood flows below the reservoirs comprises the "full Project" allocation to the two districts and Mexico. The Compact also contains provisions on volumes of water to be released from storage under certain circumstances.

7.1.1.3 Capacity of the Facilities in the Rio Grande Project to Meet Demands

In January 1906, the BoR sent a letter to the New Mexico State Engineer requesting an appropriation of 730,000 ac-ft/yr from water to be stored in Elephant Butte Reservoir. At the time of its construction (1912-1916), the Reservoir had a capacity of over 2.6 million ac-ft, but sediment from upstream lands has reduced the effective storage to just over 2 million ac-ft in recent years (Natural Services Conservation Service, New Mexico Basin Outlook Report, May 1, 1977, published by the U.S. Department of Agriculture). Caballo Dam and Reservoir (about 25 miles downstream) was constructed in 1936-1938 to hold waters released from Elephant Butte Reservoir for power generation and to provide flood-storage capacity. The usable capacity of Caballo Reservoir, including 100,000 ac-ft of flood storage, is 331,500 ac-ft (Ibid). The Project facilities are designed to provide water to as much as 178,000 irrigated acreage in the EBID in New Mexico and in the EPCWID#1 in Texas. These facilities also provide for the storage and release of the Mexican allocation under the 1906 Treaty.

Hudspeth County Conservation and Reclamation District No. 1 (HCCRD), as it is now constituted, was formalized in 1924. The HCCRD entered into a contract with the United States for the rental of surplus waters from the Rio Grande Federal Reclamation Project in 1924. Both EBID and EPCWID#1 concurred in this contract. The contract provided for the delivery of water at the terminus of the Tornillo Main Canal (see maps of EPCWID#1 and HCCRD in appendix disk). The Secretary of the Interior was to determine the availability of such water, and the rental of water was explicitly inferior to “the right to use water for any purpose on the lands of the Rio Grande Federal Irrigation Project.” The HCCRD relinquished all right, title, interest, and claim to Rio Grande water, except as provided in the 1924 contract.

The 1924 contract was amended several times, due primarily to the IBWC rectification and relocation projects. The current contract under which the HCCRD operates is dated April 27, 1951.

HCCRD is quite different from EPCWID#1 and EBID in that it is not considered a part of the Rio Grande Project, though it does lie within the stretch of river between San Marcial and Fort Quitman typically used to describe the Rio Grande Project limits. The water rights are inferior to those of the Rio Grande Project, which is a distinct disadvantage in times of short water supply. During the drought period of 1951 through 1978, the surface-water supply was reduced drastically.

HCCRD, seeing its water supply rapidly dwindling in the early 1950s, filed suit against the Rio Grande Project in an attempt to establish rights to water from the Rio Grande. The litigation was bitterly fought for several years, and it ended in a complete victory for the Rio Grande Project. The decision reaffirmed that HCCRD had no rights to the waters of the Rio Grande, only rental rights to surplus water of the Rio Grande Project as determined by the management of the Rio Grande Project (King and Maitland, 2003).

The Rio Grande Project lands, canal systems, drains and diversion-dams lie along a relatively narrow 150 river-mile reach of the Rio Grande from Elephant Butte Reservoir to the southern line of El Paso County and these facilities are adequate to meet current demands.

7.1.1.4 Demands and the Operation of the Rio Grande Project

From its inception until the late 1970s and early 1980s, the Rio Grande Project was run as a single "unit" project although irrigation districts existed as separate entities in Texas and New Mexico. BoR designed and built most of the system. BoR controlled releases from the Reservoir and the amount and timing of diversions to meet orders for water sent to them by the Districts. Planned allocation to Rio Grande Project farmlands were made at the start of each water-year based on the volume of water stored in the Reservoir. Allotments were expressed in terms of an assigned depth of water that each acre would receive during the irrigation season. Allocations were increased or decreased during the course of the year depending on runoff into the Reservoir and on significant regional rainfall. An annual operating plan guided BoR in its relationship to the two irrigation districts. Beginning in 1979, the Districts accepted responsibility for operation and maintenance of the irrigation and drainage facilities as the districts paid the balance of their debt to the Federal government for the cost of construction of their share of the facilities. While BoR still owns and operates Elephant Butte and Caballo Dams and still owns the diversion works, the two irrigation Districts own the conveyance and return flow facilities and operate their respective diversion dams.

7.1.1.5 Meeting the Annual Rio Grande Project Demands

In the design and development of the Rio Grande Project, and in conjunction with the Rio Grande Compact, an average annual release of 730,000 ac-ft per year is assumed. The Stream Adjudication of the Lower Rio Grande will quantify exactly how much water is entitled to be stored and diverted by the Rio Grande Project. Table 7.2 is a listing of the annual releases from Elephant Butte Dam for the years 1923 through 1998. The values in the table include water released to make deliveries to Mexico. Clearly, the amount of water available to meet Rio Grande Project demands has varied greatly over the years. The average annual release for the period was 707,225 ac-ft; close to the "full project supply". A conclusion that can be drawn is that that there is less than a 50-50 chance that there will be a "full supply" for the Rio Grande Project in any one year, and that shortages are strongly autocorrelated. The standard deviation for releases was 255,340 ac-ft for the period. The minimum release was only 183,400 ac-ft in 1964 or less than one acre-foot per acre, when the irrigated acreage in the Rio Grande Project is assumed to be 159,650 acres, and if some deliveries are made to Mexico.

TABLE 7.2: ANNUAL SUPPLY FOR THE RIO GRANDE PROJECT ELEPHANT BUTTE RESERVOIR RELEASES (AC-FT)

Year	Release	Year	Release	Year	Release
1923	808,300	1948	814,300	1973	605,800
1924	1,002,700	1949	813,400	1974	672,400
1925	817,400	1950	583,600	1975	653,700

TABLE 7.2: ANNUAL SUPPLY FOR THE RIO GRANDE PROJECT ELEPHANT BUTTE RESERVOIR RELEASES (AC-FT)

Year	Release	Year	Release	Year	Release
1926	761,600	1951	428,700	1976	714,700
1927	880,800	1952	557,100	1977	335,300
1928	834,500	1953	539,600	1978	375,800
1929	701,600	1954	244,900	1979	622,200
1930	793,300	1955	212,400	1980	683,400
1931	750,700	1956	253,400	1981	673,400
1932	831,600	1957	384,700	1982	618,900
1933	826,000	1958	891,200	1983	638,400
1934	803,600	1959	615,600	1984	657,000
1935	636,300	1960	666,800	1985	890,300
1936	747,000	1961	577,200	1986	1,434,500
1937	758,500	1962	691,900	1987	1,309,000
1938	880,600	1963	509,300	1988	694,300
1939	825,700	1964	183,400	1989	714,800
1940	701,300	1965	521,500	1990	665,600
1941	971,600	1966	660,700	1991	598,600
1942	1,818,700	1967	443,800	1992	690,200
1943	808,500	1968	538,100	1993	1,048,700
1944	878,700	1969	687,400	1994	777,100
1945	839,600	1970	685,800	1995	1,170,900
1946	830,200	1971	515,300	1996	647,400
1947	558,100	1972	300,100	1997	762,400
				1998	825,400

Data for this table comes from various including the Annual Reports of the Rio Grande Compact Commission, the 1936-1937 Rio Grande Joint Investigation by the Natural Resources Committee, and unpublished open files of the BoR.

A review of the data in Table 7.2 confirms concerns about the ability of the Rio Grande Project supply to meet demands. During the drought years 1950 to 1975, there was only one year when releases were greater than the 790,000 "normal release" specified in the Rio Grande Compact. The average release during this 25-year period was just a little more than 500,000 ac-ft. It must be anticipated that prolonged periods of below average Rio Grande Project water supply will be available from Elephant Butte Reservoir.

Almost from the time of conception of the Rio Grande Project, it was clear that the volume of water available in any one year might not be sufficient to meet all of the Rio Grande

Project demands. It was also evident that, even with over-year storage in Elephant Butte Reservoir, that the supply would frequently be insufficient to irrigate the full Rio Grande Project acreage (Raymond A. Hill, Development of the Rio Grande Compact of 1938, published by Raymond A. Hill 1968, page 60).

7.1.1.6 Surface Water Demands by the Elephant Butte Irrigation District (EBID)

In 1992, Congress authorized the transfer of the title to rights-of-way, easements, ditches, laterals, and canals within the EBID. (Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995,page II-3).

In addition to the Rio Grande Project storage dams (Elephant Butte and Caballo Reservoirs), there are three diversion dams in New Mexico. BoR has maintained ownership of these dams, but allows the District to control diversions through an operation and maintenance contract. These dams feed a complex system of 250 miles of canals and laterals that deliver water to District lands. The location and acreage served by each of these structures is as follows:

1. Percha Diversion Dam is a rubble concrete weir, located two miles below Caballo Reservoir, that feeds the Rincon Valley main canal, the Arrey Canal. The Arrey Canal has a capacity of 400 cubic feet per second and water deliveries to 16,260 acres. There are three siphons on the Arrey Canal to carry water from one side of the river to the other. Percha Dam also supplies water to the Percha Lateral, a very small ditch on the east side of the Rio Grande.
2. Leasburg Diversion Dam is at the northern end of the Mesilla Valley and feeds the Leasburg Canal that serves 31,600 acres in the upper part of the Valley. Capacity of the main canal is about 625 cubic feet per second.
3. The Mesilla Diversion Dam is located just downstream from where I-10 crosses the Rio Grande at the southwest edge of Las Cruces. The dam feeds an east side and west side delivery system that serves about 43,000 acres in New Mexico and 10,880 water righted acres in the Texas portion of the Mesilla Valley. The East Side Canal has an initial capacity of 300 cfs and the West Side Canal carries about twice as much water. The Del Rio Lateral is a very small lateral also diverting water from Mesilla Dam. The California Extension Lateral is another very small diversion located upstream of Mesilla Dam. (EBID, General Data and Information, October 1998, page 28) and

Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995,pages II-4 and II-5).

4. A few pumps divert water from the Rio Grande in New Mexico, and cumulatively divert a few hundred ac-ft of water per year.

7.1.1.7 The Effect of Irrigation Return-Flows in Meeting Demands

Almost as important as the water delivery system in the EBID is the drain system. Within a few years after the completion of the Reservoir in 1916 and the initiation of irrigation, it was clear that a rise in the shallow ground water system under the irrigated lands was occurring. A 400-mile long drainage system has been installed on both sides of the river, which runs generally parallel to the river. The purpose of the drain system is to prevent water-logging of farmlands by intercepting shallow ground water and by carrying away water leached from the root zone of plants in the irrigated fields and seepage from the canal system.

The drain system is important in that it carries away the salts that have been flushed from the plant root zone. These salts are then transported downstream with the return flows. Depending on the volume of irrigation water available, in southern New Mexico, most crops use about one-half to two-thirds of the water applied leaving virtually all of the dissolved salts that were initially present in the irrigation supply in the remaining one-half to one-third of the water. When water is applied to farmlands in the region, some excess water is diverted to allow for flushing of the accumulated salts from the root zone. During dryer years when the Elephant Butte supply was inadequate to provide flushing water, salts built up in the farm soils waiting to be removed in wetter years. Wilcox provides an excellent discussion of the build up and removal of salts in Rio Grande Project soils during the drought years of 1951 through 1964. (L.V. Wilcox, Discharge and Salt Burden of the Rio Grande above Fort Quitman, Texas, and Salt Balance Conditions on the Rio Grande Project, 1934-1963, U.S. Salinity Laboratory Research Report No. 113, published by the U. S. Department of Agriculture, August 1968, pages 22 and 23).

The volume of the return flow varies with the level of the shallow ground-water system, the area of the irrigated acreage, the volume of farm deliveries, and the leakage from the canal system. During the drought of the 1950's, some of the drains ceased to flow for a year or two. BoR estimates an annual volume of return flows of 300,000 ac-ft from diversions in New

Mexico for above normal water supply conditions of 919,400 ac-ft from Elephant Butte Dam (790,000 ac-ft/yr is authorized by the Rio Grande Compact) are given below from four points in New Mexico: (Department of Interior, Legal and Institutional Framework For Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995, Figure 2.)

1. 78,000 ac-ft/yr returned to the river above Leasburg Dam by the Garfield, Hatch and Rincon drains and re-diverted by the diversion;
2. 97,000 ac-ft/yr returned to the river above Mesilla Dam by the Picacho Drain and re-diverted by the dam;
3. 47,000 ac-ft/yr returned to the river from the west side of the Rio Grande below Mesilla Dam, but above El Paso by the La Mesa Drain and the Montoya Drain; and
4. 78,000 ac-ft/yr returned to the river from the east side of the Rio Grande below Mesilla Dam, but above El Paso by the Del Rio Drain and the East Drain.

The drain return flows below Mesilla Dam make up a significant part of the supply available for diversion at El Paso. BoR's estimate of return flows in New Mexico was about 30 percent of releases from Elephant Butte Dam, and 25 percent of the flow at El Paso (Ibid; Figure 2). Except for the west side drains that enter above El Paso, BoR's estimates of return flow are far higher than those of Clyde Wilson (Clyde A. Wilson, Robert White, Brennon Orr, and Gary Roybal, Water Resources of the Rincon and Mesilla Valleys and Adjacent Areas, New Mexico, Technical Report 43, New Mexico State Engineer, page 66) for 1974 when the releases from Elephant Butte were 672,400 ac-ft. Wilson's 1974 estimates were: 17,752 ac-ft returned above Leasburg Dam; 3,786 ac-ft returned above Mesilla Dam; 48,850 ac-ft returned from the east side of the Rio Grande above El Paso; and 50,351 returned to the river by west side drains above El Paso. Wilson's estimate of 1974 New Mexico drain return flows totaled 115, 739 ac-ft or only 17 percent of Elephant Butte releases. Wilson (page 66) notes that drain return flows made up 30 percent of the deliveries to the El Paso gauging station. Irrigation return flows make up an important part of the Rio Grande Project water supply and the volume of the irrigation supply available significantly effects the volume of the return flows.

Recent estimates by EPCWID#1 are that as much as 69 percent of the Rio Grande Project water supply delivered to American and International Dams for the District and Mexico are comprised of return flows from New Mexico and the Texas portion of the Mesilla Valley.

7.1.1.8 Irrigated Acreage in the Elephant Butte Irrigation District

Virtually all of the surface-water demands in the region are from lands in the EBID (District), the New Mexico unit in the Rio Grande Project. The BoR recognizes that the District has the right to irrigate 90,640 acres in the Rincon and Mesilla Valleys. The 90,640 acres represent the acres that EBID may tax on its Assessment Roll which in turn are allowed to order the annual allotment of Rio Grande Project Water.

Prior to the development of the BoR's Rio Grande Project, there was just a little more than 30,000 acres of irrigated lands in the Rincon and Mesilla valleys in New Mexico. (Frank E. Wozniak, Irrigation in the Rio Grande Valley, New Mexico: A Study and Annotated Bibliography of the Development of Irrigation Systems, RMPRS-P-2, published by the U.S. Forest Service). A series of small diversions and canals served these lands, but farming was marginal because of the very large variations in the flow in the Rio Grande. After completion of Elephant Butte Dam, and the stabilization of the supply in 1916, the number of irrigated acreage continued to grow, reaching the 90,000-acre level in New Mexico after the Second World War. The Rio Grande Project lands were fully developed by 1949 when 159,124 acres were irrigated (Unpublished open files of the BoR in El Paso, Texas). Table 7.3 provides a record of the irrigated acreage in the Rio Grande Project in New Mexico, at five year periods beginning in 1950 through the year 1990 as reported by the BoR (Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995, page II-6).

TABLE 7.3: IRRIGATED ACREAGE IN THE ELEPHANT BUTTE DISTRICT AT FIVE –YEAR INTERVALS 1950-1990

YEAR	NET ACRES IRRIGATED
1950	85,757
1955	86,153
1960	85,162
1965	83,259
1970	84,948
1975	85,364
1980	83,096

TABLE 7.3: IRRIGATED ACREAGE IN THE ELEPHANT BUTTE DISTRICT AT FIVE –YEAR INTERVALS 1950-1990	
YEAR	**NET ACRES IRRIGATED**
1985	78,697
1990	79,525

(Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995,page II-6).

From Table 7.3 it can be seen that variations in the irrigated acreage in the EBID have occurred over time. The BoR report from which the data in Table 7.3 was taken does not define "net irrigated acreage", but this value is believed to take into account "double cropped" acreage and is a measure of the total irrigated acreage in the District. This figure may include pasture lands, but not all fallow and idle lands (Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995, page II-6). Recorded irrigated acreage also depends on the purpose of the report. EBID typically reports the paid water-righted-acreage (WRA) in the District in any one year as being "irrigated" even if the paid lands may be fallow. The District also classifies land as "temporarily suspended" for land that may be reclassified as a WRA, or land may be classed as "permanently suspended" as it may be non-irrigable or annual fees may not have been paid. This leads to there being "idle and fallow" lands in the District that are not in the EBID count of irrigated lands as water-use fees have not been paid. On petition from the landowner, acreage may be reclassified. (EBID, General Data and Information, October 1998, pages 24-25, 29 and 34).

The State Department of Agriculture reports irrigated acreage on lands that produce a crop. Their figures do not include fallow and idle irrigated lands. For 1997 for Doña Ana County, the Department of Agriculture gave the total irrigated cropland 96,030 and the surface irrigated area as 86,600 acres (New Mexico Agricultural Statistics Bulletin, 1997, published by the New Mexico Department of Agriculture, page 6). For Doña Ana County, the irrigated cropped-acreage in 1999 was reported to be about 87,000 acres. (New Mexico Agricultural Statistics Bulletin, 1999, published by the New Mexico Department of Agriculture, pages 5-7).

Landsford, et al give the total irrigated lands in Doña Ana County as 96,030 acres in 1994 through 1996. This figure includes estimates for idle and fallow lands that range from 16,475 acres in 1994 to 13,887 acres in 1996 (Robert Landsford, et al, Sources of Irrigation Water and Cropland Acreage in New Mexico, 1994-1996, Technical Report 29, October 1997, Agricultural Experiment Station, New Mexico State University, Table 13 and Table 45). When Landsford's figures for idle and fallow are subtracted from the total irrigated acreage of 96,030 acres, a "cropped" irrigated acreage on the order of 80,000 acres is found for the Region in 1996. Landsford's figure of 96,030 for irrigated acreage in Doña Ana County include lands in the Elephant Butte District, but do not include irrigation in the Nutt-Hockett or the Hueco portions of the county. (Ibid, Table 45).

The variations that have been cited as to the extent of the irrigated crop lands in Doña Ana County demonstrate that care must be exercised in using figures for irrigated acreage in the Region taken from various sources. The September 1937 contract between BoR and the EBID, that allows the District to irrigate 90,640 acres from the Rio Grande Project surface-water supply, establishes the basis for present and future District demands (Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995, page II-9).

7.1.1.9 Management of Diversions to Meet Demands

Since the 1979-1980 transfer of operation and maintenance responsibilities from BoR to the two irrigation districts, management of diversions has become a district prerogative. Prior to the start of the irrigation season each year, the EBID announces the anticipated allocations to District farmers in terms of ac-ft/acre. The irrigation District must limit its diversions at Percha, Leasburg and Mesilla dams based on the storage available for release in Elephant Butte and Caballo reservoirs. The District must ensure that sufficient water will be available to provide equity to Texas irrigators and to make deliveries to Mexico.

The two districts have proposed various operating agreements that would provide for equitable distributions of the supply. No agreed upon approach has been developed. EBID has continued to follow, in general, a methodology developed by BoR. Entitlement for each irrigation district is determined using two curves that are based on historical relationships. One curve relates releases from Caballo Reservoir to water deliveries to farms. The other curve relates releases from Caballo compared to water deliveries at the system diversion dams. At the end of the water year, if there is unused water, it is allowed to remain in storage for reallocation the following year (Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995, page IV-12).

7.1.1.10 Consumptive Irrigation Demand and District Farm Deliveries

Irrigation water demands in the District are based on crop consumptive use or crop evapotranspiration. Factors that affect demand for water in the District include the cropping pattern and associated length of growing seasons, the weather (air temperature, solar radiation, and humidity), and the effective rainfall for each crop. Consumptive use estimates are available in the literature for various locations in New Mexico and for various crops (Blaney, Harry F. and Hanson, Eldon G., Consumptive Use and Water Requirements in New Mexico, Technical Report 32, New Mexico State Engineer Office, 1965; and Miyamoto, S.," Consumptive use of Irrigated Pecans", Journal of The American Horticultural Society, volume 108(5), 1983, pages 676-681). Wilson and Lucero (1997) of the State Engineer Office provide a more current estimate of 2.307 acre-feet per acre per year (ac-ft/acre/yr) for the crop-weighted consumptive flood-irrigation requirements for the EBID. (Brian Wilson and Anthony Lucero, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1995, Technical Report 49, New Mexico State Engineer Office, September 1997, Table 9).

The District has developed average-annual crop-specific consumptive-use figures for internal use that have not been published. (EBID, General Data and Information, October 1998, page 37). A surrogate for consumptive use is the volume of the water applied to a crop. For a full supply a farm should receive the adjudicated "duty of water".

There are irrigation system losses in making farm deliveries. The efficiency of District water deliveries is a function of the available supply; the larger the available supply the higher the farm-delivery efficiency. The District maintains data on delivery efficiency to determine means of preventing water losses. There are also "on farm" losses and incidental losses. Wilson and Lucero (Ibid.) provide an estimate of these losses (a total of 0.172 ac-ft/acre) for flood irrigation with surface on District lands as follows:

- Incidental depletion factors related to canal and lateral deliveries from the river to farm head-gates = 0.040 ac-ft/acre;
- On-farm incidental depletion factors = 0.050 ac-ft/acre; and
- Incidental depletion factor = 0.082 ac-ft/acre.

In the Elephant Butte District the farm delivery requirements are a function of the crop. The cropping pattern in the District varies from year to year and has changed from cotton (74%) and alfalfa (25%) in 1947 to a broader crop distribution that now features pecans, cotton, and alfalfa each on the order of 25 percent of the cropped district lands, and vegetables at 16 percent. (EBID, General Data and Information, October 1998, page 30).

In making farm deliveries, the District does not differentiate between crops, but distributes the annual allotment pro-rata for the 90,640 acres on its Assessment Role depending on the Rio Grande Project water supply available. In 1998, each water-righted-acre was charged $40.00 for an initial allotment of up to two ac-ft/acre (Ibid. page 24). Farmers were then allowed to purchase additional water, over their allotment for $16.00 per acre-foot. The purchase of water in excess of the initial allotment depends upon availability. Thus the actual District deliveries to each farm vary depending on farm orders and temporary transfers of water among farmers for that year. Table 7.4 lists the actual farm allotment from 1950 to 1990 at five-year intervals.

The best guide to allowable duty of water on Rio Grande Project lands is in a February 1941 contract between the BoR and the EPCWID#1. Department of Interior, Legal and Institutional Framework for Rio Grande Project Water Supply and Use, published by the Upper Colorado Region of the BoR, October 1995, page IV-12. This contract sets the duty of water for irrigated lands transferred to municipal use at 3.5 ac-ft/acre. (Douglas R. Littlefield, Interstate Water Conflicts, Compromises, and Compacts, Ph.D. thesis, published by UMI Dissertation Services, Ann Arbor, Michigan, 1987, page 153-176).

TABLE 7.4: SUMMARY OF THE BASIC ANNUAL WATER ALLOTMENT TO EBID FARMERS (AC-FT/ACRE)

YEAR	DISTRICT WATER ALLOTMENT
1950	3.00
1955	0.42
1960	3.25
1965	1.85
1970	3.00
1975	3.00
1980	3.00
1985	3.00
1990	3.00

7.1.1.11 Environmental Demands

Currently, there is no accurate way to determine a demand value for the environment. This is an important consideration for planning within the region and studies are currently being conducted to assess the amount of water that is used for the environment and how much will be needed in the future.

Evapotranspiration by “desired” and “undesired” riparian vegetation is implicitly included in the river efficiency (diversion/release), since it is one of the loss terms in the river. While explicit quantification of the evapotranspiration by riparian vegetation in the river reach from Caballo to the Texas state line has not been performed, some general information has been developed from research in the Middle Rio Grande. For example, Bawazir (2000) reported that a dense, monotypic saltcedar stand with shallow ground water would evapotranspires about 4.5 ac-ft/acre/yr. Open canopy cottonwood with minimal understory and deeper ground water lost about 3 ac-ft/acre/yr. Luo (1994) used data collected by the Bureau of Reclamation at Bernardo, New Mexico to develop crop coefficients for several riparian vegetation species. She reported that saltgrass used about 2 ac-ft/acre/yr. While these provide general guides to riparian water use, it should be stressed that the evapotranspiration is dependent not only on plant species, but also canopy structure and density, and depth to ground water. In some cases, salinity will also affect evapotranspiration. Estimates of the amount of surface and ground water demand for riparian vegetation between Caballo Reservoir and the State line is estimated to vary from 25,000 to 90,000 ac-ft/yr in a full supply year, when the river runs through the entire irrigation season. However, this estimate does not constitute an appropriation of a water right.

7.1.2 Ground Water Demand

Ground water is used in all categories of demands in the region including irrigation. Irrigation represents the largest source of demand followed by municipal requirements and by small public water supplies is third place. Industrial and commercial demands ranks fourth in the Region. Each of these use-categories will be reviewed in the sections that follow. Most of the ground water demands are met by the Mesilla Valley aquifer system, but some water is taken from the Hueco Bolson and there are a large number of wells in the Jornada basin serving a variety of purposes. Michael Johnson of the NMOSE lists 40 wells in the Hueco Bolson for which his agency has records (Michael Johnson, Hydrologic Evaluation of Applications HU-153, HU-153-S, and HU-153-S-2 for Permit to Appropriate Ground Water in the Hueco Underground Basin, Doña Ana County, Office of the State Engineer, Technical Division Hydrology Report 00-2, July 2000, page 4). This is not the total number of wells in the Hueco Basin. Approximately 120 wells are include in the listing Hueco Basin water rights in Appendix B and the model well file in Appendix C of that report, which is a closer estimate to the total number of wells in the basin. The NMOSE WATERS database, on line in March 2001, listed 132 wells in the Jornada basin, 190 in the Hueco Basin, 118 in the Rincon Valley and 1227 in the Mesilla Valley. The SEO WATERS database lists a total of 9874 wells in the County, indicating that the actual number of wells in the Region is far larger than reported; however, the WATERS listing represents all water rights permits and applications, and therefore may include wells that have not been drilled.

7.2 Present Uses

7.2.1 Ground Water Use Categories

- Public Water Supply – Diversions for small community and municipal water supply uses.
- Domestic Use – Private domestic wells.
- Industrial – Metered industrial uses, limited data available.
- Commercial – Metered commercial uses.
- Irrigated Agriculture – Surface and ground water diversions and depletion, taking into account return flows, categorized by type of use.
- Livestock – Based on type and total number of each animal.
- Mining – Sand and gravel and rock quarries.
- Power – Used for cooling towers.

7.2.2 Water Diversions by Category of Use

7.2.2.1 Public Water Supply

Water diversions used for Public Water Supply " include all water utilities, publicly or privately owned, which have at least 15 service connections or regularly serve an average of at least 25 individuals daily at least 60 days out of the year. Water used for the irrigation of self-supplied playing fields, golf courses and parks or to maintain the water level in ponds and lakes owned and operated by a municipality which is a public water supplier is also included in this category." This category includes small community water systems, but not individual domestic wells. Table 7.5 summarizes the water diversions used for Public Water Supply in the Planning Region.

A total of 77 public water supply systems have been identified in the Planning Region and are listed in Table 7.5. These supplies provide service to populations ranging from 25 to over 80,000 persons. These public water supplies serve a total population of more than 166,000 persons. The annual demands for the Regional public water supplies is on the order of 34,000 ac-ft/yr. The City of Las Cruces is the largest public water supplier in the County. Table 7.5 summarizes the estimated annual ground water requirements by public water supply systems in the Planning Region. The Lake Section Water Company has a public water service, but it is not listed in Table 7.5 as there is no available information on the population served by the Company. In January 1985, Lake Section filed an application with the NMOSE to re-drill three existing wells. Lake Section claims that they have the right to use 7,500 ac-ft/yr to serve a subdivision and to provide other uses including industrial, commercial, and municipal water to the area.

TABLE 7.5: PUBLIC WATER SUPPLY DIVERSIONS IN THE PLANNING REGION FOR 1995

Water Supplier	Population Served	Usage (GPCD)	Ground Water (AF)	Total Actual Use (AF)	Total Actual Use (Gal/Day)
Alameda MHP	250	100	28.09	28.09	25,081
Alto de Las Flores MDWCA	763	98	83.70	83.70	74,734
Anthony Water and Sanitation District*	7,700	110	950.31	950.31	848,510
Baylor Canyon Water Co-Op	160				
Berino MDWSW*	1,320	131	193.12	193.12	172,430
Billy Moreno Water System	55				
Brazito MDWCA	360	88	35.41	35.41	31,620
Butterfield Park MDWCA*	1,350	73	109.91	109.91	98,140

TABLE 7.5: PUBLIC WATER SUPPLY DIVERSIONS IN THE PLANNING REGION FOR 1995					
Water Supplier	**Population Served**	**Usage (GPCD)**	**Ground Water (AF)**	**Total Actual Use (AF)**	**Total Actual Use (Gal/Day)**
CBG Water Company*	1,500	93	156.25	156.25	139,510
Chaparral Mobile Home Park*	64				
Chaparral Water System*	8,200	128	1,173.25	1,173.25	1,047,560
Cielo Dorado Estates Homeowners	238				
Country Mobile Manor	183	68	13.90	13.90	12,400
Covered Wagon MHP	125	116	16.20	16.20	14,500
Delara Estates MDWCA	831	151	140.64	140.64	125,570
De La Te Mobile Manor	62				
Desert Aire MDWCA	346				
Desert Sands MDWCA*	1,500	109	182.52	182.52	162,970
Doña Ana MDWCA	9,471	127	1,344.38	1,344.38	1,200,360
El Patio Mobile Home Park #2	125				
Fairview Estates Water System	120	154	20.69	20.69	18,470
Ft Seldon Water Company*	800	164	147.10	147.10	131,300
Garfield MDWCA	1,740	96	186.60	186.60	166,600
Hacienda Acres Water System	2,174	174	424.00	424.00	379,000
Hamula Mobile Home Park*	100	121	13.55	13.55	12,100
Hangar Lake Water System	165				
Hatch Water Supply System	1,868	122	254.62	254.62	227,340

TABLE 7.5: PUBLIC WATER SUPPLY DIVERSIONS IN THE PLANNING REGION FOR 1995					
Water Supplier	**Population Served**	**Usage (GPCD)**	**Ground Water (AF)**	**Total Actual Use (AF)**	**Total Actual Use (Gal/Day)**
Holly Gardens MHP	233	136	35.40	35.40	31,600
Johnson, Floyd-MHP	250	121	33.86	33.86	30,230
Jornada MDWUA					
La Mesa MDWCA	450	86	43.15	43.15	38,530
La Quinta Water Company	235	144	37.94	37.94	33,880
Las Alturas Estates	746	255	213.48	213.48	190,610
Las Cruces Mobile Home Park	220				
Las Cruces Municipal Water System*	74,300	251**	20,897	20,897	18,658,000
Leasburg MDWCA	636	106	75.28	75.28	67,220
Madrid Mobile Home Park	23				
Mesa Development Center	819	126	115.31	115.31	102,960
Mesa Mobile Manor	200				
Mesilla Park Manor Water System	1,029	202	232.39	232.39	207,500
Mesilla Water System	2,191	96	235.53	235.53	210,300
Mesquite MDWCA*	3,389	203	770.43	770.43	687,900
Millers Mobile Manor	98				
Moongate Water System	6,000	131	883.17	883.17	788,560
Mountain View MDWCA	750	132	111.26	111.26	99,341
NASA-Johnson Space Center	1,000				

TABLE 7.5: PUBLIC WATER SUPPLY DIVERSIONS IN THE PLANNING REGION FOR 1995

Water Supplier	Population Served	Usage (GPCD)	Ground Water (AF)	Total Actual Use (AF)	Total Actual Use (Gal/Day)
Northwood Mobile Home Park	350				
Organ MDWSCA	567	93	59.13	59.13	52,800
Picacho Hills Water System	650	846**	616.23	616.23	550,220
Picacho MDWCA	1,000	118	131.89	131.89	117,760
Raasaf Hills Water System	105	180	21.22	21.22	18,950
Rancho Vista MHP	120	118	15.90	15.90	14,200
Rincon Water Consumers Co-Op	450	105	53.07	53.07	47,380
San Andres Estates Water System	868	155	150.78	150.78	134,630
Santa Teresa Water System	2,400	1,112**	2,988.68	2,988.68	2,668,520
Shangri-La Mobile Village	460				
Silver Spur MHP	148	119	19.77	19.77	17,650
Skoshi Mobile Home Park	151	101	17.14	17.14	15,300
St John's MHP	485	132	71.93	71.93	64,220
Summer Wind Estates	689				
Sun Garden Mobile Home Park	600				
Sunland Park Water System	9,331	94	985.36	985.36	879,800
Talavera Water Co-Op	70	114	8.95	8.95	7,990
Triple J Mobile Home Park	91				
University Estates	2,720	218	664.54	664.54	593,350
Vado MDWCA	300				
Val Verde Mobile Home Park*	300	87	29.15	29.15	26,030
Valle del Rio Water System	225	202	50.91	50.91	45,460

TABLE 7.5: PUBLIC WATER SUPPLY DIVERSIONS IN THE PLANNING REGION FOR 1995

Water Supplier	Population Served	Usage (GPCD)	Ground Water (AF)	Total Actual Use (AF)	Total Actual Use (Gal/Day)
Villa del Sol Mobile Home Park	500				
Vista Real MHP	100	143	15.99	15.99	14,280
West Mesa Water System	850				
White Sands Missile Range	2,450	797**	2,186.78	2,186.78	1,952,520
Winterhaven Co-Op	144				
Totals	**165,963**	**182**	**33,758**	**33,758**	**33,255,886**

* Responded to recent survey.
** Includes water used for irrigation of public golfcourse(s).

7.2.2.2 Domestic Wells

A domestic well may serve a single family home or a multiple housing unit as long as the total annual demand does not exceed 3 ac-ft. If more than 25 occupants are served, the supply would be classified as a public water system. Water from domestic wells typically is used for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets and watering lawns and gardens. This use also includes water used by that segment of the population that is served by very small groups of houses for which reliable population and water-use data are unavailable. In the valley areas in the Region, some homeowners served by a public water supply system also may have shallow wells used to irrigate lawns and gardens.

Approximately 8,813 persons are served by an individual domestic well in Doña Ana County. This figure is estimated on the basis of the difference between the number of people served by public supplies and the population of the County. The number of private wells that produce 3 ac-ft/yr or less is unknown, but it is believed to be very large (probably in excess of 6,000 wells). The NMOSE WATERS database gives the number of domestic wells as 5,692. Not all of the private wells are in current use for domestic purposes. Some rural landowners do have small orchards or other private (non-commercial) crops. Typically, the per-capita consumption is substantially lower than urban usage, because the landscaping component is minimal to non-existent. The per-capita consumption for a domestic well (typically located in a rural setting) is assumed to be on the order of 90 to100 gallons per day per person. Wilson and Lucero (1997) report that domestic wells withdraw 1538 ac-ft of ground water per year.

Domestic well uses include residences which may be single family homes or multiple housing units with less than 25 occupants, where water is used for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets and watering lawns and gardens. This use also includes water used by that segment of the population that is served by small community water systems for which reliable population and water use data are unavailable. Table 7.6 summarizes the water diversions used for Domestic Well Water Supply in Doña Ana County.

TABLE 7.6: DOMESTIC WELL WATER SUPPLY DIVERSIONS DOÑA ANA COUNTY FOR 1995

Water Supplier	Population Served	Gal/Capita/day (GPCD) Use	Ground Water (AF)	Total Diversion (AF)
Domestic Wells	8,813	100	987	987
Totals	**8,813**	**100**	**987**	**987**

7.2.2.3 Industrial

Essentially all the Regional industrial, self-supplied water demand is met by diversions from ground water. Wilson and Lucero (1997) give Regional industrial demand as 2981 ac-ft/yr. Table 7.7 summarizes the industrial uses in the Planning Region lists demands of just over 160 ac-ft/yr. Some industrial demand may be listed with commercial use in the County. The NMOSE WATERS database identifies 25 industrial wells. Table 7.7 summarizes the water diversions used for Industrial use in the Planning Region.

TABLE 7.7: INDUSTRIAL USE DIVERSIONS IN THE PLANNING REGION FOR 1995		
User	**Classification**	**Diversion (AF)**
Biad L – Chile Processing	Ground water	34.37
Biad L – Chile Processing	Ground water	15.99
Biad L – Sweet Potato Plant	Ground water	3.71
El Paso NG – Afton Station	Ground water	0.57
Jurado Farms – Chile Processing	Ground water	19.26
NMSHD – Highway Construction	Ground water	2.00
Sun Vineyards	Ground water	0.44
Valley Rendering Company	Ground water	0.94
Total		**77.28**

7.2.2.4 Commercial

Commercial uses within the Planning Region include institutions, business, campgrounds, picnic areas and visitor centers. Recreational uses (e.g., golf courses and RV parks) are also included. Wilson and Lucero (1997) give the demand for self-supplied commercial water users in Doña Ana County at 3385 ac-ft/yr from ground water. The total for industrial and commercial uses in Doña Ana County listed by Wilson and Lucero (1997) is 6,366 ac-ft/yr. Table 7.8 summarizes the water diversions used for self-supplied commercial use in the Planning Region. The total ground water demand for industrial and commercial uses give in Tables 7.8 and 7.9 exceeds the total for the two given by Wilson and Lucero. It is possible that water uses listed in commercial in Table 7.8 should have been listed as an agricultural or an industrial use. The NMOSE WATERS database lists 219 commercial wells in the County. Table 7.8 summarizes the water diversions used for commercial use in the Planning Region.

TABLE 7.8: COMMERCIAL USE DIVERSIONS IN DOÑA ANA COUNTY FOR 1995		
User	**Classification**	**Diversion (AF)** [1, 2]
Aldershot Nursery	Ground Water	90.00
Alta Vista School-Anthony	Ground Water	1.00
Alvarez Pablo S.	Ground Water	1.10
Alvarez Ramon	Ground Water	0.56
Anthony Cemetery Association	Ground Water	12.50
Anthony Country Club	Ground Water	153.91
Anthony Fire Dept	Ground Water	0.50
Anthony Port of Entry	Ground Water	0.50
Anthony Public Schools	Ground Water	30.00
Aquirre and Dripping Springs	Ground Water	0.68
Benavidez Jose	Ground Water	0.82
Best RV Park – Las Cruces	Ground Water	2.00
Biad Victor	Ground Water	0.67
Black C.O. – Greenhouse	Ground Water	0.23
Bureau of Land Management	Ground Water	0.05
Burns Lake Soccer Field	Ground Water	30.51
Burris G. W. – Truck Stop	Ground Water	0.15
Chaparral Van Lines	Ground Water	0.08
Chope’s Bar and Café	Ground Water	1.00
Coachlight Inn & Restaurant- Las Cruces	Ground Water	3.00
Crowder Land Investment	Ground Water	1.00
Dean Harry	Ground Water	0.09
Doña Ana County-La Union Park	Ground Water	3.33
Doña Ana County	Ground Water	1.00
Doña Ana County	Ground Water	2.99
Dos Lagos Golf Course	Ground Water	506.20
Gadsden ISD –Gadsden Jr. High School	Ground Water	30.03
H & H Wholesale Nursery	Ground Water	126.71
Heil Pump Sales & Service	Ground Water	1.16
HIC Liquidation	Ground Water	0.39
Holy Cross Church	Ground Water	0.94
Isidro Pena DBA Fruitland – Nursery	Ground Water	0.34
Kingdom Hall of Jehovah	Ground Water	0.94
La Cueva Picnic Area	Ground Water	0.20
La Mesa Baptist Church	Ground Water	2.87
La Mesa Fire Department	Ground Water	0.20

TABLE 7.8: COMMERCIAL USE DIVERSIONS IN DOÑA ANA COUNTY FOR 1995		
User	**Classification**	**Diversion (AF)** [1, 2]
La Union Park-Doña Ana	Ground Water	3.33
Las Cruces Country Club	Ground Water	477.65
Las Cruces School District 2 – Mayfield	Ground Water	55.31
Las Cruces School District-Vista Middle	Ground Water	28.91
Lazy E Chevron & Café – Fairacres	Ground Water	1.00
Leasburg Dam State Park	Ground Water	1.13
Lindbeck, L.B. – RV Park	Ground Water	2.65
Masson Alex – Greenhouse	Ground Water	60.64
Masson Alex – Greenhouse	Ground Water	179.18
McKee John –Veterinarian	Ground Water	0.95
Memory Gardens of the Valley	Ground Water	67.78
Mesilla Valley Christian	Ground Water	4.88
Miscellaneous Businesses	Ground Water	20.00
Mosley Rudy	Ground Water	0.63
Mt. Shadows Health Care	Ground Water	5.21
NASA-Johnson Space Center	Ground Water	154.46
New Covenant Fellowship	Ground Water	0.66
New Mexico Beverage Company	Ground Water	0.26
New Mexico State University	Ground Water	48.19
New Mexico State University	Ground Water	2,407.24
New Mexico State University –Ag. Research	Ground Water	1.57
NMSHD-Anthony Patrol	Ground Water	0.41
NMSHD-Anthony Rest Area	Ground Water	2.00
NMSHD-Ft. Seldon Rest Areas	Ground Water	4.00
Nu-Mex Landfill-Camino Real Investment	Ground Water	35.96
Picacho Hills Golf Course	Ground Water	381.00
Premier Distributing	Ground Water	4.67
Rancho Mesilla	Ground Water	0.10
Santa Teresa Golf Course	Ground Water	1,296.41
Servi-Gas	Ground Water	0.12
Sierra International	Ground Water	0.92
Sierra Wholesale Growers-Greenhouse	Ground Water	6.84
Slide-A-Ride	Ground Water	10.25
Smith & Aguirre Construction	Ground Water	0.94
Smokehouse BBQ – Fairacres	Ground Water	2.00
South Valley Fire Department	Ground Water	2.69

TABLE 7.8: COMMERCIAL USE DIVERSIONS IN DOÑA ANA COUNTY FOR 1995		
User	**Classification**	**Diversion (AF)** [1, 2]
Sun Investments	Ground Water	0.35
Sunland Park Race Track	Ground Water	100.00
Swaagstra Bert – Workshop	Ground Water	0.59
Tabachin Inc.	Ground Water	3.90
Vado Camping Resort – Mesquite	Ground Water	15.22
Vinton Congr of Jehovah's Witness	Ground Water	0.50
Vista Mid-High School	Ground Water	28.91
Western Communications	Ground Water	0.14
Woodmen of the World	Ground Water	0.58
TOTAL		**6,427.78**

[1] Commercial use of surface-water diversion (EBID) is for golf course irrigation.
[2] Total diversion includes 131 ac-ft surface-water diversion for Anthony Country Club.

7.2.2.5 Irrigated Agriculture

Ground water is used to process agricultural products, to clean facilities and to provide cooling water. Ground water is also used in the County for crop irrigation. The NMOSE WATERS database lists 1,738 as the number of wells used for irrigation. There are three types of irrigation wells in the County:

1) Those wells that provide supplemental water to Elephant Irrigation District lands during years when a full surface supply is not provided. During the drought years of the 1950's and 1960's there were a very large number of supplemental wells drilled. Many of these wells may no longer be in service.
2) Those wells that are in current use to provide additional irrigation water beyond that available from the EBID, even in years of full supply. Farmers using a combination of ground or surface water are those cultivating alfalfa and pecans. Other crops, such as vegetables, may require irrigation when EBID is not delivering water, or require water more quickly than EBID can deliver it. Ground water is used in these instances. All drip irrigation in the District is supplied by ground water.
3) Those wells that are used for crops where ground water is the only source of supply.

Lansford (1996, Table 2) provides a firm estimate for wells in class 3, that is where wells are the only source of supply. For 1995, Lansford provides a figure of 9,370 acres. If the duty of water to the farm is 3.5 ac-ft/acre, then the demand by ground water only lands is on the order of 32,800 ac-ft in 1996. Wilson (1981, page 79) lists the ground water use in Doña Ana County for irrigation as 72, 930 ac-ft in 1975. Wilson and Lucero (1997) provide a similar number (72,157 ac-ft) for 1995 ground water demand by irrigated agriculture. If the lands that receive ground water only require 32,800 ac-ft/yr, then the supplemental ground water to EBID lands was on the order of 40,000 ac-ft in 1995. The allocation of District to EBID lands in 1995 was 3 ac-ft/acre or essentially a full supply. (EBID, General Data and Information, October 1998, page 24).

Lansford also provides a combined estimate for acreage for District lands that receive EBID water and that also use ground water; that is class 1 and 2 lands. Lansford estimated that in 1995, 86,660 acres received both surface and ground water in Doña Ana County. That was essentially all of the EBID lands irrigated. Table 7.9 (Wilson and Lucero, 1997) summarizes the water diversion for Irrigated Agricultural use in Doña Ana County.

TABLE 7.9: IRRIGATED AGRICULTURAL DIVERSIONS IN DOÑA ANA COUNTY FOR 1995

Location	Type	Irrigated Acreage	Surface Water (AF)	Ground Water (AF)	Total Diversion (AF)
EBID Only	Flood	67,100	374,455	50,390	424,845
Inside EBID, but exclusive of EBID	Drip Flood	3,265	0	13,999	13,999
Outside EBID	Sprinkle	1,310	0	4,873	4,873
Hueco Basin	Flood Sprinkle	180	0	891	891
Nutt-Hockett	Flood	180	0	516	516
Santa Teresa Sod	Sprinkle	200	0	1,488	1,488
Totals		**72,235**	**374,455**	**72,157**	**446,612**

7.2.2.6 Livestock

Approximately 99 percent of the livestock demands in the Planning Region are met by ground water. Estimates of the number of commercial animals in 1999 in the Planning Region are 7,000 beef cattle, 36,000 milk cows, 1,200 sheep and lambs, and 34,000 other cattle (New

Mexico Agricultural Statistics, 1999, published by the New Mexico Department of Agriculture, pages 32-40). There are no estimates as to the number of hogs, horses, goats, and chickens using ground water as a supply. Wilson and Lucero (1997, Table 5.3.) provide references for daily water demands by various farm animals: milk cows 100 gallons per cow per day; sheep 2.2 gallons per animal per day, and beef cattle 10 gallons per animal per day. Demands for the listed animals would be on the order of 4,400 ac-ft/yr. Wilson and Lucero (1997) give the 1995 livestock demand from ground water sources as 3,732 ac-ft/yr. These figures are in the same range, but should be increased to include horses and chickens. The NMOSE WATERS database lists 140 wells in Doña Ana County as sources of water for livestock.

Approximately 99 percent of the livestock diversions are obtained from ground water, and 1 percent from surface water. Table 7.10 summarizes the water diversions for Livestock use in the Planning Region.

TABLE 7.10: LIVESTOCK USE DIVERSIONS IN THE PLANNING REGION FOR 1995

Animal	Population	Usage (GPAD)	Ground Water	Total Diversion (AF)
Beef Cattle	41,000	10.00	459.26	459.26
Chickens	877,000	0.08	78.59	78.59
Horses	1,195	13.00	17.40	17.40
Milk Cows	36,000	100.00	4,032.52	4,032.53
Sheep	1,000	2.20	2.46	2.46
Total	**956,195**		**4590.23**	**4590.24**

7.2.2.7 Mining

Mining uses in the Planning Region include sand and gravel operations, rock quarries and the mining of volcanic materials. Wilson and Lucero (1997) give annual mining demand for ground water as only 66 ac-ft. The NMOSE WATERS database gives the number of wells serving mining as 60. Table 7.11 summarizes the ground water diversions associated with mining uses in the Planning Region.

TABLE 7.11: MINING USE DIVERSIONS IN THE PLANNING REGION FOR 1995		
Water Use	**Classification**	**Total Diversion (AF)**
Apache Springs Rainbow Mine	Ground water	~39
Burn Construction	Ground water	3.69
Certified Sand and Rock	Ground water	23.09
Totals		**66**

7.2.2.8 Power

The one power generation facility in the Planning Region is owned by El Paso Electric and is located near Sunland Park in the southern part of the County. The Rio Grande Power Station utilizes ground water for cooling water. The Company has applied to the State Engineer for a permit to relocate an existing well (May NMOSE web page). The capacity of the power plant well is given as 3992.18 ac-ft/yr. Wilson et al (1981. Page 79) gave the ground water requirements for power generation in the County as 3,503 ac-ft/yr. Wilson and Lucero (1997) gave water demands for cooling water as 2,440 ac-ft/yr. Table 7.12 summarizes the water diversions associated with power generation in the Planning Region.

TABLE 7.12: POWER USE DIVERSIONS IN THE PLANNING REGION FOR 1995		
Water Use	**Classification**	**Total Diversion (AF)**
El Paso Electric – Rio Grande Power Station	Ground Water	2,775.25
Totals		**2,775.25**

7.2.2.9 Summary Total All Uses

Table 7.13 provides a summary of the surface and ground water demands in the Planning Region. The current diversions within the Planning Region total 494,307 ac-ft. Approximately 24 percent of the total diversions are from ground water, and about 76 percent are from surface-water supplies. Irrigated agriculture uses account for the majority of the diversions within the Basin (90%), and public water systems use about 7 percent. Table 7.13 also summarizes the water diversions associated with all use categories in the Planning Region. Table 7.13 does not include a demand for the environment since it does not constitute an appropriation of a water right. Environmental demand for riparian vegetation evapotranspiration between Caballo and the state line is estimated to be 25,000 to 90,000 for a full supply year, when the river runs all irrigation season.

A summary of estimated water depletions is included in Table 7.14 from data available for the years 1975 through 2000. The values presented in Table 7.14 are net depletions of the water supply. The values are not total diversions since they have been reduced to take into account return flows as described in Section 7.1.1.7.

TABLE 7.13: SUMMARY OF DIVERSIONS IN THE PLANNING REGION FOR 1995

Use	Surface Water (AF)	Ground Water (AF)	Total Diversion (AF)	Percent of Total Diversion (%)
Public Water Systems	0	33,758	33,758	6.8
Domestic wells*	0	987	987	0.2
Irrigated Agriculture*	374,455	72,157	446,612	90.2
Livestock	0	4,590	4,590	0.9
Commercial	0	6,428	6,428	1.3
Industrial	0	77	77	-
Mining	0	66	66	-
Power	0	2,775	2,775	0.6
Totals	374,455	120,838	495,293	100

* These values are for Doña Ana County.

TABLE 7.14: SUMMARY OF WATER DEPLETIONS IN DOÑA ANA COUNTY

Category	Doña Ana County Water Depletions (Ac-ft) [1,2]					
	1975[a]	1980[b]	1985[c]	1990[4]	1995[e]	2000[f]
Surface Water						
Public Water Supply	0	0	0	0	0	0
Domestic (self-supplied)	0	0	0	0	0	0
Irrigated Agriculture	153,850	166,640	139,150	149,254	171,156	160,677
Livestock (self-supplied)	268	257	136	48	41	92
Commercial (self-supplied)	0	255	160	82	89	154

TABLE 7.14: SUMMARY OF WATER DEPLETIONS IN DOÑA ANA COUNTY						
Category	**Doña Ana County Water Depletions (Ac-ft)** [1,2]					
	1975[a]	**1980**[b]	**1985**[c]	**1990**[4]	**1995**[e]	**2000**[f]
Industrial (self-supplied)	0	0	0	0	0	0
Mining (self-supplied)	0	0	0	0	0	0
Power (self-supplied)	0	0	0	0	0	0
Evaporation[3]	0	0	0	0	0	0
Total Surface Water	**154,118**	**167,152**	**139,446**	**149,384**	**171,286**	**160,923**
Ground Water						
Public Water Supply	6,052	9,332	10,342	17,410	20,716	21,453
Domestic (self-supplied)	3,508	3,844	4,653	2,312	1,538	987
Irrigated Agriculture	49,760	38,330	33,449	70,900	49,150	65,897
Livestock (self-supplied)	269	642	1,576	2,708	3,385	4,498
Commercial (self-supplied)	189	1,761	4,277	3,078	2,980	3,693
Industrial (self-supplied)	30	31	32	70	43	39
Mining (self-supplied)	59	59	60	11	16	5
Power (self-supplied)	2,627	2,150	1,601	1,332	2,440	2,775
Evaporation[2]	0	0	0	0	0	0
Total Ground Water	**62,494**	**56,149**	**55,990**	**97,821**	**80,268**	**99,347**
Total Water						
Public Water Supply	6,052	9,332	10,342	17,410	20,716	21,453
Domestic (self-supplied)	3,508	3,844	4,653	1,387	1,538	987
Irrigated Agriculture	203,610	204,970	172,599	220,154	220,306	226,574
Livestock (self-supplied)	537	899	1,712	2,756	3,426	4,590

TABLE 7.14: SUMMARY OF WATER DEPLETIONS IN DOÑA ANA COUNTY						
Category	**Doña Ana County Water Depletions (Ac-ft)** [1,2]					
	1975[a]	**1980**[b]	**1985**[c]	**1990**[4]	**1995**[e]	**2000**[f]
Commercial (self-supplied)	189	2,016	4,437	3,159	3,069	3,847
Industrial (self-supplied)	30	31	32	70	43	39
Mining (self-supplied)	59	59	60	11	15	5
Power (self-supplied)	2,627	2,150	1,601	1,332	2440	2775
Evaporation	0	0	0	0	0	0
Total Water Withdrawal	**216,612**	**223,301**	**195,436**	**246,279**	**251,553**	**260,270**

Notes:

1 In 2000 return flows from domestic water use was no longer reported and withdrawals were assumed to be equal to depletions. To provide consistency, the domestic water depletions for 1975 – 1995 were adjusted to be equal to withdrawals. The categories for reporting water use were changed in 1990 to facilitate the assimilation of data into the USGS National Water Use Information Program. To provide consistency with the 1990 and later reporting categories, the data above for 1975-1985 were reconciled into these new categories as defined in the 1990 report on page 9.

2 Environment demand is estimated to be riparian vegetation evapotranspiration between Caballo and the state line is estimated to be 25,000 to 90,000 ac-ft in a full supply year, when the river runs all irrigation season and does not constitute an appropriation of a water right.

3 Evaporation is defined as: net evaporation from man-made reservoirs of 5000 ac-ft or larger.

Source:

[a] 1975: Sorensen, E., 1977, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated and Dry Cropland Acreage in 1975, NM State Engineer Tech Rpt 41, Santa Fe, NM.

[b] 1980: Sorensen, E., 1982, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1980, NM State Engineer Office, Tech Rept 44, July 1992, Santa Fe, NM.

[c] 1985: Wilson, B.C., 1986, Water Use in New Mexico in 1985, New Mexico State Engineer Office, Technical Report 46, November 1986, Santa Fe, New Mexico.

[d] 1990: Wilson, B.C., 1992, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1990, New Mexico State Engineer Office, Technical Report 47, July 1992, Santa Fe, New Mexico.

[e] 1995: Wilson, B.C., and A.A. Lucero, 1997, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1995, New Mexico State Engineer Office, Technical Report 49, September 1997, Santa Fe, New Mexico.

[f] 2000: Wilson, B.C., A.A. Lucero, J.T. Romero, and P.J. Romero, 2003, Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 2000, New Mexico Office of the State Engineer, Technical Report 51, February 2003, Santa Fe, New Mexico.

7.2.3 Public Water Supply Systems by Community

7.2.3.1 List Domestic Uses

Table 7.5 summarizes the water diversions used for Public Water Supply in the Planning Region.

7.2.3.2 Average Daily Water Consumption

The average daily water consumption for public water supplies is computed by dividing the annual diversion by the population and converting to gallons per day. As shown on Table 7.5, the average daily consumption of water in the Planning Region, from public water supply, is more than 30 million gallons.

7.2.3.3 Per-capita Water Withdrawal Rates

As shown in Table 7.5 above, the per-capita water use varies substantially throughout the public water system. These use rates vary from just over 70 daily per-capita water consumption (GPCD) in Butterfield Park Mutual Domestic Water Consumers Association to around 255 GPCD in the Las Alturas Estates water system. Over inflated water use figures for the White Sands Missile Range water system is due to influx of non-resident populations during the working hours and the irrigation of the golfcourse. The average water use per person in the Planning Region is 182 gallons per day (GPD). Typically, any type of landscape irrigation will increase the per-capita consumption by as much as 200 percent of the typical domestic uses (drinking/cooking, bathing, washing, etc.). Additionally, in larger systems where there are commercial industrial or irrigation (parks, etc.) uses, the per-capita consumptive values are higher than their rural counterparts because the non-domestic use is averaged into the figures. This is true for Santa Teresa, Picacho Hills and White Sands Missile Range described above.

7.2 Future Water Uses in 40 Year Planning Horizon

7.3.1 Methodology to Project Future Water Needs

Population projection for the incorporated and the unincorporated communities of Doña Ana and Sierra County is a challenging task. Given the scope of work outlined below, we adopted a methodology in preparing the attached tables of population projections. The tables in this report are broken down into three parts: medium growth rate; high growth rate, and low growth rate. The reason for using these three growth rates is that we believe that any long-term projections are based on a certain mathematical model in which a number of factors (variables) are assumed to be given. However, we also believe that such models must be treated with caution since population growth depends on a variety of uncontrollable and unforeseen factors. Hence, a modest approach would be to use various scenarios, as presented here, and commonly used by demographers such as Peach and Williams (see reference).

In projecting long-term population growth of the stated communities in the scope of work, we used a commonly known methodology – regression analysis. While regression analysis was used to identify some of the key components of population growth, we used the estimated regression equation only as a reference point in predicting a growth rate for a given community. Thus there is no claim made that the estimated regression equation may be used to unequivocally arrive at the population projections included here. Following, Peach and Williams (Peach and Williams, 2000), and Campbell (Campbell, 1996) a regression model was developed to predict population growth rate. Population growth rate was assumed in this model to be determined by economic growth rate of a community, migration (domestic and international combined), and a time trend to capture natural growth of population (crude birth rate-crude death rate). Furthermore, following some cohort analysis, we used a quadratic specification in terms of the time trend variable. Thus in our model specification, we included time, square of time, economic growth of the community, and net migration to that community as predictors of population growth. To our satisfaction the predictive power of the model was estimated to be approximately 85 percent. In estimating the regression equation, we used the data for the the Planning Region since 1960 to 1999. This regression equation, again, was used as a reference point, and the parameters estimated were used to arrive at the medium growth rate scenarios. The medium growth rate scenario was further modified to arrive at high and low growth scenarios. Ideally, for each of the communities, a regression equation should have been estimated and those estimated parameters were to be utilized for projections. However, it was not possible to use community specific data for all the aforementioned variables. Migration data was available only at the county level from secondary sources.

We believe, for reasonable population projections one needs to take into account the various scenarios (medium, low and high) that are included here and use some value judgment. In comparison with the projection of Peach and Williams (noted demographers in the State of New Mexico) our projections fare well. In their projections for Doña Ana, Peach and Williams suggest that the county will have a total population of 228,041 for 2010, and 277,699 for the year 2020, while our projections show the county will have a total population of 243,425 in the year 2010, and 288,458 in year 2020 (less than 7 percent difference). Peach and Williams do not provide any projection for 2030 or 2040.

7.3.2 Future Water Demands in Ten-Year Intervals

Future water demands in the Region will be fueled, for the most part, by population growth. Not all of the future demands will be for municipal and domestic purposes; new demands will be manifested for uses such as power generation, industrial process-water, and self-supplied recreational and institutional facilities. The needed water supply will come from shifts from irrigated agriculture and/or from new developments of ground water reserves in part of the Region.

7.3.2.1 2000 Census Data

The population of the Planning Region grew from 135,510 residents in 1990 to 189,436 in the year 2000 (Data taken from www.census.gov). The population increased by almost 29 percent in the decade or at a compounded growth rate of 2.57 percent per year. Growth was not uniform. Table 7.15 shows the ten-year change in population for various parts of the Planning Region and the annual rate of increase in each area, and is organized with communities listed from north to south. Both the north end of the Planning Region (Hatch) and the south end (Anthony, Sunland Park, and Chaparral) experienced far greater rates of growth than did the central sector (Town of Mesilla and Las Cruces) and Table 7.16 reports the census data for 1990 and the year 2000 by census tract and the percent change for the ten-year period. The 2000 Census Tracts are shown on Figure 7.1. This last column in Table 7.16 shows great difference in rates of growth. The census tract with the greatest rate of increase is those near El Paso (Sunland Park, Santa Teresa, and Chaparral) and those on the Las Cruces east Mesa. Negative growth occurred in White Sands and in some of the tracts on the south side of Las Cruces.

TABLE 7.15: RATE OF GROWTH IN POPULATION BY SOME COMMUNITY AREAS IN THE PLANNING REGION (1990 TO 2000)			
Community	**1990 Population**	**2000 Population**	**Annual Rate of Growth**
Village of Hatch	1,136	1,673	3.95%
Village of Doña Ana	1,202	1,379	1.38%
City of Las Cruces	62,126	74,267	1.80%
Town of Mesilla	1,975	2,180	0.99%
University Park	4,520	2,732	-4.91%
White Sands	2,616	1,323	-6.59%
Town of Anthony	5,160	7,904	4.36%
Sunland Park	8,179	13,309	4.99%
Chaparral	2,962	6,117	7.52%

TABLE 7.16: POPULATION GROWTH BY CENSUS TRACTS IN DOÑA ANA COUNTY (1990 TO 2000)			
Census Tract Number*	**1990 Population**	**2000 Population**	**Change in the Decade**
1.01	6,493	7,902	21.7 %
1.02	3,951	3,839	-2.80 %
2	6,179	8,755	41.7 %
3	3,740	3,441	-8.0 %
4.01	3,345	3,007	-10.1 %
4.02	5,402	5,647	4.5 %
5	3,164	2,902	-8.3 %
6	3,044	2,776	-8.8 %
7	6,171	6,064	-1.7 %
8	3,391	3,556	4.9 %
9	5,349	6,514	21.8 %
10	4,520	2,772	-38.7 %
11.01	7,119	9,193	29.1 %
11.02	2,557	2,997	17.2 %
12.01	3,946	6,405	62.3 %
12.02	7,746	11,066	42.9 %
13	15,558	25,585	64.4 %
14	3,849	5,587	45.2 %
15	3,895	5,351	37.4 %

TABLE 7.16: POPULATION GROWTH BY CENSUS TRACTS IN DOÑA ANA COUNTY (1990 TO 2000)			
Census Tract Number*	**1990 Population**	**2000 Population**	**Change in the Decade**
16	2,701	2,949	9.2 %
17	13,200	20,413	54.6 %
18	17,547	26,579	51.5 %
19	2,616	1,382	-47.2 %

*The 2000 Census Tracts for Doña Ana County are shown on Figure 7.1.

7.3.2.2 Population Projections for the Forty-Year Period

A regression model has been used to extend the historic census data to provide population estimates, at ten-year intervals, over the Planning Horizon. The methodology that was used is based on the extension of past growth trends (Peach and Williams). This model assumes population growth-rates are related to the economic growth-rate of the Region, to migration (domestic and international combined), and to natural growth-rates of the population (crude birth rate and crude death rate). Projections have been made for three different rates of regional growth to provide a high-estimate, a medium range estimate and a low range estimate. The reason for using these three growth rates is that there is a great deal of uncertainty associated with long-term projections. In extending past data, there are a number of factors, the effects of which are assumed to remain constant. Table 7.17 summarizes the projected populations in the Planning Region. Table 7.18 summarizes the medium growth scenario projected populations in the Planning Region, Table 7.19 summarizes the high growth scenario projected populations in the Planning Region, and Table 7.20 summarizes the low growth scenario projected populations in the Planning Region.

TABLE 7.17: PROJECTED POPULATIONS IN THE PLANNING REGION (2000 TO 2040)					
Growth Scenario	**2000**	**2010**	**2020**	**2030**	**2040**
Medium	189,436	243,425	288,458	341,822	405,060
High	189,436	266,252	336,809	426,063	538,970
Low	189,436	220,692	235,037	250,314	266,585

TABLE 7.18: MEDIUM GROWTH PROJECTED POPULATIONS IN THE PLANNING REGION (2000 TO 2040)					
Community	**2000**	**2010**	**2020**	**2030**	**2040**
Las Cruces	74,267	95,062	110,272	127,915	148,382
Hatch	1,673	2,041	2,490	3,038	3,706
Sunland Park	13,309	17,195	20,978	25,593	31,224
Mesilla	2,180	2,485	2,744	3,029	3,344
Anthony	7,904	11,145	14,934	20,011	26,815
La Union	1,045	1,265	1,390	1,543	1,697
Salem/Garfield	795	970	1,071	1,182	1,305
Berino/Chamberino	1,831	2,215	2,460	2,730	3,030
Doña Ana	8,679	11,109	14,220	18,201	23,298
La Mesa/Vado	3,003	3,664	4,045	4,465	4,930
San Miguel/Mesquite	948	1,157	1,277	1,410	1,556
Santa Teresa	2,607	3,337	3,871	4,490	5,209
Radium Springs	1,738	2,016	2,117	2,223	2,334
Chaparral	12,876	16,481	19,118	22,177	25,726
Total rural	45,917	59,274	71,623	85,960	102,477
Total	**178,772**	**229,416**	**272,610**	**323,967**	**385,033**

TABLE 7.19: HIGH GROWTH PROJECTED POPULATIONS IN THE PLANNING REGION (2000 TO 2040)					
Community	**2000**	**2010**	**2020**	**2030**	**2040**
Las Cruces	74,267	99,741	121,684	148,454	181,114
Hatch	1,673	2,359	3,019	3,865	4,947
Sunland Park	13,309	18,766	24,020	30,746	39,355
Mesilla	2,180	2,790	3,321	3,951	4,702
Anthony	7,904	12,884	19,068	28,220	41,766
La Union	1,045	1,475	1,865	2,360	3,985
Salem/Garfield	795	1,121	1,435	1,837	2,351
Berino/Chamberino	1,831	2,582	3,305	4,230	5,414
Doña Ana	8,679	12,237	15,664	20,050	25,664
La Mesa/Vado	3,003	4,234	5,420	6,937	8,880
San Miguel/Mesquite	948	1,403	1,880	2,519	3,376

TABLE 7.19: HIGH GROWTH PROJECTED POPULATIONS IN THE PLANNING REGION (2000 TO 2040)					
Community	**2000**	**2010**	**2020**	**2030**	**2040**
Santa Teresa	2,607	3,858	5,170	6,928	9,284
Radium Springs	1,738	2,329	2,841	3,466	4,229
Chaparral	12,876	19,056	25,536	34,218	45,852
Total rural	45,917	67,234	88,420	115,208	147,707
Total	**178,772**	**252,069**	**322,648**	**412,989**	**528,626**

TABLE 7.20: LOW GROWTH PROJECTED POPULATIONS IN THE PLANNING REGION (2000 TO 2040)					
Community	**2000**	**2010**	**2020**	**2030**	**2040**
Las Cruces	74,267	85,407	94,375	104,284	115,234
Hatch	1,673	1,941	2,143	2,365	2,611
Sunland Park	13,309	15,438	17,044	18,817	20,774
Mesilla	2,180	2,383	2,504	2,632	2,766
Anthony	7,904	10,117	12,343	15,058	18,371
La Union	1,045	1,150	1,275	1,415	1,590
Salem/Garfield	795	878	922	969	1,019
Berino/Chamberino	1,831	2,021	2,122	2,229	2,340
Doña Ana	8,679	10,068	10,722	11,419	12,161
La Mesa/Vado	3,003	3,483	3,658	3,841	4,033
San Miguel/Mesquite	948	1,048	1,100	1,155	1,213
Santa Teresa	2,607	3,024	3,175	3,334	3,501
Radium Springs	1,738	1,919	2,015	2,115	2,221
Chaparral	12,876	14,936	15,683	16,467	17,290
Total rural	45,917	53,333	51,462	48,707	44,871
Total	**178,772**	**207,146**	**220,543**	**234,807**	**249,995**

7.3.2.3 Future Public Water Supply

The average daily per-capita water consumption in the public water supplies of the County varies greatly from system to system. In the following tables the major water systems are shown separately to account for the variation of per-capita consumption rates. It is assumed that the current per-capita use rates will continue into the planning period, however, conservation measures could reduce these values by a significant amount in the larger systems serving urban areas such as the City of Las Cruces. The rural public water supply systems are grouped together. It is unlikely that use rates in small rural systems with already low rates (~100 gpcd or lower) will decrease and may actually increase over time. However, these systems constitute a relatively small proportion of the total usage for water supply in the region. For many of these smaller systems the water source that will meet public water demand will continue to be ground water. By 2015 or so, surface water may be available to the larger communities. Projected water demands, through the year 2040, for the Low, Medium and High growth scenarios versus the total water rights for City of Las Cruces, Village of Hatch and Doña Ana Mutual Domestic Water Consumers Association (estimated total users only), are shown on Figures 7.2, 7.3 and 7.4, respectively. Tables 7.21, 7.22 and 7.23 summarize the projected annual Public Water Supply diversions in the Planning Region for the Medium Growth, High Growth and Low Growth scenarios, respectively.

TABLE 7.21: MEDIUM GROWTH PROJECTED PUBLIC SUPPLY DEMANDS IN THE PLANNING REGION FOR 2000 TO 2040 (AC-FT/YR)

Community	**2000**	**2010**	**2020**	**2030**	**2040**
Las Cruces	20,897	26,121	30,039	34,545	39,727
Hatch	198	241	293	356	433
Sunland Park	1,409	1,797	2,185	2,657	3,231
Mesilla	282	323	357	396	440
Anthony	1,040	1,477	1,987	2,673	3,595
La Union	213	258	283	315	346
Salem/Garfield	113	137	152	168	187
Berino/Chamberino	269	325	361	401	445
Chaparral	1,864	2,359	2,747	3,200	3,728
La Mesa/Vado	217	263	291	323	359
San Miguel/Mesquite	368	446	495	549	609
Rural areas	13,269	17,663	21,379	25,749	30,873
Total	**40,138**	**51,409**	**60,568**	**71,331**	**83,972**

TABLE 7.22: HIGH GROWTH PROJECTED PUBLIC SUPPLY DEMANDS IN THE PLANNING REGION FOR 2000 TO 2040 (AC-FT/YR)					
Community	**2000**	**2010**	**2020**	**2030**	**2040**
Las Cruces	20,897	28,085	34,012	41,188	49,879
Hatch	198	241	293	356	433
Sunland Park	1,409	2,001	2,532	3,203	4,051
Mesilla	282	357	423	501	594
Anthony	1,040	1,696	2,510	3,714	5,497
La Union	213	301	380	481	609
Salem/Garfield	113	159	202	255	323
Berino/Chamberino	269	379	479	606	767
Chaparral	1,864	2,759	3,710	4,990	6,712
La Mesa/Vado	217	306	386	489	618
San Miguel/Mesquite	368	545	733	986	1,326
Rural areas	13,269	19,099	24,425	31,007	39,052
Total	**40,138**	**55,927**	**70,084**	**87,777**	**109,860**

TABLE 7.23: LOW GROWTH PROJECTED PUBLIC SUPPLY DEMANDS IN THE PLANNING REGION FOR 2000 TO 2040 (AF-FT/YR)					
Community	**2000**	**2010**	**2020**	**2030**	**2040**
Las Cruces	20,897	23,948	27,397	31,341	35,855
Hatch	198	241	293	356	433
Sunland Park	1,409	1,649	1,839	2,050	2,286
Mesilla	282	310	330	351	374
Anthony	1,040	1,316	1,592	1,927	2,331
La Union	213	234	260	288	324
Salem/Garfield	113	125	139	154	171
Berino/Chamberino	269	298	318	338	360
Chaparral	1,864	2,171	2,313	2,463	2,623
La Mesa/Vado	217	252	269	286	305
San Miguel/Mesquite	368	409	435	462	492
Rural areas	13,269	15,657	14,693	13,361	11,582
Total	**40,138**	**46,611**	**49,876**	**53,377**	**57,136**

7.3.2.4 Future Industrial, Commercial, Mining and Power

In the future, it is likely that much of the growth in water demand for industrial and commercial purposes will be provide by regional water supply systems. It is assumed that those other uses relying on self-supplied ground water will continue to increase at a small rate (less than 0.5 percent per annum) throughout the planning period. Mining demands are assumed to follow a similar pattern. There will be new power generation facilities in the County in the next 40 years. It is assumed that the demand for cooling water will more than double during the planning period (2.5 times current demand) for the medium projection. Table 7.24 shows these demands for industry, commercial, power and mining sectors.

TABLE 7.24: PROJECTED DEMANDS IN THE PLANNING REGION FOR 2000 TO 2040 (AF-FT/YR)

Category	**2000**	**2010**	**2020**	**2030**	**2040**
Commercial, Industrial and Mining	6,500	7,000	7,500	8,000	8,500
Power	2,500	3,500	4,500	5,500	6,500
Total[2]	**9,000**	**10,500**	**12,000**	**13,500**	**15,000**

7.3.2.5 Future Irrigated Agriculture

No growth is anticipated in the irrigated acreage in the Region over the next forty years. Shifts away from present agricultural water demand will likely occur over the next forty years as water moves to municipal and industrial uses. The total available surface-water supply is already fully allocated and is not likely to increase in the future.

The process, for changes in the purpose and place of the use of the surface supply, is already under way. Conceptual plans have been outlined in two reports that include locations and costs for treatment facilities for regional drinking water plants using Rio Grande surface water. (New Mexico – Texas Water Commission, El Paso – Las Cruces Regional Sustainable Water Project, Central Planning Area SWTP Siting Study for a Las Cruces Plant and a Leasburg Plant, Report by Boyle Engineering and Parsons Engineering Science, January 2000, 22 pages plus maps; New Mexico – Texas Water Commission, El Paso – Las Cruces Regional Sustainable Water Project, Siting Study for Phase 1 Facilities for Doña Ana County, Report by Boyle Engineering and Parsons Engineering Science, March 2000, 126 pages plus maps).

In March 2001, the City of Las Cruces (City) and the EBID (District) entered into a joint resolution that initiates the steps for change in surface-water use from irrigation to municipal use in a surface-water treatment plant. This agreement provides a mechanism for the City to purchase some surface-water rights within the District. (A Resolution Establishing a City of Las Cruces Municipal Water-Users Association, authorized March 19, 2001 by the Las Cruces City Council and May 9, 2001 by the Board of the EBID). Mechanisms that will allow an orderly transfer of irrigation rights, in other parts of the Region, are under consideration and agreements will be reached as future domestic, municipal and industrial demands are manifested.

7.3.2.6 Summary Total All Future Water Uses

The projected annual water diversions in the Planning Region are summarized Table 7.25.

TABLE 7.25: PROJECTED DEMANDS IN THE PLANNING REGION FOR 2000 TO 2040 (AC-FT/YR)

Category	2000	2010	2020	2030	2040
Private/ Public Water Supply	35,000	47,000 to 56,000	50,000 to 70,000	53,000 to 88,000	57,000 to 110,000
Irrigated Agriculture	446,500	446,500	446,500	446,500	446,500
Livestock	4,500	4,500	4,500	4,500	4,500
Commercial, Industrial and Mining	6,500	7,000	7,500	8,000	8,500
Power	2,500	3,500	4,500	5,500	6,500
Environment[1]	25,000 to 90,000	25,000 to 90,000	25,000 to 90,000	25,000 to 90,000	25,000 to 90,000
Total[2]	**495,000**	**508,500 to 517,500**	**513,000 to 523,000**	**517,500 to 552,500**	**523,000 to 576,000**

[1] This is for a full supply year for riparian vegetation evapotranspiration between Caballo and the state line, when the river runs all irrigation season. It does not constitute an appropriation of a water right.
[2] Total does not include the demand estimated for the environment.

For the planning horizon of 2000 to 2040, water use in the Planning Region may grow from approximately 495,000 ac-ft/yr to 576,000 ac-ft/yr.

8.0 WATER PLAN ALTERNATIVES

8.1 Water Supply versus Future Demands

The water supply available to the region in meeting future water demand must consider both the surface water (Rio Grande) and the ground water in storage in the ground-water basins (Rincon Valley, Mesilla, Jornada del Muerto and Hueco). The annual supply of surface water in the Planning Region is extremely variable as documented in section 6.1.1. Additionally, the ground-water supplies in the Jornada and Hueco basins are essentially a fixed amount (e.g., annual recharge to these basins is very low) and any withdrawal above this recharge amount will basically mine the ground-water supply. The Rincon Valley and Mesilla ground-water basins are interconnected to the Rio Grande, which has historically and fortunately been able to recharge these basins in years of above-normal flows. However, if ground water development expands much above the current levels, the Rio Grande will not be able to continue replenishing the ground water and this will result in ground-water mining in the Rincon Valley and Mesilla basins. Since the river cannot be isolated from the Rincon Valley and Mesilla basins, it will continue to replenish the basins, which in-effect robs the river of water. This is water that should be in-stream flow for local agricultural users as well as meeting Compact delivery obligations to Texas users and the Mexican Treaty water users.

The Mesilla and Hueco bolson aquifers are both shared by New Mexico, Texas, and the Republic of Mexico. This fact generates a great deal of uncertainty relative to the long-term management and viability of the aquifers. Mexico and El Paso are by far the largest users of the Hueco, and their extensive withdrawals have mined the aquifer significantly. In Mexico, uses of the Hueco bolson include irrigation and as the primary source of water for Ciudad Juarez. In El Paso, the Hueco has provided a major part of the City's municipal and industrial supply. While estimates vary, it is clear that the long-term viability of the Hueco bolson is poor, with declining water levels and declining water quality already presenting problems for these two areas. Both will have to look elsewhere for water to support their current and future needs, and while surface water will take much of the burden previously shouldered by the Hueco, periods of drought require a ground-water reserve, and El Paso and Mexico will both turn to the Mesilla basin.

The City of El Paso already draws heavily on the Mesilla basin, having pumped about 22,600 ac-ft in 2002. El Paso's draw on the Mesilla basin will likely increase in 2003 and in the future, as the continuing drought reduces their available surface-water supply. One interesting development has been the stipulation, in the third party implementing contract of 2001 among the City of El Paso, EPCWID#1, and the BoR, of an accounting mechanism for offsetting depletions of Rio Grande Project Water supply induced by the City of El Paso's pumping in the Mesilla basin. Basically, the loss of available surface water would be charged against EPWU's surface-water allotment.

Mexico is much more of an unknown in terms of demands on the Mesilla basin. With the Hueco in rapid decline and the surface-water supply reduced by drought, it is very likely that Juarez will develop significant well fields in the lower Mesilla bolson. The effect that such a well field would have on water supply in New Mexico is uncertain. It will likely capture some inflows to the New Mexico portion of the aquifer, but it may reduce the inflow of salt. This is an area that needs significant research and negotiation among Mesilla basin ground-water users.

The water managers and water right holders in the region have recognized these facts and this Plan is developed so that the best solutions can be found that will allow for continued growth and development without exhausting a critical resource. Conjunctive management of both surface and ground water is essential. Likewise inter-temporal management will be required to deal will shortages due to drought and to take advantage of excess supplies. These strategies are discussed in the following sections.

In Section 6.1.2 the ground-water basins were each described separately. However, for the analysis of supply versus demand it is more appropriate to combine the Mesilla and Rincon Valley basins due to the interconnectedness with the Rio Grande. Even though the Jornada basin is connected to these two basins (there is leakage from the Jornada to the Mesilla and the northern Jornada drains to the Rincon basin) the analysis of supply versus demand will be presented separately. The projections of water demand for each category was segregated into these three areas and are based on the medium growth scenario.

In general, ground-water supply values used in this chapter are discussed in Section 6.1.2, with additional information used to complete the ground-water balance as discussed in the following sections where applicable. The following sections summarize the ground water balance.

8.1.1 Mesilla-Rincon Basin

Water demands in the Mesilla-Rincon Basins include the majority of the lower Rio

Grande valley's incorporated communities and irrigated agriculture, as well as livestock, commercial and power uses. The future water demands from the Mesilla-Rincon Basins are summarized below in Table 8.1. The future demands for ground water for the livestock and power categories are not expected to change significantly in the next 40 years. The demand for ground water by agriculture is also projected to remain flat on average. To makeup for shortages in the surface-water supply due to the extreme variability of the surface-water supply and the reliance on the ground water in these two basins, there will be many years when the withdrawals will be considerably above 69,000 ac-ft as well as many years when it will be less. Demands to meet public water supply needs and the commercial, industrial, and mining needs are projected to increase. The public water supply needs are projected to almost double increasing from 27,860 ac-ft/yr in 2000 to over 47,700 ac-ft/yr in 2040. This is an average growth rate of approximately 3% per year over the 40-year period. The commercial needs are projected to increase from 3,000 ac-ft/yr to 6,500 ac-ft/yr in 2040 (see Section 7.12 for summary of estimated water demands by basin).

TABLE 8.1: MESILLA-RINCON BASIN - FUTURE GROUND WATER DEMANDS (AC-FT/YR)

Category	**2000**	**2010**	**2020**	**2030**	**2040**
Public Water Supply[1]	27,860	29,814	31,638	38,984	47,733
Irrigated Agriculture[2]	69,000	69,000	69,000	69,000	69,000
Livestock	3,000	3,000	3,000	3,000	3,000
Commercial, Industrial, Mining	4,500	5,000	5,500	6,000	6,500
Power	2,500	2,500	2,500	2,500	2,500
Total	**106,860**	**109,314**	**111,638**	**119,484**	**128,733**

[1] Note: Projections based on medium growth scenario
[2] Ground water only

Much of the Mesilla-Rincon basin is in a dynamic equilibrium, being recharged by the river, irrigation activities, and some natural sources particularly during full-supply years, followed by periods of temporary drawdown during drought cycles. Some areas of sustained pumping and reduced irrigation have showed persistent drawdown, such as around municipal wells shown in figures 6.25 and 6.26.

8.1.2 Jornada Basin

Ground-water demands projected for the Jornada Basin are primarily for public water supply needs. The demands for livestock water are small and are projected to remain at present levels. There are no current demands for power and none are expected. The needs for commercial, industrial and mining uses are projected to double from 250 ac-ft/yr to 500 ac-ft/yr in 2040. The significant change is expected between the present and 2010 as the City of Las Cruces begins withdrawal of an additional 10,200 ac-ft/yr from the Jornada to supplement future municipal demands on the east mesa of the City, only a portion of which lies within the Jornada Basin boundaries. NMOSE records show that there are about 1,577 ac-ft of existing rights and/or pending applications in the southern Jornada Basin for irrigation purposes. This demand by irrigated agriculture is projected to continue through 2040. Total demand for Jornada Basin water ranges from around 5,774 ac-ft/yr presently to almost 22,500 ac-ft/yr in year 2040 (Table 8.2).

TABLE 8.2: JORNADA BASIN – FUTURE GROUND-WATER DEMANDS (AC-FT/YR)

Category	2000	2010	2020	2030	2040
Public Water Supply[1]	3,847	11,035	16,658	18,569	20,264
Livestock	100	100	100	100	100
Irrigated Agriculture	1577	1577	1577	1577	1577
Commercial, Industrial, Mining	250	300	350	400	500
Power	0	0	0	0	0
Total	**5,774**	**13,012**	**18,685**	**20,646**	**22,441**

[1] Note: Projections based on medium growth scenario

The ground water supply in the Jornada Basin is basically a finite amount. Annual recharge has been estimated at about 5,000 ac-ft/yr and leakage and drainage to the Mesilla and Rincon basins has been estimated to be about 4,000-5,000 ac-ft/yr. If these estimates are accurate the basin is in equilibrium. The additional withdrawals may initially and for some time only reduce water in storage, but will eventually begin to effect the leakage and drainage of water to the adjacent basins.

The majority of the ground-water rights for the Jornada del Muerto aquifer have been appropriated. This aquifer will become an increasingly important source to meet the growth in demand for the City of Las Cruces and surrounding area. Hydrologic modeling of the Jornada del Muerto Basin indicates that ground-water withdrawals to meet projected growth in demand will not impact the aquifer until the year 2020. However, after 2020, continued pumping will result in significant localized drawdown of the basin within the vicinity of the active well field(s).

8.1.3 Hueco Bolson

Ground water demands projected for the Hueco Bolson are shown in Table 8.3. The principal uses are rural domestic and power. The demands by irrigated agriculture and commercial and livestock uses are minor and expected to remain flat. The demand for power is due to future planned development in the area. Total demand for Hueco Bolson water expected to increase from around 4,000 ac-ft/yr presently to almost 11,000 ac-ft/yr (with approximately 5,000 ac-ft/yr for rural domestic) in year 2040. This area has been identified as one of the fastest growing areas in the region.

TABLE 8.3: HUECO BOLSON – FUTURE GROUND-WATER DEMANDS (AC-FT/YR)

Category	**2000**	**2010**	**2020**	**2030**	**2040**
Public Water Supply[1]	2,481	3,175	3,683	4,273	4,956
Irrigated Ag	900	900	900	900	900
Livestock	500	500	500	500	500
Commercial, Industrial, Mining	100	125	150	175	200
Power	0	1,000	2,000	3,000	4,000
Total	**3,981**	**5,700**	**7,233**	**8,848**	**10,556**

[1] Note: Projections based on medium growth scenario

The ground water supply in the Hueco Bolson is assumed to be limited to stored water. However, for the Hueco Bolson, degradation of water quality over time is expected to be the limiting factor. Pumping of wells, for the City of El Paso, Texas located just across the state line, is the primarily reason for depletion of the limited fresh water (TDS < 1,000 mg/L). It is projected that the fresh water underlying the Town of Chaparral will be depleted by year 2012 (USGS, 1991).

Based on USGS study information (1991), continued pumping in the Hueco Bolson in the Chaparral area with pull saline ground water (TDS >1000 mg/L) into the Bolson by the year 2012. After the year 2012, TDS values are expected to increase to levels greater than 1200 mg/L and would require desalination treatment before use.

8.1.4 Comparison of Water Rights versus Demand for High, Medium and Low Growth Scenarios

Projected water demands, through the year 2040, for the Low, Medium and High growth scenarios versus the total water rights for City of Las Cruces, Village of Hatch, and Doña Ana Mutual Domestic Water Consumers Association (estimated total users only) are shown on Figures 7.2, 7.3 and 7.4, respectively. As shown on the graph of the project water demands, the City of Las Cruces demand for water will exceed their total water rights (for both the Mesilla and Jornada del Muerto basins) by the year 2012 for the high growth scenario, by the year 2016 for the medium growth scenario and by the year 2030 under the low growth scenario. The Village of Hatch will exceed their total water rights for the Rincon Basin by the year 2020 for the high growth scenario, by the year 2029 for the medium growth scenario and after the year 2040 under the low growth scenario. However, based on the projections, the Village of Hatch will not exceed its total water rights for both the Rincon and the Nutt-Hockett by 2040. Based on the estimated total water users, the Doña Ana Mutual Domestic Water Consumers Association will exceed their total water rights by the year 2025.

8.2 Future Water Supply Alternatives

8.2.1 Water Management Alternatives

The water resources in the region may be extended with proper management tools. These tools are called Water Management Alternatives and include educational, institutional and governmental programs, which protect and enhance the water resources in the Region. Some suggested water management alternatives are:

- Public education
- Water conservation
- Re-use

Water Management Alternatives are described in more detail in the following sections.

8.2.1.1 Public Education

Management of water resources begins with education. An aggressive public educational campaign on water conservation and supply protection could extend the water supplies, both in agricultural and rural areas and in developed communities.

Probably the most effective conservation measure that can be taken in our communities is education and awareness training. Education goals should include: (1) bringing to the attention of the general public the value of water, (2) emphasizing the fact that precipitation is low on the average and can vary dramatically from year to year in the Southwest, and (3) making people aware of the fact that we are mining potable water resources as demands increase and that our supply is finite. This increased awareness will encourage people to use water more wisely and effectively.

8.2.1.2 Water Conservation and Re-use Plans

Water Conservation and Re-use Plans summarize conservation methods, methods to monitor progress and conservation goals. A generic Water Conservation Plan has been included in Appendix I of this report. However, in addition to this general document, specific Water Conservation Plans should also be developed by each member entity in the region. Members are encouraged to develop their own conservation goals and monitor progress. In conjunction with conservation goals, the communities should develop incentives to accompany the Conservation Plan targets. Conservation is not just limited to domestic and commercial uses but should also include agricultural uses as well. For example, since reclaimed water (treated waste water effluent) is considered an existing water supply, re-use on parks, golf courses and other green space which currently use potable water should also be considered and strongly encouraged as part of the Conservation Planning effort. Detailed descriptions of reclaimed water (re-use) are provided in the following Section.

8.2.1.3 Reclaimed Water/Re-Use

Treated wastewater effluent may be reclaimed and used on green spaces (parks, golf course, etc.) to replace potable water use. This resource is considered a “water supply” because it offsets potable water use for the same demands. The advantage to using reclaimed water on green spaces is that it is a 100% (1:1) recovery of the resource to replace potable water demands, and frees up the saved potable water for additional domestic use.

Because the ground-water basin supplies in the region may be over drafted in some drought years it is essential to have facilities in place to replenish these basins when supplies are above normal. Excess surface-water supplies can be treated and injected into the aquifers in the Plan area. The LRGWUO has sponsored hydrologic investigations to identify areas in the region where ground-water aquifer storage and retrieval could be possible. It may not be feasible to treat municipal wastewater for re-injection, since these supplies are currently captured and used by the irrigation system.

Some of the communities in the planning area that are currently practicing re-use include: Anthony, Picacho Hills, Las Cruces, Rincon, and Santa Teresa Industrial Park. The re-use or reclaimed water is generated by wastewater effluent treated to NMED Groundwater Protection standards and each facility must have a discharge permit issued by the NMED Groundwater Section. These wastewater facilities chose re-use because they do not have access to a receiving stream such as the Rio Grande to dispose of their treated effluent. Communities that are utilizing re-use/ reclamation systems must meter their discharge so it is possible to get the annual discharge allowed for each community.

The methods of application of treated effluent vary in the planning area however, sprinkler systems are the most typical method used. For example, Anthony Water & Sanitation District irrigates the Dos Lagos Golf Course and Picacho Hill irrigates the Picacho Hills Golf Course with sprinkler systems. The City of Las Cruces applies its re-use water by sprinkler to native vegetation in the West Mesa Industrial Park and Rincon uses a subsurface leach field system. Future re-use or water reclamation systems are planned for the east mesa of Las Cruces and are likely to be considered for the Chaparral area.

None of the existing re-use/ reclamation systems inject directly into aquifers, however, as standards for re-use and reclaimed water become more stringent and the quality of the water increases, injection may become a more attractive method for disposal of excess reclaimed water and recharge for the aquifer.

8.2.1.4 Residential / Commercial Water Conservation

The residential water use in the region is roughly about 50% indoor and 50% outdoor. This is due primarily to the traditional landscape design schemes in use from the 1950's which included complete development of the outdoor property in lawn and non-native shrub. In recent years much more emphasis has been placed on xeriscaping and the use of native desert plants by developers. Presently the percentage of these residences of the total is small. A few lawn-to-xeriscape conversions occur every year, but to achieve significant conversion rates in the region is expected to require substantial water price rate increases or incentive programs. These conservation programs should not be confused with drought contingency programs, although the prolonged use of drought restrictions can effectively stimulate more water conservation conversions.

Indoor water use can be reduced at relatively low cost by installing low-flow fixtures in the home, repairing leaking faucets and fixtures, and auditing water consumption to see where water can be saved without sacrificing results. Savings of the order of 10% may be achieved by this method of water conservation.

There are often many ways in which industrial and commercial water demands can be reduced with relatively little capital investment and without reducing the competitive position of the product produced. One of the most cost-effective is to try to re-use water in the production process. Another is to find ways to reduce or eliminate altogether the amount of water needed in selected steps in the production process. Some of the latter options can be expensive and could take considerable time to implement. In these instances, options for providing financial assistance should be explored by the community entities since a reduction in the amount of water consumed can reduce community infrastructure costs and could help promote further economic expansion for select industries.

8.2.1.5 Agricultural Use Water Conservation

The material in this section, following the summary, has been quoted directly from King, J. P. and J. Maitland, 2003, Water for River Restoration: Potential for Collaboration between Agricultural and Environmental Water Users in the Rio Grande Project Area, Report prepared for Chihuahuan Desert Program, pages 108 to 126.

8.2.1.5.1 Summary

Since the largest water demand in the Lower Rio Grande is for agricultural use, conservation measures that are in place as well as those being considered should be described. Water conservation in EBID is a complex and often non-intuitive proposition. The unique hydrology of EBID, including its conjunctive use of surface and ground water, delivery obligations to downstream users, and severe drought cycles requires a complex program. The EBID Board of Directors adopted a Water Conservation Plan in their July 2003 meeting that details much of what is summarized here.

A schematic of the hydrologic cycle for the reach of the Rio Grande between the gauging station below the outlet of Caballo Reservoir and the gauging station in the Rio Grande at El Paso (Courchesne Bridge) is shown in Figure 8.1. Data for many of the hydrologic components are lacking, and will be considered largely qualitatively. However, the net depletion (total inflows minus total outflows) can be calculated from the long-term flow measurement records at the Rio Grande below Caballo and at El Paso. These are particularly convenient measurements because the subsurface flow past these points is negligible. The alluvial aquifers pinch out in these areas, so that virtually all of the flow is in the river and measured. Note that this reach of river includes parts of Sierra County and part of El Paso County in Texas. The Texas portion includes 10,880 acres of land irrigated by El Paso County Water Improvement District No. 1 from diversions at Mesilla Dam in New Mexico as part of the Rio Grande Project Authorized Acreage.

The net depletions represent the total amount of water depleted by all sources in the reach (irrigation, M&I, domestic, riparian evapotranspiration, etc.) less the inflows within the reach (precipitation and storm runoff, imported water, tributary ground-water flows, etc.). The annual net depletion typically runs about 300,000 ac-ft/yr, but there is significant interaction among years, as a short supply of surface water from Caballo leads to heavier use of ground water, and wet years immediately following dry years will show a higher net depletion due to the recharge of the ground-water supply depleted in the drought. This is an important view of the water consumption in the area because significant long-term increases in this net depletion may lead to an inability to deliver adequate water to Mexico and Texas. The specific quantity of Rio Grande Project water that Mexico is entitled to is clearly spelled out in the Treaty of 1906. The quantity of Rio Grande Project water to which Texas is entitled is more complex, and certainly more controversial. Any water use or restoration planning should consider this downstream obligation as a limiting constraint to the ultimate development of water consumption in the area, unless additional sources for importation of water are available.

Water conservation measures must be considered both from the farmer's perspective and from a District wide perspective. On-farm measures such as drip irrigation can certainly reduce required delivery to a farm, producing a saving for the farmer. It does not, however, necessarily decrease the depletion to the system; in fact, drip irrigation may even increase it as it increases crop yield. EBID has supported farmers' conservation efforts in on-farm metering by agreeing to use measured deliveries for water charges, reducing the standard charge for farmers who laser-level their fields, and with technical support on farm ditch lining and other water management measures.

EBID's focus in its water conservation effort has been primarily on system level conservation, for example reducing operational spills, facilitating transfer of conserved water to other users, and matching diversions and deliveries to orders. EBID estimates that of the water it diverts from the river, about 35 percent seeps into the ground before the water is delivered to the farm, with about 10 percent loss in the main canal systems and 25 percent loss in the smaller lateral canals. EBID recently began planning a project to replace about 16 miles of unlined laterals with aluminized steel pipe to reduce seepage and operating losses. Twenty-one laterals will be placed in 48 inch pipe at a total cost of about $9 million, or just over $100 per foot, including control structures and labor. About half of the cost is for materials, and half for labor and administrative expenses. This should present an excellent opportunity to evaluate the effectiveness of lining for water conservation in EBID.

However, depending upon the conservation approach utilized, the location and the farming practice, determination of actual conservation savings will need to be balanced with potential loss of recharge to ground-water reserves and the resultant effects on long-term ground water availability.

8.2.1.5.2 On-Farm Water Conservation

On-farm water conservation generally would directly involve irrigators, and the role of the district would be that of cooperator and administrator of any conserved water to ensure that it could be quantified and put to use for restoration or instream flows as negotiated. Several options for on-farm conservation are presented and discussed below. The effects of turnout metering are many, including allowing the quantification of conserved water due to other management practices, awareness and planning capability for water management, and a basis for conservation incentives. Drip irrigation and high flow turnouts are aimed at decreasing applied water by increasing application efficiency. Low water use crops and deficit irrigation scheduling can reduce depletion to the system as well as reducing the applied water. The various options certainly are not independent. For example, deficit irrigation will also increase application efficiency, and metering would provide the quantification of savings. A discussion of on-farm water conservation measures follows.

Farm Delivery Metering

Farm deliveries in the study area’s three districts are surface water, through turnouts that are the physical interface between the irrigation district and the farmer, and ground water, though farmer-owned wells. While farmers in all three districts have historically used ground water to supplement surface supplies, none of the districts administers ground water at present, though drought management in 2003 will likely draw at least EBID into some involvement with the distribution of ground water and possibly even the production of it.

The primary benefit of metering deliveries to farms is that it allows the quantification of the benefit of other conservation measures. For example, a farmer installing a high flow turnout can compare his pre-high flow water use to his use after the improvement to determine quantitatively what his water saving is, and what could be made available for restoration projects.

It has been noted by several researchers that the very act of metering reduces the amount of water people use, though it is difficult to prove because there is no pre-metering baseline to which metered water usage can be compared. Newly installed meters often show an initial drop in use with time as water users adjust their management practices in response to the new information provided by the meters. Fipps (1999) suggested that metering is a necessary part of a water conservation program. The fact that farmers have quantitative metrics to guide their management can, in itself, significantly reduce water use by as much as 20 percent.

Several approaches to turnout measurement are possible. If available energy and funding are not too restrictive, a dedicated structure such as a flume or weir may be installed to measure surface-water deliveries. This requires the structures and the appropriate sensor (generally an electronic pressure transducer to measure head over the control surface) and a data logger to record the flow data. Some method of getting the data from the field where it is measured to the farmer's and district's computers where it can be used is also necessary. This can be accomplished either by manually downloading the data to a portable computer or through radio telemetry. Alternatively, turnout gates themselves have been used as measurement structures. While this method may not give as precise results as those of a dedicated flow measurement structure, it has the advantage of not requiring an additional structure or the head loss associated with an additional structure. No additional head loss means that flow measurement will not reduce the flow of the turnout as a flume can do under low head situations.

The cost of turnout metering is variable, depending on the approach taken. Prefabricated or cast-in-place concrete flow measurement flumes typically cost \$600 to \$2,000, depending on size and type. An off-the-shelf pressure transducer appropriate for metering such flumes (one is required per installation) costs about \$800, and an appropriate data logger runs about \$800, for a total cost of equipment of \$2,200 to \$3,600. Radio telemetry units cost an additional \$2,000.

To reduce the cost and promote the dissemination of flow measurement devices, EBID has developed its own lower cost components. Using the turnout as a measurement structure, no flume is required. The District fabricates its own pressure transducers for about $150 each, and two are required for each turnout gate. EBID's data logger/controller combination with built-in low power radio costs $700. In order to use a turnout gate to meter flow, the gate opening must also be monitored, and the sensor for that costs $50. This puts the total price for metering one turnout using EBID's system at $1,050, and this price is independent of turnout size. This approach for turnout measurement is described in a paper by Henry Magallanez and Fernando Cadena currently under review by the American Society of Civil Engineers Journal of Irrigation and Drainage.

Well metering is traditionally accomplished using an impeller-type meter that accumulates total flow on an analog counter. Such meters typically cost between $700 and $2,500, depending on size and manufacturer. The drawback to such meters is that they require manual reading or expensive electronic counters and data loggers, making data management awkward and expensive if a large number of wells are being monitored.

EBID is also developing a metering approach to the wells used by its constituents. The approach is to use a modified pitot tube (dubbed the "Mag Tube" after inventor Henry Magallanez) to measure the velocity in the well discharge pipe, which, when multiplied by the cross sectional area of the pipe, gives flow. The electronic instrument is a pressure transducer very similar to those used for the District's turnout measurement, and the data logger and telemetry units are identical, and compatible with EBID's data acquisition system. The cost of the tube is about $100, so with a pressure transducer and data logger/telemetry unit, the total cost for parts is about $950. This system will see its first use in 2003.

The three districts do not require farmers to measure their well flow, nor do they have the authority to do so. Adjudication processes in both states will likely require metering in the future. Many farmers meter ground-water pumping for their own management use, but the data from those metered wells are not systematically compiled. There are, however, incentives for farmers to meter their wells. Most obviously, if farmers meter their wells, they can better manage their water, as discussed above. Secondly, they can quantify beneficial use for a water rights claim on their well. Thirdly, it is likely that well metering will be mandated by both New Mexico and Texas in the near future, and a program that can help defray the cost to farmers of well metering could be very attractive indeed.

Laser Leveling

Surface irrigation efficiency can be greatly enhanced by precision-grading the field using laser leveling equipment. Advance is more rapid and uniform, producing a more uniform infiltration profile, thus allowing the manager to fully irrigate the field with minimal deep percolation losses. Laser leveling is very popular and widespread within the study area. The cost of initial leveling of an irrigated field can vary with the condition of the field, but typically costs about $350 per acre. Touch-up leveling is done every three or five years, and costs $200 to $250 per acre. The only drawback to laser leveling as a new approach for conserving water is that virtually all of the significant acreage in all three districts has been laser leveled already by the farmers.

Pressurized Irrigation (Drip and Sprinkler)

Irrigation systems are generally classified as surface systems, or flood irrigation, and pressurized systems, including sprinkler and drip. Surface irrigation is the oldest and most common method in the world, but for better efficiency, lower labor requirements, ability to irrigate on uneven land, and potential improvements in yield and quality, pressurized systems have become very popular in recent years. Comparative advantages and disadvantages of surface, sprinkler, and drip irrigation systems are given below in Table 8.4. It should be noted that each class of irrigation system presented here represents a very broad class of systems that, depending on design, installation, and operation, may perform very well or very poorly. The descriptions given here are only intended as general guides.

TABLE 8.4: GENERAL CHARACTERISTICS OF IRRIGATION SYSTEM TYPES, BASED ON CUENCA (1989)

Characteristic	Surface	Sprinkler	Drip
Irrigation Efficiency	50-85%	70-85%	90-100%
Yield Potential	Low-mod	Moderate	High
Depletion/acre	Low-mod	Moderate	High
Diversion/acre	Mod-high	Moderate	Mod-low
Capital Investment	Low	Moderate	High
Labor requirement	High	Low	Low
Labor skill level	Low	Moderate	High

TABLE 8.4: GENERAL CHARACTERISTICS OF IRRIGATION SYSTEM TYPES, BASED ON CUENCA (1989)			
Soil types	Fine	Mod to coarse	Any
Topography (slope)	0-2 %	0-5 %	0-15%+

Sprinkler systems are often divided into stationary systems, where sprinkler heads are in fixed positions (common for landscape irrigation), hand-move systems, where an operator must manually move sprinkler lined, and self-propelled systems, where the system moves on wheels as irrigation progresses. Self-propelled systems generally include side-rolls, where a sprinkler line moves laterally across a field, irrigating a rectangular area, and center pivots, where the sprinkler line pivots about a central source, irrigating a circular area. Attachments to the end of center pivots also allow them to irrigate square areas. Center pivots are by far the most popular, because they allow more trouble-free operation and have a lower cost per acre than side-roll systems. They could be used on larger fields in the study area, but the use of sprinkler systems in general will be limited by field size and geometry, water quality (salt deposition on crop can cause problems with many of the area's crops), and crops. In the Rio Grand Project area, potential water saving by conversion to sprinklers is probably limited, since the wind and evaporation losses incurred by conventional sprinklers offer little savings over the evaporation loss of existing surface irrigation systems.

The primary components of a center pivot irrigation system are:

1. The pressurized source, generally a well or canal pump system producing pressure of 40 to 70 psi (older systems ran on higher pressure).
2. The pivot, a vertical pipe riser that allows the sprinkler lateral to rotate freely.
3. The sprinkler lateral, ranging in length from 250 feet to over 1500 feet, providing radial pressurized flow. The lateral is generally supported between towers by trusses.
4. Sprinkler assemblies, consisting of an outlet from the lateral, a drop pipe, a pressure compensator, electronic control valves, and the sprinkler head.
5. Wheel-driven towers provide movement of the center pivot. The drive units on modern center pivots are electric motors allowing variable speed of travel.
6. A central computer, generally located at the pivot, maintains control of the unit.

Sprinkler systems allow small, frequent irrigations, and can achieve high efficiency. Drawbacks include comparatively high energy costs, wind drift of spray, mineral deposits on crops, and evaporative loss of spray. A photograph of a center pivot irrigation system is presented on Figure 8.2.

The cost of center pivots varies with size. The area covered by a center pivot increases with the square of the length of the lateral, but the required diameter of the lateral pipe increases with length. A cost function was developed by the author based on regression of various sizes of center pivots and quotes from Valley (Valmont) vendors. The resulting cost per area is given below in Table 8.5. This includes only the on-field components. Conveyance system components are highly variable, depending on source, distance, elevation difference between source and the field, and other considerations that are beyond the scope of this report. Land preparation costs of $200 to $600 per acre (depending on preexisting land condition) should also be included in cost estimation.

TABLE 8.5: CENTER PIVOT COST AS A FUNCTION OF SIZE

Area (acres)	Cost	Cost/acre
40	$ 17,653	$ 441
50	$ 21,464	$ 429
60	$ 25,275	$ 421
70	$ 29,086	$ 416
80	$ 32,897	$ 411
90	$ 36,708	$ 408
100	$ 40,519	$ 405
110	$ 44,329	$ 403
120	$ 48,140	$ 401
130	$ 51,951	$ 400
140	$ 55,762	$ 398
150	$ 59,573	$ 397
160	$ 63,384	$ 396

Center pivots are often depreciated over a 10 to 15 year useful life. For budgeting purposes, maintenance and repair can be assumed to be 25 to 50 percent of the annual depreciation using straight-line depreciation.

Sprinkler irrigation of alfalfa presents some problems, as harvesting operations during peak demand periods can induce moisture stress, particularly on the sandy soils with low water holding capacity at the site of interest. Irrigation must be suspended long enough before mowing to allow the field to dry to the point where the soil is trafficable. After mowing, the hay must be windrowed, cured, bailed, and removed from the field. By the time the hay is off and the field can be irrigated again, the crop will have been stressed, and a yield reduction will result. Under sprinkler irrigation, about 80 percent of maximum ET is feasible.

Pecans obviously present a problem for center pivot irrigation. In Israel, citrus trees have been successfully irrigated with special high clearance center pivots, but pecan trees are much taller, and New Mexico and West Texas are probably windier.

There is a continuum of pressurized irrigation system types from sprinkler to drip, including microsprinklers (small, low pressure sprinklers that function similar to an above-ground drip system) and bubblers (essentially drip irrigation with a flow typical of a small sprinkler).

Drip is the racehorse of irrigation. Managed correctly, this type of system can produce the highest yield, and the highest quality, for a wide variety of crops. Drip proves in many cases to be economically quite viable. Unfortunately, as with a racehorse, anything less than the highest level of management can create serious problems. Clogging of emitters is the biggest problems faced by most growers, particularly when using sediment-laden surface water. Clogging may occur due to sediment, precipitation of minerals at the emitter outlet, and biological growth within the drip lines. An acid flush will generally take care of precipitants and biological growth, but removal of sediment requires multi-stage filtration and frequent cleaning of filters.

The primary components of a drip system are:

1. Pressurized source, generally in the range of 15 psi.
2. Headworks, consisting of backflow prevention valves, chemigation injectors, pressure and flow gauges, and multistage filtering (always downstream of the injectors). The computer control unit is generally located at the headworks.
3. Main line and sub mains, generally controlled by electronic solenoid valves.
4. Manifold pipes.
5. Drip laterals, which are, for the candidate crops discussed here, generally buried drip tape.

The cost of drip systems has come down in recent years as wider use achieves an economy of scale. The general cost range in New Mexico is $1,700 to $2,800 per acre. The drip lines of the more expensive laterals last about ten years, twice as long as the lower priced systems. The present value of the two is similar for a discount rate of ten percent, so the choice is largely dependent on choice of crops. A good working estimate would be $2,500 per acre. An additional $200 to $400 should be included for land preparation.

Drip systems are often depreciated over a 10 to 15 year useful life. For budgeting purposes, maintenance and repair can be assumed to be 25 to 40 percent of the annual depreciation using straight-line depreciation. The drip laterals should be depreciated separately over a five to 10 year life, depending on choice of tape, with no salvage value.

Drip should allow production of all crops near maximum levels. Since the system can be buried, irrigation need not be discontinued for field operations with alfalfa. In the design of the system, specific traffic ways should be included so that tractors and semi trucks can get on the field for harvest operations without running over laterals.

Drip is the most promising pressurized irrigation system, though sprinklers will find their use. Drip allows more efficient use of water without incurring the wind loss associated with sprinklers. Drip is also well-suited to the vegetable crops grown in the project area. Restricted water supply due to drought may motivate farmers to switch to drip, but there are problems to overcome, including use of canal water in a drip system and the changes in the surface water – ground-water interaction in the Rio Grande Project area caused by a reduction in deep percolation.

High Flow Turnouts

High flow turnouts allow rapid and efficient advance across the irrigated field by pushing the advancing water with as high a flow as possible without eroding the field. The rapid advance produces less infiltration time variation between the head and tail of the field, thereby producing better uniformity of infiltration and potentially high efficiency. The structure consists of a large gate that functions as a turnout from the supply ditch to the field, and energy dissipation to protect the field surface from erosion by the high and energetic flow. The high flow turnout shown Figure 8.3 has a capacity of about 25 cfs, as opposed to one or two cfs for a standard turnout.

Field evaluations by one of the authors (King) indicated a uniformity of about 94 percent for a high flow turnout on a low infiltration rate soil, which is excellent performance for a surface irrigation system, compared to a uniformity of about 55 percent for a conventional turnout on a similar sized field with a much sandier soil. The higher infiltration rate of the soil served by the standard turnout was responsible for much of the difference in uniformity, but a high flow turnout would certainly improve it to 60 or 70 percent. With proper irrigation scheduling, this could produce a reduction in applied water of about 25 percent. The drawback to high flow turnouts is that the ditches supplying a given turnout may lack the capacity to perform high flow irrigation. It doesn't matter what the capacity of the turnout is if the ditch can't get the water to it fast enough.

High flow turnouts typically cost about $2,000 for standard construction, though farmers in the area have gotten the price down to $1,200 by using their own labor and cinderblocks, rather than formed concrete, for the baffle blocks that dissipate the energy on the downstream side. While data on the number of high flow turnouts in the District are not available, many of the fields that have suitable supply ditches, crops, and geometry have already been fitted with high flow turnouts. If lining of laterals and farm ditches is significantly expanded, the increased flow capacity of lined channels may make more fields eligible for high flow turnouts. This should be a consideration in the prioritization of laterals and farm ditches for lining.

Low Water Use Crops

Looking at the "Big Three" crops comprising more than three quarters of the cropped area within the study area, alfalfa and pecans are high water use crops (consumptive use > 3.0 f) and cotton is a low water use crop (consumptive use < 3.0 f). However, cotton is generally the least profitable of the three, and future market outlook is not good for the crop. While farmers in the area have the experience and equipment to grow cotton, if it is not economically attractive, it does not represent a viable solution to reducing depletion due to crop production.

Sorghum is also a low water use crop grown in the area, with a consumptive use of about 1.5 f. However, McGuckin (2001) states that, while cotton has a modest return, sorghum has a negative return. Clearly, it is not an attractive low water use alternative.

Vegetable crops such as lettuce, onions, chile, and cabbage are also grown in significant quantities in the study area. They are generally low water use crops in terms of depletion. However, they require frequent irrigation to maintain marketable quality, resulting in high required application. The difference between the high application and low depletion suggests that these crops produce relatively large quantities of drain flows, which return to the river and are available for downstream diversion and use. Vegetables are a potentially high return option, but they can also present very high risk, and require a high level of management. Lettuce, for example, is sensitive to moisture stress, disease, pests, and storage time. It sometimes is an extremely valuable crop. However, market forces may drive the value of a crop so low that the revenue from the sale of the crop will not even pay for the harvest operation, in which case the crop is disked in, with no revenue return.

Corn is a lower water use crop (though the 1.9 f consumption stated by McGuckin seems too low) that is grown in increasing quantities in EBID. It can be grown with a relatively lower level of management than vegetables can, and the market for corn is reasonably secure with the local dairies requiring silage. The lower management level and low market risk of corn make it an attractive alternative for many farmers in EBID.

The perfect crop would be a low water use crop with low market risk, high potential return, and it would require a low management level. Unfortunately, the crops that fit this description are generally not legal. For example, hemp, a popular fiber crop that has found many other legal uses, can typically be produced with about 21 inches of applied water, and it handles stress due to deficit irrigation well. Rio Grande Project farmers have demonstrated the ability to adapt to environmental and market conditions, and this ability may represent an opportunity for collaborative conservation efforts.

Economic and agronomic research into low water use crops specifically suited to conditions in the study area could identify crops new to the area with the benefits of low water use, low market risk, and as low a management level as possible. It is likely that if such ideal alternatives were readily available, farmers would have found them already. Some market research and development may be necessary to make lower water use crops attractive. In any case, promotion of low water use crops in an excellent possibility for wet water conservation that should certainly be investigated.

Deficit Irrigation

Deficit irrigation is a technique for dealing with short water supply where less water is applied during an irrigation than is required to fully replenish the root zone soil moisture, or irrigation application is delayed until some moisture stress has occurred. The farmers in the study area often deficit irrigate, particularly in times of drought and particularly with cotton, alfalfa, and forage crops. The problem with implementing deficit irrigation in the study area is that the crops that can be economically deficit-irrigated already are, and the other crops, such as pecans and vegetables, are not economically suited to deficit irrigation because of their comparatively high value and stringent quality requirements. There may be some potential for deficit irrigation scheduling, but in terms of water conservation, this is not the "low hanging fruit."

Cultural Practices

Farmers have shown remarkable ingenuity in developing cultural practices to improve irrigation efficiency and manage deficit irrigation. One example is alternate furrow irrigation. Irrigating every other furrow allows the farmer to manipulate the wetted profile and reduce irrigation while maintaining adequate drainage. Alternate furrow irrigation allows for faster, more efficient advance of the irrigation water across the field for a given available inflow. Equipment for alternate furrow irrigation of cotton has been developed and used successfully in EBID, though the lack of metering prevented specific quantification of the water saving. This innovative development has not been widely publicized, and there are likely many other similar innovations or improvisations developed by local farmers that could help to conserve water if they are thoroughly evaluated and publicized. One high potential water conservation project that would work in conjunction with the farm turnout metering previously discussed, would be to survey farmers as to their cultural practices for water conservation and develop a set of candidate measures for detailed on-farm (rather than at an experiment station) evaluation and demonstration within the study area. While the water savings is impossible to estimate without executing the project, the identification and evaluation of these local technologies would be productive and low cost if carried out in cooperation with the irrigation districts.

8.2.1.5.3 System-Level Conservation

System level conservation practices generally would be implemented through collaboration with the districts, though individual farmers may well be active participants. The water conserved through system level conservation would not historically be associated with an individual user. Rather, the conserved water would be allocated to all constituents pro rata as a normal part of the district water supply. Negotiations would necessarily address how system level water conservation efforts would be evaluated, and how conserved water would be administered for river restoration. Individual system conservation approaches are discussed below.

Canal Lining

The three districts in the study area all have significant lengths of unlined canals out of which water seeps as it is transported from diversion to delivery. Many irrigation districts have drastically reduced the seepage from canals by lining them. By far, the most common lining material is concrete, though many other materials have been tried. Few can match concrete's durability, economy, and familiarity.

The cost of concrete lining is most directly a function of square footage of area to be lined and thickness of lining. For a given canal trapezoidal section, with bottom width B (feet), side slope z, and overall depth D (feet), the square footage of lining per linear foot of canal P (feet) can be computed from the relationship.

Based on data from ditch lining projects in EBID, for smaller canals, the cost per square foot is about $2.22/square foot. This would mean that a typical farm ditch with a one foot bottom width, 30 inch overall depth, and 1.25:1 side slope would require 9 square feet of lining per linear foot of canal, for a cost of $20 per linear foot of canal or $105,600 per mile of canal. A canal or lateral with a bottom width of two feet and a five foot overall depth would require twice the square footage per linear foot of canal, and twice the cost, $40 per linear foot of canal, or $211,200 per mile of canal. In larger canals, the price per square foot increases as the lining becomes thicker and more reinforcement steel or fiber is required. Blair (2001) estimated that in order to line the Hudspeth Main Canal, which has a 22 foot bottom width and a 4 foot depth, the cost would be $600,000 per mile, or $113.64 per linear foot of canal, or $3.26 per square foot. This is basically consistent with the EBID data for smaller canals, considering that the lining must be about 50 percent thicker for the larger canal, and the cost per square foot is therefore 50 percent higher for the larger section.

EBID could benefit from the ability to release and divert less water to achieve a given farm delivery if seepage rates were reduced by lining. This would allow the District to keep water in storage where it can be actively managed. Because it is not a net gain in available water supply to EBID, this is not as attractive an alternative for EBID as it is for EPCWID#1, particularly considering the detrimental effects on ground water discussed above. However, EBID is currently planning to place some of its less efficient sub-laterals in pipe to evaluate the costs and benefits of seepage reduction.

Rates and Rate Structures

Observers often state that irrigation water is too cheap in the study area. They fail to consider one critical point: irrigators own the water rights, and the districts assess them for the delivery of that water. The districts do not operate for profit, and the boards set the assessments based on the cost of operating the districts. Minor modifications to the rate structure might be possible to encourage reduction in water use, such as inclined block rates, but water is clearly priced well below its marginal value for irrigation.

It is likely that the opportunity cost, rather than the assessed cost of water to irrigators will drive a reduction in irrigation use as municipalities compete more aggressively for use of irrigation water. The municipal market will effectively drive the cost of water to the point where irrigators will conserve water because it is more profitable to grow houses than many of the crops in the study area. One can expect to see farmers growing lover value row crops such as cotton and sorghum seek opportunities to market their water to municipalities and reduce cropped acreage, pump more ground water (as long as it is uncontrolled), or outright fallow their lands. This is likely an unfortunate development for the prospects for obtaining water and water rights for environmental management, as environmental interests will have to compete for water not with relatively low priced irrigation markets, but with increasingly competitive municipal and industrial water markets.

Charges to Constituents

The present drought is forcing the districts to look at more stringent administration of the available water supply, and one area of consideration is the charging of diversions and deliveries. In the past in EBID, farmers were not charged for ordering water that they did not use. Many reasons may cause a farmer to not take water when delivered, ranging from the water arriving at an inconvenient time, such as the middle of the night, to serious problems with the on-farm system. Water ordered but not taken is generally delivered and charged to another constituent who is ready for it or spilled back to the river. The district would be charged for the diversion of water to make the delivery, so if it is spilled back to the river, it is a waste as far as the district is concerned. There are reasons for spills other than farmers' failure to take water that they ordered, such as variation in diversion and conveyance efficiency, and storm flows into the conveyance system, and variation in lag times between control points in the conveyance system.

Release Management to Maximize System Efficiency

In times of drought, the districts managed releases from Caballo to maximize the utility of the surface-water supply. Surface water flows tend to be able to provide higher, more efficient flow rates for irrigation application. For example, a well producing 2,250 gallons per minute would be considered quite substantial. However, that is only about 5 cfs, not even enough water for a single high flow turnout. The general strategy was to start the releases from Caballo later than in full supply years, release water when the demand for irrigation is high, in the early season for start-up irrigation and in June, July, and August, and then shut down early, often when the usable water in storage was exhausted.

Current practice is to schedule releases for irrigation or maintaining flood control space in Elephant Butte and Caballo Reservoirs. The schedule for irrigation is dictated by crops, cultural practices, and the weather, and offers little flexibility for substantial variation. EBID and EPCWID#1 farmers do irrigate in the off season to produce lettuce, onions, cabbage, and possibly wheat and barley. However, the acreage in these crops during the off season is comparatively small (less than 10,000 acres in the two Districts), and the efficiency of running water in the canal systems year round for this small acreage would be quite poor. The City of El Paso relies on ground water in the off season, though there is some talk of year-round releases to facilitate municipal surface-water users in both states and, potentially, in Mexico.

Changing release patterns could alter the hydrograph to simulate natural spring runoff conditions, but it would be a major shift in the policy and philosophy of Rio Grande Project operations. The early season peak in release flow occurring during the week of March 15 in the full supply year of 1999 and during the week of March 27 in the short supply year of 1956 has a peak flow of about 2,200 cfs both years and a volume of release in both cases of about 29,000 AF for the week. For an additional release of about 5,000 ac-ft during this period, a peak flow of 3,500 cfs could be released for two days, simulating a spring runoff flow. This flow would be reduced by diversions as it moves downstream, to roughly 1,300 cfs below International Dam (3,500 cfs – 2,200 cfs for diversion requirements; this is something of a simplification, and the actual peak flow below International Dam would be lower due to attenuation of the peak).

The additional flow in the river would have little benefit to irrigators if the flow stayed in the river. The Districts do not have the capacity to divert the Rio Grande Project Water supply resulting from a release of 3,500 cfs, but if the Districts could divert some of the additional flow through their systems to flush the canals, there would be some benefit to the Districts. Such diversion may largely defeat the purpose of the spring runoff simulation.

While such a release might have beneficial effects on the condition of habitat on the river, measures would have to be taken to ensure that such releases did not harm river structures. In 1995, two months of release in excess of 3,000 cfs, peaking at 4,500 cfs caused scour damage to the siphons under the river in the Rincon Valley that convey EBID water from one side to the other. The effect on these siphons of an increased flow to simulate spring runoff would have to be carefully evaluated. Current practice is to schedule releases to match flows in the river to demands for diversion or to release water from storage to create flood control storage space when Elephant Butte Reservoir is nearly full. Releasing water from storage to create a surge down river that would exceed the diversion requirements of the Districts and Mexico would, under current operations, be considered wasteful, and have serious implications for Compact storage accounting. Of course, some method for obtaining the necessary water by, and assigning that water to, an environmental group would need to be established before such an exercise could be implemented. It all depends on negotiation involving the Districts, BoR, and the Compact Commissioners from Colorado, New Mexico, and Texas.

8.2.2 Water Development Alternatives

Whereas the Water Management Alternatives outline managerial methods to extend the life of the supply, the following Water Development Alternatives actually create additional "wet water" for the Region. The following subsections are general descriptions of potential water development alternatives.

8.2.2.1 Watershed Management

Watershed Management considers methods to improve the quantity and/or quality of water within a Basin. For the Lower Rio Grande Region, this may include the thinning or removal of invasive plant species along the Rio Grande, which have excessive evapotranspiration and water use. Thinning or removal of phreatophyte should be accomplished with appropriate safeguards for the surrounding native terrestrial and aquatic plant and animal communities. Because the riparian corridor provides critical habitat for plants and animals and because successful phreatophyte control and management will necessitate revegetation, this will be accomplished with key native riparian plant communities. Watershed Management alternatives may increase recharge in the upper aquifer layers.

8.2.2.2 Rainfall Augmentation

Clouds are comprised of water droplets that form as water vapor condenses or sublimates around extremely small particles such as sea salts that are carried naturally by the winds throughout the atmosphere. Only a small part of the available moisture in clouds is transformed into precipitation that reaches the surface. Scientists have found through experimentation that adding particles to natural clouds may, under the right conditions, cause or increase the amounts of rain or snow. The particles may be similar to naturally occurring sea salts, or may be ice crystals. The process of adding particles to clouds is called cloud seeding, whether the particles are delivered from aircraft or from ground-based sites.

Scientists and engineers have conducted cloud seeding experiments and operations in many countries around the world over several decades. Weather modification activities to enhance water supplies have been conducted for a wide variety of users including government agencies, water resource managers, hydroelectric power companies, and agricultural interests. While some experiments have yielded inconclusive results, others have been quite successful. Scientists have learned that cloud seeding is a complex operation that requires much thought and careful planning to obtain desired results. Successful cloud seeding efforts may augment rain volumes by as much as 130 percent as shown by experiments conducted in West Texas. A modest increase of 5 to 20 percent appears reasonable.

It is an obvious but important fact that cloud seeding is unlikely to produce rainfall from a cloudless sky. Cloud seeding is not a viable alternative to produce near-normal rainfall during a drought. The objective of a cloud seeding program would be to increase the amount of average rainfall so as to increase the long-term average annual supply of both surface and ground water in storage. The quantities of water added during the wetter months and years would then be available in long-term storage to meet needs during drier months and years. Thus, the cloud seeding alternative is one that would be most useful when coupled with other alternatives such as expanding storage capacity.

8.2.2.3 Desalination

Desalination of brackish ground water is a technology used to create potable water supply from saline (or non-potable) supplies. More than 12,000 desalination plants are under use worldwide. Deeper, brackish aquifers in the Hueco Bolson, Jornada and Mesilla Basins can be tapped to create useable water resources. The deeper aquifers have less pumping effects on the Rio Grande, and may be utilized more efficiently by desalination. Costs to desalinate brackish waters are proportional to the level of TDS, and sharply increase when TDS levels are above 10,000 mg/L. A significant cost component of inland desalination systems is the disposal of the concentrate (brine) that is generated.

8.2.2.4 Underground Aquifer Storage and Recovery

Aquifer Storage and Recovery (ASR) may be used to store water for future use. ASR refers to taking excess water and injecting it into an aquifer for storage. The water may be withdrawn at a later time for uses such as irrigation, municipal, and commercial. Storing water in an aquifer allows for a vast quantity of water to be stored without evaporation losses or the construction of surface lakes or tanks. ASR is currently being performed in neighboring states in order to replenish areas where severe declines in ground water levels have occurred, and to re-use water. Potential sources of injection water include treated waste-water, storm-water runoff, excess EBID water, and treated surface water that could be leased or purchased from agricultural users. Treated wastewater streams from municipalities could be re-injected up gradient of well fields to reduce ground-water drawdowns. Peery and Finch (2002) performed an assessment of ASR in the Mesilla and Jornada basins in which preliminary ASR sites were identified.

New Mexico Statute 72-5A-6 (NMSA, 1978, 72-5A-1 to 72-5A-17 Ground Water Storage and Recovery Act, New Mexico Laws 1999, chapter. 285, § 1) specifies requirements for evaluating ASR projects as follows:

A. The state engineer shall issue a permit to construct and operate a project if the applicant has provided a reasonable demonstration that:

(1) The applicant has the technical and financial capability to construct and operate the project;

(2) The project is hydrologically feasible;

(3) The project will not impair existing water rights or the state's interstate obligations;

(4) The project will not be contrary to the conservation of water within the state;

(5) The project will not be detrimental to the public welfare of the state;

(6) The applicant has completed applications for all permits required by state and federal law;

(7) The applicant has a valid water right quantified by one of the following legal processes:

(a) Water rights adjudication;

(b) Consent decree;

(c) An act of congress, including a negotiated settlement ratified by congress;

(d) A contract pursuant to 43 USC 620 et seq.; or

(e) An agreement with an owner who has a valid water right subject to an application for a change in purpose, place of use or point of diversion; and

(8) That [sic] the project will not cause harm to users of land and water within the area of hydrologic effect;

B. A permit for a project shall include:

(1) The name and mailing address of the person to whom the permit is issued;

(2) The name of the declared underground water basin in which the project will be located;

(3) The capacity and plan of operation of the project;

(4) Any monitoring program required;

(5) All conditions required by or regulations adopted pursuant to the Ground Water Storage and Recovery Act [72-5A-1 to 72-5A-17 NMSA 1978]; and

(6) Other information the state engineer determines to be necessary.

C. The permit shall not become effective until the applicant obtains all other required state and federal permits.

D. The state engineer shall adopt regulations to carry out the provisions of the Ground Water Storage and Recovery Act, including monitoring the operation of projects and their effects on other water users in the area of hydrologic effect, including an Indian nation, tribe or pueblo. In determining monitoring requirements, the state engineer shall cooperate with all government entities that regulate and monitor the quality of water, including the department of environment.

8.2.2.5 Storm Water Capture

A significant portion of the Rio Grande Project Water supply has come from local rainfall/runoff. Storm flows tend to come when irrigators least need it – during large rainfall events that reduce the need for irrigation. Some natural drainages are plumbed into EBID's conveyance system, so that storm flows can be used to make deliveries to EBID constituents.

Flow measurement systems are needed to quantify stormwater inflows, and to provide early warning so those water managers can alter their operations in anticipation of a runoff event providing water to the system. However, additional impoundment of storm flows and use of that water could alter the historical equity of distribution of Rio Grande Project water between EBID and EPCWID#1. This, and many other water management issues, depends on the development of an operating agreement between EBID and EPCWID#1 that specifies EPCWID#1's entitlement to Rio Grande Project Water.

Shallow infiltration and aquifer recharge can also be accomplished through flood control facilities. Detention ponds used for storm-water control can also be used. Spreading basins or "french drain" type shallow infiltration wells are used to percolate flood or storm waters into the shallow aquifer for recharge to the ground water.

8.2.2.6 Leasing of Agricultural Water Use to Municipal, Industrial and Environmental Use

8.2.2.6.1 Transfer Policies and Procedures.

In discussing transfer policies and procedures, it is important to make a semantic distinction between the transfer of water and the transfer of a water right. Transfer of water is a short-term arrangement that leaves the water right associated with the transferred water appurtenant to the land from which it was transferred. Transfer of a water right is a permanent arrangement in which the water right is removed from the land from which it is transferred, and the right becomes appurtenant to the land to which it is transferred. The EBID is in the process of establishing regulations to implement the SWUA (see Section 5.6). Under this legislation, member municipalities may lease EBID water for municipal use in a surface-water treatment plant.

8.2.2.6.2 Non-Agricultural Water Use

At present, all water managed by EBID is delivered to nominally agricultural users. This includes some landscape irrigation, particularly on small tracts (less than two acres). However, EBID and the City of Las Cruces, recognizing the need for a water supply for municipal growth in EBID's service area jointly went to the Legislature to create a SWUA for the delivery of agricultural water for municipal treatment and use. While the SWUA policy was negotiated with the City of Las Cruces, SWUAs may be cities, counties, public water suppliers, state universities, or privately owned water suppliers.

The SWUA concept established by EBID Board-approved policy sets several rules for the use of water for municipal purposes. It is intended to facilitate the use of surface water by municipal providers. The policy was negotiated to maintain equity among EBID water users (both agricultural and municipal), to maintain consistency with EBID's policies and statutory obligations, and to maintain the hydrologic health of the system. It is anticipated that EBID will adopt similar regulations to implement the SWUA legislation.

Patterned on the EBID's existing framework for moving water around the District, the policy allows SWUAs to acquire water in four different ways:

1. They may acquire water-righted land, and use the appurtenant water right for municipal purposes;
2. They may acquire non-water righted land within EBID's boundaries that meet District criteria for water rights, and purchase water rights from other land within the District. The water rights can then be assigned to the previously non-water righted land through the District's process of volitional suspension and transfer.
3. They may lease water right from other water users in the District. The term of the lease can be from five to 40 years, and the price is negotiated between the SWUA and the individual leasing water to them;
4. They may purchase water on an annual basis from the District's conservation pool. This procedure is still under development, and the District is considering dividing the current Conservation Pool into an Agricultural Conservation Pool, from which irrigators would acquire water, and a Municipal Conservation Pool, from which SWUAs would acquire water.

The resulting organizational structure is shown in Figure 8.4.

Other details of the policy include:

- The water rights owned and leased by a SWUA are consolidated for billing purposes.
- A SWUA receives the same pro rata allocation as irrigator, and that allocation is diminished proportionally in water-short years.
- The point of delivery for a surface-water treatment plant (SWTP) must be within District boundaries.
- The SWUA must deliver the amount of water produced by their SWTP to users within District boundaries.

- Land from which water rights are leased must be within the SWUA's service area, or the lease must be approved by EBID's Board of Directors. Water righted land owned by the SWUA may be inside or outside the SWUA's service area.
- If water is to be leased from water righted land, all of the water must be leased, and the land not irrigated.
- Until the SWUA is ready to put water to use in a surface-water treatment plant, any water rights they acquire through purchase or lease will go to the agricultural conservation pool where farmers can purchase it.

There are details to be worked out for the administration of the policy, but the foundation is in place. The City of Las Cruces and EBID collaborated to develop and promote legislation to allow the policy to work, including extending the maximum lease term from ten years to 40 years and exempting SWUA transfers from the State Engineer's process for changes in purpose of water rights. The City and District continue to cooperate to remove all obstacles to the implementation of the policy before the SWTPs are actually ready to take delivery of water.

In times of drought, junior water users who continue to use water will be required to obtain water rights to offset their impacts on the available water supply. The SWUA provides a workable way of accomplishing this offset. However, there will be water users who are not in a position to be a part of a SWUA. They would be required to obtain water rights subject to the basic hydrologic constraints imposed upon SWUAs, such as obtaining offsets in their local area if possible to minimize impacts on the system as a whole. EBID may investigate the need for the creation of a Municipal Conservation Pool of water similar to its Agricultural Conservation Pool. Basically, EBID could look at soliciting short-term leases of water allotments from its constituents and then brokering that water to entities or users that do not qualify for SWUA. A policy would have to be developed that contained all the safeguards applied to Rio Grande Project water that is used by an SWUA. It is probable that the SWUAs will pursue the long term leasing of water for their use and that there may be EBID constituents that would be interested in short term leases. One of the drawbacks would be that the transfer process involving the NMOSE that is available for SWUA entities is not currently available to non-SWUA entities.

8.2.2.6.3 Water Use for the Environment (King and Maitland, 2003)

The first and most critical project that must be executed before, or at least in parallel with, physical restoration projects is the development and negotiation of the rules and institutional framework under which water can be acquired, transferred, managed, and accounted for restoration projects. The details of this framework will have profound effects on what is feasible and how projects are executed.

Several issues must be addressed, and several agencies will necessarily need to be involved. The irrigation districts are the logical place to begin negotiations, because the government agencies will be much more likely to cooperate with a unified district - environmentalist proposal than a divided one. Experience suggests that it is not productive to try to satisfy everyone at the same time, so choosing single entities to initiate the process will be most productive.

A logical starting point would be for an environmental group to approach one of the districts to jointly develop a policy creating a class of water use for environmental use paralleling that developed by EBID and the City of Las Cruces for transfers to municipal use. This policy should cover the acquisition of water rights, on a permanent basis, through sale, donation, or reclassification, and transfer of water on a temporary basis. Criteria for suitability and classification of land for restoration should be discussed. The details for accounting for the water, land appurtenance, application of water to land that is not irrigable or is owned by the federal government along the river, consumptive use, and transfers from one part of a given district to another must be addressed.

The other agencies involved in water regulation and management will obviously have to be addressed. Parallel negotiations to develop the institutional means to acquire, manage water for restoration with the state regulatory agencies (New Mexico Office of the State Engineer), and federal agencies involved in river management and administration of water compacts and contracts (BoR, the International Boundary and Water Commission, Fish and Wildlife Service, Army Corps of Engineers) should be undertaken when negotiation with the irrigation districts is making progress.

While the development of the institutional infrastructure for restoration will not in itself immediately put water for use in restoration projects, it is the most important step in the long-term restoration of the river. Irrigators, regulators, and water managers are accustomed and required by statute to follow a uniform set of rules for the allocation and management of water that ensures equity in distribution and protection of individual property rights. Any collaborative restoration effort will have to maintain these qualities. Other projects may certainly be attempted in parallel, but until the institutional arrangements are made to allow water to be put to use for river restoration, the projects will be highly contentious and limited in scope.

Estimating the cost for developing the institutional framework for applying water to river restoration is very difficult to estimate. Legal costs will likely be the largest component of such an effort, and technical evaluation will also be necessary. As the districts are all rather fully committed to fighting legal battles on multiple fronts (including with each other), a grant to help them defray the legal and technical costs of negotiation would certainly make them more receptive to an institutional framework proposal. A pilot project could probably be launched for as little as $10,000, but it is not unreasonable that total costs of such a negotiation could run up to $100,000 or more, if issues are difficult to resolve. In any case, it is a necessary investment.

Returning to the example of EBID and the City of Las Cruces, that negotiation process and resulting policy on SWUAs can provide a model for the development of a policy on Environmental Water Users Associations (EWUA), to coin an acronym. In fact, the EWUA could be classified as a specific type of SWUA. While there are many issues to address, a starting point for negotiations between irrigators and environmentalists could be a policy mirroring that for SWUAs. Allowing EWUAs to acquire water through purchase, lease, or from transfer through an environmental pool would provide access to surface water for restoration activities through the market or by donation. A first cut at an organizational structure is presented in Figure 8.5. Presumably, many of the same restrictions on water use and service area discussed for SWUAs in Section 8.2.2.6 would apply to EWUAs. Several issues come to mind that would have to be addressed in negotiations and with legislation. For example:

1. The EWUA does not have a defined service area, so the location of leased of water rights would have to be addressed.
2. Some sort of definitive statement that river restoration is a beneficial use of water would need to be made by the participating District and probably the appropriate state if the EWUA is to receive water or water rights.
3. Much of the land that would be preferred for restoration activities is not suitable for water use under current agricultural criteria. Some modified criteria for environmental water would have to be developed.

Once the institutional details are worked out, many projects are possible for obtaining water for river restoration.

Purchase of Water Rights

If an EWUA has the financial resources and the institutional framework has been implemented to facilitate it, outright purchase of water rights is the simplest and most flexible method of obtaining water rights. Most irrigators are strong proponents of private property rights, including water. Purchase of the water right for restoration with a willing buyer and a willing seller is likely the most acceptable method to irrigators for acquisition of water.

As the institutional framework now stands, land would have to be purchased or already owned by an environmental group or its members if they are to purchase water rights. The going price of water righted land varies widely, depending on parcel size, parcel location, quality of land for agriculture, existing permanent crops and other improvements, zoning, and general trends in the real estate market. Currently in EBID, water righted agricultural land in parcels of a few dozen acres or larger sells for $4,000-$5,000 per acre in the northern Rincon Valley near Arrey and Garfield, $5,500-$6,000 per acre in the vicinity of Hatch and Rincon, over $10,000 per acre in the Las Cruces area, $6,000 per acre south of La Mesa, and about $8,000 in the Anthony, New Mexico area. Parcel size is a major factor as well, with a 5 acre lot in Mesilla Park selling for $25,000 per acre.

The drawback, of course, is the price. While McGuckin (2001) suggested an average return of $45.45 per AF delivered to an EBID farm, one must consider the opportunity cost to a water rights holder. Growing competition for water, particularly due to the rapid urban growth in the area, has made the price of water rights escalate rapidly. In EBID, the City of Las Cruces is acquiring rights for water on a 40-year lease basis that amounts to an outright purchase for the water right. The City pays $1,000 per acre for small tract (flat rate, less than two acres) water rights, which would be $333/AF in a full allocation of three feet. They pay a sliding scale for farm rate water rights, going from $607 per AF for a two acre parcel to $1,000 per AF for a parcel that is 20 acres or larger. They assume a 3 acre-foot allotment in calculating the total price, so a two acre parcel would receive $1,821 per acre, and twenty acres or larger would receive $3,000 per acre. Note that the price of water approaches the lower end of land prices in EBID. Values between two and 20 acres are linearly interpolated. Of course, if the allocation is short due to drought, the City's allocation will be reduced in the same proportion as the farmers'.

Since Las Cruces has no surface water treatment capacity on line yet, they have not used any of the water.

The lease amounts to a purchase because at the term of the lease, the City has the option to extend the lease or purchase the water right for no additional compensation. Basically, the City controls the water rights until the City can work out the details of land to which the rights can be appurtenant if the City owns them, because the City is not buying the land from which the water rights come.

The City of Las Cruces also purchased water righted land, and maintains the rights appurtenant to those lands. The infamous Kmart parking lot in downtown Las Cruces is an example of water righted land whose water has been going to the Conservation Pool for many years, and will continue to do so until Las Cruces has surface water treatment capability. The City of Las Cruces' preference would be to lease water as described above, so that they do not have to pay for land as well. The problem is that currently, the only way to own District water rights is to have land to which the rights are appurtenant.

Leases of Water

Leases offer much the same advantages as purchase. They are a contractual agreement between a willing lessor and a willing lessee to convey the use of property. Long term leases are a multiple year lease, as opposed to an annual transfer of water. As stated previously, the City of Las Cruces has a long term lease program building water rights for the time when their surface-water treatment plants go online, but in this case it really amounts to a sale.

In 1999, EPCWID#1 commissioned a study of water prices in the western United States by Business Valuation Services. Adjusting various complicated contract terms and details for sales and leases to common dollars per acre-foot per year, that study showed the transactions provided in Table 8.6.

TABLE 8.6: WATER PRICES IN THE WESTERN UNITED STATES BY BUSINESS VALUATION SERVICES (1999)							
To	**From**	**$/af/yr**	**Purpose**	**Quantity**	**Year**	**Lease/ Buy**	**Term (years)**
City of Westminster (CO)	Irrigator	1,026.67	Municipal	22.5	1997	Buy	
Residential Developer (UT)	Irrigators	480.00	M&I	15	1999	Buy	
Town of Taos (NM)	Irrigators	382.00	Municipal	98	1997	Buy	
San Diego County Water Authority (CA)	Imperial Irrigation District	249.00	M&I, Ag	130000	1997/ 98	Transfer	45
Santa Fe County Utility (NM)	4 individuals	244.90	M&I	588	1997/ 98	Buy	
City of Fort Collins (CO)	3 irrigators	165.82	Municipal	30.25	1997/ 98	Buy	
City of Boulder (CO)	Irrigator	140.00	M&I	25.5	1998	Buy	
City of Boulder (CO)	2 irrigators	114.71	Municipal	39.44	1997/ 98	Buy	
Lower Colorado River Authority	Garwood Irrigation Co.	89.11	M&I	101000	1998	Buy	
City of Brownsville (TX)	Brownsvill e Irrigation Dist.	85.20	Municipal	1152	1998	Buy	
North Alamo Water Supply Corp. (TX)	Hidalgo County Irrigation Dist.	76.80	Municipal	68	1997/ 98	Buy	
Bexar Municipal Water District (TX)	BMACWC ID	56.00	Municipal	6000	1997	Lease	20
Sacramento County Water Agency (CA)	Browns Valley Irrigation Dist.	50.00	Municipal	4000	1997	Lease	1
Sacramento County Water Agency (CA)	Browns Valley Irrigation Dist.	50.00	M&I	3000	1999	Lease	1
Martindale Water Supply Corp. (TX)	Green Valley Farms	45.00	M&I	396	1999	Lease	5
Sandy City (UT)	Irrigators	34.73	M&I	492.66	1999	Buy	

TABLE 8.6: WATER PRICES IN THE WESTERN UNITED STATES BY BUSINESS VALUATION SERVICES (1999)							
To	**From**	**$/af/yr**	**Purpose**	**Quantity**	**Year**	**Lease/ Buy**	**Term (years)**
San Antonio (TX)	Irrigators	34.00	Municipal	550	1999	Buy	
San Antonio Water System (TX)	Irrigators	30.00	M&I	2219.8	1999	Lease	5
San Antonio (TX)	Irrigators	25.00	Municipal	588	1999	Lease	3
San Antonio Water System (TX)	Irrigators	25.00	M&I	1126	1999	Lease	3

Passive Use of Water for Restoration

One major consideration in planning restoration activities is that not all restoration needs to have water allocated to it. If a restoration project can be implemented without impairing other water rights, most farmers would not object. Of course, it would have to be demonstrated that the quantity, timing, and quality of water deliveries are not impaired, and developing acceptable methods based on the best available science would be a valuable contribution to the field of river restoration.

This passive use of water, in which water need not even be allocated or diverted, could occur in the river channel as improvements are made along its course. Various forms of this approach are being analyzed in an EIS process being conducted under the supervision of the IBWC for restoration of varying degrees in the canalized sections of the river. The alternatives are not being well received by the irrigators, at least in EBID, because the alternatives other than no action will increase riparian depletions along the river, and there is no way for the IBWC to offset these depletions other than taking it from the Rio Grande Project water supply. This appears to many farmers in the Rio Grande Project to be a government taking of their water right. Unfortunately from a river restoration perspective, the river has been engineered and manicured for many decades to minimize riparian evapotranspiration, maximize flood conveyance capacity to protect property, and convey water as efficiently as possible to the diversion points of the Rio Grande Project. The river is maintained in an incised, relatively straight channel, and the overbank between the flood control levies is kept mowed except for a bank stabilizing fringe of native and exotic trees at the edge of the main channel. Any significant attempt to restore the river to a more natural stream will result in increased depletions, so before any such project is attempted, some way of addressing the institutional issues discussed in this chapter and offsetting depletions with acquired or conserved water will be necessary if farmer cooperation or approval is expected.

On the other hand, the drain system of EBID represents an opportunity for creation of riparian habitat. The drains represent about four times the length of the river in the study area. They are generally more heavily vegetated than the river. The flow velocities are much lower than in the river channel, and their flow tends to continue through the non-irrigation season. Since the drains already are fairly heavily vegetated, largely by the high consumptive use exotic species salt cedar, riparian restoration projects could be implemented in the drains without increasing the depletion to the system. The drainage system of EBID is in many respects the most viable riparian habitat in the study area.

This approach is the basis for a collaborative project among EBID, the City of Las Cruces, and the Southwest Environment Center (SWEC). Using a parcel of land owned by the New Mexico Game and Fish Department, the cooperating organizations are developing a Bosque Park at the confluence of the Picacho Drain and the Rio Grande. The site, shown in October of 2001, has large stands of heavy salt cedar that are to be removed and replaced with a more open canopy of native vegetation species. Work by Bawazir (2000) at the Bosque del Apache indicates that the difference in evapotranspiration between a dense salt cedar stand and a restored cottonwood stand with less dense canopy was more than one foot. The reduction in evapotranspiration due to the change in vegetation at the Bosque Park allows restoration of native vegetation and even some open water and wetlands without increasing net depletion. EBID agreed to this particular project as a pilot to explore the possibility of restoration within existing frameworks.

There are drawbacks to restoration in the drains. In times of drought the drains may dry out for months or even a year at a time. This could cause the loss of plant materials and habitat. One possible solution would be to hold some water rights, either by ownership, donation, or lease, which could be applied to the drain to keep it alive in times of drought. Basically, this amounts to irrigating the drain when the water table drops below the drain invert.

While the rights-of-ways are narrow enough to present some restoration problems (typically 75 to 100 feet, including maintenance roads), they also present an opportunity for farmer collaboration. Much of the extensive length of drains is adjacent to private farm land. The width of the drains as riparian habitat could be widened, at least in sections, by implementing a conservation easement program. Under such a program, either incentive based or purely voluntary, farmers could set aside frontage along drains to provide extra width to the riparian zone. Environmental groups could assist in planning and construction of restoration corridors along the drains and conservation rights-of-way, and farmers would receive the benefit of the improved habitat literally right in their own back yards.

The depletion within the drain right-of-way could generally be maintained as unchanged, and the conservation right of way would already be water righted. The cost to the farmer would be the loss of potentially productive farm land, and so some sort of an incentive program would likely be necessary. A logical place to start on this concept would be to do a comprehensive survey of irrigated land owners along the drains to see what the level of interest would be in such a program, what the spatial distribution of interest along the drains would be, and what sort of incentives would be necessary to motivate irrigators to participate. EBID and EPCWID#1 have geographical information systems that could perform a spatial query to identify all land owners along suitable drains who could then be surveyed. Agreements with the districts would also need to be negotiated to allow restoration in the drain rights-of-ways while maintaining the function and maintenance access to the drains.

The feasibility of restoring habitat in the drains would have to be carefully evaluated and planned. In the agricultural areas, the depth of the water surface below the surrounding land generally runs from about six feet to as much as ten feet. Generally the drains need to be as deep as they are to avoid elevated ground water in local agricultural lands. The interaction of riparian vegetation with the ground-water table is a critical element of restoration planning, so depth to ground water in the drainage and conservation rights-of-ways would also have to be evaluated

8.2.2.7 Las Cruces Sustainable Water Project

By making use of the above SWUA process, surface water will be available to augment the ground water supply for a number of communities in the Mesilla-Rincon basin. This surface water will need to be treated to meet drinking water standards. The Las Cruces-El Paso Sustainable Water Project described three regional surface-water treatment plants that could be constructed; one each at Hatch, Las Cruces and Anthony.

8.2.2.7.1 Hatch Area Water Treatment Plant

The proposed Hatch Area SWTP would be located approximately 0.5 mile east of Hatch, New Mexico. The Plant would serve Doña Ana County's North Planning Area, which includes the communities of Hatch, Salem, Garfield and Rincon, as well as a potential spaceport. The SWTP would have an initial capacity of 3.5 MGD possibly beginning around 2007 and increase to 4.5 MGD around 2015. If the proposed spaceport is not constructed, then the capacity would be 1.0 MGD initially and 2.0 MGD in 2010.

8.2.2.7.2 Las Cruces Area SWTP

The Las Cruces area SWTP would be located on the Rio Grande at Interstate-10 (I-10). The plant would serve Doña Ana County's Central Planning Area, which will include the City of Las Cruces and possibly some mutual domestic water users. The SWTP would have an initial capacity of 20.0 MGD beginning around 2005 and increase to 27.0 MGD for Phase 2, and increase to 34.0 MGD in Phase 3 (year 2020 to 2030).

8.2.2.7.3 Anthony Area SWTP

The Anthony area SWTP would be located on the Rio Grande about midway between the communities of Anthony, New Mexico and Chamberino, New Mexico. The plant would serve Doña Ana County's South Planning Area, which will include the communities of Anthony (New Mexico), Vado, Berino, Chamberino and La Mesa. The SWTP would have an initial capacity of 4.0 MGD beginning around 2005 and increase to 8.0 MGD in Phase 2, and increase to 16.0 MGD in Phase 3.

8.2.2.8 Importation of Water

Water from other Regions outside of the Lower Rio Grande may be imported into the region. Even though this option would be extremely difficult to implement and expensive, some possibilities were put on the table for discussion. These potential importation schemes included importing water from the Gila River Central Arizona Project (up to 18,000 ac-ft/yr); importing water from the Nutt-Hockett Basin and importing water from the Salt Basin in southern Otero County. Imported water could also be used in an ASR program for immediate or drought use.

The aquifers providing water to wells in the Nutt-Hocket Basin consist of alluvium which has saturated thicknesses ranging from about 250 to 700 feet. The upper portion of the underlying Uvas Basalt is also reported to provide water production to wells. Well yields range from hundreds up to 1,500 gpm in a well completed in 1997. The ground water does appear to flow towards the Rio Grande/Rincon Basin. Current work by John Shomaker and Associates, Inc., in the Nutt-Hocket Basin, indicates that there were drawdowns of up to 80 feet in some areas of the Basin between 1975 and 1997. Although there have been relatively large drawdowns in portions of the Nutt-Hocket Basin, this does not preclude the Nutt-Hocket Basin from potentially providing a valuable alternative water source assuming that the water importer purchased the water rights. Exportation of water from the Nutt-Hocket Basin would have no greater impact on either the ground water system within the basin, or the Rio Grande, than water consumptively used within the Nutt-Hocket Basin.

8.2.2.9 Summary of Water Development Alternatives

The following Table summarizes the applicable Water Development Alternatives by Basin.

TABLE 8.4 – SUMMARY OF WATER DEVELOPMENT ALTERNATIVES BY BASIN

Alternative No.	Alternative	Description and Place of Use
MESILLA/RINCON BASIN		
1	Watershed Management	Removal of invasive plants along Rio Grande
2	Brackish Water Desalination	In conjunction with deep aquifer development
3	Aquifer Storage and Recovery	Off-river ASR for excess flows below Caballo Reservoir
4	Storm Water Capture Aquifer Recharge	Add shallow aquifer ASR to existing flood control dams
5	Reclaimed Water Re-use	Reclaimed water on NMSU, City of Las Cruces green spaces, golf courses. Doña Ana County and La Mesa WWTP develop reclaimed water
6	Residential Conservation	Per capita reduction goal of 8 to 45 GPCD in Basin*
7	Agricultural Conservation	Compensate farmers for conservation; savings used in EBID lease program
8	Agricultural Water Lease	Las Cruces, Anthony and Hatch participate in EBID lease

TABLE 8.4 – SUMMARY OF WATER DEVELOPMENT ALTERNATIVES BY BASIN		
Alternative No.	**Alternative**	**Description and Place of Use**
MESILLA/RINCON BASIN		
9	Water Importation	Import water from other Regions for use, ASR or compact obligations on Rio Grande, trade with EBID up-stream.
10	Water Metering	Quantification of water used.
JORNADA BASIN		
1	Rainfall Augmentation	Cloud seeding in upper elevations of San Andreas and Organs
2	Reclaimed Water Re-use	CLC use reclaimed water on green spaces; return flow credits
3	Residential Conservation	Per capita reduction goal of 10 GPCD in Basin
4	Storm Water Capture Aquifer Recharge	San Andreas Mtns./ASR
5	Brackish Water Desalination	In conjunction with deep aquifer development
6	Water Importation	Import water from other Regions for use, ASR.
7	Water Metering	Quantification of water used.
HUECO BOLSON		
1	Brackish Water Desalination	In conjunction with deep aquifer development
2	Water Importation	Import water from Salt Basin for use and ASR to re-charge Basin; import Rio Grande water for ASR.
3	Retire Agricultural Water Rights	About 900 ac-ft/yr use for M&I
4	Reclaimed Water Re-use	Use for ASR to re-charge ground water
5	Residential Conservation	Per capita reduction goal of 17 GPCD in Basin
6	Water Metering	Quantification of water used.

*This is based on an estimated 10% reduction.

8.3 Drought Contingency Plan

Drought is a natural climatic condition which has occurred many times in the past and which will occur again. The purpose of a drought plan is to provide a management framework for dealing with drought. In addition, it may be used to manage water emergencies that result in temporary loss or reduction in service due to non-climate related factors.

The specific purposes of a drought contingency plan are as follows.

- To provide contingency plans to manage drought and emergency conditions.
- To continue to deliver a cost effective, adequate, safe and reliable supply of high quality water.
- To assist in implementing the Lower Rio Grande Valley 40-Year Water Plan which identifies the need to plan for periods of critical water shortages as a result of drought.
- To identify successful public information strategies which will motivate the community to reduce normal consumption to drought allowances.
- To recommend a programmed response for each stage which would most effectively reduce water consumption to the available supply with the least adverse impact on the residents of the Lower Rio Grande Regional Water planning area.

An example Drought Contingency Plan is provided in Appendix I. However, the water management entities in the Lower Rio Grande are encouraged to develop their own drought contingency plan that is designed to meet their individual needs. Some of the larger entities (City of Las Cruces, NMSU, and EBID) already have plans in place. A copy of the Drought Contingency Plan for the City of Las Cruces is also included in Appendix I.

8.4 Evaluation of Water Management and Water Supply Alternatives

The evaluation of the water management and water supply alternatives was performed by the public, the consultant team and the LRGWUO Technical Committee during several meetings. Initial meetings with the public, the consultant team and the LRGWUO Technical Committee, held in June and July 2001, developed the alternatives and the screening criteria for selection of the "short list" alternatives that are presented in Tables 8.5 and 8.6. Additional meetings were held by the consultant team with the LRGWUO Technical Committee on July 28 and October 23, 2003 to review the alternatives and their respective rankings. The feasibility of each of the alternatives was based on the criteria outlined in the ISC Regional Water Planning Handbook (modified June 24, 1999) and include technical, political, legal and financial. A system of high, medium and low feasibility was used where low indicates an alternative that would be the most difficult or most costly to implement. Alternatives were also evaluated on their social and cultural impacts and on their physical, hydrological and environmental impacts. For the impacts, low implies minimal impacts and high indicates that if the alternative was selected for implementation, the consequences could be quite significant.

The Committee reviewed the impacts of the alternatives on the area benefiting from the source of the water supply but also where the supply might be coming from. For example, importing water from outside the Mesilla Basin from the Salt Basin may not have a significant environmental effect on the Mesilla Basin, but that importation may have serious consequences on future potable supplies in the Salt Basin itself, so this alternative would be ranked as having a high impact.

The evaluations were assessed by basin/ bolson and not for the whole Planning Region due to the complexity of the Region described in Section 8.1. However, since grant/ funding requests, etc., for projects within the Planning area are administered by the LRGWUO, the prioritization of "short list" projects (see Section 8.4.5) has been addressed for the Planning Region as a whole. A list and brief description of the "no go" alternatives is presented in Section 8.4.4.

8.4.1 Evaluation of Water Management Alternatives

The following Tables summarize the evaluation of Water Management Alternatives for each basin/ bolson.

TABLE 8.5: EVALUATION OF WATER MANAGEMENT ALTERNATIVES

Alternative	Feasibility (Low = Most Difficult to Implement)				Social and Cultural Impacts	Physical, Hydrological, Environmental Impacts
	Technical	Political	Legal	Financial		
MESILLA / RINCON BASIN						
Public Education	High	High	High	High	Low	Low
Residential Conservation	High	High	High	High	Low	Low

TABLE 8.5: EVALUATION OF WATER MANAGEMENT ALTERNATIVES						
Alternative	Feasibility (Low = Most Difficult to Implement)				Social and Cultural Impacts	Physical, Hydrological, Environmental Impacts
	Technical	Political	Legal	Financial		
Agricultural Conservation	High	High	High	Medium	Low	Medium
Reclaimed Waste Water Re-use	High	High	Low	Medium	Low	Low
JORNADA BASIN						
Public Education	High	High	High	High	Low	Low
Residential Conservation	High	High	High	High	Low	Low
Agricultural Conservation	High	High	High	Medium	Low	Medium
Reclaimed Waste Water Re-use	High	High	Low	Medium	Low	Low
HUECO BOLSON						
Public Education	High	High	High	High	Low	Low
Residential Conservation	High	High	High	High	Low	Low
Reclaimed Waste Water Re-use	High	High	High	Low	Low	Low

8.4.2 Evaluation of Water Development Alternatives

The following tables summarize the evaluation of Water Development Alternatives for each basin/ bolson.

TABLE 8.6: EVALUATION OF WATER DEVELOPMENT ALTERNATIVES						
Alternative	**Feasibility (Low = Most Difficult to Implement)**				**Social and Cultural Impacts**	**Physical, Hydrological, Environmental Impacts**
	Technical	**Political**	**Legal**	**Financial**		
MESILLA/RINCON BASIN						
Brackish Water Desalination	High	High	High	Low	Low	Low
Water Importation	High	Medium	Low	Low	Low	High
Aquifer Storage and Recovery	Medium	High	Medium	Medium	Low	Low
Storm Water Capture	High	High	Medium	Medium	Low	Medium
Watershed Management	High	High	High	High	Low	Low
Water Metering of Surface and Ground-Water Systems	High	Medium	Medium	Medium	Medium	Low
Agricultural Water Lease (SWUA)	High	High	Medium	Medium	Low	Low
Environmental Water Lease (EWUA)	High	High	Medium	Medium	Low	Low
JORNADA BASIN						
Brackish Water Desalination	Low	High	High	Low	Low	Medium
Water Importation	High	Medium	Low	Low	Low	High
Aquifer Storage and Recovery	High	High	Medium	Medium	Low	Low
Storm Water Capture	High	High	Medium	Medium	Low	Medium
Watershed Management	High	High	High	High	Low	Low

TABLE 8.6: EVALUATION OF WATER DEVELOPMENT ALTERNATIVES						
Alternative	Feasibility (Low = Most Difficult to Implement)				Social and Cultural Impacts	Physical, Hydrological, Environmental Impacts
	Technical	Political	Legal	Financial		
HUECO						
Brackish Water Desalination	High	High	High	High	Low	Medium
Water Importation	High	Medium	Medium	Low	Medium	High
Aquifer Storage and Recovery	Medium	High	High	Low	Low	Low
Retire Agricultural Water Rights	High	Medium	High	High	Medium	Low

8.4.3 Recommended Actions

The following actions are recommended to provide the additional water supply needed for the planning period, by basin.

8.4.3.1 Water Management Alternatives

Water Management Alternatives for the Planning Region include water conservation and public education and a Region-wide public educational and water conservation programs should be developed. The following Water Management Alternatives are recommended to provide the additional water supply needed for the planning period, by basin.

8.4.3.2 Water Development Alternatives

8.4.3.2.1 Mesilla-Rincon Basin

Water Development Alternatives include watershed management through the removal of high water use invasive vegetation along the Rio Grande, storm-water capture, and ASR. The EBID water lease program, in conjunction with the El Paso-Las Cruces Sustainable Water Project will be used as the basis to convert surface water currently used to meet agricultural demands to municipal and industrial uses by the communities of Hatch, Salem/Ogaz, Garfield, Rincon, Doña Ana, City of Las Cruces, Anthony (NM), Berino, Chamberino, Vado and Las Mesa and for environmental demands.

A reclaimed water program should be developed by NMSU for golf course and turf irrigation. The City of Las Cruces should use reclaimed water on parks, school playing fields and golf courses (Sonoma Ranch and Las Cruces Country Club). The La Mesa WWTP can provide reclaimed water to green spaces in the area. These reclaimed water use alternatives will require significant financial investments for the necessary infrastructure. Water metering has been implemented in some areas where participating entities have the authority to do so; however, there is a need for a comprehensive metering program throughout the basin.

8.4.3.2.2 Jornada Basin

The Water Development Alternatives include additional ground-water use by the City of Las Cruces, storm-water capture, ASR and, at some point in the future, desalination of deeper brackish ground water may be required. Waste water reclamation and re-use is also recommended for the public schools with large turf irrigation requirements.

8.4.3.2.3 Hueco Bolson

The Water Development Alternatives include desalination of deeper brackish ground water; storm-water capture, ASR and importation of Salt Basin water for aquifer recharge. Waste water reclamation and re-use is also recommended for turf irrigation requirements on public properties. Retirement of some agricultural water rights, and their conversion to municipal use may also be considered. Importation of Rio Grande water is not considered feasible.

8.4.4 Alternatives Considered but not Recommended for Further Study or Implementation

The following alternatives were considered but were not recommended for further study or implementation.

- Ground-water Mining - this has too high of a potential to cause salt water intrusion to well fields that presently have TDS levels below 1000 parts per million.
- Cloud Seeding – this has not been demonstrated to be a viable option for this region and has serious political ramifications (Mexico).
- Expanding well fields in the Jornada to the north to spread the pumping impacts out over the entire ground-water basin - this would significantly increase the length of conveyance systems since the water is primarily for use within the City of Las

Cruces, it would also have the same long term effect as water mining since there is a higher concentration of brackish water in the north portion of the Jornada Basin.

8.4.5 Recommended Implementation Schedule

TABLE 8.7: RECOMMENDED IMPLEMENTATION SCHEDULE BY BASIN

Ranking	Alternative	Implementation Schedule	Reference
1	Metering	On-going	Section 8.2.1.5.2
2	Re-Use	On-going	Section 8.2.1.3
3	Special Water Users Association-EBID Surface Water	City of Las Cruces-2010 Village Hatch-2010 Doña Ana MWCA-2005	Section 8.2.2.7, El Paso – Las Cruces Sustainable Water Project, Water Resources Technical Report, Vol. 1, p. 1-13.
4	Agricultural Conservation	On-going	Section 8.2.1.5
5	Residential Conservation	On-going	Section 8.2.1.4
6	Watershed Management	On-going	Section 8.2.2.1
7	Aquifer Storage and Recover (ASR)	Develop Plans – On going should be complete by 2005 to 2007 Funding – 2008 to 2010 Begin Projects – 2010	Section 8.2.2.4/ ASR studies are currently being prepared by John Shomaker & Associates, Inc, *Aquifer Storage and Recovery Assessment, Nutt-Hockett Basin, Dona Ana, Luna, and Sierra Counties, and Mesilla, Jornada, Hueco, Corralitos Basin, Dona Ana County, New Mexico*.
8	Brackish Water Desalination	Develop Plans –2004 to 2005 Funding – 2005 to 2006 Begin Projects – 2007	Section 8.2.2.3
9	Storm Water Capture	On-going/ Future	Section 8.2.2.8
10	Water Importation	Develop Plan – 2005 to 2008 Funding – by 2008 Begin Project – 2008	Section 8.2.2.9

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