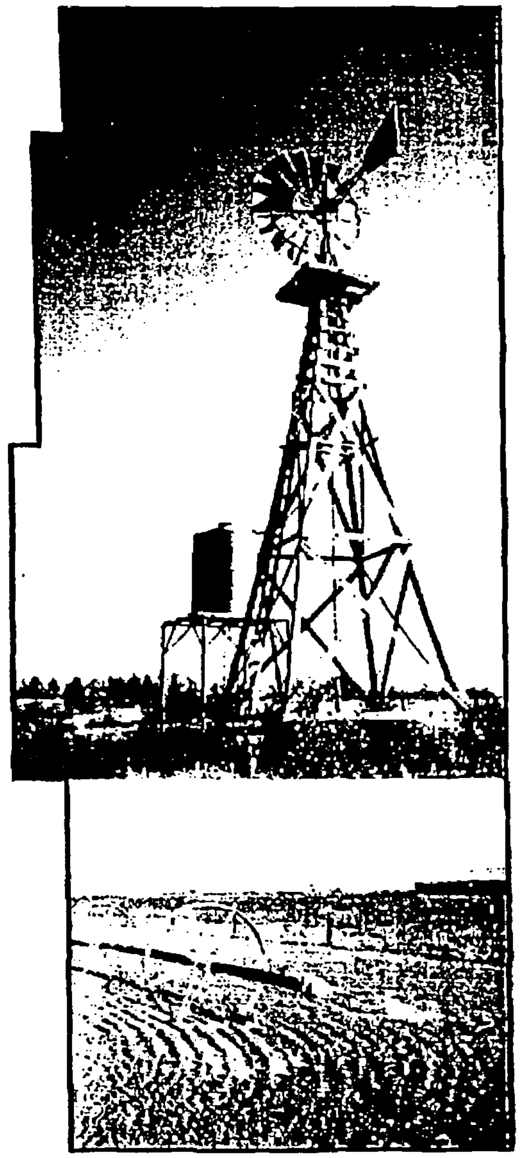
LES Exhibit 26

"Final Report – Lea County Regional Water Plan,"
(Dec. 7, 2000)

FINAL REPORT

Lea County Regional Water Plan

prepared for
Lea County Water Users Association



prepared by

Leedshill-Herkenhoff, Inc.
John Shomaker & Associates, Inc.
Montgomery & Andrews, P.A.

December 7, 2000

EXECUTIVE SUMMARY

Description of Planning Process

The "*Regional Water Planning Handbook*", *December 1994*, provided by the New Mexico Interstate Stream Commission outlines the purpose and method for developing regional water plans for entities within the State of New Mexico. This handbook includes the template that should be followed when completing the water plan. This template lists all of the required elements for a water plan to be considered complete.

The planning process for the completion of the Lea County 40-year Water Plan (Plan) began in September 1998 when the Lea County Water Users Association (LCWUA) awarded the contract to Leedshill-Herkenhoff, Inc. (LHI). John Shomaker & Associates and Montgomery & Andrews, PA have sub-consulted with LHI in development of the Plan.

Four public meetings were held during the planning process of the Plan in different municipalities throughout Lea County. Each meeting was well attended and beneficial to both the consultant team and the communities. Numerous other meetings were held between the consultants, the steering committee, and/or the LCWUA Board of Directors. These meetings were advertised and made open to the public.

Findings

Water Supply

Ground water resources in Lea County include hydrogeologic strata within five underground water basins declared by the New Mexico Office of the State Engineer (NMOSE). The basins from north to south are the Lea County Underground Water Basin (UWB), a very small portion of the Roswell UWB, the Capitan UWB, the Carlsbad UWB, and the Jal UWB. There are no perennial streams in the County, and surface water is limited to stockponds, playas, and ephemeral drainage.

Ground water in the Lea UWB is present in the Ogallala aquifer, which is part of the High Plains aquifer. Water from the Lea UWB is used for agriculture, domestic, municipal, domestic, livestock, commercial, oil and gas, mining, and industrial purposes. Ground water in the Basin is being pumped out at a faster rate than it is being recharged. Historic water level declines from pumping near Hobbs and along the New Mexico-Texas state line are as great as 50 to 70 feet.

The Jal UWB is the smallest in Lea County, and is the only other basin in the County that provides water for municipal use. The City of Jal is the primary user of water in the Basin. Historic ground water diversions from the Basin have had little impact on water levels, indicating that recharge is about in equilibrium with the amount of water being removed by pumping.

The other UWB's in the County provide water for livestock, domestic, mining, and the oil and gas industry. Water use in these UWB's is fairly limited because aquifers are unable to provide adequate quantities of water to wells for large users, or the water quality is poor.

The annual ground water diversion in Lea County in 1995 was 179,341 acre-feet, the majority of which was from the Lea UWB. Ground water diversions from Lea County are projected to more than double by the year 2040, primarily in response to increased agricultural demands for the dairy industry. While an ample number of water rights exist to meet this projected demand, the reality is there physically not enough water in the Basin to maintain an annual diversion of this magnitude.

Water Demand

The largest type of user of water in Lea County is non-municipal irrigation. The NMOSE has on record a total of 2,007 non-municipal wells with an associated water right of 344,625 acre-feet. The next largest user group is municipalities, with water rights of 48,035 acre-feet.

Water demand in Lea County increased 33% from 1985 to 1995 and is presently about 180,000 acre-feet per year. Similar increases in water use from 1985 to 1995 occurred in Irrigated Agriculture (33%), Public Supply (26%), Domestic (40%), Livestock (106%), and Commercial (21%) use categories. During 1995 to 1998 Industrial use increased 69%. Decreases in water use occurring during 1985 to 1995 in the Mining (-26%) and Power (-22%) categories; these declines are attributed increases to process efficiency. Present water use by category, as a percentage of Lea County's total, is 78% Irrigated Agricultural, 10% for Public Water Supply, 7% Mining, and 3% Power. Present water use by Domestic, Livestock, Commercial Reservoir Evaporation, and Recreation uses are all less than 1% of the total use.

Over the next 40 years –if unrestrained– the water use in Lea County is estimated to increase to approximately 360,000 acre-feet, 105% greater than the 1995 total; this assumes the current CRP acreage returns to irrigated farmland. The largest part of this increase is anticipated to come from Irrigated Agricultural, which is projected to require 290,000 acre-feet in 2040, in response to demands for feed from Lea County's expanding dairy industry. If the current CRP acreage remains fallow, the estimated total annual water use in year 2040 is estimated to be a 340,000 acre-feet per year (of which Irrigated Agricultural will require about 270,000 acre-feet), a 94% increase compared to 1995.

All other water use categories are expected to increase in Lea County over the next 40 years. Specifically, 55% Public Supply, 58% Domestic, 364% Livestock, 58% Commercial, 134% Industrial, 32% Mining, 57% Power, and 55% Recreation are estimated above 1995 uses. These other categories account for a total of approximately 70,000 acre-feet per year of the total annual 2040 estimate.

Water Plan Alternatives

Water plan alternatives for Lea County are intended to accomplish one or more of three things. 1) Conserve water, 2) Develop additional supplies, and 3) Management strategy for all water resources. Water conservation measures which will be evaluated include use of low energy precision applicators for irrigation, soil moisture monitoring, more dryland farming, xeriscaping, installation of low flow plumbing fixtures, implementation of an inclining block-rate rate structure for billing, and public education efforts to encourage water conservation. Methods of developing additional water supplies are development of deep aquifers, treatment of lower quality water, water importation, aquifer recharge, and cloud seeding. A management strategy for all water resources will include trying to get the Lea UWB closed to new appropriations, utilizing a ground-water flow model to predict the impacts from ground water pumping as well as ground water recharge projects, monitoring seasonal water level fluctuations, and monitoring water quality.

Recommended Water Plan for the Region

The recommendations made within this report suggest ways Lea County can become proactive in managing its own water-related issues. The plan notes the supply problems that will occur if the County as whole does not implement a strategy to make their resource last longer. The recommended plan for Lea County involves evaluating the feasibility of the alternatives mentioned above, and implementing the alternatives that will prolong ground water resources in the County.

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1. INTRODUCTION

1.1 INDIVIDUALS INVOLVED IN WATER PLAN DEVELOPMENT

Key individuals involved in the development of this Lea County Regional Water Plan (the Plan) are listed below along with their role. The interest of their participatory organizations is discussed more fully in Section 2.3.

1.1.1 The plan was prepared for the Lea County Water Users Association (LCWUA). The LCWUA was represented in the planning process by its Board of Directors:

Chairman	Buster Goff, Lea County,
Vice Chairman	Bob Carter, Lovington,
Secretary/Treasurer	Scott Bussell, Hobbs,
Member	State Rep. Stevan Pearce, Lea County,
Member	County Comm. Bill Brininstool, Lea County,
Member	Mayor Betty Rickman, Tatum,
Member	Don Bratton, Hobbs,
Member	Jim Britton, Hobbs,
Member	Becky Jo Doom, Jal,
Member	John Norris, Lovington,
Member	J. W. Neal, Lea County, and
Ex Officio	County Mgr. Dennis Holmberg, Lea County.

1.1.2 The Board of Directors delegated oversight of the Plans development to a Steering Committee consisting of five individuals:

Public Utilities	John Benard, Lea County Electric Coop,
Agriculture	Leon Hemann, Local Farm Bureau President,
Oil & Gas	Chris Williams, OCD - Energy & Minerals,
Municipalities	Ernie Wheeler, Hobbs Fire Department, and
Domestic Users	Cleve Griffin, Private Well Driller.

1.1.3 The Plan was prepared by a **Consulting Team** consisting of four key professionals:

Leedshill-Herkenhoff	Dan Boivin PE, Project Engineer,
Leedshill-Herkenhoff	Jerry May EI, Project Scientist,
John Shoemaker & Assoc.	Roger Peery CPG, Hydrogeologist,
Montgomery & Andrews	Galen Buller, Attorney.

1.1.4 The LCWUA hired an **Independent Consultant** to review and advise the Consulting Team on their work:

Progressive Environmental Systems Len Stokes, President.

1.1.5 In addition, through the LCWUA and through the public participation program all the Officials and Citizens of Lea County and the Municipalities and Associations therein were involved.

2. DOCUMENTATION OF PUBLIC INVOLVEMENT IN PLANNING PROCESS

2.1 INTERSTATE STREAM COMMISSION - SPONSORED WATER WORKSHOPS

No New Mexico Interstate Stream Commission (ISC) sponsored workshops on water have been held in Lea County. However, in July, 1999 a workshop on GIS mapping for all regions in the state was held and made available to Lea County interests. The ISC contracted with the Water Resources Research Institute (WRRI) to provide these services at no cost to the participants.

2.2 BACKGROUND SUMMARY OF REGION PREPARED FOR PUBLIC DISSEMINATION

A Lea County regional background summary was not prepared. However, the following notice, which announces the Plan and states its purpose, was printed in the general circulation newspapers of Lea County, aired on local radio stations, and posted at public locations in early December, 1998, prior to beginning the planning process.

NOTICE
OF
ORGANIZATIONAL MEETING

LEA COUNTY WATER USERS ASSOCIATION

> The Lea County Water Users Association (LCWUA) Board of Directors invites all interested parties to attend an organizational meeting at 7:00 PM, Monday, December 14, 1998 at the Lea County Cultural Center, 5101 Lovington Hwy, Hobbs, NM. The purpose of the meeting will be to hear an overview of the proposed LCWUA 40 Year Regional Water Plan as suggested by the Interstate Stream Commission, the New Mexico Office of State Engineer and state law. Following the project overview, participants will be asked to assist in the formation of a steering committee to help guide the Board of Directors and the Engineering Consultant in the development of the 40 Year Water Plan for Lea County. All Lea County residents are urged to attend this important meeting as the steering committee will be most effective if it represents all interests (oil, gas, agricultural, mining, municipal, environmental, general interest and others). Questions should be addressed to Mr. Dennis Holmberg, County Manager, Lovington, NM (505) 396-8521.

At the Organizational Meeting, advertised in the notice, a water resource background of the Region was given and the goal of the planning process was explained.

2.3 LIST OF STAKEHOLDERS AND PARTICIPANTS

The Participants involved in the development of this Plan were selected from the major Stakeholders of the water resources of Lea County. They include the Lea County Water Users Association (LCWUA), its Board of Directors, and its ex-officio members, a Steering Committee comprised of individuals from five defined segments of the population of Lea County, and the citizens of Lea County. The LCWUA consists of a representative from the County and each of the five incorporated municipalities located therein. The Steering Committee, whose members were selected from groups representing Public Utilities, Agriculture, Oil and Gas Industries, Municipalities, and Domestic Water Users, was organized by the LCWUA. These groups were developed from the interests of approximately 250 citizens of Lea County that attended an open project kickoff meeting. A listing of the individuals representing these Stakeholders is included in Section 1.1.

In 1998, the Lea County Water Users Association (LCWUA) issued a Request for Proposals from Professional Engineers and Hydrogeologists to prepare a Regional Water Plan (Plan) for the county. Proposals were accepted and a Project Consultant, Leedshill-Herkenhoff, Inc. (engineers) was selected. The Project Consultant has been assisted by John Shomaker & Associates (hydrogeologists) and Montgomery & Andrews, PA (attorneys). Leedshill-Herkenhoff entered into a contract with the LCWUA on September 24, 1998.

3.STRATEGY CHOSEN TO MAXIMIZE PUBLIC INVOLVEMENT

3.1 USE OF THE MEDIA

During the planning process the media was invited to all meetings and forums associated with the Plan. While local radio never attended, area newspapers often did. Daniel Russell (the Business Reporter with the Hobbs News-Sun) was a regular attendee, and W. H. Graham (with the Lovington Leader) regularly covered the planning progress. Mr. Russell's and Mr. Graham's columns reported on the meetings/forums, usually the next day, and had attractive buy-lines and often photographs. There are no local television stations in Lea County.

3.2 PRESS RELEASES

At two key points in the planning process, LCWUA's Board of Directors, Leedshill-Herkenhoff, and the Office of Lea County Manager developed press releases to inform the public of upcoming meetings and events. The first such release, reprinted in Section 2.2, was made in early December 1998. It announced the Organizational Meeting held at the beginning of the project. The second release, reprinted below (except for location listings), was made in mid April 2000. It advertised a series of three Public Involvement Meetings.

.PUBLIC MEETING
Lea County 40-Year Water Plan

> Public meetings will be held by the Lea County Water Users Association to present the final draft report of the Lea County 40-Year Water Plan. The Plan will be finalized and submitted to the New Mexico Interstate Stream Commission upon receipt of public response to the Plan. Copies of the Plan may be reviewed at: (Locations are listed in Section 3.5 of this Plan). Public meetings will be held at 6:30 PM on the following dates and locations: (Locations are listed in Section 3.5 of this Plan).

Both releases were carried by local newspapers and radio stations.

3.3 OUTREACH EFFORT TAILORED TO SPECIFIC COMMUNITIES

Because the Plan is important to all segments of Lea County, no community was targeted for special outreach. Press releases and other disseminated information were aimed at the County at-large.

3.4 PROJECT TIME TABLE

The project began with a Notice to Proceed issued on the contract date (September 24, 1998). Various intermediate milestones were set between the Steering Committee and the Consulting Team to facilitate communication. Completion was scheduled for July, 2000.

3.5 PUBLIC MEETINGS

As discussed above, a total of four public meetings were held. The first, an Organizational Meeting, was at the Lea County Cultural Center in Hobbs on December 14, 1998. The next three were Public Involvement Meetings held at the locations and times listed below.

Eunice - Eunice Community Center, April 18, 6:30 PM
Hobbs - Lea County Services Building, April 19, 6:30 PM
Lovington - Lea County Courthouse, April 20, 6:30 PM

The Orgazational Meeting, held at the beginning of the project, is discussed in Section 2.2. It was attended by an estimated 250 citizens and served as a kick-off ceremony for the project.

The Public Involvement Meetings were held after the quality and quantity of the water resources in Lea County had been determined and the demands on those resources were identified. In the month before the meeting the water resource information and alternatives for conserving water and managing its use were reported in a Final Draft Report. The Final Draft Report was made available to the public at several locations listed below.

Hobbs:	Hobbs Public Library 809 N. Shipp Hobbs, NM 88240 (5005)397-9328
	Hobbs City Hall – Clerk's Office 300 N. Turner Hobbs, NM 88240 (505)397-9200
Lovington:	Lovington Public Library 115 S. Main Street Lovington, NM 88260 (505)396-3144
	Lovington City Hall – Clerk's Office 214 S. Love Lovington, NM 88260 (505)396-2884
Eunice:	Eunice Public Library 1039 10th Street Eunice, NM 88231 (505)394-2336
	Eunice City Hall – Clerk's Office 1106 Avenue J Eunice, NM 88231 (505)394-2576
Jal:	Woolworth Library P.O. Box 1149 Jal, NM 88252 (505)395-3268

Jal City Hall – Clerk's Office
Drawer 340
Jal, NM 88252
(505)395-3340

Tatum: Tatum Library
216 E. Broadway
Tatum, NM 88267
(505)398-4822

Tatum Town Hall – Clerk'sOffice
20 W. Broadway
Tatum, NM 88267
(505)398-4822

The information contained in the Final Draft Report was presented at the meetings by the Consulting Team and comments were sought.

In addition to the advertised public meetings, additional meetings between the Consulting Team and the Steering Committee and/or the LCWUA Board of Directors were held to review the project and discuss the issues. The meetings were open to the public.

4. BACKGROUND INFORMATION

4.1 DESCRIPTION OF THE REGION

Water users in Lea County have much in common with each other, such as shared politics, common physical geographic features, the regional climate, area demographic characteristics, and local economic issues. In fact, most of the things that influence the lives of Lea County water users are to a large extent unique to Lea County and are not shared by other adjacent New Mexico Counties. Actually when it comes to water, Lea County is more related to the adjacent counties in Texas than to any entity in New Mexico. Because of this, when the Lea County Water Users Association, as encouraged by the ISC[1], accepted the task of preparing a Regional Water Plan, all the area within Lea County was included and areas outside of the County were not.

4.1.1 Location and Boundaries

Lea County, located in the southeast corner of New Mexico, is approximately 4,400 square miles in size. Lea County is bounded to the north by Roosevelt County, New Mexico, to the east and south by the Texas Counties of Cochran, Yoakum, Gaines, Andrews, Winkler, and Loving, and to the west by Chaves and Eddy Counties, New Mexico. The Lea County Water Users Association represents water users in all areas of Lea County, including the cities and towns of Hobbs, Lovington, Eunice, Jal, and Tatum (**FIGURE 1**).

4.1.2 Geography and Landscape

Lea County is divided approximately in half by an escarpment oriented northwest to southeast. This prominent topographic feature is known as Mescalero Ridge (**FIGURE 2B**). The Mescalero Ridge traverses the western and central portions of Lea County and is a nearly perpendicular cliff that indicates the southern limits of the High Plains[2] in New Mexico. The High Plains are capped by a thick layer of caliche, locally known as Caprock, that extends throughout northern Lea County. In the east-central part of Lea County, the cliff relief becomes more subdued and is no longer considered a ridge. In the eastern portion of the County it is barely visible as it is partly buried beneath sand dunes.

Elevations in Lea County vary from approximately 2,900 feet in the southeast to approximately 4,400 feet in the northwest. This relief provides for two surface water drainage basins in the County. The Texas Gulf Basin, located in the northern portion of Lea County, and the Pecos River Basin, located in the southern portion of the County, are separated by Mescalero Ridge and its extended escarpment. The high area north of the Ridge, known as the Llano Estacado, is a depositional, low relief surface that slopes uniformly to the southeast. The Llano Estacado contains loamy and sandy soil deposits with numerous undrained depressions, known as playas or "buffalo wallows." The area south of the Ridge is an irregular erosional surface that generally slopes to the west and south, towards the Pecos River. This southern area includes large areas of stabilized and drifting sand dunes and drainage areas created by solution deep-seated collapse.

Two areas having different soil associations exist in Lea County. They are also divided by the Mescalero Ridge and include the southern High Plains and the southern Desertic Basins, Plains, and Mountains (**FIGURE 3**). The southern High Plains area, located in the upper half of Lea County, consists of five related soil associations,

[1] New Mexico Interstate Stream Commission (1994, pg. 5)

[2] Also known as the Great Plains Physiographic province (Fenneman, 1931).

Kimbrough, Kimbrough-Lea, Portales-Stegall-Lea, Amarillo-Arvana, and Brownfield-Patricia-Tivoli. These associations are generally comprised of shallow to deep gravelly and loamy soils or deep sandy soils formed from windblown and water-deposited materials in the Quaternary and late Tertiary periods. Soft or hard caliche is generally found to below soils in the majority of this area. The southern Desertic Basins, Plains, and Mountains area, located in the lower half of Lea County, consists of three soil associations; Simona-Tonuco, Berino-Cacique, and Pyote-Maljamar-Kermit. These associations are generally comprised of shallow to deep sandy and/or loamy soils. Soils in this area were also formed from windblown and water-deposited materials in the Quaternary and late Tertiary periods, however, some valley-fill sediments are from the Permian, Triassic, and Recent periods. Soft and/or hard caliche may be found beneath soils of the Simona-Tonuco and Berino-Cacique associations. The majority of the surface geology in Lea County may be historically classified as Cenozoic in origin. A limited area having a Mesozoic origin exists in the southwestern portion of the County (**FIGURE 2A**). A geologic time scale and stratigraphic nomenclature chart is provided in **APPENDIX D**. **TABLE 4-1** summarizes the characteristics of the primary soils in each soil association and **APPENDIX E** presents a textural guide for soil classifications.

Two life-form zones exist within Lea County. Life-forms can be either plant or wildlife. As with the other geography and landscape features, they are separated by the Mescalero Ridge. The Upper Sonoran zone is located in the northern half of County and the Lower Sonoran is located in the southern half. Grasses and interspersed oak shinnery are the predominant native plant type for both zones. While ranching and farming have impacted native vegetation in most parts of the County, the only rare and sensitive plant species listed is the dune unicorn plant (*Proboscidea sabulosa*). The dune unicorn plant is rare, especially outside of New Mexico, but it is not endangered. **APPENDIX F** contains more information regarding this plant and a description of the New Mexico Energy, Minerals, and Natural Resources Department program to protect native plant species. Native wildlife in Lea County includes coyote, deer, antelope and other lesser desert mammals as well as reptiles and birds. The Aplomado Falcon is the only species in the County listed under the U.S. Fish and Wildlife Service Endangered Species Act (ESA). The American Peregrine Falcon, another bird of prey found in the County, was removed from the endangered species list in 1999. Lea County contains many other raptors that are federally protected under the Migratory Bird Treaty Act. The listing of the Black-tailed Prairie Dog under ESA is currently being considered by the U.S. Fish and Wildlife Service. **APPENDIX F** contains information on other wildlife of concern in Lea County and a list of migratory birds protected by the Migratory Bird Treaty Act.

4.1.3 Climate

The climate of Lea County is semiarid with warm summers, cool and dry winters, with abundant sunshine all year. In the north, Tatum's average highest temperature of 92.5°F occurs during August and the average lowest temperature of 22.8°F occurs during January. In comparison, Jal, in the south, has an average highest temperature of 96.5 F (°F) in August and an average lowest temperature of 27.9°F in January. Approximately 80% of the yearly rainfall occurs during May through October from brief, heavy thunderstorms. Average yearly precipitation ranges from 12 to 16 inches, from southern Lea County (Jal) to northern Lea County (Hobbs and Tatum), respectively. Average yearly snowfall ranges from 4 to 9 inches, from southern Lea County (Jal) to northern Lea County (Lovington), respectively. The average annual wind velocity in Lea County is 12.2 miles per hour. The highest wind velocities occur in the spring. Tornadoes and dust storms may occur several times per year. Lake surface evaporation averages approximately 45 inches per year and the average annual relative humidity ranges from 45 to 50%.

TABLE 4-1: SUMMARY OF CHARACTERISTICS OF THE PRIMARY SOILS IN EACH SOIL ASSOCIATION IN LEA COUNTY

Soil Series	Description	Total Depth Inches	Permeability Inches/Hour	Salinity Mmhos/Cm	Degree of Limitation For Filter (Sewage Disposal) Field	Shrink-Swell Potential
Amarillo	sandy clay loam, chalky loam	60	0.63 to 2.0	0-1	slight to moderate: moderate permeability	low to moderate
Arvana	sandy clay loam	28	0.63 to 2.0	0-1	severe: indurated caliche at shallow depth	moderate
Berino	sandy clay loam, soft caliche	60	0.63 to 2.0	0-2	slight to moderate: moderate permeability	moderate
Brownfield	fine sand, sandy clay loam	63	0.63 to 20.0	0-1		low to moderate
Cacique	loamy fine sand, sandy clay loam	28	0.63 to 6.3	0-1	severe: indurated caliche at shallow depth	low to moderate
Kermit	fine sand	60	>20.0	0-1	slight to moderate: in places slopes exceed 5%; pollution of ground water possible	low
Kimbrough	gravelly loam	6	0.63 to 2	0-2	severe: indurated caliche at shallow depth	low
Lea	loam	26	0.63 to 2.0	0-2	severe: indurated caliche at shallow depth	moderate
Maljamar	fine sand, sandy clay loam	50	0.63 to 20.0	0-1	slight to moderate: moderate permeability	low to moderate
Patricia	fine sand, sandy clay loam	70	0.63 to 20.0	0-1	slight to moderate: moderate permeability	low to moderate
Portales	loam and clay loam	60	0.63 to 2.0	0-2	slight to moderate: moderate permeability	moderate
Pyote	fine sand, loamy fine sand, fine sandy loam	60	2.0 to 20.0	0-1	severe: moderately rapid permeability	low
Simona	fine sandy loam	16	2.0 to 6.3	0-1	severe: shallow over indurated caliche	low
Slegall	clay loam	28	0.06 to 0.2	0-4	severe: indurated caliche at shallow depth; slow permeability	high
Tivoli	fine sand	60	6.3 to 20.0	0-1	slight to moderate: possible contamination of underground water; 0 to 12 percent slopes	low
Tonuco	loamy fine sand	60	0.63 to 2.0	0-1	severe: indurated caliche at a shallow depth	low

Source: USDA, Soil Conservation Service, 1974
Mmhos/cm millimhos per centimeter

4.1.4 Natural Resources

The availability of accessible ground-water for irrigation enabled agriculture to become established and flourish in the County over the last 50 to 65 years. As a result, agriculture has played a major role in Lea County's economy. Sales of beef cattle and milk are currently the primary agricultural incomes. Current major cash crops include cotton, hay (including alfalfa), peanuts, and chile.

Large active oil and gas fields have existed in Lea County for more than 50 years. The New Mexico portion of the Permian Basin contains 1,112 designated, discovered oil reservoirs and 672 designated, discovered gas reservoirs. Production zones are found in rocks as old as Ordovician age, through Permian age[3]. Mined potash and gypsum deposits are located in the southern portions of the County. Both have played major economic roles since their discovery. Other natural resources include sand and gravel, cultural resources, and other minerals.

4.1.5 Major Surface Water and Ground-water Sources

4.1.5.1 Surface Water

Surface water within Lea County is limited to intermittent streams, lakes, and small playa lakes that result from heavy rainfall during summer months. These intermittent surface water sources are used primarily for livestock purposes. In such cases, small, manmade earthen structures have been constructed to collect surface runoff.

4.1.5.2 Ground-water

Ground-water sources in Lea County include hydrogeologic strata within five underground-water basins declared by the NMOSE. The basins, from north to south, are the Lea County Underground-water Basin (UWB), the Capitan UWB, the Carlsbad UWB, and the Jal UWB (FIGURE 4). A small area (approximately 55 square miles) of a fifth, the Roswell UWB, exists within west-central and northwest Lea County. It is important to note that the NMOSE has designated these basins based on their distinct hydrogeologic configurations, which do not typically end at county or state boundaries. In fact, several of the basins found within Lea County extend across county lines in New Mexico and the State Line into Texas.

New Mexico statutes provide that all underground-waters of the State belong to the public, and are subject to appropriation for beneficial use. The New Mexico Office of the State Engineer (NMOSE) is charged with inventorying and accounting for the many waters of the State, including ground-water. To aid this task, the NMOSE may declare certain areas of underground-water in the State as Underground-water Basins (UWB). The NMOSE has jurisdiction over the wells drilled in UWBs. No such jurisdiction exists in undeclared subsurface water basins. In order to declare UWBs the NMOSE has evaluated the surface topography, sub-surface inclination of rock and sediment beds, and water-bearing properties of geologic units in many areas of the State. Lea County spans parts of five separate NMOSE-declared UWBs and one undeclared basin (FIGURE 4).

Lea County UWB

The Lea County UWB is approximately 2,180 square miles in size. The Lea County UWB extends east to west across the width of Lea County and generally terminates to the south along the Mescalero Ridge and its associated escarpment. The primary aquifer of the Lea County UWB, as well as the primary ground-water source in Lea County, is the Ogallala Formation. Sediments found within this formation include sands, silts, clay, and gravel. The maximum saturated thickness of the Ogallala aquifer in the Lea County UWB is approximately 250 feet. Cretaceous and Triassic rocks underlying the Ogallala Formation limit downward percolation from the Ogallala aquifer. Ground-

[3] Broadhead and Speer, 1993

water flow in the Ogallala aquifer is generally to the southeast. The primary uses of ground-water from the Lea County UWB are irrigation and public water supply. The cities and towns of Hobbs, Lovington, and Tatum are located within the Lea County UWB and have municipal well fields that withdraw potable water from the Ogallala aquifer.

Capitan UWB

The Capitan UWB covers approximately 1,100 square miles and occupies the south-central portion of Lea County. The Capitan UWB is located within a geologic province known as the Delaware Basin, a subdivision of the Permian Basin. The Capitan UWB is aerially oriented in a northwest-southeast alignment above an arc shaped section of a formation known as the Capitan Reef Complex. The Capitan aquifer occurs within dolomite and limestone strata deposited as an ancient reef. The ground-water quality of the Capitan in Lea County is very poor. Other aquifers in the Capitan UWB are found in the overlying Rustler Formation[4], Santa Rosa Sandstone[5], and Cenozoic Alluvium. The primary uses of ground-water from the Capitan UWB are mining, oil recovery, industry, livestock, and domestic use. The towns of Eunice and Jal are located within the Capitan UWB, but currently tap beds of saturated Quaternary alluvium located within the Lea County UWB and Jal UWB respectively.

Jal UWB

The Jal UWB is approximately 15 square miles in size and is located at the southwest corner of the Capitan UWB. Cenozoic Alluvium, approximately 550 to 750 feet thick, is the principal water-bearing zone in the Jal UWB. No cities or towns are located within the Jal UWB, although the Town of Jal and El Paso Natural Gas have drilled wells within the UWB.

Carlsbad UWB

The Carlsbad UWB, located in the southwestern portion of Lea County, is approximately 477 square miles in size. The principal aquifer in the Carlsbad UWB is in the Santa Rosa Sandstone, which is approximately 200 feet thick in this area. General ground-water flow in the Carlsbad UWB is in a southerly direction. The primary use of water from the Carlsbad UWB is mining. The area within the Carlsbad UWB is sparsely inhabited.

Approximately 550 square miles of northernmost Lea County lie within a larger undeclared subsurface water basin. The Ogallala Formation occurs in some of this area, however, little information is known due to the scarcity of population and permitted water wells. Previous oil exploration activity in this area may have created conduits for upward migration of ground-water from the Cretaceous Tucumcari Formation to the thin overlying Ogallala beds at the expense of artesian pressure within the Tucumcari unit.

4.1.6 Demographic

The largest portion of the Lea County population is located in the County's eastern half, at or near the cities and towns of Hobbs, Lovington, Eunice, Jal, and Tatum. Lea County's historical population characteristics, from 1940 until 1990, are shown in **TABLE 4-2**. The population of Lea County increased substantially from 1940 until 1960, decreased slightly from 1960 to 1970, increased during 1970 to 1980, and then declined again from 1980 to 1990.

[4] The Rustler Formation underlies most of the Delaware Basin. Ground-water from the Rustler formation within Lea County is of poor quality and is used only for irrigation, livestock, or oil recovery enhancement.

[5] The Santa Rosa Sandstone, a specific unit of the Lower Dockum Group, is the principal potable water aquifer in the southwestern third of Lea County. The Santa Rosa was formerly tapped by the Town of Jal's municipal wells until they were abandoned due to low yield.

TABLE 4-2: LEA COUNTY HISTORICAL POPULATION

Year	1940	1950	1960	1970	1980	1990
Population	21,154	30,717	53,429	49,554	55,993	55,765
Change	--	+45%	+74%	-7%	+13%	-1%

Source: U.S. Census

Dramatic changes in population may be attributed to needs and requirements of the oil and gas industry. Demographics by city and town (not shown) indicate sustained population growth in the City of Hobbs from 1940 to 1990. The population in the cities and towns of Eunice, Jal, Lovington, and Tatum increased from 1940 till 1970, but decreased from 1970 to 1990. In 1995 the estimated population of Lea County was 56,793 and the estimated population of Hobbs in 1994 was 29,712. Growth in Lea County is expected to be less than 1% every 5 years throughout the 40-year horizon of this Plan.

4.1.7 Economic Picture

The economy of Lea County is generally stable[6] with the median family income in Lea County rising from $26,620 to $33,200 from 1989 to 1996. Decreases in the price of oil, such as occurred during the late 1990's, have caused and may in the future cause economic setbacks. These setbacks tend to be cyclic, following the price of oil. Currently, oil prices are again on the rise in response to production limits in the Middle East and in South America. The unemployment rate in 1996 was 4.7%. In 1990 the major areas of employment were mining, retail trade, and services; each of these employed in more than 17% of the County's workforce. Agricultural employment accounted for only 3% of the workforce. Between 1990 and 1996 nonagricultural jobs increased in the areas of retail trade, services, and government. During that same period of time, the number of persons employed in mining declined approximately 13%. Most other job markets remained stable. Total gross receipts for 1996 were $1.39 billion, an increase of 5.2% from 1995. Primary gross receipt sectors for 1996 were retail trade (26% of total), services (20% of total), and mining (18% of total). Agriculture gross receipts of $5 million in 1996 were 0.4% of the County's total gross receipts. Of the $5 million generated by agriculture in 1996, 71% was from livestock and 29 % was from crops. Promotion of industrial and large-scale commercial property is currently prevalent in Lea County, primarily in the cities and towns of Hobbs, Lovington and Jal. Future development of this nature could greatly improve the County's economic outlook.

4.1.8 Land Ownership and Land Use

Lea County is approximately 2.8 million acres in size. Property ownership is 17% federal government, 31% state government, and 52% private (FIGURE 5). The federally owned land is primarily located in the southwestern portion of the County, the state-owned land is predominately located throughout the middle, and the privately owned land primarily extends from north to south in the County's eastern portion. Large tracts of land in Lea County are privately owned by farmers, ranchers, oil, gas, and mining companies. Urbanized areas near cities and towns include ownership of smaller tracts of land for residential, municipal, and commercial purposes (FIGURE 6). Expected continued growth within the City of Hobbs will require an increase in the number of residential properties and likely a limited increase of commercial properties as well. Approximately 93% of Lea County is used as range land for grazing and approximately 4% is used for crop farming. Urban areas and the roadway system account for the County's remaining land use. Most of the land actively farmed in Lea County is irrigated.

[6] Lea County Fact Book, Economic Development Corporation of Lea County, January 2000

4.2 HISTORICAL OVERVIEW OF WATER USE IN REGION

Until 1890, Lea County was sparsely populated and occupied only by nomadic bands of Comanche and Apache Indians. Limited ranching extended into the area with the spread of Texas cattlemen into the Pecos Valley. Homesteading of the area occurred during the early 1900's. As a result, Lea County was formed in 1917 from parts of Eddy and Chaves Counties.

During the developing stages of Lea County, water use was limited to withdrawals from shallow hand dug or drilled wells. Periods of drought during the 1910's, 1930's, and 1950's reduced the scale of dryland farming and the number of farms in Lea County. With the advent of advanced well drilling and pumping technology, ground-water irrigation began in the late 1930's in the northeastern portion of the County. Development was fairly limited from 1937 to 1939, averaging about 1,900 acre-feet per annum (ac-ft/an), but increased significantly from 1940, when 3,200 ac-ft/an were pumped, to 1950, when 95,000 ac-ft/an were pumped. Pumping for irrigation varied from 1951 to 1960 and ranged from 105,000 ac-ft/an in 1960 to 170,000 ac-ft/an in 1955 (Ash, 1963). The combination of pumps, increased population, and increased livestock herds (and their feed requirements) caused a dramatic increases in water use throughout the 1940's till the 1980's, with the bulk of that use going for irrigation. The irrigated acreage in the County increased from 1,970 acres to 119,240 acres during 1940 to 1982. Fluctuations in the ground-water level, periods of above-average rainfall, and drops in agricultural market prices resulted in a decrease of total irrigated acreage in the 1980's. As of 1997, Lea County had 104,600 acres of cropland, of which 83,500 acres were irrigated and 21,000 acres were dryland. This is illustrated in **TABLE 4-3** which presents a time line summarizing the history of development and water use in Lea County. While the largest type of water use in Lea County, past and present, is agricultural irrigation[7], many other types of activities are dependent on the area's water resources.

Historically, two of the most dynamic are oil and livestock. Oil has been instrumental in building the County's economy. The first oil well in the County was drilled near Maljamar in 1926. Oil exploration and production quickly spread through other parts of Lea County. Subsequent development of oil and gas fields supported increases in population. Water required for oil production[8] is used to pressurize subsurface deposits so production rates will increase and probably ranges from 3-9% of all water used.

[7] 65-80% of all water used each year since 1975

[8] Oil and Gas water use is reported under Amining@ water use category by the NMOSE.

TABLE 4-3: HISTORICAL DEVELOPMENT OF WATER USE IN LEA COUNTY

Time Line	
Early 1920's	Lea County residents first use ground-water. (Clark, 1987).
Late 1920's to recent	Trend from stock raising and dry-farming (pasture grasses and seasonal precipitation-irrigated crops) to economy based on irrigated farming and production of oil and gas.
1926	First Lea County oil well drilled, near Maljamar. Initial oil fields (until 1954) were drilled along the edge of the Delaware Basin on shallow structures (Nicholson and Clebsch, 1961).
By 1929	41 irrigation wells drilled on the Llano Estacado. 17 unused and 24 used occasionally (NMOSE, 1959).
Early 1930's	Drought increases ground-water irrigation around Lovington and Hobbs. Estimated irrigation pumping for 1930 was 500 ac-ft, for 1931 was 850 ac-ft, for 1932 was 950 ac-ft, and for 1933 was 1,225 ac-ft (NMOSE, 1959).
1931	Lea County UWB declared with 1,270-square-miles. It was closed to further appropriations at end of 1948, and not earlier because of its relatively slow development (Clark, 1987).
1930's	Livestock and cattle production increasing since 1929. Wells in northeastern Lea County that tapped Cretaceous beds stopped producing artesian flow following widespread drilling of uncased seismic shot holes, which allowed excess hydraulic head from the Cretaceous unit to dissipate into the overlying Ogallala. Limits of oil fields greatly enlarged (Clark, 1987).
1940 B 1950	Ogallala rises with above-average precip., except near Hobbs, Lovington, Humble City, and McDonald, where pumping increased (1947-1950). Water pumped from Cenozoic deposits rises from 3,200 ac-ft (1940) to 95,000 ac-ft (1950).
During W.W.II	Critical need for rubber led to construction of four carbon black plants in southern Lea County, near Eunice. Oil production develops rapidly in 1944 (Nicholson and Clebsch, 1961).
1946 B 1954	Amount of irrigated acreage rose, by 1954 there were 93,000 total irrigated acres. Subsequent increase in irrigation pumping quantities: 1946 B 3,500 ac-ft, 1947 B 19,000 ac-ft, 1948 B 39,000 ac-ft, 1949 B 60,000 ac-ft, 1950 B 95,000 ac-ft, 1951 B 153,000 ac-ft, 1952 B 166,000 ac-ft, 1953 B 165,000 ac-ft, 1954 B 163,000 ac-ft, 1955 B 170,000 ac-ft.
1948	Acreage with water rights reaches 117,700-acre total and estimated net recharge is 4,000 ac-ft annually (Clark, 1987). December 29, the basin was closed to further appropriation.
1950 B 1960	Below-average precipitation and increased pumpage results in Ogallala decline. Water pumped from Cenozoic deposits rises from 95,000 ac-ft in 1950, to 105,000 ac-ft in 1960. Early 1950=s drought cut down size of herds (Nicholson and Clebsch, 1961). Oil wells drilled at 3 mile intervals in Moore-Devonian Pool. Proportion of saline water production increases with continued development of field (Stephens and Spalding, 1984).
1952	Lea County UWB extended to current 2,180 square miles, and opened to further appropriations in 1952 and 1953. USGS and NMOSE begin work to define thickness of saturated sediments in northern Lea County. J.C. Yates made intensive township-by-township investigation in 1952. Pumping was concentrated in 20 of the 71 townships in the basin. Yates Aestimated the supply in each township and the total which could be withdrawn annually from each to make water available for irrigation for forty years, leaving one-third of the basin=s waters. These would be reserved for domestic and municipal purposes thereafter@ (Clark, 1987).
1954	Increases in irrigated land slowed in 1954 as most cropland was between Tatum and Hobbs, and in a NW-trending line, 15 miles W. of Tatum and Lovington. By 1954 there were 1,000 irrigation wells. First oil well drilled in a deeper part of the Delaware Basin (rather than along fringe), near Bell Lake (Nicholson and Clebsch, 1961). 2,400 ac-ft of water from Paleozoic units pumped out in the producing oil. 20,500 acre-feet water pumped since start of oil production. Annual average of 7.35 acre-feet water produced per well.
1955	3,000 operating oil wells; almost 570 million barrels oil and 940 million cubic feet natural gas produced since 1926. Highest year on record from 1937 to 1960 for irrigation pumping - 170,000 acre-feet.
1958 1960 1961	Apparent wet growing season; reported irrigation down to 107,000 acre-feet for year. Apparent wet growing season; reported irrigation down to 105,000 acre-feet for year. Jal Underground-water Basin is declared.
1965	NMOSE declares Capitan UWB. Oilfield withdrawals from Capitan Basin and reefs may adversely effect Pecos River and ground-water supply in valley (Carlsbad and Roswell Basins), so basin declared in 1965 (Clark, 1987).
1967 B 1968	New Mexico Oil Conservation Commission enters Order No. R-3221, prohibiting salt-water disposal in unlined surface pits. Use of salt-water disposal wells and lined evaporation pits allowed.
1972	State engineer reports that 16 percent of all diversions in Lea County were made up of withdrawals for municipal and industrial uses, more than three times the average for other underground basins (Clark, 1987).
1978	New Mexico began performing annual bradenhead tests to check mechanical integrity of all salt-water disposal wells (Class II wells) in southeastern New Mexico (Stephens and Spalding, 1984).

Source: Ash 1963 unless indicated otherwise

Livestock, while always present has never exerted a large direct demand on the County's water resources, is now increasing its demand. The Lea County livestock industry has changed since the mid1900's when dry conditions in the early 1950's reduced the size of many Lea County cattle herds. Today, the beef cow has largely given way to the milk cow. The number of milk cows increased 127% from 1995 to 1998[9]. The total number of current mature and immature dairy cattle has been estimated to be 30,000[10] to 40,000[11]. This data suggests increases in total herd size of 200% to 300% since 1995. Lea County dairy farmers indicate that up to 100 gallons per day per cow are required for consumption and processing. Plus, in order to meet the increasing demand for feed, continued dairy industry growth in the County is likely to increase irrigated agricultural water use.

TABLE 4-4 presents recent water use for the County by NMOSE water use category in 1975, 1985, 1995 [12], and 1998[13]. During the period from 1975 to 1985, large increases in water use occurred in most categories, with exceptions for irrigation, livestock, and power. A 13% increase in population in Lea County during this period of time (see Section 6) may account for much of the increased water use. Above-average rainfall in 1985 may account for the reported decrease in irrigated agriculture and livestock use.

Water use increased in Lea County from 1985 until 1995 by 22%. During this period, increases in water use occurred in all categories, except mining and power. Public water supply use and domestic use increased 26% and 40%, respectively, even though the population of Lea County increased only 1% (see Section 5). The primary water use categories in 1995 were irrigated agriculture (74% of total), public water supply (11% of total), mining (11% of total), and power (3% of total). Water use by the remaining categories was less than 1% of the total water use in Lea County for 1995.

Recent water use in Lea County, from 1995 until 1998 can not be completely addressed as the NMOSE total use data for 1998 has not yet been compiled. The 1998 NMOSE data shown in TABLE 4 is primarily collected from the Lea County UWB and uses on the other UWBs have not yet been accounted. Still the partial 1998 data compared to the complete 1995 data indicates a 10% increase in public water supply use, a 6% increase in irrigated agricultural use, and a 69% increase in industrial use. Using these figures, the total water use in Lea County increased by approximately 1% from 1995 to 1998, even though the 1998 data is incomplete.

4.3 NMOSE WATER USE RECORDS

The completeness and accuracy of the NMOSE reported water use data, shown in TABLE 4-4, depends on water users providing accurate meter records, estimates, and other data to the NMOSE. Discrepancies in data do occur when inaccurate information is provided.

Water use by agriculture is determined by multiplying the amount of irrigated acres by a factor of water use per acre. This factor is called the farm delivery requirement (FDR) (Calculated by the NMOSE). For example, if the FDR is 2.0

9 USDA and New Mexico Agricultural Statistics Service (see APPENDIX T)

10 Mr. Bob Carter, Lovington City Manager, reporting on a survey of dairy farmers.

11 NMSU Cooperative Extension Service

12 Data for 1975, 1985, and 1995 are derived from water use inventories published by the New Mexico Office of the State Engineer (Sorenson, 1977, Wilson, 1986, and Wilson, 1997).

13 Data for 1998 are derived primarily from the *Lea County Underground-water Basin Annual Report 1998* (NMOSE, 1998). The 1998 report is an unpublished report prepared at the NMOSE District No. 2 Office in Roswell by the Lea County Underground-water Basin Supervisor and Assistant Basin Supervisor (Johnny Hernandez and Fred McMinn, respectively). It is important to note that the 1998 report data is primarily for the LEA County UWB and does not represent total use in all Lea County basins. The Lea County total use report for 1998 has not been completed at this time.

TABLE 4-4: LEA COUNTY HISTORICAL WATER USE: 1975-1998 (ACRE-FEET)

Water Use Category	1975	1985	1995	1998[a]	Change 1975-1985 (%)	Change 1985-1995 (%)	Change 1995-1998[b] (%)
Public Water Supply	9,966	12,818	16,153	17,790[c]	+29	+26	+10
Domestic	714	949	1,331	n/a[d]	+33	+40	n/a
Irrigated Agricultural	191,290	98,409	131,163	138,601[e]	-49	+33	+6
Livestock	1,025	727	1,497	1,111[f]	-29	+106	-26
Commercial	555	1,111	1,346	606	+100	+21	-55
Industrial	no report	0	1,497	2,524[g]	n/a	n/a	+69
Mining	21,612	25,783	18,975	12,439[h]	+19	-26	-34
Power	13,876	5,708	4,445	4,485	-59	-22	<1
Reservoir Evaporation	100	0	0	0	-100	0	0
Recreation	0	887	no report	966[i]	n/a	n/a	n/a
Total Use	239,138	146,392	176,407	178,522	-39	+21	+1

Source: Sorenson, 1977, Wilson, 1986, Wilson, 1997, and NMOSE, 1998

a. Data for 1998 is incomplete. Figures are based on withdrawals from the Lea County UWB only.
b. Actual increases and decreases for this period are yet to be determined due to incomplete NMOSE data.
c. The value includes 1,608 ac-ft of commercial, domesticm, and industrial use by the City of Carlsbad and 725 ac-ft of municipal non-cities use.
d. Domestic use has not been estimated.
e. This figure reflects an estimated area of 83,500 acres irrigated at 1.6 ac-ft per acre plus metered irrigation at 5,001 ac-ft.
f. This value includes dairies and cattle feed lots, but does not include livestock use in the Jal or Capitan UWBs.
g. This figure includes manufacturing and petroleum processing.
h. This value includes secondary recovery of oil, mining of ore, and oil well dwellings.
i. Recreation was eliminated as a separate category by the NMOSE Technical Report 47 (Wilson, 1992).

acre-feet per acre and 2,000 acres are irrigated, then the total withdrawal is equal to 4,000 acre-feet. The FDR is not constant because it is calculated from components that vary based on climate, crop type, cropping patterns, and other conditions.

Specifically, the FDR is computed[14] by dividing the consumptive irrigation requirement (CIR) by the on-farm irrigation efficiency (E_f). The consumptive irrigation requirement (CIR) is determined by subtracting the effective rainfall (R_e) from the consumptive use (U). Besides the obvious variance in rainfall, consumptive use (U) is also calculated from variable factors such as temperature, daylight hours, and latitude. Furthermore, on-farm efficiency (E_f) is also based on elements that are affected by farm and field conditions that can vary and change. Therefore, it is important to note that the FDR varies yearly as seasons, climate, crops, farm methods, and cropping patterns change. A copy of the detailed procedure for quantifying irrigation withdrawals and depletions is provided in APPENDIX R.

[14] The calculation is set forth in the NMOSE's Technical Report 49 (Wilson, 1997a).

5. LEGAL ISSUES

5.1 INTRODUCTION

Lea County is committed to thoroughly studying its water supply and the demand for water in Lea County so that it can manage this precious resource to meet the current and future demand for water in Lea County. Legal issues can potentially have a significant impact on a county's supply of and demand for water. This section thus discusses the federal, state and local legal issues that may impact the supply of and demand for water in Lea County. This discussion is important in assessing Lea County's future need for water and its ability to meet such need.

As the following discussion indicates, there are no federal legal issues that directly constrain water supply in Lea County or Lea County's ability to adequately plan for future demand of water in Lea County. However, the Pecos River Compact and the United States Supreme Court's ruling in *Texas v. New Mexico,* 462 U.S. 554 (1983), while not placing a direct burden on Lea County's water supply, may indirectly affect Lea County's water supply by creating pressure for water users outside of Lea County to obtain water from Lea County as an alternate source of water. State legal issues similarly do not appear to directly affect the supply of or demand for water in Lea County. One state legal issue of concern to Lea County, however, is the potential effect that the New Mexico State Supreme Court ruling in *Mathers v. Texaco, Inc.*, 77 N.M. 239, 421 P.2d 771 (1966) will have in causing water levels in Lea County's underground water basins to continue to decline. As discussed in more detail below, Lea County is attempting to resolve this concern by appropriating the remaining water rights in the Lea County Underground water basin so it can conserve these rights and have flexibility to better plan for development and expanded use of water in Lea County.

5.2 FEDERAL LEGAL ISSUES IMPACTING THE SUPPLY OF AND DEMAND FOR WATER IN LEA COUNTY

No federal reservations, federal environmental law issues, treaties, or federal water projects are known to exist within Lea County. In addition, no known, direct compact obligations currently exist within Lea County. As discussed in Section 5.2.1, federal water quality standards, however, do apply to all municipalities within Lea County. As also discussed by Section 5.2.1, federal water quality standards do not impact the supply of or demand for water in Lea County. As discussed in Section 5.2.2 and 5.2.2.1, however, the supply of and demand for water in Lea County may be indirectly impacted by the Pecos River Compact and the United States Supreme Court's decision in *Texas v. New Mexico,* 462 U.S. 554 (1983).

5.2.1 Impact of Federal Water Quality Standards on the Supply of and Demand for Water in Lea County

All municipalities within Lea County must comply with current water quality standards for drinking water established by Federal law. The current guidelines for assessing the suitability of a surface water or ground-water for use as a public water supply are the regulations mandated by the U.S. Environmental Protection Agency (EPA). The regulations are delineated in Title 40, Parts 141 and 143 of the Safe Drinking Water Act. The primary regulations include maximum permissible levels for inorganic and organic chemicals, turbidity, coliform bacteria, and radiological constituents. In accordance with the Safe Drinking Water Act, the EPA promulgates a regulatory scheme for maintaining the quality of the public drinking water. The New Mexico Environment Department (NMED) has primacy to adopt and implement the EPA standards in regulating community water facilities. Federal drinking water standards, as enforced by the NMED, and the results of the most recent laboratory results of the major public water supply systems in Lea County are summarized in Tables 11 and 12 in Section 6.2. As these Tables indicate, the water quality in the major public water supply systems meets the standards promulgated by the EPA. As a result, these standards do not negatively affect the supply of or demand for water in Lea County.

5.2.2 The Pecos River Compact and *Texas v. New Mexico* (1983)

The 1949 Pecos River Compact between New Mexico and Texas divides the water of the Pecos River between the two states. Due to the river's irregular flow, the Compact does not specify a particular quantity of water to be delivered to Texas by New Mexico annually. Instead, in Article III(a), the key provision of the Compact provides that ..."New Mexico shall not deplete by man's activities the flow of the Pecos River at the New Mexico-Texas state line which will give to Texas a quantity of water equivalent to that available to Texas under the 1947 condition."

In 1974, Texas filed an original action in the United States Supreme Court to resolve a dispute between the two states as to the meaning of "1947 condition." A Special Master was appointed and, in 1979, filed a report defining "the 1947 condition" and proposed a method of determining Texas entitlement to water. The Supreme Court adopted the Special Master's report in its entirety.

The successor to the original Special Master held hearings to determine whether, based on the method adopted by the Supreme Court, New Mexico had fulfilled its Compact obligations. The Special Master issued a report concluding that for the years 1950-1983, New Mexico had fallen short in its delivery requirements by 340,100 acre-feet. The Master recommended that New Mexico be required to not only perform its ongoing Compact obligations, but also be required to make up the delivery shortfall by delivering 34,010 acre-feet of water each year for ten years, with a "water interest" penalty for any bad faith failure to deliver the make-up quantities. In *Texas v. New Mexico*, 462 U.S. 554 (1983), the Court accepted the Special Master's conclusion regarding the shortfall quantity, but returned the matter to the Master for further proceedings and recommendations regarding whether New Mexico should be allowed to elect a monetary rather than an in-kind remedy. The Court issued a decree which enjoined New Mexico "to comply with its Article III(a) obligations under the Pecos River Compact and to determine the extent of its obligation in accordance with the formula approved by the decisions of this Court."

The Supreme Court's holding in *Texas v. New Mexico* requires New Mexico to make as much water as possible available for delivery to Texas in order to meet the Compact obligations. New Mexico is now forced to acquire, by purchase or lease, water rights in the Pecos River system to meet its delivery requirements to Texas. Through the Interstate Stream Commission (ISC), the State is currently purchasing water rights in the Pecos River system and placing those rights in the Pecos River Conservation Project. However, if there are insufficient irrigation rights available to reach compliance, the State will be forced to retire junior water rights upstream or strictly enforce forfeiture statutes across the board. Strict enforcement of forfeiture statutes would affect every water user in the Pecos River system.

5.2.2.1 Impact of the Pecos River Compact and *Texas v. New Mexico* (1983) on the Supply of and Demand for Water in Lea County

Available information indicates that water in the Capitan Underground Water Basin is in hydraulic communication with the Pecos River. Withdrawals from the Capitan UWB could cause reduction in the flow of the Pecos River and the supply available to wells in the Pecos Valley. Consequently, New Mexico's obligations under the Pecos River Compact could affect existing water rights, as well as the availability of ground-water for future appropriations, within the Capitan UWB. Portions of the Carlsbad UWB are also thought to be hydrologically connected to the Pecos River. However, the portion of the Carlsbad UWB within Lea County has no known hydrological connection to the river, and appropriations within that area should not be affected by New Mexico's Compact obligations.

An additional concern is that the reduction in the availability of water in the Pecos River system will cause municipalities and industry in that region to attempt to appropriate greater amounts of water from Lea County. As discussed in Section 5.4.3, litigation has already arisen out of attempts by water users to appropriate large quantities of ground-water from the Lea County UWB for use outside the basin.

5.3 STATE LEGAL ISSUES IMPACTING THE SUPPLY AND DEMAND FOR WATER IN LEA COUNTY

5.3.1 Surface Water

Surface waters within the State of New Mexico are public and subject to appropriation for beneficial use. Beneficial use provides the basis, measure and the limit for all water rights. Surface water use in all of New Mexico is governed by the provisions of NMSA 1978, 72-5-1 through 72-5-39 (1997).

Surface water within Lea County is limited to ephemeral streams, lakes, and small playa lakes that result from rainfall during the summer months. Some surface water runoff is impounded for livestock purposes. None of these ephemeral waters fall within the jurisdiction of the New Mexico Office of the State Engineer (NMOSE) because they are not viewed as surface waters subject to appropriation for beneficial use. Since surface water in Lea County is not subject to appropriation and is predominantly lost to evapotranspiration, such water currently does not impact Lea County's present or future availability of water. Lea County may, however, study alternative methods of using ephemeral waters to recharge its aquifer. See Aquifer Recharge, Section 8.1.2.4 If a suitable method is found to recharge Lea County's aquifer using ephemeral waters, the fact that such waters are not subject to appropriation by the general public will enable Lea County to use ephemeral waters to supplement its water supply.

Additionally, Surface water outside of Lea County is not diverted for beneficial use within the County. Therefore, surface water within or outside of Lea County does not currently impact Lea County's availability or supply of water.

5.3.2 Ground-Water

5.3.2.1 State Statutes Affecting Ground-water in Lea County

New Mexico statutes provide that the water of underground streams, channels, artesian basins, reservoirs or lakes, having reasonably ascertainable bodies are public waters of the State, and are subject to appropriation for beneficial use. Appropriation of ground-water from basins declared by the NMOSE is governed by the provisions of NMSA 1978, 72-12-1 through 72-12-28 (1997). As discussed in Section 5.3.2.2, the primary ground-water sources in the Plan area governed by these statutory provisions include, from north to south, the Lea County UWB, the Capitan UWB, the Carlsbad UWB, and the Jal UWB. In addition, a small portion of the Roswell UWB lies within west-central and northwest Lea County.

In addition, New Mexico regulates ground-water quality pursuant to its own Water Quality Act in 20 NMAC 6.2. Under this Act, NMED and the Oil Conservation Division (OCD) implement ground-water protection standards and regulate discharge by all activities that could impact the supply of protectable ground-water. New Mexico ground-water quality standards, for the most part, mirror the federal standards for drinking water. A key contaminant of concern in New Mexico and Lea County is nitrogen, particularly in the form of nitrate, which can originate from many sources. NMED in administering its ground-water protection program is, to a large extent, concerned with limiting the amount of nitrogen that enters underground-water supplies. These standards have a positive impact on Lea County's supply of water in that these standards help protect the quality of Lea County's water.

5.3.2.2 State Regulatory Policies Affecting Ground-water In Lea County

The NMOSE has jurisdiction over appropriation of ground-water within declared basins for beneficial use. Permits may be issued, provided that application is made to the NMOSE and is subjected to notice and the opportunity for protest. The permit will be granted if the NMOSE determines that there is available water, the granting of the application will not impair other water rights, and will not be contrary to the conservation of water within the state or detrimental to the public welfare of the state. In addition, NMSA 72-12-1 allows parties to obtain a permit without notice if they are seeking to appropriate up to three-acre-feet of ground-water from a declared basin for domestic use, livestock, watering, or up to one acre of non-commercial irrigation, or to seek to use the water right for prospecting, mining, or construction of public works, highways and roads or drilling operations designed to discover or develop the natural resources of the state. The NMOSE will grant the permit as long as the proposed use will not permanently impair the existing water rights of others. All permits may be subject to conditions. For instance, consumptive use figures for ground-water, which vary depending upon the source of supply and purpose of use, may be calculated and imposed upon permits.

5.3.2.2.1 Declared Ground-water Basin Criteria - Lea County Underground-water Basin

The Lea County UWB (see FIGURE 4) was declared by the NMOSE in 1931 and closed to further appropriation in 1948. The basin was extended in 1952, and Orders reopening parts of the basin to further development were issued in 1952 and again in 1953. In 1953, the NMOSE developed specific administrative criteria for managing ground-water appropriations within the Lea County UWB.

Because the Lea County UWB is a "mined basin,"[1] it is administered to allow ground-water use at rates which will not deplete its reserves in less than a predetermined forty-year planning period. The current administrative criteria estimate the annual ground-water recharge within the basin to be approximately 29,000 acre-feet, although estimates by others[2] indicate a recharge in the range of 29,000 to 58,000 acre-feet may occur. The current administrative criteria permit the annual basin-wide withdrawal of approximately 440,000 acre-feet.

The NMOSE has divided the Lea County UWB into individual management units known as "townships," or "blocks." Block administration, when used in conjunction with a time dimension, attempts to insure a uniform life for most of the water rights, and permit the orderly development and greatest use of the ground-water resource by distributing the points of diversion throughout the basin. Unfortunately, the majority of diversions occur on the eastern portion of the basin because the lack of good soil cover on the western portion of the basin generally prohibits agriculture. There are 71 administrative blocks in the Lea County UWB.

The NMOSE applies the "move-to area" test to all applications to change the location of a well, the place the water from a well is used, or the way the water is used. Under this test, if moving the well, or changing the place or method of use, will impair existing rights in the move-to area, the application will likely be denied. In the Lea County UWB, water rights transfers between blocks will not be permitted where the move-to block is fully appropriated, or does not have enough water available. Several blocks within the Lea County UWB are closed to new appropriations.

5.3.2.2.2 Declared Ground-water Basin Criteria - Capitan Underground-Water Basin

The Capitan UWB (see FIGURE 4) was declared by the NMOSE in 1965. The basin includes the portion of the Capitan reef and near associated backreef formations not included in the previously declared underground-water basins. Water is currently available for appropriation from several aquifers within the Capitan UWB, provided that there would be no impairment or detriment to existing water rights. In the Capitan UWB, consideration of an

[1] A "mined-basin" is a ground water basin in which well withdrawals exceed recharge.
[2] Theis, 1934 and McAda, 1984

application to appropriate water is based on nine administrative blocks arranged in a square with three blocks to a side. Each block is a square unit of four sections. The center block of the nine administrative blocks is the block in which the proposed appropriation is to be made. The primary criterion for approval of a new appropriation, aside from impairment, is that each of the nine administrative blocks considered have an existing useful life extending through 2006.

5.3.2.2.3 Declared Ground-water Basin Criteria - Jal Underground-Water Basin

The Jal UWB, in southeastern Lea County, was declared by the NMOSE in 1961. Consideration of applications to appropriate water in the Jal Basin is based on basin quadrants. Water is available for appropriation in those administrative quadrants in which vested and permitted water rights have not reached the administrative limit, provided that there would be no impairment or detriment to existing water rights.

5.3.2.2.4 Declared Ground-water Basin Criteria - Carlsbad Underground-Water Basin

The NMOSE began declaring portions of this UWB in 1947. According to the NMOSE, there are only 12 wells located in that portion of the Carlsbad UWB located within Lea County. These wells are used in oil recovery, and together account for approximately 50 to 100 acre-feet of annual ground-water withdrawal. The NMOSE is developing a new ground-water model for management of the Carlsbad Basin. Currently, the entire Carlsbad UWB is closed to new appropriations.

5.3.2.2.4 Declared Ground-water Basin Criteria - Roswell Underground-water Basin

The NMOSE has no recorded declarations within the portion of the Roswell UWB which lies within Lea County. In addition, the entire UWB is closed to new appropriations.

5.3.2.3 State Case Law Affecting Ground-water in Lea County - Mathers v. Texaco, Inc. - 1966

Mathers v. Texaco, Inc., 77 N.M. 239, 421 P.2d 771 (1966), involved a challenge by several water users to Texaco's application to appropriate ground-water from the Lea County UWB. The New Mexico Supreme Court held in *Mathers* that the lowering of the water table in any particular amount in a non-rechargeable basin effected by a new appropriation of ground-water does not necessarily constitute impairment of senior water rights. The Court reasoned that the beneficial use by the public of ground-water in a closed or non-rechargeable basin requires giving such use a time limitation. Thus, the rights of the protestants to appropriate water from within the Lea County UWB were subject to this time limitation. The Court held that the lowering of the water level of the protestants' wells, together with increased pumping costs and reduced pumping yields, did not constitute an impairment of the protestants' rights as a matter of law, because these are the inevitable results of the beneficial use by the public of ground-water in a non-rechargeable basin.

5.3.2.4 Impact of State Statutes, Regulatory Policies, and Case Law on the Supply and Demand on Ground-water in Declared Underground Water Basins in Lea County

All of the basins in Lea County are "mined" basins. In addition, the Lea County, Capitan, and Jal UWBs are still open to new appropriations. State statutes and regulatory policies, as discussed in Sections 5.1.2.1 and 5.1.2.2, direct that appropriations in these basins are approved as long as the requested appropriation does not impair existing water rights. *Mathers v. Texaco, Inc.*, however, holds that lowered water levels in wells, increased pumping costs, and reduced pumping yields do not constitute impairment of existing water right holders sufficient to deny an application for a new appropriation of water from a declared underground water basin. Thus, New Mexico State law, along with the New Mexico Supreme Court's decision in *Mathers v. Texaco*, and the fact that water is not recharged into these basins as quickly as it is consumed, means that Lea County's ground-water supply will likely continue to decline over the next forty years.

Lea County, however, is investigating ways to counteract this projected decline. For example, the Lea County Water Users Association has filed an application with the NMOSE to appropriate any remaining water rights within the Lea County UWB. By filing this application, Lea County is proactively seeking to take control of its ground-water supply so that it can conserve its water supply and have flexibility to efficiently and conscientiously plan for and manage present and future demand for its water supply. In addition, Lea County is investigating methods it can employ to treat poor quality water from the Capitan, Jal, and Carlsbad UWBs and reinject such treated water into the Lea County UWB, and thereby increase the water supply in this basin. Lea County has also requested that the NMOSE close the LEA UWB to new appropriations.

5.3.2.5 Pending Adjudications Affecting Ground-water in Lea County

Approximately 550 square miles in the northern portion of Lea County (see FIGURE 4) has not been declared by the NMOSE. Appropriation of ground-water in this region is governed solely by the common law doctrine of prior appropriation. No pending adjudications within the Plan area are known at this time. Thus the ground-water in this region may likely be relied upon as a future source of water for Lea County water users.

5.3.3 Legal Issues Needing Resolution

Aside from Lea County Water Users Association's application with the NMOSE to appropriate any remaining blocks within the Lea County UWB, there are currently no legal issues pertaining to Lea County's water supply needing resolution.

5.4 LOCAL CONFLICTS

5.4.1 Oil Production Ground-Water Contamination

Oil production in the plan area involves the use of substantial quantities of brine. Studies have implied there have been cases of ground-water contamination of wells in Lea County caused by brine intrusion and oil seepage. Alleged well contamination was also the basis of at least one lawsuit filed in district court in Lea County by a well owner against several oil producers. In addition, there are various know areas of contamination of fresh water by brine water and petroleum products. It has not been proven that well contamination by oil production activities has occurred, however, and, to our knowledge, no judgments against oil producers have been found.

5.4.2 Ground-Water Drawdown

The NMOSE predicts significant ground-water depletion in and around municipalities in Lea County over the next 40 years. This drawdown may render existing municipal well fields incapable of providing a sufficient supply of potable water. To the extent that these municipalities seek new appropriations of ground-water, there exists the potential for challenges to the appropriations by other water users. Ground-water depletion throughout the plan area may also lead to legal conflict between appropriators pumping fresh water for secondary recovery of oil or for irrigation water users.

5.4.3 Out of County Use

Current and future use and demand for water outside of Lea County not only intensifies the pressure of outside water users to obtain water from Lea County, but it also impacts Lea County's water supply.

An example of outside pressure to obtain water form Lea County occurred in 1997 when the ISC attempted to purchase and retire water rights in the Pecos River system owned by IMC Kallium, a potash mining company. The LCWUA filed a lawsuit against ISC that specifically challenged the Commission's plan to pump water from the Lea County UWB for use in subsidizing the available water in the Pecos River system. The commission ultimately abandoned its plan to retire IMC Kallium water rights.

In 1998, IMC Kallium filed applications with NMOSE seeking licenses to pump an additional 6,000 acre-feet of ground-water per year from the Lea County UWB for use outside of the basin at its potash mining operation in Eddy County, New Mexico. IMC Kallium's applications were protested. IMC Kallium and the LCWUA ultimately entered into a global settlement involving not only these applications, but also IMC Kallium's annual water use appropriations from the Lea County UWB. Under the terms of the settlement, although IMC Kallium has licenses for Lea County UWB water totaling 6,529 acre-feet per annum, it agreed to reduce its usage of water from the Lea County UWB to a maximum of 2,000 acre-feet per year subject to the contingency of an occurrence of legal stoppage or curtailment of water usage by IMC Kallium from its La Huerta Capitan water rights. If such stoppage or curtailment occurs, the annual 2,000 acre-feet maximum from the Lea County UWB may be exceeded by IMC Kallium using its licensed rights only by an amount equal to the loss of water resulting from such stoppage or curtailment of water usage from its La Huerta Capitan water rights and, then, only for the period of time the stoppage or curtailment continues. IMC Kallium withdrew its applications for the additional 6,000 acre-feet and LCWUA has made application for these water rights with NMOSE.

The demand for water along the Texas-New Mexico border has increased significantly and is expected to continue to increase. One reason for the increase in water is that range land in this area is being converted into irrigated land. The water used to irrigate these lands is mined water form the Ogallala Water Basin. Mining water from the Ogallala Water Basin will likely impact Lea County's water supply. Currently there is no legal mechanism to protect underground water basins in New Mexico from mining.

5.4.4 Special Districts

The Soil and Water Conservation District exists within Lea County. Their concerns have been included in the development of this plan.

6. WATER RESOURCES ASSESSMENT FOR THE PLANNING REGION

6.1 WATER SUPPLY

6.1.1 Surface Water

Developed surface water is rare in Lea County due to meager storm runoff and the presence of only a few small springs. The surface water that is used goes to stock watering, supplemental domestic service and irrigation. There are no surface water supply facilities for community, municipal, or industrial uses.

6.1.1.1 Precipitation Data

Through the 1950's the mean annual precipitation in Lea County ranged from 12.5 inches to 15.5 inches per year [1]. From 1951 to 1980 this amount dropped to between 10 and 14 inches[2]. From 1951 to 1980 this amount dropped to between 10 and 14 inches. Recent data[3] for 1981 to 1992, show Lea County receiving an average annual precipitation of 16 to 20 inches, 6 inches greater than the average over the 1951 to 1980 span. This follows a similar trend in much of the eight-state area encompassing the U.S. high plains. Most precipitation is received in May and October in the form of heavy showers with limited durations and small coverage areas. Rainfalls lasting longer than 24 hours are rare, averaging one to four times a year. Snowfall in the area is light.

Climatological data were collected from eight National Oceanic and Atmospheric Administration (NOAA) weather stations in Lea County. Station locations, elevations, and available parameters are shown in **TABLE 6-1**. **TABLE 6-2** shows the average temperature and annual precipitation for each station. The average temperature and precipitation of locations in Lea County depends largely on their elevation (see **FIGURE 7**). The western – higher – part of the County is slightly cooler and wetter that then eastern – lower – part . **APPENDIX G** contains summaries and additional statistical analysis of these parameters.

TABLE 6-1: LEA COUNTY CLIMATE RECORDING STATIONS

NOAA Station Name	Coop ID	Elevation (feet msl)	Latitude	Longitude	Parameters Recorded
Crossroads #2	292207	4,148.9	33° 31' N	103° 21' W	precipitation, min. temperature, max. temperature, snowfall
Hobbs	294026	3,614.2	32° 42' N	103° 08' W	
Jal	294346	3,059.3	32° 07' N	103° 11' W	
Lovington 2 WNW	295204	3,902.9	32° 58' N	103° 23' W	
Maljamar 4 SE	295370	3,999.0	32° 49' N	103° 42' W	
Ochoa	296281	3,459.1	32° 11' N	103° 26' W	
Pearl	296659	3,798.9	32° 39' N	103° 23' W	
Tatum	298713	4,099.0	33° 16' N	103° 19' W	

Source: WRCC web-site, January 1999

[1] Nicholson and Clebsch, 1961
[2] Dugan and Cox, 1994
[3] Dugan and Cox, 1994

TABLE 6-2: LEA COUNTY AVERAGE PRECIPITATION

Station Name	Average Precipitation* (in/yr)	Average Temperature* (in/yr)
Crossroads #2	15.57	58.22
Hobbs	16.06	61.91
Jal	12.76	63.79
Lovington 2 WNW	14.58	59.62
Maljamar 4 SE	14.77	60.32
Ochoa	10.82	61.5
Pearl	14.19	60.78
Tatum	16.00	58.39

Source: WRCC web-site, January 1999
* record through 1995

6.1.1.2 Drainage Basins and Watersheds

In Lea County neither of the two major drainage basins, the Texas Gulf Basin in the north and the Pecos River Basin in the south, contain large-scale surface-water bodies or through-flowing drainage systems. The surface water supplies that exist are transitory and limited to quantities of runoff impounded in short drainage ways, shallow lakes, and small depressions, including various playas and lagunas. The Texas Gulf Basin contains a lakes, the Llano Estacado, and the Simona Valley. The Pecos River Basin contains the Querecho Plains, the Eunice Plains, and the Antelope Ridge.

Six perennial lakes are located in the Texas Gulf Basin. They include Lane Salt Lake, Ranger Lake, and a cluster of four smaller lakes located approximately 10 miles northeast of the Town of Caprock. Water in the lakes is brackish and is derived from both surface runoff and ground-water discharge. Northwest of Tatum the Simanola Valley represents the Texas Gulf Basins only semblance of a through-flowing drainage feature; though it is only discernable for a few miles, it can concentrate surface flows for large storms.

In the Llano Estacado the drainage areas of the numerous playas capture 80 to 90 percent of the area's rainfall [4]. Most of the playas average less than one-acre in area, but can be as large as 150 acres; depths range from 1 to 50 feet. The playas only temporarily impound water; clay accumulations in their bottoms retard percolation, resulting in extended seasonal or perennial impoundment during wet years. It's thought that many of the depressions may have been formed by leaching of the caliche cap and subsurface calcareous sandstones of the Ogallala Formation, with subsequent removal of the loosened material by wind[5]. Deep-seated collapse of underlying strata has also been suggested as a mechanism for some. Surface interconnection of the wallows, particularly in the eastern part of the

[4] Musharrafieh and Chudnoff (1999)
[5] Nicholson and Clebsch, 1961

county, results in some poorly defined drainage patterns. The interconnections are possibly the result of original surface irregularities.

The heads of several well-developed gullies are found in the Eunice Plain area, but the gullies do not persist through the sand-covered South Plain region of southern Lea County. Instead there are areas of internal drainage, such as San Simon Swale that reflect deep-seated dissolution and collapse. South of the Mescalero Ridge there exist several ephemeral stream valleys, which when flowing, do so to the south-southeast. The valleys are locally referred to as draws (Monument Draw, Cheyenne Draw, Dogie Draw, Iron Horse Draw, and Seminole Draw). Only Monument Draw covers a significant length, approximately 35 miles. Monument Draw also is the only major drainage-way that deviates from a southeast bearing, possibly due to character of the underlying sediments crossed where the draw makes a southerly bend.

A cluster of four saline playas is located in the Querecho Plain area of the west-central part of the county. These playas, which retain runoff temporarily, are referred to locally as lagunas. Laguna Plata covers the largest area, about 2 square miles. Laguna Toston, the smallest of the four with a surface area of approximately one-quarter mile, is completely filled with sediments; the other three all contain accumulations of clastic sediments and salts (halite, gypsum).

The lagunas help to create shallow saline ground-water which exists under much of the Querecho Plain[6]. The lagunas help to create shallow saline ground-water which exists under much of the Querecho Plain. The presence of the shallow saline water has been recognized to the extent that the New Mexico Oil Conservation Commission Order No. R-3221, banning the surface disposal of Aroduced water into unlined pits within the State was amended (OCC Order No. R-3221-B, July 25, 1968) to exclude much of the area[7]. The presence of the shallow saline water has been recognized to the extent that the New Mexico Oil Conservation Commission's Order No. R-3221, banning the surface disposal of produced water into unlined pits within the State was amended (OCC Order No. R-3221-B, July 25, 1968) to exclude much of the area.

Two playa lakes, including Bell Lake, are located in the Antelope Ridge area of southwest Lea County. Both are associated with dune-fields of gypsum sand, although gypsum deposits do not exist nearby. The locations of the playas may be controlled by underlying collapse depressions. Head-driven brines of concentrated chloride and sulfate may have followed fractures to the surface to result in earlier precipitation of these deposits.

Though southern Lea County is part of the Pecos River Basin, there is no connecting drainage to the Pecos River. Still, the Pecos River is the most significant surface water body in southeastern New Mexico. The Pecos carved its present valley in Eddy County thousands of years ago during Quaternary time. In doing so, the River isolated both the Ogallala Formation and the Dockum Group sediments in Lea County from their ancient upland recharge areas. In the eons since this occurred, ground-water flow in these aquifers attained a balance with the more limited recharge provided by the High Plains. Since the advent of large-scale ground-water development in the early to mid part of this century, this equilibrium has been lost. Aquifer levels in Lea County are now declining (see Section 6.1.2), as ground-water is mined from storage. Lower aquifer levels limit the ability of ground-water to sustain springs historically dependent on subsurface water for their existence.

[6] It is also thought that the saline aquifers receive subsurface discharge from the Permian Rustler Formation; dissolutioned evaporite beds within the unit have resulted in collapse of the Magenta Dolomite Member to close proximity with the Culebra Dolomite Member, resulting in a vigorous saline flow zone. San Simon Sink origination is also related to deep-seated dissolution of Permian evaporite beds and subsequent unit collapse. The depression is approximately one half mile in area and 100 feed deep. A secondary collapse, with noticeable active subsidence in the mid-1930s is also evident. Runoff from heavy rainfall flows into the sink, which is otherwise dry.

[7] Specifically, 18 square miles within Lea County and a substantially larger area in Eddy County (Fig. 33) have been determined to contain extremely high concentrations of chlorides, therefore the oil-fied practice of disposal of produced water into unlined pits has been allowed to continue.

6.1.1.3 Streamflow Data

The U.S. Geological Survey (USGS) does not have gages in Lea County which measure daily surface flows. However, peak flow rates have been spot measured at Monument Draw (near Monument) and Antelope Draw (near Jal). Each of these Draws can occasionally convey sizable flows. In June of 1972, a flow of 1280 cubic feet per second (CFS) (the highest recorded) occurred at Monument Draw. In July of 1994, a flow of 53% (CFS) (also the highest recorded) occurred at Antelope Draw. These flows should be considered indicative of flows that can occur at other gullies and swales in Lea County. APPENDIX I contains detailed flow measurements recorded at these gages.

6.1.1.4 Evaporation & Evapotranspiration Data

The region's total annual pan evaporation potential is estimated to range from 32.9 inches to 131.5 inches, depending on season and location[8]; a good average value appears to be 100 inches[9]. Evaporation potential from larger standing water bodies is estimated at appproximately 70 inches[10], but lower values in the 39 to 52 inches per year range have been used[11]. The months of greatest evaporation potential are April through August.

Water loss through evaporation occurs from both the playas and lakes of Lea County. The playas on the High Plains (i.e. Llano Estacado) have been studied to determine the fate of impounded runoff. Some studies suggest the majority of the playas water is lost to evaporation, while others have found infiltration prevails. Its estimated that approximately 100,000 acre-feet of water accumulates in the playas, in years of normal precipitation, and that 20 to 80% of the impounded water infiltrates into the subsurface[12]. If a maximum 18-inches per year evapotranspiration at ground level (with a linear decrease to nil at 20 feet below ground) is assumed, the average annual evaporation from shallow reservoirs can be calculated to be approximately 72 inches[13]; and evaporation rates in the playas may actually approach that of the pan device. Because of these high evaporation rates, the small lakes of northern Lea County, which intersect the water table, probably produce a net discharge of ground-water to the atmosphere.

In most of Lea County the water table lies below the depth at which evapotranspiration occurs. The depth of evapotranspiration appears to be 20 feet with the rate decreasing linearly with distance below the surface[14, 15]. In areas around Monument, the water table is close enough below the surface for ground-water to be lost by evapotranspiration[16]. The Four Lakes Area may also contain places of shallow water table prone to evapotranspiration losses. Evapotranspiration by crops common to Lea County is approximately 60 to 80 percent of evaporation from a free water surface.[17] Evapotranspiration from natural/native vegetation occurs at lesser rates. Most transpiration by native vegetation occurs near the perennial lakes, and springs and seeps.

Evaporation from playa lakes in Lea County in 1975 was estimated at 8,900 acre-feet[18]; the NMOSE discontinued including evaporation from playa lakes as a separate water-use category in 1980. Stockpond evaporation estimates

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[8] Havens (1966)
[9] Nicholson and Clebsch (1961) reviewed (undated) evaporation data from Portales, New Mexico, and Red Bluff Dam and Grandfalls, Texas.
[10] Nicholson and Clebsch (1961)
[11] Havens, (1966)
[12] Havens, (1966)
[13] Hale, Reiland, and Beverage (1965)
[14] Hale, et al. (1965) and McAda (1984)
[15] Bjorklund and Motts (1959) report that although depths from which plants can lift ground water vary greatly with species, consumption has been noted to occur at depths to 50 feet.
[16] McAda (1984)
[17] Gray (1973)
[18] Sorensen (1977)

for 1975, 1980, and 1985 were 137 acre-feet, 279 acre-feet, and 279 acre-feet, respectively[19]; the NMOSE compiled data for stockpond evaporation until 1990, when it was removed as a separate category. Reservoir evaporation in Lea County was estimated at 100 acre-feet in 1975[20]. Reservoir evaporation withdrawals in Lea County for 1980, 1985, 1990, and 1995 were zero[21]. This is because the NMOSE reduced the scope of reservoir evaporation to only included major reservoirs with a capacity of approximately 5,000 acre-feet or more[22].

6.1.1.5 Surface Water Yields

Surface water yields in Lea County occur as spring flow. The USGS has inventoried numerous springs throughout New Mexico, including two within Lea County. Spring information from the USGS is in APPENDIX I. Notable discharge occurs at Monument Spring[23] and other lesser springs, but flows have decreased drastically since the initiation of large scale pumping. Some spring and seep discharge has been noted along the Mescalero Ridge and at the contact between Tertiary and Triassic sediments about 26 miles due west of Tatum. Other springs are known to discharge into the lakes of the northern County. Ranger Lake and North Lake appear to receive the majority of this discharge.

6.1.2 GROUND-WATER

6.1.2.1 Geologic Data

Geologic data for the Lea County area are described in this Section according to ascending geologic age. The objective of the discussion is to provide a brief and general summary of the County's lithology, the type of rocks present that may produce water, and the approximate thickness of water bearing strata. The summary is not intended to provide a complete overview of the depositional environments and geologic structure of the County. Geologic units deposited prior to the Permian age are not addressed in this document because they are present at relatively great depths, produce water with high total dissolved solids concentration, and have little possibility of being used for purposes other than oil and gas exploration and production. Some of the geologic units in the study area are present in more than one underground-water basin (UWB) and may be used as a water source in each basin in which they are present. APPENDIX D contains a geologic time scale and stratigraphic nomenclature chart. **FIGURES 11 through 14** depict Lea County geology in cross-sectional format. **FIGURE 10** shows the location of the cross-section lines.

Quaternary (present to 2 MYBP)

Quaternary-age alluvial material is present throughout Lea County and unconformably overlies the Ogallala Formation and Triassic-age rocks, which were eroded to varying degrees prior to the deposition of the alluvium. The erosion occurred during the Cenozoic Era, after the Ogallala Formation had been locally eroded away[24]. The alluvial material consists of unconsolidated, interbedded layers of clay, sand, silt, and gravel. Thickness of the alluvial material generally ranges from zero to about 30 feet above the Ogallala Formation, zero to about 40 feet above the Triassic-age rocks, and in excess of 750 feet in the Jal UWB[25]. Erosional channels can be responsible for increases in alluvium thickness. In places, the saturated thickness of the alluvium is sufficient to be an aquifer, but in only used as a public water source in the Jal UWB. The alluvium is used to lesser degrees for water- supply wells in the Capitan UWB. Most of the Capitan UWB wells are completed near the Mescalero Ridge's Monument Draw area, but

[19] Sorensen (1977, 1982) and Wilson (1986)
[20] Sorensen (1977)
[21] Sorensen (1977, 1982) and Wilson (1986, 1992, and 1997)
[22] Wilson (1992)
[23] Musharrafieh and Chudnoff (1999)
[24] Ash (1963)
[25] Nicholson and Clebsch (1961)

some exist scattered across the Querecho Plains, at the northeast San Simon Swale, and at Dogie Draw. A red dune sand cover is present in areas as extensive as 80 percent of southern Lea County, and beyond into Eddy County, New Mexico, and Texas. The sand dunes are stable to semi-stable over most of the area, but are drifting in a few places.

Tertiary (2 to 67 MYBP)

The Tertiary-age Ogallala Formation unconformably overlies Tertiary- and Cretaceous-age rocks. The Ogallala is the predominant aquifer throughout the Lea County UWB. The Ogallala Formation, deposited to the east of the southern ancestral Rocky Mountains, has retained an eastward slope typical to such a deposition. Limited portions of the Ogallala Formation exist west of Lea County in Chaves and Roosevelt Counties, New Mexico. The aquifer extends eastward into Texas where it is a major source of ground-water for irrigation. It is also used to some extent in the undeclared basin at the north end of the County and in the Capitan UWB. The thickness of the Ogallala ranges from 0 to 350 feet and contains an upper caliche layer that ranges from a few feet to 60 feet thick. It appears that most of the variations in the overall thickness were due to irregularities in the underlying depositional surface rather than the result of post-depositional erosion to the Ogallala[26]. These irregularities consist of eroded stream channels cut into the Tertiary- and Cretaceous-age rocks by ancestral streams prior to the deposition of the Ogallala. The erosional channels can locally account for increased thickness of the Ogallala Formation. The channels generally trend to the southeast[27].

The caliche layer ranges from being very soft to hard, depending on the degree of cementation. Where the layer is very hard, it is resistant to erosion and locally known as Caprock. Caprock forms the higher promontories and the cliff-forming unit of Mescalero Ridge. Cementation tends to be greater toward the top of the formation, becoming poorly cemented with depth[28]. Interbedded layers of fine- to medium-grained sand and gravel underlie the caliche layer and compose the remaining thickness of the Ogallala. The sand and gravel layers are the primary water bearing strata of the formation. Cretaceous and Triassic rocks underlying the Ogallala form a relatively impermeable barrier that restrict downward movement of water. Where the Ogallala is absent, underlying Triassic- or Cretaceous-age rocks are exposed or are the unit lying directly below alluvial cover. FIGURE 8 shows the base of the Ogallala Formation.

Cretaceous (67 to 140 MYBP)

Cretaceous-age Tucumcari Formation rocks were deposited in southern Lea County, but were subsequently almost entirely removed by erosion[29]. The Tucumcari is approximately 150 feet thick in northeastern Lea County and thins to the southwest. The Tucumcari Formation generally consists of fossiliferous dark gray siltstone and thin beds of brown sandy limestone, and gray limestone and sandstone. Outcrops of the Tucumcari are reported along the shores of North Lake[30], Ranger Lake, and Middle Lake in northern Lea County. There the maximum exposed thickness is approximately 17 feet, and the contact with the overlying alluvium is unconformable. The North Lake locality represents the basal part of the Tucumcari Formation. The North Lake outcrop is part of a sequence that is known to extend from west Texas, across northern Lea County and southeastern Roosevelt County, although there exists some thinning and pinching-out north of Lovington, which disrupts continuity of the unit[31]. Tucumcari Formation rocks are described about 3/4 miles east of Eunice in a Lea County Concrete Company gravel pit[32].
Triassic (200 to 250 MYBP)

[26] Nye (1930)
[27] Ash (1963)
[28] Ash (1963)
[29] Nicholson and Clebsch (1961)
[30] Theis (1934)
[31] Kues and Lucas (1993)
[32] Nicholson and Clebsch (1961)

The Triassic-age rocks in the study area are generally referred to as the Dockum Group[33], which includes the basal Santa Rosa Sandstone and the overlying Chinle Formation. Recent stratigraphic work refers to the basal Triassic-age rocks in the study area as the Santa Rosa Formation and the overlying Triassic-age rocks as the San Pedro Arroyo Formation, both of the Chinle Group[34]. Since the Dockum Group is the most common nomenclature in this area, when referring to more than one specific formation of Triassic-age rocks, other sections of this report will refer to the combined formation as the Dockum Group or as the Upper and Lower Dockum Group units.

The Upper Dockum Group is thought to conformably overlie the Lower Dockum sediments. Thickness of the formation is reported to be at least 165 feet. The San Pedro Arroyo Formation consists of variegated mudstone and siltstone, with minor interbeds of sandstone and conglomerate[35]. Triassic-age beds dip, or tilt, to the east or southeast[36].

The Lower Dockum Group sediments consist of interbedded sandstone, mudstone, and clay beds, which as a unit, unconformably overlie Permian-age rocks. The Santa Rosa Sandstone is a specific, largely sandstone and conglomerate sequence within the Lower Dockum Group. Thickness of the Santa Rosa is reported to be about 85 feet.

Permian (250 to 290 MYBP)

The major deep structural province of southern Lea County, the Delaware Basin, is formed from Permian sediments. Much of the Delaware's circumferential carbonate complex lies within Texas. Deposition of Delaware Basin sediments began early during the Permian era and by the middle Permian a reef primarily composed of dolomite and limestone began forming at the basin margins. This reef complex consists of the Goat Springs and Capitan Limestones, which make up what is known as the Capitan Aquifer[37]; the geologic units forming the aquifer were deposited as either a fringing reef or a shelf-margin complex of organic mounds or banks ringing the structural Delaware Basin[38]. Subsequent deposition included sandstones and shales, which were overlain by evaporite beds and limestone, known as the Castile and Salado Formations. Through later episodes of mountain-building, parts of the unit have been raised well above surrounding land as the Guadalupe Mountains near Carlsbad, and the Glass Mountains near Fort Stockton, Texas. The Rustler Formation overlies the Salado Formation and consists of interbedded layers of limestone, dolomite, sand, and shale[39]. The Capitan Aquifer and Rustler Formation are the only major aquifers of the areas Permian-age rocks. The Capitan Aquifer is about 1,500 feet thick, although in an arc only 10-12 miles wide (FIGURE 9), and the Rustler Formation is about 200 to 300 feet thick in Lea County[40].

6.1.2.2 Hydrology Data by Aquifer

Alluvial Aquifer

The Allluvial Aquifer of the underlies most of southern Lea County and represents the northernmost extension of thick alluvial water-bearing deposits, common to Winkler, Ward, Loving, and Reeves Counties in Texas. In Lea County the Alluvial Aquifer is unconfined. At its extremities, areas such as Monument Draw, Querecho Plains, San Simon Swale, and Dogie Draw and along the Mescalero Ridge, the Alluvial is not continuous. The saturated thickness is substantial in places, such as in the Jal UWB, but thin at most other locations. Deep-seated dissolution and collapse

[33] Ash (1963)
[34] Lucas and Anderson (1993)
[35] Lucas and Anderson (1993)
[36] Ash (1963)
[37] Hiss (1973)
[38] Hiss (1973)
[39] Richey, et al. (1985)
[40] Hiss (1973)

of salt-rich geologic units, not erosion, is believed the reason for the trough extending from the Winkler Alluvium in Ward County into the Jal UWB. The Winkler alluvium is deeper than that in the adjacent Jal UWB, creating potential for future ground-water development in Texas that could increase the rate of drawdown of the JAL UWB in Lea County.

Even at locations where it is thin, the Alluvial Aquifer is capable of producing adequate supplies of water for livestock and domestic uses. The greatest production from the Alluvial Aquifer is in the Jal UWB for the City of Jal. The transmissivity for the aquifer ranges from 2,140 to 3,075 ft2/d (16,000 to 23,000 gpd/ft)[41] with depth to water ranging from 50 to 100 feet[42]. In the Jal Water Well Field, the saturated thickness of the alluvial aquifer is reported to exceed 500 feet, with a transmissivity of 2,400 ft2/d (18,000 gpd/ft), and an average effective porosity of 16 percent[43]. One of the City of Jal wells was pump tested at 450 gallons per minute for 36 hours[44].

Water depths in the Alluvial Aquifer have decreased in some areas by 10 feet in the last 24 years[45]. Ground-water pumping is the most significant discharge. Where the water table lies close to land surface, evapotranspiration constitutes another source of discharge[46]. Recharge is from infiltration of surface water from surrounding uplands and along channels of ephemeral streams. Regional percolation is not a factor unless storms are of long duration or frequent occurrence, in which case the soil can fully hydrate - allowing deeper percolation[47]. Subsurface recharge may occur through flow from adjacent artesian formations. This is problematic in Reeves County, Texas, where the Rustler Formation may be recharging the alluvium with saline water because the low permeability rock of the Dewey Lake Red Beds, is not present to separate the two units.

It is not possible to estimate the total amount of ground-water in storage in the Lea County's portion of the Alluvial Aquifer, because of the Aquifer's discontinuity and because the horizontal and vertical extent of smaller areas of saturated alluvium are poorly defined. The only portion of the County in which an estimate of ground-water in storage can be made with accuracy is within the Jal UWB. Estimated ground-water in storage[48] in the Jal UWB is shown in TABLE 6-3.

TABLE 6-3: ALLUVIAL AQUIFER

Area (acres)	Average Saturated Thickness (feet)	Specific Yield	Estimated Ground water in Storage (acre-feet)
9,600	310	0.16	476,160

Source: Miller (1994)

Ogallala Aquifer

The Ogallala Aquifer is the main source of water in the Lea County, where it underlies about 2,800 square miles; it almost completely underlies the area covered by the Lea County UWB and the undeclared basin-area in the north part of the County. The Ogallala only provides limited amounts of water to wells in other portions of the county

[41] Nicholson and Clebsch (1961)
[42] Miller (1994)
[43] Engineers, Inc. (1998)
[44] Miller (1994)
[45] Miller (1994)
[46] See Section 6.1.1.4
[47] Richey, et al., 1985
[48] Not all ground water in storage can be pumped from an aquifer. Water is retained in an aquifer by surface-tension forces associated with the grains of clay, silt, sand, gravel, or other particles. The smaller the grain size, the greater the amount of water that will be retained.

because the saturated thickness is fairly small or non-existent in those areas. The Ogallala is unconfined and therefore flows east-southeast in response to gravity, following the inclination of Ogallala beds and the top of the underlying confining stratum.

The hydraulic conductivity reported for various portions of the Ogallala Aquifer in the Lea County UWB has been evaluated by a number of different authors using different techniques. The techniques include aquifer tests and laboratory analysis[49], and model calibration[50]. Values reported range from 3 to 262 ft/d. Reported values from ground-water flow models indicate areas with higher hydraulic conductivity near the central portion of the basin, between Tatum and Lovington - eastward to the Texas border and near Hobbs - eastward to the Texas border. Specific yields reported range from 0.10 to 0.28[51, 52]. Depth to water ranges from about 20 feet near Monument and the Four Lakes area to about 250 feet along the edge of Mescalero Ridge[53]. Saturated thickness of the aquifer ranges from a few feet along the northeast portion of the UWB and along portions of the Mescalero Ridge, to about 250 feet near the Texas State Line. Irrigation well yields range from about 200 to nearly 2,000 gallons per minute.

Under pre-pumping conditions, recharge of the Ogallala was in equilibrium with natural discharge. The greatest amount of natural discharge has always been through subsurface flow across the Texas Line. Some natural discharge also occurs through springs, seeps, lakes[54], and evapotranspiration[55]. Pumping for irrigation, municipal supply, domestic use, industrial use, and stock causes a large artificial discharge. Because pumping is in excess of the Ogallala's recharge rate the elevation of the top of the aquifer has declined or experienced drawdown. A recent ground-water flow model[56] indicated that, in response to heavy pumping in Texas, the most severe drawdowns occur along Lea County's east border, the Texas Line. In this area drawdowns in excess of 60 feet have occurred since 1940. The model predicts that the saturated thickness will decrease another by 50 to 100 feet in the area between the State Line and the communities of Hobbs, Lovington, and Tatum in the next 40 years. Actual drawdowns could be much greater than this amount[57]. As the model use County Water demand for 1995, not predicted

Recharge to the Ogallala occurs when precipitation[58], flows in ephemeral streams and arroyos, and water retained in playas and lakes infiltrates into the subsurface[59]. Recharge rates vary with changes in precipitation, soil type, and the hydraulic properties of underlying sediments and rocks. Estimates of recharge range from 0.25 to 0.5 inches per year[60, 61]. It follows then that the amount of annual rechargeto the Ogallala in Lea County is between 37,500 to

[49] Theis (1934)

[50] McAda (1984), and Musharrafieh and Chudnoff (1999)

[51] The specific yield for an unconfined aquifer is the volume of water that will drain from a unit of surface area per unit of decline. The value is expressed in percent.

[52] Musharrafieh and Chudnoff (1999) provide a thorough summary of hydraulic conductivity and specific yield data for the Ogallala aquifer in the Lea County UWB and other nearby areas.

[53] Musharrafieh and Chudnoff (1999)

[54] See Section 6.1.1.5

[55] See Section 6.1.1.6

[56] Prepared by Musharrafieh and Chudnoff (1999)

[57] Drawdown projections are based on all demands although irrigation is most significant on the present irrigation of approximately 51,000 acres. Lea County had about 150,000 acres of iffigable land with permitted water rights. The role and rate of aquifer decline will be greater if more acres are irrigated.

[58] The greatest amount of recharge from precipitation comes in areas covered by dune sand, and in areas well covered by playa lakes.

[59] Some investigators in the area have suggested that irrigation return flow is recharge. Water returned to the aquifer from irrigation is more appropriately recycled water, because the water is simply returning to the same awuifer from which it was pumped. Return flow to the aquifer from irrigation was estimated by Stone (1984) to be 10.3 inches per year per irrigated acre.

[60] Theis (1934) and McAda (1984)

[61] Dugan and Cox (1994) estimate that 0.5 inches is recharged to the aquifer each year. They note that the Department of Agriculture Conservation Reserve Program (CRP) may reduce the amount of recharge, because the

75,000 acre-feet per year, on average[62]. The average annual recharge to the Lea County UWB is between 29,000 to 58,000 acre-feet, on average[63]. Additional recharge can be expected from precipitation falling on small areas of the Llano Estacado outside County boundaries to the north and west. Also, a small amount ground-water in the Ogallala Formation in adjacent parts of Roosevelt and Chaves Counties flows southeasterly, and likely enters the area along the County's northern border.

A study of the potentiometric surface data over the last 46 years shows large declines in the Ogallala and a decrease in its natural flow potential. Potentiometric surface[64] elevation data from 1952, shown in FIGURE 15, indicate the ground-water flow direction was about 30 degrees south of east, with a gradient of 15.8 feet/mile in north and central Lea County[65]; in the southeast part of the County flow was apparently more southerly. Potentiometric elevation data for 1968 are shown on FIGURE 18; the direction of ground-water flow was southeast and the gradient averaged about 15 feet/mile. Changes in the potentiometric surface elevation from 1952 to 1968 indicate decreasing water levels throughout much of the Ogallala[66]. Potentiometric surface elevation contours for 1981[67] are shown on FIGURE 19; the contour lines tend to be more sinuous than those of earlier years, but this is probably because a greater amount of data - with a larger spatial distribution, were available. The location of the contours changed little from 1968 to 1981, indicating only small changes in water levels for the period; the direction of flow was southeast and the gradient averaged about 13.7 feet/mile. Potentiometric surface elevation contours for the combined years 1995 through 1998[68] are shown on FIGURE 21. The general flow direction and location of the contours changed little from 1981, indicating only small changes in water levels; the direction of ground-water flow was southeast and the gradient was about 13 feet/mile.

Declines in the Ogallala's thickeness, in excess of 8 feet, occurred from 1940 to 1950 in the area from McDonald to Prairieview, and at Lovington, Humble City, and Hobbs (FIGURE 16); the areal extent of declines were greatest around Lovington, reaching about 25.5 square miles[69]. Larger declines of up to 25 feet occurred from 1950 to 1960, as ground-water development increased; measurable declines were noted throughout most of the County (FIGURE 17), with the greatest decline occurring about 2 miles northeast of Prairieview[70]. Depth to water measurements from wells during 1968 to 1981 (FIGURE 20) reveal additional declines in excess of 25 feet along the State Line, with declines exceeding 10 feet in other locations. Then again during the interval between 1981 and 1998 depth to water measurements showed declines exceeding 25 feet at the State Line (FIGURE 22); however, during this last period ground-water levels actually rose throughout the north and west parts of the County[71]. Drawdowns are localized

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CRP takes land out of irrigation for ten years, allowing the vegetation to revert to grassland. Grasses have larger water requirements than most cultivated crops. This decrease will be more than offset by the corresponding decrease in irrigation pumping.

[62] = (0.25-0.5 inches) X (2,800 sq. mi.)

[63] = (0.25-0.5 inches) X (2,180 sq. mi.)

[64] The potentiometric surface of an unconfined aquifer, such as the Ogallala, is essentially the water table surface.

[65] Ash (1963)

[66] This is noted by westward shifts in equal elevation contours in the eastern, central, and southern portions of the basin between the two time periods. For example, east of Lovington, the 3,700 foot contour was present about 1.4 miles farther east in 1952 than in 1968. Since the water table elevations increase to the west, the westward shift indicates a decrease in the water levels in the area. Comparison of data east of Tatum for the two time periods indicates a similar trend.

[67] The contours were made using significantly more data than were available for 1968. The data came from water-level measurements at individual wells.

[68] This is the most recent water level data available for this report.

[69] Ash (1963)

[70] Ash, (1963)

[71] Dugan and Cox (1994) indicate that decline rates from 1980 to 1993 could have been greater, except the annual precipitation from 1981 to 1992 was more than 6 inches above normal. The above average annual precipitation could likewise be responsible for the water level rises experienced throughout much of the north and west parts of the County during the same time period.

along these main pumping centers. In order to meet future demands, well fields may need to be drilled into areas where less drawdown has occurred, generally the western portions of the basin.

Pumping in Texas, along the Texas-New Mexico State Line is in large part responsible for more than 80 feet of localized declines in the water-level since 1940. Continued pumping along the Line will continue to drop the water-level and increase the hydraulic gradient in the area. Estimated flows across the New Mexico-Texas Line have been calculated and are shown in the graph below and in TABLE 6-4. Although the hydraulic gradient from New Mexico to Texas has increased over time, the amount of water flowing from New Mexico to Texas has decreased from 1967 to present. This is because the saturated thickness of the aquifer along the New Mexico-Texas border has decreased[72]. In the future, the flow across the Line should continue to decrease as the thickness of the aquifer declines and there is less water to pump.

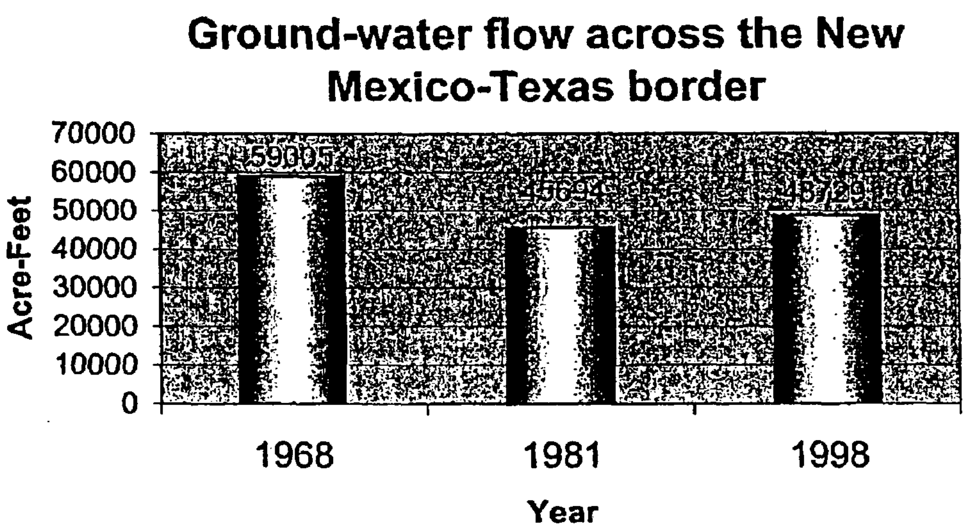

TABLE 6-4: FLOW ACROSS

Time Period	SaturatedThickness Length Along NM-TX Line, In Miles	Flow In Acre-Feet/Year
1967-1968	61.9	59,005
1981	61.9	45,694
1995-1998	61.9	48,729

Source: estimated from hydraulic conductivity values.

Pumping rates and costs are affected by the depth of water and the thickness of the aquifer. As the water-table depth increases the energy required to lift water increases; to raise water to the surface, one additional unit of power is required for each additional 10 feet of water depth[73]. Depth to Ogallala water in 1952 was about 40 feet in the

[72] As the thickness of the aquifer decreases, there is less saturated area through which water can flow. For similar reasons the rate at which water can be pumped from an aquifer is related to its thickness.
[73] Power = $(Depth_{watertable} \times Pump_{discharge} \times Efficiency)/3956$

central and south-central parts of the County. Current depth to water for the Ogallala ranges from 50 feet to 200 feet along the Texas Line. Depths to water in 1968, 1981, and present are shown on **FIGURES 23, 24, and 25**, respectively. Hydrographs from wells in the Lea County portion of the Ogallala, showing historic water level changes, are included in **APPENDIX J**.

As the saturated thickness of an aquifer decreases, well yields (the amount of water available) from vertical wells also decreases. Due to the nature of the Ogallala, it is not feasible to produce large quantities of water from vertical wells in Lea County when less than 70 feet of saturated thickness exist. **FIGURES 26, 27 and 28** show approximate saturated thicknesses for the Ogallala Formation for 1952, 1967 and present, respectively.

At various times, estimates of ground-water in storage have been made for the Ogallala in Lea County. The estimates are made by assuming specific yields and saturated thicknesses. Ground-water in storage estimates are shown in **TABLE 6-5**. As noted for the Alluvial Aquifer, not all ground-water in storage can be withdrawn. About 40 percent of the total stored water in Lea County's portion of the Ogallala (approximately 20,000,000 acre-feet in 1952) was considered recoverable for large-scale users. This equals about 100 years of supply at 1960 pumping rates. Because about 45 percent of the water in the basin is in areas where the saturated thickness is 140 feet or greater, this Plan has determined that 45 percent (approximately 14,000,000 acre-feet) of the water presently in storage can be recovered. It follows that approximately only 8,000,000 acre-feet of recoverable water will exist in 2040 if a continuation of 1998 pumping rates occurs. The bulk of this figure will also probably be located away from existing well fields due to drawdown in the aquifer.

TABLE 6-5: OGALLALA AQUIFER – STORED WATER IN LEA COUNTY

Aquifer Area	Average Specific Yield	Estimated Ground-water in Storage (acre-feet)	Recoverable water	Date	Reference
1,400,000 acres	0.35	49,000,000	19,600,000[a]	1952	Ash, 1963
1,500,000 acres	0.20	48,000,000	21,600,000[a]	1984	McAda, 1984
1,400,000 acres	0.21	31,100,000	14,000,000[b]	1995-1998	calculated from Musharrafieh and Chudnoff (1999)

[a] Assumes 40% of water is recoverable.
[b] Assumes 45% of water is recoverable.
[c] Calculations are for the Lea County UWB. Other parts of the Ogallala in Lea County are insignificant.

Dockum Group Aquifers

Dockum Group sediments exist throughout Lea County. While the Dockum Group has thick areas of sediments and large estimates of stored ground-water, the Group's aquifers are largely undeveloped due to the availability of shallower water and the high cost of producing the deep Dockum waters. The development that has occurred is limited specifically to the Santa Rosa sandstone unit. The Santa Rosa Aquifer is the principal source of ground-water for domestic and livestock uses in the southwestern portion of the County and was the principal aquifer for the City of Jal before 1954. The only community in Lea County that currently pumps part of its water from the Dockum Group is Oil Center.

The available hydraulic data for the Santa Rosa Aquifer are sparse and indicate a wide ranges of values. Well yields range from 6 to 100 gpm[74]. Specific capacities range from 0.14 to 0.2 gallons per minute per foot of drawdown. Depth to water varies from 120 feet to 700 feet and the potentiometric surface elevation ranges from 2,820 to 3,400 feet above mean sea level (msl). The saturated thickness varies from 200 to 250 feet; the saturated thickness of the

[74] Nicholson and Clebsch (1961)

Dockum Group sediments as a whole can be much thicker, up to 2,400 feet in northern Lea County[75]. The direction of flow varies from south in the south-central part of the Lea County to southwest towards Eddy County in Lea County's southwestern part; it has been suggested that water from the Dockum Group is also flowing downward from the Santa Rosa Sandstone into underlying Permian rocks[76].

Discharge from the aquifer is through pumping or subsurface flow into other underlying formations. Recharge to the Dockum occurs through precipitation on overlying sand dunes, precipitation directly on the Group's outcrop, and runoff flowing over the outcrop. It is also possible that some vertical migration of water from the overlying Ogallala and Alluvial Aquifers contribute[77]. Major recharge areas for the Dockum Group are in the southwest part of the County, where Tertiary formations are not significant overlying structures. Recharge areas can be seen in the potentiometric surface elevation data of **FIGURE 15**.

Changes in water level from 1968 to 1981 for the south parts of the Dockum Group can be seen on **FIGURE 20**. Data south of Mescalero Ridge are primarily from the Dockum Group aquifer, but do include some wells in the Alluvial and Ogallala aquifers. Declines of up to 50 feet occurred in spots, but increases of up to 15 feet also occurred. Water level changes for the same area from 1981 to 1998 can be seen on **FIGURE 22**. Ground-water declines of 10 to 50 feet occurred and increases of 10 to 30 feet are indicated. Hydrographs showing historic water level changes for the southern portion of the county are included in **APPENDIX-J**.

Tucumcari Formation

The Cretaceous Tucumcari Formation exists in a limited area of northeastern Lea County. The Tucumcari is overlain by sediments of the Ogallala Formation. Close to one-third of Lea County's known Tucumcari has part of its strata above the water table[78]. Lithologically, the Tucumcari is characterized as a shale with lesser limestone and sandstone beds. Basal sandstone beds provide limited amounts of water from within the Tucumcari Formation, but only limited exploration of the unit's ground-water has occurred.

Several well completions into Cretaceous beds in northern Lea County are reported. Prior to the 1940's, some beds contained sufficient hydrostatic head to provide large flows at the ground surface[79]. Cretaceous-zone water wells ceased being artesian at the surface due to widespread drilling of uncased seismic shot-holes. The shot-holes made hydraulic connections to the overlying Ogallala Formation, providing a path for excess head in the Tucumcari to dissipate into the unconfined Ogallala Aquifer. Ground-water flow could occur through natural pathways between the Cretaceous rocks and the Ogallala aquifer[80]. In the area near Ranger Lake, the Ogallala is known to gain water from the Cretaceous units rising to the west and northwest.

The fine-grained character of most of the thickness of the Tucumcari Formation in Lea County will likely impede development of substantial amounts of water from this unit without the occurrence of secondary permeability features (i.e. fractures, limestone solutioning, etc.). Estimates of ground-water in storage for the Tucumcari are presented in **TABLE 6-6**. The percent of the storage that is economically feasible to develop has not been determined.

Rustler Formation

The Permian Rustler Formation is believed to underlie all of Lea County at depth. Like other Permian units lacking nearby fresh-water recharge, the Rustler produces brackish to saline water. Lithologically, the majority of the unit is composed of evaporite beds (halite, gypsum) which are poorly permeable unless solutioned, and have obvious water

[75] Dutton and Simpkins (1986)
[76] Nicholson and Clebsch (1961)
[77] Nicholson and Clebsch (1961)
[78] Any overlying Ogallala Formation beds in these areas would also be unsaturated.
[79] Ash (1963) reported one well with a potentiometric surface elevation 14 feet above the ground surface.
[80] McAda (1984)

quality limitations for potable or agricultural use. Two marker beds within the Rustler, the Culebra and Magenta Dolomites are acknowledged as the formation's main production beds. Near-surface flow from these units has contributed to the saline shallow ground-water found in Nash Draw in Lea and Eddy Counties.

Ground-water produced from the Rustler Formation is primarily used for stock watering and secondary recovery of oil. Water in the formation is generally present under confined (artesian) conditions. Depth to water ranges from about 240 to 355 feet below ground surface and the potentiometric surface elevation ranges from 2,835 to 2,765 feet above msl, sloping to the southwest[81]. The formation's thickness has been estimated to range from 90 to 450 feet[82]. Depth to the top of the formation may range from 900 to 1,100 feet.

Little data regarding the hydraulic properties of the Rustler in Lea County are available. The nearest data concerning hydraulic properties of the Formation are from Eddy County, where the transmissivity of the Culebra Dolomite Member at the Project Gnome Site was reported as 468 ft2/day[83], 0.001 to 140 ft2/d at the Waste Isolation Pilot Plant (WIPP), and 18 to 1,250 ft2/d at Nash Draw. Transmissivity of the Magenta Dolomite Member at the WIPP site ranges from 0.004 to 0.1 ft2/d[84]. Well yields in Lea County are reported to range from 10 to 100 gpm[85]. Surface recharge to the formation occurs from infiltration of precipitation and surface water flow on outcrops. Recharge probably occurs at some distance from Lea County because the closest outcrops are in Culberson County, Texas[86]. Subsurface discharge exists in Eddy County, where the Rustler is in places found to be in hydraulic connection with the Pecos River. Discharge from the aquifer in Lea County is from wells and ground-water flow out of the county.

TABLE 6-6: LEA COUNTY AQUIFERS - GROUND-WATER IN STORAGE

Aquifer	Aquifer Area (acres)	Specific Yield	Estimated Ground water in Storage (acre-feet)	Water Level Data	Reference, Formation Geometry
Ogallala Formation (unconfined)	1,441,000	0.12	17,200,000	1995-98	this report using 1995 to 1998 data
Ogallala Formation (unconfined)	1,440,000	0.21	31,400,000	1995-98	this report using 1995 to 1998 data, NMSEO January 1999 model
Tucumcari Formation (unconfined)	493,000	0.05	1,170,000	1995-98	Ash, 1963
Tucumcari Formation (unconfined)	493,000	0.1	2,340,000	1995-98	Ash, 1963
Upper Dockum Group (unconfined portion)	143,000	0.05	19,400,000	1995-98	Dutton and Simpkins, 1986 Nicholson and Clebsch, 1961
Upper Dockum Group (unconfined portion)	143,000	0.1	19,400,000	1995-98	Dutton and Simpkins, 1986 Nicholson and Clebsch, 1961
Upper Dockum Group (confined portion)	2,000,000	.000001	1,060	1995-98	Dutton and Simpkins, 1986 Nicholson and Clebsch, 1961
Lower Dockum Group (unconfined portion)	122,000	0.05	2,770,000	1995-98	Dutton and Simpkins, 1986 Nicholson and Clebsch, 1961

[81] Richey, et al. (1985)
[82] Richey, et al. (1985), and Hiss (unpublished, 1975)
[83] Cooper and Glanzman (1971)
[84] Mercer (1983)
[85] Richey, et al. (1985)
[86] Richey, et al. (1985)

Lower Dockum Group (unconfined portion)	122,000	0.1	5,540,000	1995-98	Dutton and Simpkins, 1986 Nicholson and Clebsch, 1961
Lower Dockum Group (confined portion)	2,690,000	.000001	2,770	1995-98	Dutton and Simpkins, 1986 Nicholson and Clebsch, 1961
Rustler Formation (confined)	2,810,000	.000001	633	1995-98	Wells, Richey, and Stephens, 1985
Rustler Formation (confined)	2,810,000	.000001	759	1995-98	Hiss, unpublished, 1975
Capitan Reef (confined)	374,000	.000001	467	1995-98	Hiss, unpublished, 1975

Capitan Aquifer

The Permian Capitan Reef Complex is a geologic unit found within New Mexico and Texas. The Capitan is positioned about the perimeter of the Delaware Basin as shown in **FIGURE 9**. Where adjacent to uplifted recharge areas, or in direct hydraulic connection with freshwater river systems, the aquifer can provide water for potable consumption and agriculture. Deeper portions of the Capitan Reef Complex without direct surface water connections form a productive, although typically saline, aquifer. Still further down gradient, the Capitan produces highly saline brine due to unflushed salts and proximity to bedded salt deposits. It is believed that the Capitan Reef complex functions as a single hydrogeologic unit and, therefore, is referred to as the Capitan Aquifer[87]. The geologic units surrounding the Capitan Aquifer generally have significantly less permeability than the Capitan and lower hydraulic conductivity, allowing the units to act as barriers to ground-water attempting to move in or out of the aquifer[88]. The main use of the Capitan Aquifer in Lea County is for re-pressurizing production zones in oil fields for secondary oil recovery. Due to elevated salinity concentrations, it is not used for potable water in Lea County. However, it serves as the municipal water supply for the City of Carlsbad (Eddy County) and as irrigation supply in portions of west Texas, because the water quality is better at these locations.

Hydraulic properties of the Capitan Aquifer are variable and are a function of the degree and interconnectedness of fractures and solution channels within the rock. The average hydraulic conductivity of the Aquifer, in southern Lea County and for east of the Pecos River at Carlsbad, is approximately 5.0 feet per day. Values have been reported several orders of magnitude higher west of the Pecos at Carlsbad[89]. Within Lea County the Capitan Aquifer ranges in thickness from 800 to 2,200 feet, with a width of approximately six miles in the vicinity of Jal to approximately 12 miles in County's western part[90]. Ground-water flow in Capitan aquifer converges from north and south to an area approximately 20 miles southeast of San Simon Swale[91].

Discharge from the aquifer is in the form of pumping for industrial purposes in Lea County, and in Ward and Winkler Counties, Texas[92]. Discharge also occurs through Carlsbad Springs along the Pecos River, north of Carlsbad. The Capitan aquifer is recharged by precipitation on its outcrop in the Guadalupe Mountains and Guadalupe Ridge along the New Mexico-Texas border. Recharge is by percolation of water through shelf deposits and infiltration into cavernous zones. Surface water also flows into the formation through caverns in part of the outcrop near Carlsbad and through Lake Avalon northwest of Carlsbad. It's estimated that 10,000 to 20,000 acre-feet per year of water leak

[87] Hiss (1973) and Huff (1997)
[88] Hiss (unpublished, 1975)
[89] Richey, et al. (1985)
[90] Hiss (1973)
[91] This phenomenon may be related to a pumping centroid or a collapse-induced hydraulic connection to an aquifer of lower head.
[92] Hiss (unpublished, 1975)

through sediments under Lake Avalon into the Capitan[93].

In Lea County it is known, through the long term monitoring of five wells, that Capitan Aquifer water levels are declining. From 1967 through 1975 a constant decline in the aquifer occurred, with drops as great as 160 feet[94]. Withdrawal of water from adjacent Guadalupian-age formations, in hydraulic connection with the Capitan, is also thought to have contributed to Capitan declines. Examples of hydrographs in the Lea County portion of the Capitan Aquifer are presented in APPENDIX J.

Ground-water stored in Lea County's portion of the Capitan Aquifer is thought to be close to 500 acre-feet (TABLE 6-6).

[93] Richey, et al., (1985)
[94] Four of the five monitored wells recorded slight rebounds between 1976 and 1977 – Huff (1997)

6.2 WATER-QUALITY ISSUES

6.2.1 Assess Quality of Water Sources

The most common indicator of water quality is the amount of total dissolved solids (TDS) the water contains. The less TDS a water sample has, the better the quality of the sample. The water quality data for this study has been measured and recorded by others and is reported as Specific Conductance (SC), because SC measurements are more easily made in the field[95]. SC multiplied by a value ranging from 0.55 to 0.75[96] will give an approximation of the TDS concentration. TABLE 6-7 lists SC data for a majority of the aquifers in Lea County. The higher values are usually associated with increased sulfate levels[97].

TABLE 6-7: SC & TDS OF WATER IN SELECT LEA COUNTY AQUIFERS

Aquifer	Specific Conductance (μmhos/cm)	Total Dissolved Solids (mg/l)	Comments
Alluvium	200 to 15,000[m]	130 to 9,750[e]	
Ogallala	419 to 21,500[m]	272 to 13,975[e]	
Santa Rosa Sandstone	1,030 to 2,840[m]	635 to 1,950[m]	depths from 350 to 747 feet
Dockum Group	350 to 9,180	228 to 6,377[e]	
Rustler	16,000 to 500,000[e]	10,347 to 325,800[m]	data from adjacent counties
Capitan	18,300 to 220,000[m]	12,800 to 173,448[m]	depths from 2,923 to 4,695 feet

[m]measured μmhos/cm (micromhos per centimeter)
[e]*estimated mg/l (milligrams per liter)*

In Lea County three aquifers, the Alluvial, the Ogallala, and the Dockum Group produce water of suitable quality for a wide variety of uses[98]. SC contour maps of the County were generated in order to assess historical changes in the ground-water quality[99] of these three aquifers. FIGURE 29 reflects SC measurements from 1948-1958[100]. FIGURE 30 was generated from data in the mid 1980's[101]. FIGURE 31 shows current data. FIGURE 32a shows changes in the SC from 1950 to the mid 1980's, when ground-water quality decreased by about 100 to 300 μmhos/cm (55 to 225 mg/l, TDS) across the County; some areas – such as those west of Tatum, southwest of Hobbs, around Eunice, and east of Jal - experienced considerably worse reductions in quality, approaching 5000 μmhos/cm (2750 to 3750 mg/l, TDS) in places. FIGURE 32b shows changes in SC from the mid1980's to the late 1990's. In contrast to the earlier degradation trend, during this later period the quality of the ground-water – in the north parts of the County, west of Tatum and below the Mescalero Ridge (Ogallala Aquifer) – increased by as much as 500 μmhos/cm (275 to 375 mg/l, TDS). Only one area in the Ogallala, located along the Texas Line – east-southeast of Tatum - shows decreasing water quality. Likewise, throughout most of the southern portion of the county - south of the Mescalero Ridge (Dockum Group and Alluvial Aquifers), water quality increased. The greatest improvement in quality, more than 2,000 μmhos/cm (1,100 to 1,500 mg/l, TDS), occurs 6 miles west of a point equidistant between Hobbs and

[95] Specific Conductance is only a general measure of water quality and often does not account for the effects of pesticides and herbicides.
[96] This value depends on relative concentration of ions.
[97] Hem (1970)
[98] Aquifers in rocks older than the Triassic-age Dockum Group produce water high in total dissolved solids.
[99] The majority of ground water quality information is specific conductance data from the Ogallala Aquifer.
[100] The earliest water-quality data available for the Ogallala were collected from 1948 to 1958, with the majority of measurements being made around 1952 (Ash, 1963).
[101] Based on USGS and NMOSE electronic databases.

Eunice. A few localized decreases of as much as 1,200 µmhos/cm (660 to 900 mg/l, TDS) occurred between Eunice and Jal. Improved water quality from the mid 1980's to present, is probably attributed to changes in oil-field practices related to brine water. Before 1968 brine water had been discharged to unlined pits, often referred to as evaporation ponds, from which vertical migration into ground-water occurred. This infiltrated brine increased the TDS of the shallow ground-water. Regulations developed in 1967 and 1968, requiring evaporation ponds to be lined, appear to have been successful in reducing the brine water's migration into underlying aquifers. The mechanisms responsible for areas still experiencing decreasing water quality (since the mid 1980's) are unknown. It may be possible that water migrating from former unlined brine disposal pits is still occurring. Another possibility is that saline water from deeper aquifers is able to migrate into the shallow ground-water though poorly completed or failing oil field wells. Many different types of elements and molecules can be dissolved in water and contribute to the water's TDS, such as fluorides, chlorides, sodium, and sulfates. A TDS concentration of 500 mg/l is considered marginally acceptable for use in public supply and irrigation[102]. When concentrations above 500 mg/l are encountered treatment options and use restrictions are often considered. Fluoride concentrations of more than 1.6 mg/l are undesirable for drinking water and a slightly lower concentration of 1.0 mg/l is recommended for irrigation[103]. Irrigation use is not restricted when chloride concentrations are less than 150 mg/l and a concentration of no more than 250 mg/l is desirable for drinking water[104]. Sodium in concentrations exceeding 70 mg/l can indicate problems with irrigation usage. Sulfates are often indicative of water's hardness and concentrations in excess of 500 mg/l are not recommended for drinking water.

More detailed information on the quality of the water found in each of the major Lea County aquifers is presented below.

Alluvial Aquifer

Water from the Alluvial Aquifer varies widely in quality. In most locations the quality is good and the water can be used for a wide variety of activities. However, the quality is poor at some places and the types of activities which the water can support are restricted. TDS concentration in the Alluvial Aquifer is ranges from 200 to 15,000 mg/l, depending on the nature of the local sediments. Alluvial sediments having high portions of parent material (evaporite beds) will have high TDS concentrations. Fluoride concentrations[105] tend to be high, ranging from 0.3 to 10 mg/l. Chlorides can be very high, ranging from 5 to 7,500 mg/l[106]; Sodium concentrations approach 70 mg/l where they are acceptable, but very high. Sulfates are low ranging from 30 to 120 mg/l. Water is produced for the Jal distribution system from the Alluvial Aquifer. Quality information from Jal water sampling is shown in TABLE 6-8. The water produced from the Jal system is very hard.

[102] Masters (1991) and Metcalf & Eddy (1991)
[103] Metcalf & Eddy (1991)
[104] Metcalf & Eddy (1991)
[105] Dissolved fluoride concentrations in children's drinking water of about 1 mg/l reduces cavities. Fluoride concentrations above 2 mg/l can cause dental fluorosis when teeth are developing. Concentrations exceeding 4.0 mg/l may result in crippling skeletal fluorosis, a serious bone disorder (NMED, 1995).
[106] Richey, et al. (1985)

TABLE 6-8: NATURALLY OCCURRING GROSS ALPHA CONCENTRATIONS FOR PUBLIC SUPPLY WELLS IN LEA COUNTY

Parameter	Concentration (mg/l)	NMWQCC Standard (mg/l)	EPA MCL (mg/l)
pH		6 to 9	6.5 to 8.5
specific conductance	1,004 µmhos/cm	none	none
total dissolved solids	768	1,000	500
alkalinity	188	none	none
bicarbonate	229	none	none
hardness	303	none	none
calcium	75	none	none
sodium	67	none	none
potassium	11	none	none
magnesium	28	none	none
chloride	59	250[a]	250[a]
sulfate	118 to 291	600[a]	250[a]
fluoride	2.3 to 3.2	1.6	4.0
radon	132 to 323 pCi/l	none	300 pCi/l

reported concentrations from Engineers, Inc., 1988

a	aesthetic standard
NMWQCC	New Mexico Water Quality Control Commission
EPA	Environmental Protection Agency
MCL	maximum contaminant level
mg/l	milligrams per liter
µmhos/cm	micromhos per centimeter
pCi/l	picocuries per liter

Ogallala Aquifer

The waters of the Ogallala, while very hard, are consistently good quality and can be used for a variety of activities, including public supply and irrigation. TABLE 6-9 lists recent water quality testing results of public water systems that obtain water from the Ogallala Aquifer. TDS concentrations ranging from 300 to 415 mg/l are high, but acceptable - except at Tatum, where the TDS is very high - in excess of 700 mg/l. Fluoride concentrations are also high, but acceptable, ranging from 0.9 to 1.2 mg/l. Chlorides concentrations are moderate, at concentrations varying from 30 to 120 mg/l, and sulfates are low ranging from 50 to 120 mg/l.

TABLE 6-9: OGALLALA AQUIFER WATER QUALITY[a]

Parameter	Units	Hobbs	Eunice	Tatum	Lovington	Monument Water Users Assoc.[i]	EPA MCL
Date (may vary for parameters)		1998 annual averages	03/05/97	see notes	February 1997	March 1997	
alkalinity – carbonate	mg/l	0.0	0.0	0.0[b]	0.0	184.4	n/a
alkalinity – bicarbonate	mg/l	183.7	197.6	193.0[b]	210.4	225.1	n/a
alkalinity – total	mg/l	163[c]	186.5	158[b]	172.4	0.0	
arsenic	mg/l	0.008	0.008[d]	0.009[e]	0.0127	0.011	0.050
calcium	mg/l	80.7	80.5	112.0[b]	85.4	58.4	n/a
chloride	mg/l	114.0	63.4	93.0[b]	67.6	28.1	250a
specific conductance	µmhos/cm	839.9	716.8	1,103[b]	651.5	562	n/a
fluoride	mg/l	1.1	1.0[f]	1.2[g]	1.02	0.9	4.0
hardness	mg/l	293.3	248	376[b]	262.9	190	n/a
iron	mg/l	0.05	<0.25[b]	<0.25[b]	<0.25[b]	<0.25[b]	0.3
color		not detected	0.25	not detected[b]	not detected	not detected	250a
magnesium	mg/l	44.4	11.5	23.4[b]	12.1	10.7	4.0
mercury	mg/l	not detected	<0.0002[d]	<0.0005[e]	<0.0002	<0.0005	n/a
nitrate	mg/l	3.8	2.6	3.4	2.7	2.2	10
pH	standard	7.5	7.2	7.86[b]	7.4	7.1	6.5-8.5
potassium	mg/l	3.4[c]	4.8	2.73[b]	0.92	5.3	
sodium	mg/l	38.0	42.6	82.8[b]	52.5	32.7	n/a
sulfate	mg/l	113.1[e]	67.2	181[d]	88.9	55	
total dissolved solids	mg/l	410.0	415.7	729[b]	406.1	312	500a
turbidity	NTU	not detected	1.0	0.3[b]	0.1	.08	n/a
gross alpha	pCi/l	3.1 ± 0.9 to 16.6 ± 2.9[h]	2.8 ± 1 to 6.6 ± 1[h]	2 ± .8 to 5.4 ± 1.4[h]	1.6 ± .8 to 5.8 ± 1.2[h]	5.4 ± .9[h]	15

[a] results are either annual averages for all wells in a system, at the entry point of a system, or averages of a all wells in a system for a particular sampling date
[b] samples taken from 1975 to 1979 (Source: *Chemical Quality of New Mexico Community Water Supplies 1980*)
[c] sampled at entry point, August 23, 1994
[d] sampled at entry point, March 1995
[e] sampled at entry point, February 1996
[f] sampled at entry point, March 1996
[g] average of three wells sampled December 4, 1995
[h] range in concentration, low and high; sampled 1994 through 1997
[i] only one well in the system

EPA Environmental Protection Agency
MCL maximum contaminant level
µmhos/cm micromhos per centimeter
mg/l milligrams per liter
pCi/l picocuries per liter
NTU nephelometric turbidity units
a aesthetic
n/a not available

Dockum Group

The limited information available for the Dockum Group comes from the Santa Rosa Aquifer and indicates the water quality to be marginal. TDS concentrations were high to very high, ranging from 635 to 1,950 mg/l for one well sampled in 1942 and three wells sampled in 1953[107]. Sulfate concentrations varied from low to high or from 71 to 934 mg/l, with deeper wells having higher concentrations. While these parameters range above suggested limits, they indicate the water may often be used for public supply purposes, albeit occasionally with aesthetic restrictions. Irrigation uses should be even less restricted.

Rustler Formation

The quality of water produced from the Permian-age Rustler Formation in Lea County is inferred from data collected in Eddy County, at the WIPP site, where the formation also exists. Rustler Formation water is extremely poor in quality and cannot be used for public supply or irrigation without treatment. The TDS concentration of water produced from the basal portion of the Rustler Formation, near the contact with the underlying Salado Formation, ranges from 311,000 to 325,800 mg/l - extremely high. The TDS concentration of water produced from Culebra Dolomite and the Magenta Dolomite Members of the Rustler Formation ranges from 23,721 to 118,292 mg/l, and 10,347 to 29,683 mg/l, respectively[108]. The extreme TDS concentrations are due principally to the presence of gypsum beds within the formation.

Capitan Aquifer

The Capitan aquifer is an important source of water for secondary recovery of oil. The concentration of TDS in the Lea County parts of the Aquifer is very high ranging from 10,065 to 165,000 mg/l[109]. The lowest concentrations reported occur in the western portion of the County and increase to the southeast. Because of the great depth to water and the high TDS concentration, the potential development of water from the Aquifer is severely restricted. **TABLE 6-10** shows production intervals and corresponding TDS and SC of water in selected wells in the Capitan aquifer.

[107] Nicholson and Clebsch, (1961)
[108] Richey, et al. (1985)
[109] Hiss (1973)

TABLE 6-10: CAPITAN AQUIFER QUALITY

Well Name	Location	Aquifer	Producing Depth (feet)	TDS (mg/l)	Specific Conductance (μmhos/cm)
Middelton Federal B1	19S 32E 31.110	Seven Rivers/Capitan	2,923 - 2,957	25,800	36,100
South Wilson Deep 1	21S 34E 23.310	Capitan	4,169 - 4,187	12,800	18,300
North Custer Mountain 1	23S 35E 28.120	Capitan	4,470 - 4,507	not reported	59,500
Federal Davis 1	24S 36E 20.210	Capitan	4,278 - 4,285	173,448	220,000
Southwest Jal Unit 1	26S 36E 4.230	Capitan	4,199 - 4,695	not reported	168,000

Source: Hiss (1973)

6.2.2 Identify Sources of Contamination

In general, existing wells in Lea County are not impacted by ground-water contamination. As of 1998 the ability of area aquifers to supply wells in Lea County has been limited in only a few places by contamination. Potential sources of contamination are determined by identifying discharges, leaks and spills and by recognizing industries, land uses, and enterprises that employ processes, materials and methods that have the ability to negatively impact water supplies. The activities that most commonly are sources of ground-water contamination in Lea County and the types of contaminants associated with the activities are:

- Petroleum Production Facilities - salts from oil well brine pits, hydrocarbons from leaks and spills;
- Agricultural Activities - residues from applied and stored pesticide and fertilizers;
- Wastewater Disposal Systems - leachate containing nitrogen from community wastewater treatment facilities and septic systems;
- Underground Storage Tanks - hydrocarbons from leaks and spills
- Mines and Quarries - heavy metals;
- Industrial Facilities - chemicals and heavy metals;
- Landfills - leachate containing nitrogen, chemicals, and heavy metals;
- Livestock Industry - wastewater and runoff from dairies and feed lots; and
- Radioactive Mineralization.

Actual and possible sources of contamination in the County were identified by studying State and Federal records[110].

[110] Data were obtained from records, reports, and electronic databases available from the NMED Bureaus of Ground Water Quality, Drinking Water, Community Services, Solid Waste, and Underground Storage Tank, plus the Oil

Confirmed sources of ground-water contamination in Lea County, since 1986, are listed in APPENDIX M; the threat from some of these sites no longer exists. Current potential sources of contamination are plotted on **FIGURE 33**. To more fully assess the possibility of ground-water contamination for a certain location, several site-specific factors need to be considered. Such factors include: depth to ground-water, soil type and layer thicknesses, and the presence of fractures or channels in rocks.

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA) are two Federal programs that attempt to identify, catalogue and address contaminated sites and manage hazardous wastes. CERCLA sites are thought to already be contaminated and RCRA sites may be contaminated and/or have the potential to become contaminated. Currently in Lea County, there are two sites that have been been considered for participation in the CERCLA program; they are Highway 18 Solvents and Snyder Street PCE. Both sites have been assessed and are not on the National Priority List (NPL), which contains the worst cases. Several other sites have been investigated under CERCLA and are currently designated as having No Further Remedial Action Planned (NFRAP); a few of these

Conservation Division (OCD) of the NMED. Secondary data were obtained from the U.S. EPA, the NMOSE, the USGS, and other geologic and hydrogeologic references pertaining to the study area. Databases researched for this section include the federal version of the Safe Drinking Water Information System (SDWIS), the NMED databases for Underground Storage Tanks and Public Water System Sampling Results, the federal CERCLA Information System (CERCLIS), and the Resource Conservation and Recovery Information System (RCRIS).

later sites are participating in the State of New Mexico's Volunteer Remediation Program (VRP), while others have been referred to the OCD and the RCRA program[111]. A list of sites investigated under CERCLA and their current status are shown in **TABLE 6-11.** Over 200 facilities are part of the RCRA program in Lea County. Most of these RCRA facilities are small quantity generators which may be conditionally exempt. However, some of the facilities are large quantity generators, storers, transporters, or disposers of hazardous waste. The RCRA program information documents list only facilities that deal with hazardous waste and do not track leaks, spills or other contamination. APPENDIX L lists the RCRA sites and some of the basic information regarding them.

TABLE 6-11: SITES INVESTIGATED UNDER CERCLA IN LEA COUNTY

Site Name and Location	Status	Last Action and Date	Comments
Highway 18 Solvents, Hobbs	discovery	discovery in 1998	listed on CERCLIS, not on NPL
Snyder Street PCE, Hobbs	discovery	discovery in 1998	listed on CERCLIS, not on NPL
AAA Feed Store, Lovington	NFRAP	preliminary assessment in 1995	
BLM – Kerr McGee Laguna Totson, Hobbs	NFRAP	site inspection in 1980	referred to GWQB AAS
BLM – Kerr McGee Potash Co., Hobbs	NFRAP	site inspection in 1980	referred to GWQB AAS
Cardinal Surveys Co., Hobbs	NFRAP	site inspection in 1981	
Chevron USA Maljamar	NFRAP	preliminary assessment in 1981	
Climax Chemical Co., Monument	NFRAP	site inspection in 1981	
Cueltar BL-1100 Site, Hobbs	NFRAP	preliminary assessment in 1991	VRP
Diamond Tank Rental, Hobbs	NFRAP	site inspection in 1986	referred to OCD
Gooch's Tank Farm, Tatum	NFRAP	preliminary assessment in 1992	referred to OCD
City of Jal Landfill	NFRAP	preliminary assessment in 1982	VRP and needs referral
McCasland Service (Oil)	NFRAP		may need OCD enforcement; may be in VRP
Mumford Properties, Hobbs	NFRAP	preliminary assessment in 1991	
National Potash Co.	NFRAP		referred to GWQB AAS; VRP
New Mexico Electric Co., Hobbs	NFRAP	site inspection in 1981	
Oil Processing Inc., Monument	NFRAP	site inspection in 1989	referred to OCD
Phillips Petroleum – Eunice Natural Gas Plant	NFRAP	site inspection in 1985	referred to OCD
Phillips Petroleum – Lee Plant, Lovington	NFRAP	site inspection in 1985	may need RCRA enforcement
Phillips Petroleum – Lovington (compressor station)	NFRAP	site inspection in 1985	VRP
Phillips Petroleum – Maljamar	NFRAP	preliminary assessment in 1981	
Southern Union Refinery Co., Hobbs	NFRAP	site inspection in 1981	referred to OCD
Southern Union Truck Facility, Hobbs	NFRAP	site inspection in 1981	
City of Tatum Landfill	NFRAP	preliminary assessment in 1982	inactive landfill
Tipperary Resources, Lovington	NFRAP	preliminary assessment in 1995	referred to ABQ
Two Mile Pit, Hobbs	NFRAP	site inspection in 1981	VRP
Warren Petroleum – Eunice	NFRAP	site inspection in 1985	referred to RCRA
Warren Petroleum – #118, Monument	NFRAP	site inspection in 1985	referred to RCRA
Warren Petroleum – #146, Saunders	NFRAP	site inspection in 1985	referred to RCRA
Warren Petroleum – #139 VADA, Tatum	NFRAP	site inspection in 1985	referred to RCRA
Waste Control of New Mexico, Hobbs	NFRAP	site inspection in 1981	
Western Oil Transportation Co. Shop, Hobbs	NFRAP	site inspection in 1985	
West Hobbs, T18S R38E and vicinity	NFRAP	site inspection in 1986	

Source: NMED Ground Water Quality Bureau, Superfund Oversight, 2/99 and CERCLIS

6.2.2.1 Petroleum Production Facilities

Fresh water aquifers in Lea County are often underlain by oil reservoirs, particularly in the Permian Basin areas. The

[111] It is important to note that petroleum contamination is exempt from CERCLA guidelines.

petroleum industry is beneficial to the Lea County economy, but it also poses environmental problems. A 1993 NMOSE memoranda states that the quality of fresh ground-water in Lea County oil fields has deteriorated[112]; some water wells can no longer be used because their water quality has been degraded by oil-field activities. Of the 197 reported cases of ground-water contamination in Lea County since 1986, 141 of them were caused by oil-field activity and petroleum processing[113]; approximately 64 percent of those are caused by brine waste water. Indications of brine contamination include elevated concentrations of chloride, sodium, calcium, magnesium, and other dissolved solids. Other contaminants related to petroleum production include hydrocarbons and solvents. **TABLE 6-12** summarizes cases of contamination due to petroleum production. The most obvious potential source of ground-water contamination is brine production and disposal. Brine is almost always produced with oil, and as oil fields get older the relative proportions of saline water to oil tend to increase[114]. In Lea County about twice as much brine water is produced as oil, and some of older and larger oil fields produce six times as much brine water as oil[115]. Prior to 1969 when the use of unlined brine pits was discontinued, estimates based on data from the New Mexico Bureau of Mines and Mineral Resources (BMRR) place the amount of produced brine water to be about 180,000 ac-ft. During this time, approximately 96 percent of the brine discharged to unlined pits for evaporation instead seeped into the ground[116]. Remnant oil floating on the water surface of the pits inhibited evaporation and contributed to the high seepage amounts. Since 1969 the BMRR approximates the amount of produced brine water to be 2 million acre-feet. Most of this has been injected down salt-water disposal wells where the potential for contamination still exists, as brine plumes migrate into freshwater. Contamination from brine takes place where production of brine with oil has continued for a long time, as in the vicinity of Hobbs and Monument[117]. It is possible that brine plumes have already migrated to the bottom of general use aquifers and may become a problem as the aquifers continue to be depleted[118]. Saline water always has the potential to migrate into freshwater zones and this potential is increased due to oil production.

Much of the infrastructure, equipment, and piping in the petroleum fields of Lea County is old, deteriorated, and susceptible to leaks and failures. In August of 1989 alone, 46 oil field spills and leaks were reported in southeast New Mexico. Corrosion was responsible for nearly one-half of these leaks[119]. Brine and hydrocarbon contaminants can be introduced into fresh water aquifers through improperly constructed, poorly maintained, deteriorated, damaged, or corroded wells and other infrastructure. Poorly plugged and abandoned wells can also lead to ground-water contamination.

[112] NMOSE (1993)
[113] GWQB (1999)
[114] Bingham (1986)
[115] Hiss, unpublished (1975)
[116] Nicholson and Clebsch (1961)
[117] Ash (1963)
[118] Much of the deeper aquifers in Lea County are saline and as freshwater aquifers decline, the likelihood of salt water intrusion into the freshwater zones increases.
[119] Boyer (1989)

TABLE 6-12: PETROLEUM PRODUCTION CONTAMINATION

petroleum production activity	reported number of cases	types of contaminants	source type
produced water (brine)	91	chloride and TDS	point source[a]
general petroleum production	23	Undifferentiated hydrocarbons, BTEX, and TDS	point source
gas plant processing	10	Methane, undifferentiated hydrocarbons, chloride, and TDS	point source
Pipeline	4	crude oil	point source
petroleum production plant	1	Undifferentiated hydrocarbons	point source
production well	1	crude oil	point source
injection well	1	chloride and TDS	point source
petroleum production activity: source not specified	10	Undifferentiated hydrocarbons and BTEX	point source
total petroleum production activity cases	141		
total non-petroleum production activity cases	56	Nitrate, hydrocarbons, explosives, TDS, chloride, pesticides, misc.	point and non-point sources
total number of cases of contamination reported since 1986	197		

Source: NMED GWQB, 1999
[a] produced water can also be described as non-point source pollution due to multiple injection wells / disposal ponds
[b] all cases reported since 1986

The City of Hobbs has taken two wells out of production because of hydrocarbon contamination. City Well No. 12 was removed from the system about 4 years ago, and Well No. 9 has been shut-off for over 10 years. Gasoline constituents (benzene, toluene, ethylbenzene, and xylene) have been detected in City of Hobbs Wells 10, 11, 14 and 17. Currently, benzene is routinely detected above drinking water standards in Well 25. Well 25 had a benzene concentration of 0.0105 milligrams per liter (mg/l) on June 6, 1999, which is slightly above NMED and EPA standards[120]. The water from Well 25 is combined into a reservoir with water from other wells and the hydrocarbon concentration at the entry point to the system is below action levels. However, the average benzene concentration at the reservoir is still 0.001 mg/l[121]. Analytical results for some of the City of Hobbs wells are presented in APPENDIX N. APPENDIX N also contains analytical results for other public water systems that are discussed in this section.

6.2.2.2 Agricultural Activities

Large quantities of ground-water return flow[122] originate from irrigation[123]. Most irrigation in Lea County occurs over the Ogallala Aquifer where sediments are permeable and depth to ground-water is shallow. The quality of water that returns to the Aquifer from irrigation is unknown, but – in addition to being saline– the return water probably contains residues from fertilizers, pesticides, herbicides, and fumigants. Due to the long history of irrigation in the area - and the fact that ground-water quality degraded between 1950 to 1995 - it can be assumed that irrigation return flow is contaminating the aquifer. The NMED lists only one ground-water contamination case resulting from agricultural pesticides. The case, called "DCPA Acid Metabolites," regards a well sampled by the EPA during a National Pesticide Survey in June of 1989[124].

While groundwater contamination from irrigation return flow is occurring, the amounts of contaminants being generated are likely much less today than in the past. Decreases in the amount of acres irrigated, increased water-use efficiency, and better methods of chemical application, which have occurred since the 1970's, have reduced the sources.

6.2.2.3 Wastewater Disposal Systems

The leachate from community and onsite wastewater systems can cause elevated nitrate concentrations in ground-water[125]. Besides nitrates, wastewater can be a source of phosphorus, inorganic compounds, heavy metals, bacteria and viruses. Other sources of nitrate in ground-water, include feed lots, dairies, landfill leachate, and agriculture. The EPA and WQCC standard for nitrate in drinking water is 10 mg/l[126].

In 1979 the average nitrate concentration for all public water systems in New Mexico was 0.82 mg/l and for Lea County was 2.47 mg/l[127]. Between 1993 and 1998 the average nitrate concentration for 71 wells sampled on 13 Lea County public water systems[128] was 3.5 mg/l. Lea County's current nitrate levels appear to be about 40% higher than

[120] The New Mexico Water Quality Control Commission (NMWQCC) standard for benzene is 0.01 mg/l, and the EPA standard is 0.005 mg/l.
[121] Anne Dean, City of Hobbs Laboratory, personal communication (1999)
[122] Return flow is water that has been pumped from an aquifer and used, then allowed to discharge into the subsurface and return to the aquifer.
[123] Large quantities of return flow were also produced by oil field brine disposal before 1969. Wastewater disposal system leachate is also a form of return flow, but is small in comparison, the quantities resulting from irrigation.
[124] NMED GWQB database (1999)
[125] Earp and Koschal (1980) state that wells with Anitrate concentrations of greater than 5.0 mg/l indicate incipient contamination and should be investigated.
[126] High nitrate levels can be particularly harmful to young children and animals, causing serious health problems or death)Peavy, Rowe, and Tchobanoglous, 1985).
[127] Earp and Koschal (1986)
[128] NMED Public Water System – Sampling Results Database

in 1979 and about 400% higher than the State average in 1979. TABLE 6-13 shows current nitrate concentrations for public water systems in Lea County. The highest nitrate concentration in the recent data was 10.9 mg/l for the City of Hobbs Well 10, and the lowest concentration was 0.8 mg/l for Jal's EPNG well. Hobbs Municipal Well 10 consistently has had nitrate concentrations above 10 milligrams per liter since 1993. Five wells have concentrations over 5.0 mg/l and several more have concentrations over 4.5 mg/l.

TABLE 6-13: NITRATE CONCENTRATIONS

Public Water System	No. of Wells Sampled	Average Nitrate Concentration (mg/l)
Adobe Village	2	2.8
Chapperal MHP (Hobbs)	2	6.0
Continental MHP	1	4.3
Country Estates MHP	2	4.8
Eunice	7	2.6
Hobbs	28	4.2
Jal	1	1.6
La Siesta Retirement Center	1	4.4
Lovington	15	2.6
Monument WUA	1	2.2
Rancho Estates Subdivision	2	4.6
Tatum	3	3.4
Triple J Trailer Ranch	1	3.6

Source: NMED Public Water System Sampling Results Database

In all NMED lists 20 present cases of nitrate contamination, out of 197 total groundwater contamination cases in the County, which have impacted 137 water wells[129]. TABLE 6-14 summarizes information related to these 20 sites and FIGURE 34 shows known locations of nitrate contamination in Lea County.

[129] GWQB database (1999)

TABLE 6-14: LEA COUNTY NITRATE CONTAMINATION CASES

Case	City	Twn/Rng Location	Type of Contaminant(s)	Source Type	Point or Non-point Source (NP or P)	Water Supply Wells Impacted
Lovington Dairy	Lovington		nitrate	dairy	P	0
Beetstra Family Dairy	Hobbs	17S.37E.34	nitrate	dairy	P	0
Jimmy Doom Well	Jal	23S.37E.33	nitrate	septic tanks	NP	1[a]
Larry B. Jenkins Well	Lovington		nitrate	septic tanks	NP	1[a]
Shelly Barica Well	Lovington		nitrate	septic tanks	NP	1[a]
Lovington, Sadelle	Lovington		nitrate	septic tanks	NP	2[a]
Hobbs Area	Hobbs		nitrate	septic tanks	NP	59[a]
Lea County WF 8/14/92			nitrate; anoxic conditions	septic tanks	NP	26[a]
Jal Sewage Treatment Plant	Jal	25S.37E.29.32	nitrate	WWT – PO	P	0
New Hobbs Sewage Treatment Plant	Hobbs	20S.38E.02	nitrate	WWT – PO	P	0
Old Hobbs Sewage Treatment Plant	Hobbs	19S.38E.02.320	nitrate	WWT – PO	P	40[a]
Lovington Sewage Treatment Plant	Lovington	16S.36E.10.421	nitrate	WWT – POLA	P	0
Eunice Golf Course	Eunice		nitrate	WWT – POLA	P	1[b]
Dan's Bar			nitrate	STP – PRO	P	1[b]
Hobbs Phillips #6	Hobbs	19S.38E.04.124	nitrate	STP – PRO	P	1[a]
Hobbs MHP	Hobbs		nitrate	STP – PRO	P	1[b]
Yellow Dawg Bar	Hobbs		nitrate	STP – PRO	P	1[b]
Hobbs Port of Entry	Hobbs		nitrate	STP – PRO	P	1[b]
Border Bar			nitrate	STP – PRO	P	1[b]
Custom Slaughter & Meat		19S.38E.05.1	nitrate	slaughter house or meat packing	P	0

Source: NMED GWQB database, 1999 (Jennifer Parker)
[a] impacted privately owned water supply well(s)
[b] Impacted publicly owned water supply well
WWT - PO publicly owned wastewater treatment plant
WWT - POLA publicly owned wastewater treatment plant with land application
STP - PRO privately owned sewage treatment plant

Nitrate contamination of ground-water has been an on-going problem for the City of Hobbs. FIGURE 34 shows locations of nitrate contamination around Hobbs. Several testing programs were carried out in the late 1960's and early 1970's[130]. Many private wells near the WWTP were found to have extremely elevated concentrations of nitrate. The New Mexico Water Quality Control Commission (WQCC) brought a lawsuit against the City of Hobbs in 1974 to halt its operation of the plant. Hobbs was required to improve operations, address the issues of contaminated ground-water, consider relocating the plant's discharge, and establish water service lines to residents impacted by the contamination[131]. Many private wells near the WWTP were found to have extremely elevated concentrations of

[130] Fossmark Associates (1972)
[131] Clark (1987)

nitrate. In 1980 a new WWTP, with a monitoring well network, was completed by the City[132]. A second well network, 7 miles south of the plant, monitors the area where effluent water used to be discharged. The monitoring well network near the plant contains elevated concentrations of nitrate. The most recently installed well, the "New Well," was installed in the area where sewage sludge was disposed in past years. The New Well has nitrate concentrations of 30.6 milligrams per liter[133]. TABLE 6-15 summarizes the City of Hobbs monitoring well information. FIGURE 34 shows the general location of the monitor wells. Even though there have been several cases of ground-water contamination by community wastewater facilities in Lea County, they are not enough to account for the total amount of nitrate contamination occurring. In 1986 there were 40 cases of ground-water contamination in Lea County, caused by sewage disposal. These 40 cases accounted for 22% of all the ground-water contamination cases reported that year[134]. Since there are only a few community wastewater systems in the County, most cases are attributed to septic systems. It is estimated that Lea County contains between 3,500 and 4,000 residential septic systems[135]. Most septic systems produce little flow by themselves, but when combined together produce a substantial amount. The potential for contamination is highest when many septic systems are in close proximity to each other and the ground-water is shallow. Geologic and soil characteristics also play important roles. NMED has noted the problem of septic systems in the past and in a recent document has stated "[s]eptic tanks continue to insideously (sic) degrade Lea County's ground-water"[136]

TABLE 6-15: HOBBS WWTP MONITORING WELL DATA

Well (Sample Site)	Location	Sample Date	Nitrate Concentration (Mg/l)
Monitor Wells Near WWTP			
New Well	south and east of WWTP, on top of old disposal area for sewage sludge	9/29/99	30.6
Everglade	further south of the New Well	9/30/99	5.1
L-220-S-6	south and west of the WWTP	9/30/99	10.4
L-220-S-7	north of the WWTP	9/30/99	5.0
New Cemetery Well	directly east of the New Well	9/30/99	9.0
Monitor Wells Around Old Effluent Disposal Area[a]			
Nadine Monitor Well #1	7 miles south of the WWTP	9/30/99	4.1
Nadine Monitor Well #2	7 miles south of the WWTP	9/30/99	1.4

Source: analytical results from the City of Hobbs Lab., Anne Dean, 1999
[a] Nadine Monitor Wells 6, 9, and 12 were dry on 9/30/99

[132] Presently, effluent from the WWTP is used by farmers for crop irrigation.
[133] Contrary to the experience of Hobbs, the City of Lovington analyzed 12 wells around the City's wastewater plant in September of 1998, and all the wells had nitrate concentrations below the detection limit (analytical results from Cardinal Laboratories, 1998).
[134] McQuillan (1986)
[135] From 1987 to October of 1999, 921 new permits for liquid waste systems were issued in Lea County. Based on an average of 70 permits per year, it can be estimated that 3,500 liquid waste systems have installed since 1950. The rural population of Lea County in 1995 was estimated at 11,880 people. At an average of 3 people per household, the number of households would equal 3,960. This correlates with the estimate of permits and indicates that Lea County contains between 3,500 and 4,000 households reliant on some form of liquid waste system.
[136] McQuillan (1986)

6.2.2.4 Underground Storage Tanks

The District 2 Office of the NMED, Underground Storage Tank Bureau (USTB) provided information on all reported underground storage tank leaks within Lea County. Possible contaminants associated with leaking underground storage tanks (LUSTs) include petroleum products, cleaning and degreasing compounds. Data regarding LUSTs and sites are provided in APPENDIX M. Sites listed as active are not necessarily in active remediation, but may be under investigation or undergoing monitoring.

The GWQB lists some of the same sites provided by the USTB. The GWQB also lists one leaking above ground storage tank in Tatum, at Lil's Truck Stop. The above ground tank has impacted two public supply wells with diesel contamination, and a leaking underground storage tank (LUST) at Lills has impacted one public supply well. Tatum City Wells 2, 3, and 4 and two privately owned water supply wells have been contaminated by LUSTs at Cotton Texaco, 101 East Broadway. A LUST at the Firehouse in Tatum has impacted City Well 1, and a LUST at Simpson Fina, 108 East Broadway in Tatum, has impacted one privately owned well. Morris Oil, 1214 East Bender, has impacted one public supply well in Hobbs because of a LUST.

6.2.2.5 Mines and Quarries

Two mills, the National Compaction Plant (a potash operation) and National Tailings (a salt operation) - both located about 30 miles west-southwest of Hobbs (off Hwy. 62/180), are reported within Lea County. Seven gravel, rock, and caliche operations are also located in the County[137]. APPENDIX U provides information regarding specific mines, mills, pits, and quarries. The impact of current operations at these facilities on water quality has not been assessed. However, impacts from past mine tailings, waste disposal, and other mining operations are probable. National Potash Company, based in Carlsbad, is listed by the NMED as being the cause of TDS and chloride contamination[138].

6.2.2.6 Industrial Facilities

The NMED lists 8 cases of point source ground-water contamination due to industrial facilities, manufacturing plants, and a recycling plant. The contamination includes various petroleum hydrocarbons, TDS, chloride, heavy metals, organics, explosives, and nitrogen. Two public supply wells and three privately owned water supply wells were impacted by these incidents[139]. TABLE 6-16 summarizes the reported cases of ground-water contamination due to industrial facilities in Lea County and FIGURE 33 shows the location of the sites.

[137] Hatton (1998)
[138] NMED GWQB database (1999)
[139] NMED GWQB database (1999)

TABLE 6-16: LEA COUNTY INDUSTRIAL FACILITIES CAUSING CONTAMINATION

Case	City	Address	Twn / Rng Location	Type of Contaminant(s)	Source Type	Water Supply Wells Impacted
Koch Industrial Inc. (900-gallon diesel spill in July 1992)	Hobbs			hydrocarbons	industrial facility	1[b]
Tatum Well #2	Tatum		12S.36E.29.222	waste oil	industrial facility	1[b]
Hobbs Gibbs Gasoline	Hobbs	Arkansas Junction		hydrocarbons and lead	industrial facility	1[a]
Axelson, Inc.	Hobbs	2730 W. Marland		hydrocarbons	industrial facility	0
Lovington Dominquez Well	Lovington		16S.36E.03	ethylene dichloride	industrial facility	1[a]
Ladshaw Explosives, Inc.	Hobbs	Hobbs Industrial Air Park	18S.37E.12	explosives, nitrogenous material	manufacturing plant	0
Monument Climax Chemical	Monument		19S.36E.35	TDS, chloride	manufacturing plant	0
Monument Oil Processing	Monument		20S.36E.09	TDS	recycling plant	1[a]

Source: NMED GWQB database, 1999 (Jennifer Parker)
[a] privately owned water supply well
[b] public water supply well

6.2.2.7 Landfills

The NMED lists five municipal landfills, one industrial waste landfill, and one municipal landfill (with limited industrial waste) in Lea County. Of the five municipal landfills, four are closed and one is under construction. The Town of Tatum has an inactive landfill, but the NMED does not have it listed. Additionally, no information was available for landfills in Maljamar or other small communities. No information on hazardous waste dumps in Lea County was found, although the industrial landfill may contain hazardous materials. Contamination from landfills is usually waste generated leachate. Landfill leachate can contain a variety of inorganic and organic compounds and heavy metals, including solvents. TABLE 6-17 summarizes the available Lea County landfill information.

TABLE 6-17: LEA COUNTY LANDFILLS

Location	Name	Type	Status	Estimated Depth to Water, feet
16S.36E.31.22	Lovington Landfill	municipal	closed 10/31/92	100
18S.38E.36.4	Hobbs: Waste Management Landfill	municipal and limited industrial waste	open, proposed closure in 1999	70-100
19S.39E.06.3	Old Hobbs Landfill	municipal	closed 1972	n/a
20S.32E.32.	Lea Land Company Landfill	industrial waste	open	n/a
21S.36E.36.	Eunice Landfill	municipal	closed 10/31/92	110
22S.38E.04.N1/2	Lea County Regional Landfill	municipal	under construction	n/a
25S.36E.24.4W1/2	Jal Landfill	municipal	closed 12/91	n/a

Source: NMED, Solid Waste Bureau, Fred Bennett, 2-12-99

6.2.2.8 Livestock Industry

Livestock operations can produce strong wastewater from operational and processing activities. Also, when precipitation comes into contact with animal feces and urea highly contaminated runoff can result. Two dairies (Lovington Dairy and Beetstra Family Dairy) and one meat packing operation (Custom Slaughter and Meat) are listed by NMED as having caused ground-water contamination (see TABLE 6-14). TABLE 22 lists other Lea County facilities, including 13 dairies and 3 feed lots, that are required to have discharge permits because they are potential sources of nitrate contamination.

6.2.2.9 Radioactive Mineralization

Public water system wells in Lea County area were tested in 1994 and 1997 for gross beta, radium-226, and radon. Hobbs Municipal Well 50 had a gross alpha concentration of 16.6 pCi/l □ 2.9. Given the plus or minus factor, this result may not be above the EPA and WQCC standard of 15 pCi/l[140]. Continental Mobile Home Park Well 1 and Country Estates Mobile Home Park Well 1 had gross alpha concentrations of 13.9 pCi/l ± 2.5 and 13.4 pCi/l ± 3, respectively. Given the plus or minus factors the gross alpha concentrations in these wells could be over the 15 pCi/l limit. TABLE 6-18 shows the gross alpha concentrations for public water supply systems in Lea County. Radium-226 is tested for if gross alpha concentrations are above 5 pCi/l. All radium-226 concentrations for the public water supply wells tested were below 3 pCi/l[141].

Gross beta concentrations in Lea County are from natural sources and consistent with background levels. Regulations for gross beta refer only to anthropogenic sources of which none exist in Lea County.

Radon is not a known contaminant of concern in Lea County. Only Jal Well 2, which has a radon concentration of 323 pCi/l 20, is above the proposed EPA standard of 300 pCi/l. An alternative radon standard of 4,000 pCi/l has been proposed which correlates radon in water with radon levels found in indoor air.

Naturally occurring radioactive deposits have been found in the Triassic-age Dockum Group and the Gatuna

[140] Picocuries per liter is a measure of radioactivity. One curie is equivalent to 37 billion nuclear disintegrations per second and one picocurie is one trillionth of a curie, or 0.037 nuclear disintegrations per second.
[141] If the concentration was 3 pCi/l, then radium-228 would be tested for, and the result summed with the radium-226 result. Resulting sums above 5 pCi/l exceed the WQCC standard and are subject to compliance regulations.

Formation of Pleistocene age[142]. These deposits appear to be very small and are not reported to have affected ground-water. The radioactivity in most wells in Lea County is within the limits established by the EPA and WQCC.

TABLE 6-18: GROSS ALPHA CONCENTRATIONS IN LEA COUNTY PWSs

Public Water System	No. of Wells Sampled	Average Alpha Contamination (pCi/l)	Average Test Accuracy (pCi/l)
Adobe Village	2	3.4	1.1
Chaparral MHP (Hobbs)	2	5.1	1.2
Continental MHP	1	13.8	2.5
County Estates MHP	2	10.4	2.1
Eunice	6	4.5	1.1
Hobbs	26	6.2	1.9
Jal	5	10.9	2.0
La Siesta Retirement Center	1	5.3	1.3
Lovington	14	3.6	1.1
Monument WUA	1	5.4	.9
Rancho Estates Subdivision	2	3.1	1.0
Tatum	3	3.7	1.1

Source: NMED Public Water System Sampling Results Database

[142] Finch (1972)

7. WATER DEMAND

Water-use data and water rights information were obtained from records at the New Mexico Office of the State Engineer (NMOSE), and interviews with individual public water suppliers. NMOSE records provide the best picture of water use and water rights available, but are routinely incomplete and at times uncertain. Two NMOSE reports, entitled "*Water Use by Categories in New Mexico Counties and River Basins, and Irrigated Acreage in 1995, NMOSE Technical Report 49*" *(Wilson, 1995)* and "*Lea County Underground Water Basin Annual Report 1998*" *(Wilson, 1998)*, both by Brian Wilson, were principal sources. Differences in the designated categories of water use and the way irrigation quantities are calculated between the reports are especially notable. The 1998 report is incomplete and unpublished. Therefore, recent water use data were primarily derived from the 1995 source; although1998 data were referenced when available. Wherever possible, clarifications are made in the text to identify and explain inconsistencies.

Some terms important to this section of the Plan are:[1]

> **Depletion** - that part of a diversion that has been evaporated, transpired, incorporated into crops, consumed by man or livestock, or otherwise removed from the water environment. It includes that portion of ground water recharge resulting from seepage or deep percolation (in connection with a water use) that is not economically recoverable in a reasonable number of years, or is not usable;
>
> **Diversion** - the quantity of waters taken from a ground or surface water source. A withdrawal is the same as a diversion;
>
> **Diverted (set-a-side) Acreage** – agricultural land in one of the production adjustment programs administered by the Agricultural Stabilization and Conservation Service;
>
> **Idle and Fallow Acreage** – agricultural land plowed and cultivated during the current year, but left unseeded – or acreage that is left unused one or more years;
>
> **Irrigable Acreage** - the sum of irrigated acreage, diverted (set-a-side) acreage, and idle and fallow acreage. The term implies that such land is developed and that irrigation works exist to apply water. It does not include farmstead, feedlots, area in roads, and ditches, etc.;
>
> **Irrigated Acreage** - agricultural land to which water was artificially applied by controlled means for preplant, partial, supplemental, and semi-irrigation (inclusive) during the calendar year. Land flooded during high water periods is included as irrigation only if the water was diverted to agricultural land by dams, canals, or other works.
>
> **Return Flow** - the difference between diversion and depletion.

7.1 PRESENT USES

7.1.1 Type, Location, and Ownership of Water Rights

TABLES 7-1 and 7-2 summarize the water rights information for Lea County listed by the NMOSE.

On August 5, 1999, the LCWUA filed 138 permit applications to appropriate the remaining ground-water rights within the Lea County UWB. A total of 51,797 acre-feet of water were applied for in administrative blocks located west of Tatum, Lovington, and Hobbs. The LCWUA applied for the permits in order to take a more active role in managing

[1] per Wilson (1995)

TABLE 7-1: WATER RIGHTS FOR PUBLIC WATER SYSTEMS IN LEA COUNTY[a,b]

Public Water Supplies	Basin	Water Rights[f] (ac-ft/yr)
City of Eunice	Lea County	3,292.00[c]
City of Hobbs	Lea County	20,066.40
City of Lovington	Lea County	6,017.58[d]
Monument Water Users Co-Op	Lea County	80.00
Village of Tatum	Lea County	291.16[e]
City of Carlsbad	Lea County	18,288.00
Mescalero Ridge Co-Op[h]	Lea County	20.00
Continental Mobile Home Village	Lea County	46.00
Country Estates Mobile Home Park	Lea County	18.00
Townsend Trailer Park	Lea County	18.00
City of Jal	Jal	1,586.00[g]
Adobe Village	n/a	n/a
Chaparral Mobile Home Park	n/a	n/a
La Siesta Retirement Center	n/a	n/a
Rancho Estates Subdivision	n/a	n/a
Triple J Trailer Ranch	n/a	n/a
Total		49,723.14

Source: NMOSE electronic database; John West Engineering Company, letters, May 15, 1998 and July 28, 1998; Engineers, Inc, 1998; Miller, letter, August 24, 1998; and Miller, 1994

[a] The information regarding public water systems comes from questionnaires that were sent to all public water suppliers in Lea County by the NMOSE. Missing data is likely the result of unanswered, incomplete or erroneous questionnaires.

[b] This does not include transient or non-transient community water systems. The number of public water systems, as defined by the NMOSE definition, is unknown.

[c] This does not include 1,203.71 acre-feet of rights in T20S R38 E. Potable "water was virtually depleted out of this little area by 1965" (John West Engineering Company, letter, May 15, 1998).

[d] This does not include 309.5 acre-feet of irrigation water rights owned by the City of Lovington, which had not been changed to municipal use by July 28, 1998 (John West Engineering Company, letter, July 28, 1998).

[e] 32 acre-feet of the appropriation is for "Return Flow Credit from Treated Sewage Effluent" (Miller, letter, August 24, 1998).

[f] The way some public water system rights are designated makes them indistinguishable from commercial, industrial or domestic rights; and municipalities often sell water to other public water systems, which is not reflected.

[g] includes 4 wells owned by the City of Jal, and not the well owned by the EPNG.

[h] Mescalero Ridge Co-Op is a public water supplier with purchased rights listed under commercial and petroleum processing.

and protecting the water resources of the Lea County UWB.[2] The NMOSE has not yet ruled on this application and is still accepting appropriation applications. Additionally, the LCWUA has taken over permit applications originally applied for by IMC Kalium in August of 1996. These applications have a proposed water right diversion of 5,990 acre-feet per annum from 12 proposed wells located 18 miles west of Lovington.

The declared or licensed water rights, filed before an UWB is declared, are recognized by the NMOSE as "pre-basin" rights. Water rights permitted in a declared UWB are rights that were issued by the NMOSE based on the basin's administrative criteria. Pending licenses for water rights include applications for water rights that have been submitted to the NMOSE.

Water rights information for the Lea County UWB is listed in **APPENDIX Q** and **TABLE Q-1** contains non-irrigation wells within the Lea County UWB that do not have the amount of their water right listed by the NMOSE. The number of wells is estimated, based on the number of permits, and may include proposed wells or wells no longer in use. Similarly, **TABLE Q-2** lists water-rights information for the Capitan UWB and **TABLE Q-3** lists water rights information for the Jal UWB.

[2] Russell (1999)

7.1.2 Water Rights by Category of Use

TABLE 7-2: SUMMARY OF LEA COUNTY WATER RIGHTS

All Basins			
Type of Water Right	Irrigated Acreage	Right[a] (acre-feet)	Number of Wells
declared or licensed water right		304,374.90	1,743
current permitted water right	6,493.79	19,481.37	116
pending license for water right	6,922.99	20,768.97	149
non-irrigation water right (municipal, etc.)	n/a	171,911.31[b]	1,553
self supplied domestic users	n/a	17,052.00[c]	5,684
self supplied stock user	n/a	2,988.00[c]	996
Total, All Categories	**114,875.08**	**536,576.55**	**10,241**

Source: NMOSE electronic database
[a] based on 3.0 acre-feet per annum per acre
[b] non-irrigation uses
[c] based on 3.0 acre-feet per annum per permit

7.1.2.1 Public Water Systems

Public water supply systems[3,4] are owned and managed by municipalities, mutual domestic water associations, water cooperatives, and private purveyors. Records from the Environmental Protection Agency (EPA) and New Mexico Environment Department (NMED) list 15 public water systems in Lea County (serving a population of 47,864) and 28 transient[5] and non-transient[6] water systems (serving more than 2,600 persons). APPENDIX Q provides a listing of public water systems in Lea County. TABLE 7-1 summarizes water rights information for public systems. To delineate the rights to withdraw water further, substantial research into NMOSE and NMED records is required.

Five municipalities have water rights[7] within the Lea County UWB: Hobbs, Lovington, Eunice, Carlsbad, and Tatum. One water coop, the Monument Water Users Cooperative – which serves the community of Monument, was also listed. These communities combined have rights to 48,035 acre-feet of Lea County UWB water, accounting for 99.8% of all the public system rights. All the communities except Carlsbad are located in Lea County. Carlsbad is in Eddy County[8]. The NMED and EPA list several smaller public water systems, including mobile home parks, subdivisions, gas stations, and other transient and non-transient systems, with rights in the Lea County UWB.

The City of Carlsbad has permits to appropriate 18,288 acre-feet of multiple use water[9,10]. This represents 37% of all public water system rights in the Lea County[11] UWB. Carlsbad's rights are designated as "multiple use", which includes waterflood, commercial, industrial, domestic, mining, and municipal uses. Currently, Carlsbad provides Lea County UWB water for all these uses, except mining and municipal.

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[3] The Safe Drinking Water Act of 1986 states that public water-supply systems "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".

[4] The NMOSE defines public water systems as: "....community water systems which rely upon surface and/or ground-water diversions...., and which consist of common collection, treatment, storage, and distribution facilities operated for the delivery of water to multiple service connections. Examples of such systems include municipalities that serve residential, commercial, and industrial water users; prisons; residential and mixed subdivisions; and mobile home parks. Water used for the irrigation of self-supplied golf courses, playing fields, and parks or to maintain the water level in ponds and lakes owned and operated by a municipality or water utility is also included in this category" (Wilson, 1997).

[5] Transient systems do not serve regular occupants and are generally rest stops, campgrounds, and gas stations.

[6] Non-transient systems serve regular occupants, but not year-round - such as schools with their own water systems.

[7] Ground water rights are given in quantities of water that may be annually retrieved from a UWB.
[8] Water rights owned outside Lea County could be used outside of the County.
[9] (NMOSE, 1998)
[10] The City of Roswell withdrew its ownership to 12,636 ac-ft of municipal water rights in 1992.
[11] Stokes (1999) places the amount of Carlsbad water rights, within Lea County UWB, at 19,232 acre-feet (38% of the total rights owned by public water systems). APPENDIX Q contains a copy of Stokes' water rights abstract.

The City of Eunice has rights to 3,292 acre-feet of water in the Lea UWB. Eunice is the only public system to have water rights within the Lea UWB.

The City of Jal has rights to 1,586 acre-feet of water in the Jal UWB. Jal is the only public system to have water rights in the Jal UWB.

7.1.2.2 Domestic

Domestic uses include "self-supplied 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."[12] 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".[13] Public water systems, listed by the NMED and EPA, that are not recognized by the NMOSE would be included in this category because the NMOSE does not have reliable population or water use data for them.

Domestic wells are permitted to use up to 3 acre-feet per year for non-commercial uses. There are 5,421 domestic well permits in the Lea County UWB, 261 in the Capitan UWB, and 2 in the Jal UWB. Correspondingly, there are 16,263 acre-feet of domestic water rights in the Lea County UWB, 783 acre-feet Capitan UWB, and 6 acre-feet in the Jal UWB. **TABLE Q-4** lists the location of domestic water rights in the Lea County UWB. The locations of domestic water rights in the Capitan UWB are listed in **TABLE Q-5**.

7.1.2.3 Irrigated Agriculture

NMOSE has records for 1,946 well permits with irrigation acreage and 987 well permits without acreage, in the Lea County UWB. The water rights for the wells with acreage total 113,400 acres or 340,202 acre-feet, assuming the application of 3.0 acre-feet per acre[14]. Similarly, the Capitan UWB has 61 permitted wells for 1,475 acres or 4,424 acre-feet. There are no irrigation wells permitted in the Jal UWB. There are 2,007 irrigation wells in all of Lea County, corresponding to 114,876 acres or 344,625 acre-feet. In contrast, the 1995 irrigable acreage[15] in all of Lea County was 83,500 acres and the actual acreage irrigated was only 51,345 acres; the total withdrawal was 131,163 acre-feet. **TABLE Q-6** lists irrigation wells that do not have an approved acreage appropriation.

There is a distinction between the amount of water allocated to an irrigation water right and the amount the NMOSE considers to have been used by that right. An irrigation water right entitles an owner to use up to three acre-feet of water per acre. The NMOSE estimates the amount of water actually applied by an empirical method (**see APPENDIX R**). Allocated water rights do not change, unless they are reallocated. Periodic NMOSE estimates of actual water use vary with changes in crop type, cropping patterns, type of irrigation, and recent weather patterns—to name a few. Irrigation water rights are summarized on lines 1, 2, and 3 of **TABLES 7-3** for the individual UWBs in Lea County and for Lea County as a whole, respectively.

[12] Wilson (1992)
[13] Wilson (1992)
[14] The Lea County UWB Annual Reports use 3.0 acre-feet per acre for the approved appropriation for irrigation
[15] Irrigable acreage is the land area available for crop planting, with basic irrigation infrastructure available. These areas are ready for agricultural use, but do not necessarily support active farming.

TABLE 7-3 : SUMMARY OF WATER RIGHTS FOR LEA COUNTY UWBs

Type of Water Right	Irrigation Right (acres)	Right (acre-feet)[a]	Number of Wells
Lea County Underground Water Basin			
declared or licensed water right	100,326.80	300,980.40	1,697
current permitted water right	6,493.79	19,481.37	116
pending license for water right	6,579.99	19,739.97	133
non-irrigation water right (municipal, etc.)	n/a	134,382.04[b]	801
self supplied domestic users	n/a	16,263.00[c]	5,421
self supplied stock uses	n/a	1,923.00[c]	641
total water rights, all categories	113,400.58	492,769.78	8,809
Capitan Underground Water Basin			
declared or licensed water right	1,131.50	3,394.50	46
current permitted water right	0	0	0
pending license for water right	343.00	1,029.00	16
non-irrigation water right (municipal, etc.)	n/a	34,784.27[b]	741
self supplied domestic users	n/a	783.00[c]	261
self supplied stock uses	n/a	1,056.00[c]	352
total water rights, all categories	1,474.50	41,046.77	1,416
Jal Underground Water Basin			
declared or licensed water right	0	0	0
current permitted water right	0	0	0
pending license for water right	0	0	0
non-irrigation water right (municipal, etc.)	n/a	2,011.00[b]	11
self supplied domestic users	n/a	6.00[c]	2
self supplied stock uses	n/a	9.00[c]	3
Total Water Rights, All Categories		2,026.00	16

Source: NMOSE electronic database. This database includes actual water rights that are being put to use and permits to appropriate water.
[a] based on 3.0 acre-feet per annum per acre
[b] non-irrigation uses
[c] based on 3.0 acre-feet per annum per permit

7.1.2.4 Livestock (& Dairies)

There are 641 well permits for stock uses in the Lea County UWB, with 1,923 acre-feet of water rights – assuming 3 acre-feet. Likewise, the Capitan UWB has 355 permitted stock wells, with 1,065 acre-feet of water rights, and the Jal UWB has 3 wells with 9 acre-feet. The total number of livestock permits for Lea County is 999 with water rights of 2,997 acre-feet. TABLE Q-4 lists the location of stock water rights in the Lea County UWB. The locations of stock water rights in the Capitan UWB are listed in TABLE Q-5.

There are 14 dairies in Lea County[16]. These dairies are large operations, typically covering over 50 acres.[17,18] The NMOSE lists 15 well permits for dairy use in the Lea County UWB. The available water rights for these wells total 1,393 acre-feet[19]. There are no permits for dairy use in the other ground-water basins of Lea County. The NMOSE categorizes self-supplied water for dairies under livestock use.[20]

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[16] Dairies in Lea County have between 8 and 16 ground-water wells, implying that the NMOSE list is incomplete (Buster Goff, personal communication, 1999).
[17] Lea County Farm Service Agency (1999)
[18] The area of a dairy can be determined by examining NMED ground water Discharge Plans. Discharge Plans require effluent application areas based on nitrogen loading rates from wastewater. The number of dairy cows, the amount of wastewater produced, and the type of application (crop or range) used for the wastewater determine the size of a dairy's application area. The application areas for most dairies is well in excess of 50 acres.
[19] Wilson (1998)
[20] NMOSE (1997)

7.1.2.5 Commercial

There are 123 well permits for commercial use in the Lea County UWB. The water rights for these wells total 1,066.57 acre-feet. There are 109 well permits for commercial use in the Capitan UWB, with water rights of 6,158.43 acre-feet. There are two commercial well permits in the Jal UWB, with 35 acre-feet. The entire Lea County has a 234 well permits for commercial use with water rights of 7,260 ac-ft per annum.

7.1.2.6 Industrial

There are 42 well permits for industrial uses in the Lea County UWB. The NMOSE does not list a water right quantity for each permit. The listed water rights exceed 4,950 acre-feet. There are 14 well permits for Industrial uses in the Capitan UWB, with water rights totaling 4,808.80 acre-feet. There are 3 well permits for industrial uses in the Jal UWB, with water rights totaling 390 acre-feet. There are 6 well permits for industrial uses located in unspecified basin(s); these unspecified water rights total 734 acre-feet. The entire Lea County has a total of 65 well permits for Industrial uses with water rights of in excess of 10,882.8 acre-feet.

7.1.2.7 Mining

Mining uses include secondary recovery of oil, oil well drilling, ore mining, and petroleum processing. There are 1,891 well permits for mining uses in the Lea County UWB. The approved appropriation for each well permit was not available, however, their combined permitted water rights total 59,707.95 acre-feet. There are only 56 well permits in the Lea County UWB listed for mining use; the remaining 1,835 wells are used for petroleum industry activities. Six mining companies have water rights within the Lea County UWB. All the companies are involved in the mining of potash. The appropriated water for mining wells totals 25,299 acre-feet[21] in the Lea County UWB; the appropriated water for petroleum wells totals 34,408.95 acre-feet.[22] The Capitan UWB has 274 well permits for mining use, with water rights totaling 23,817.04 acre-feet. Of these 274 well permits, only 3 are actually used for mining; the remaining permits are for petroleum production. The 3 mining permits have water rights of 2,855 acre-feet and are owned by two potash mining companies. The Jal UWB has one mining well permit for a well that supplies a petroleum processing plant.[23] All of Lea County has approximately 2,165 mining use well permits with at least 83,525 acre-feet of water rights. Fifty-nine of the 2,165 well permits are for potash mining and have water rights totaling 28,154 acre-feet.

7.1.2.8 Power

All 79 of the Lea County wells, permitted for power generation, are within the Lea County UWB. The total permitted water rights for these wells are 20,520.38 acre-feet.

7.1.3 Water Diversions by Category of Use

TABLE 7-4 summarizes the water withdrawals associated with all water diversions in Lea County in 1995 and 1998.

7.1.3.1 Public Water Supply

Seven public water-supply systems, with service populations ranging from 53 to over 29,500, responded to a 1995 survey conducted by the NMOSE. Information on three additional public suppliers is listed in the 1995 NMOSE

[21] Their total approved appropriation, according to Wilson (1998) is 22,619 acre-feet, a figure similar to that listed by the NMOSE.
[22] Wilson (1998) states the approved appropriation for secondary oil recovery is 27,606 acre-feet. This includes some commercial sales, but does not include water use from the Capitan or Jal UWBs.
[23] The well is listed under industrial use instead of mining use.

TABLE 7-4: 1995 and 1998 DIVERSION SUMMARY FOR LEA COUNTY

Use	Surface Water (ac-ft)	Ground Water (ac-ft)	Total Diversion (ac-ft)	Surface Water (ac-ft)	Ground Water (ac-ft)	Total Diversion (ac-ft)
public water systems	0.00	16,153.06	16,153.06	0.00	17,790.44[a]	17,79.44[a]
domestic (self supplied)	0.00	1,330.73	1,330.73	0.00	n/a[b]	n/a[b]
irrigated agriculture	0.00	131,163.00	131,163.00	0.00	138,601.00[c]	138,601.00[c]
livestock (self supplied)	64.33	1,432.23	1,496.56	n/a	1,111.00[d]	1,111.00[d]
commercial (self supplied)	0.00	1,345.77	1,345.77	0.00	606.00	606.00
industrial (self supplied)	0.00	1,497.32	1,497.32	0.00	2,524.00[e]	2,524.00[e]
mining: mineral production	0.00	11,659.00	11,659.00	0.00	12,439.00[f]	12,439.00[f]
mining: petroleum production	0.00	7,315.55	7315.55	0.00	4,485.00	4,485.00
power (self-supplied)	0.00	4,445.00	4,445.00	n/a	n/a	n/a
reservoir evaporation	0.00	0.00	0.00	0.00	966.00	966.00
Total	**64.33**	**176,341.86**	**176,405.99**	**0.00**	**178,522.44**	**178,522.44**

Source: Wilson, 1997

diversion data.[24] Data for 1998 includes the ten 1995 systems (7 via survey + 3 via diversion data, just mentioned), the City of Carlsbad, and municipal water sold for other uses[25].

The largest public supplier in Lea County is the City of Hobbs, which withdraws nearly three times the water that the City of Lovington, the next largest user, does. Hobbs withdrew 9,972 acre-feet in 1995 and 9,750 acre-feet in 1998. For the same years, Lovington withdrew 3,485 acre-feet and 3,277 acre-feet respectively. The City of Eunice has the highest usage per capita at 476 gad in 1995 and 525 gad in 1998. The average usage for public water supply customers, in both 1995 and 1998, was 290 gallons per capita per day. Limited information concerning water use at the following small systems is available: Townsend Trailer Park, Country Estates Mobile Home Park, and Continental Mobile Home Village was found. No information was available for Adobe Village, Chaparral Mobile Home Park, La Siesta Retirement Center, Rancho Estates Subdivision, or other public water-supply systems in Lea County. **TABLES 7-5** summarizes the water withdrawals for public water use in Lea County in 1995 and in 1998, respectively.

Between 1994and October of 1999, 51 percent of Hobbs' water was sold to residential customers, 26 percent went to unspecified uses, and 21 percent was sold to commercial accounts. In 1999, 71 percent of the City of Lovington's water went to residential customers, 15 percent was used commercially, and 6 percent went to industrial facilities. The City of Eunice in 1998 sold 47 percent of its water for residential use, 21 percent for unspecified uses, and 16 percent to vendors for resale; commercial and industrial uses were only 4 and 9 percent of the total respectively.

TABLE 7-6 summarizes the distribution of municipal water in the **City of Hobbs**.

In December of 1999 the **City of Lovington** WWTP received 96 acre-feet of wastewater, which equals 1,156 acre-feet per year. An annual amount would be dependent on evaporation, but it would probably be no less than 55 acre-feet. The City of Lovington reused 3 acre-feet of the treated water for agriculture and less than 1 acre-foot for an experimental wetland in December of 1999. Infrastructure leaks are repaired almost immediately by the City of Lovington, and no estimates of water lost by leaking systems was provided. TABLE 7-7 summarizes the distribution of municipal water in the City of Lovington. [26]

[24] Wilson (1995)
[25] Wilson (1998)
[26] Kelly (2000), see APPENDIX V

TABLE 7-5: 1995 and 1998 PUBLIC WATER SUPPLY DIVERSIONS IN LEA COUNTY

Water Supplier	Population Served 1995	Usage 1995 (gpcd)	Total Diversion 1995 (ac-ft)	Population Served 1998[a]	Usage 1998 (gpcd)	Total Diversion 1998 (ac-ft)
Eunice Water Supply System	2,824	476	1,506.00	2,824	525	1,663.00
Jal Water Supply System	1,911	413	884.37	1,911	222	476.00
Monument WUA	175	378	74.00	175	331	65.00
Hobbs Municipal Water Supply	29,860	298	9,972.00	29,860	260	9,750.39
Lovington Municipal Water	9,322	334	3,485.00	9,322	334	3,277.05[d]
Tatum Water System	768	230	198.00	768	227	195.00
City of Carlsbad[b]	n/a	n/a	n/a	n/a	n/a	1,608.00
municipal – not cities[c]	n/a	n/a	n/a	n/a	n/a	725.00
Continental Mobile Home Village	25	107	3.00	25	178	5.00
Country Estates Mobile Home Park	41	261	12.00	41	239	11.00
Townsend Trailer Park	n/a	n/a	n/a	n/a	n/a	15.00
Triple J Trailer Park – Hobbs	53	113	6.69	53	n/a	n/a
Total	**44,979**	**290.09 (avg.)**	**16,153.06**	**44,979**	**289.5 (avg.)**	**17,790.44**

Source: Wilson, 1997 and NMOSE, 1995 and 1998

[a] population figures are from Wilson, 1997 instead of NMOSE, 1998, which uses 1990

[b] water for waterflood, commercial, industrial, and domestic uses

[c] public water system water sold to commercial, industrial, and other users

[d] reported by the City of Lovington on November 15, 1999

The **City of Eunice** does not measure influent or effluent at its WWTP. It is estimated that the annual rate to the wastewater treatment facilities is 169 acre-feet. An estimated 5 acre-feet per year is lost to evaporation at the facility. Reuse or sale of the treated wastewater is not being done by the City of Eunice, however, an adjacent landowner does irrigate with effluent removed from the storage / oxidation lagoon. Two areas of the Eunice water supply system are known to have leaks, the Nadine Ground Storage Tank and the Eunice Ground Storage Tank. The amount of water lost to leaks in the system is unknown, however, 14 percent of water use is made up of waste and miscellaneous use which includes leaking water mains, faulty meters, evaporation, and public use (City parks, recreational areas, and City facilities).[27] **TABLE 7-8** summarizes the distribution of municipal water in the City of Eunice.

The **City of Tatum** uses 57 acre-feet of water a year for municipal purposes, but withdraws 195 acre-feet. The extra 138 acre-feet are sold. The Tatum Wastewater Treatment Plant processes 64 acre-feet of wastewater per year. Of that, 33 acre-feet (40 percent) are evaporated and over 30 acre-feet per year are recharged.[28]

[27] The Ross Group (2000), see **APPENDIX V**

[28] Rickman (2000), see **APPENDIX V**

used for irrigated agricultural use in Lea County in 1995. Irrigated acres, irrigable acreage, and irrigation quantities in Lea County from 1930 to 1999 are shown in TABLE 7-11.

7.1.3.4 Livestock

Estimates of water withdrawal for livestock use rely on the number of livestock reported by state and federal agencies and per animal water requirements determined by research.[42] Self-supplied livestock includes "water used to raise livestock, maintain self-supplied livestock facilities, and provide for on-farm processing of poultry and dairy products."[43] By this definition, water used by dairies is included as livestock use and is so referenced throughout this report. This category includes both surface (stock ponds) and ground water and the underground basins are unspecified.

Livestock use has increased in recent years because many west coast dairies have relocated to parts of New Mexico, including Lea County. These dairies are pursuing affordable land, inexpensive feed crops, good climate, and water available in New Mexico[44]. It can be expected, as the Lea County dairy industry expands, that demand for feed will increase, causing irrigated agriculture will expand. In January 2000, the total dairy cow population was estimated by dairy farmers to be 30,000 head, with 16,000 milkers and 14,000 non-milkers. At a rate of 100 gallons per day per cow,[45] the total withdrawal is 3,363 acre-feet per year.[46] To get an estimate of total livestock use, water use by range cattle would also have to be considered. The following TABLE 7-12 summarizes the water withdrawals used for livestock use in Lea County in 1995.

TABLE 7-12: 1995 DIVERSIONS AND DEPLETIONS FOR LIVESTOCK USE IN LEA COUNTY

	Diversions (ac-ft)			Depletions (ac-ft)		
Water Use	Surface Water	Ground Water	Total	Surface Water	Ground Water	Total
Live-stock	64.33	1,432.23	1,496.56	64.33	1,348.22	1,412.55

Source: Wilson, 1997

TABLE 7-11: IRRIGATED ACRES, IRRIGABLE ACREAGE, & IRRIGATION DIVERSIONS IN LEA COUNTY

Year	Irrigated Acres	Irrigable Acreage	Water Withdrawn for Irrigation (ac-ft)
1930			500
1931	567		850
1932			950
1933			1,225
1937	1,500		1,800
1938	1,850		1,700
1939	2,400		2,200
1940	2,950	3,200	3,200
1941	2,600		1,550
1942	3,000		3,500
1943	3,200		6,000
1944	3,400		3,500
1945	3,800	3,900	6,500
1946	5,000		3,500
1947	9,300		19,000
1948	25,000	117,700	39,000
1949	71,000		60,000
1950	89,000		95,000
1951	91,000		153,000
1952	92,000		166,000
1953	92,600		165,000
1954	93,000		163,000
1955		77,000	170,000
1958			107,000
1960		100,000	105,000
1975	74,430	100,000	191,290
1980	63,350	119,240	148,750
1985	44,161		98,409
1990	30,245	119,240	92,049
1993	52,000	83,500	124,456
1994	47,595	83,500	125,720
1995	51,345 (49,015)²	83,500	131,163
1998	83,500	116,805	138,601³
1999		150,128.1 ⁴	

Sources: Clark (1987); New Mexico Agricultural Statistics Service (1991, 1994, 1995, 1996, 1997, communication 1999); NMOSE (1959, 1967, 1977, 1986, 1992, 1997, and 1998)

¹ including idle, fallow and diverted acreage

² according to the New Mexico Agricultural Statistics Service

³ based on *Lea County UWB Annual Report 1998*

⁴ total crop land in Lea County. Source: Lea County FSA, LaVerne Standifier, letter to County Commissioners (Graham, 1999).

[42] Wilson (1997)

[43] Wilson (1997)

[44] Wilson (1997)

[45] The figure includes both consumption by cows and water for dairy processes The water used per cow varies between milkers and non-milkers and is not precisely known.

[46] Carter (2000)

7.1.3.5 Stockpond and Playa Lake Evaporation

The number of stock ponds in Lea County is not known and the NMOSE discontinued including evaporation from playa lakes as a separate water use category in 1980.[47] Evaporation from playa lakes in Lea County in 1975 was estimated at 8,900 acre-feet.[48] TABLE 7-13 summarizes the water withdrawals associated with stockpond and playa lake evaporation in Lea County.

TABLE 7-13: PLAYA LAKE & STOCKPOND EVAPORATION DEPLETIONS IN LEA COUNTY

Year	Playa Lake Evaporation (acre-feet)	Stockpond Evaporation (acre-feet)
1975	8,900	137
1980	n/a*	279
1985	n/a*	279

Sources: Sorensen, 1977; Sorensen, 1982; and Wilson, 1986
* playa lake evaporation was not determined in succeeding New Mexico water inventories

7.1.3.6 Commercial

Commercial uses include businesses, campgrounds, picnic areas, and visitor centers that derive their water from dedicated wells and not a public water system[49]. The largest commercial users in Lea County are golf courses: the Hobbs and Lovington country clubs in the Lea County UWB and the Eunice Golf Course in the Capitan UWB. In the past, golf courses were listed under recreation, but in 1990 the New Mexico inventory removed recreation as a separate category. Now recreational facilities are reported under commercial uses.[50] TABLE 7-14 summarizes the water withdrawals for commercial use in Lea County.

TABLE 7-14:
1995 COMMERCIAL DIVERSIONS AND DEPLETIONS IN LEA COUNTY

User	Basin	Total Diversion (ac-ft)	Depletion Factor	Total Depletion (ac-ft)
Allsup's Store – Hobbs	Lea County	0.50	45%	0.23
Cadillacs & Wranglers – Hobbs	Lea County	0.50	45%	0.23
Country Food Store – Hobbs	Lea County	0.50	45%	0.23
Dan's Bar – Hobbs	Lea County	0.50	45%	0.23
Gibbs Shell Cafe – Hobbs	Lea County	2.00	45%	0.90
Harry McAdams State Park	Lea County	1.77	45%	0.80
Hobbs Country Club	Lea County	307.80	92%	283.18
Hobbs Port of Entry	Lea County	0.50	45%	0.23
Hobbs Public Schools	Lea County	155.00	45%	69.75
K.L. Towle Roadside Park – Hobbs	Lea County	1.00	45%	0.45
Lea County Airport	Lea County	18.00	45%	8.10
Lil's 380 Café – Tatum	Lea County	2.00	45%	0.90
Lovington Country Club	Lea County	357.00	63%	224.91
NM Game Commission	Lea County	170.00	100%	170.00
NM State Park & Rec.	Lea County	88.00	80%	70.40
Tatum Public Schools	Lea County	10.00	80%	8.00
Town & Country Food Store – Hobbs	Lea County	0.50	45%	0.23
VFW Post 9477 – Lovington	Lea County	1.00	45%	0.45
Lea County UWB total	Lea County	1,116.57		839.22
Eunice Golf Course	Capitan	229.20	92%	210.86
Capitan UWB total		229.20		210.86
Grand Total		1,345.77		1,050.08

Source: data compiled by Wilson for NMOSE Technical Report 49, 1995 (Table 6 1)

[47] Values for stockpond evaporation were obtained from 1975, 1980, and 1985 data compiled by the NMOSE and used in previous reports. These data are not available for current NMOSE inventories
[48] Sorensen (1977)
[49] Wilson (1997)
[50] Wilson (1992)

7.1.3.7 Industrial

Industrial water uses include "...self-supplied enterprises engaged in the processing of raw materials...or the manufacturing of durable or nondurable goods".[51] Within Lea County, the largest industrial users are companies involved in natural gas processing: El Paso Natural Gas, Texaco, and Warren Petroleum. **TABLE 7-15** lists the industrial water withdrawals in the underground water basins of Lea County in 1995.

TABLE 7-15: 1995 INDUSTRIAL DIVERSIONS AND DEPLETIONS IN LEA COUNTY

User	Basin	Sub-Category	Total Diversion (ac-ft)	Depletion Factor	Total Depletion (ac-ft)
American Pro (prv Maple) - Hobbs GP	Lea County	gas processing	0.28	50%	0.14
Clines Chemical - Monument	Lea County	gas processing	90.53	80%	72.42
El Paso Natural Gas - Eunice/Monument	Lea County	gas processing	244.00	80%	195.20
Warren Petroleum - Monument	Lea County	gas processing	203.46	90%	183.11
El Paso Gas Co. - turbine station yard	Lea County	natural gas pipeline	1.00	80%	0.80
El Paso Natural Gas - Caprock Station	Lea County	natural gas pipeline	1.41	100%	1.41
GP Engineering (prv Rice Eng)	Lea County		1.00	50%	0.50
Gandy Corp	Lea County		10.00	50%	5.00
LG & E (prv Llano) - Hobbs	Lea County	gas processing	0.04	50%	0.02
Phillips Petroleum - East Vacuum	Lea County	gas processing	3.00	100%	3.00
TX-NM Pipeline - Lovington	Lea County	natural gas pipeline	0.23	100%	0.23
Texaco (prv Transwestern PL)	Lea County	natural gas pipeline	3.00	100%	3.00
Texaco - Buckeye GP	Lea County	gas processing	30.06	80%	24.05
Tipperary (Davis J.L.) - Denton GP	Lea County	gas processing	85.00	80%	68.00
Transwestern PL - Hobbs	Lea County	natural gas pipeline	4.64	100%	4.64
Wallach Concrete - batching plant	Lea County		10.00	100%	10.00
Warren Petroleum - King GP	Lea County	gas processing	5.00	80%	4.00
Lea County UWB total			692.65		575.52
Able, John - Getty Oil Plant	Capitan	gas processing	88.00	80%	70.40
El Paso Natural Gas - Jal No. 3	Capitan	gas processing	107.00	80%	85.60
Texaco - Eunice GP 1 & 2	Capitan	gas processing	139.00	80%	111.20
Warren Petroleum - Eunice	Capitan	gas processing	42.99	80%	34.39
Capitan UWB total			376.99		301.59
El Paso Natural Gas - Jal No. 1	Jal	gas processing	200.00	80%	160.00
Northern Natural Gas	Jal	natural gas pipeline	3.00	100%	3.00
TX-NM Pipeline - Jal	Jal	natural gas pipeline	2.24	100%	2.24
Jal UWB total			205.24		165.24
Conoco - Maljamar GP	unspecified	gas processing	0.04	50%	0.02
Warren Petroleum - Vada (90 data)	unspecified	gas processing	0.31	80%	0.25
LG & E (prv Llano) NG comp. station	unspecified	natural gas pipeline	0.09	100%	0.09
Northern Natural Gas	unspecified	gas processing	76.00	80%	60.80
Northern Natural Gas	unspecified	gas processing	55.00	80%	44.00
Warren Petroleum - Saunders	unspecified	gas processing	91.00	80%	72.80
unspecified total			222.44		177.96
Grand Total			**1,497.32**		**1,220.31**

Source: data compiled by Wilson for NMOSE Technical Report 49, 1995 (Table 7 1)

[51] (Wilson, 1997)

TABLE 7-16: TOP 15 MINING DIVERSIONS IN LEA COUNTY (1995)

	Under Ground Basin	Sub-Category/Activity	Total Diversion (ac-ft)
Eddy Potash	Capitan	Mineral: mine and mill	2,091.00
Western – AG Min. – potash	Lea County	Mineral: mine and mill	1,954.00
New Mexico Potash Corp.	Lea County	Mineral: mine and mill	1,712.00
Western – AG Min. – potash	Lea County	Mineral: mine and mill	1,712.00
Eddy Potash	Lea County	Mineral: mine and mill	1,411.00
Mississippi Chemical – potash	Lea County	Mineral: mine and mill	1,174.00
Mobile Oil	Lea County	Petroleum: secondary oil	726.00
City of Carlsbad – purchased Rights	Lea County	Petroleum: secondary oil	623.00
National Potash (MS Chemical)	Lea County	Mineral: mine and mill	589.00
J & W Inc.	Lea County	Petroleum: secondary oil	541.00
Texaco	Lea County	Petroleum: secondary oil	500.00
Yates Petroleum Corp.	Lea County	Petroleum: secondary oil	448.00
National Potash (MS Chemical)	Lea County	Mineral: mine and mill	442.00
Texaco	Lea County	Petroleum: secondary oil	406.00
Continental Oil (Maljamar Co-Op)	Lea County	Petroleum: secondary oil	358.00

Source: Wilson (1995) – Table 8.1

7.1.3.8 Mining

Mining use includes "...self-supplied enterprises engaged in the extraction of minerals occurring naturally in the earth's crust: solids, such as coal and smelting ores; liquids, such as crude petroleum; and gases, such as natural gas".[52] Within Lea County mining activities which require water are well drilling, petroleum processing, secondary recovery of oil, milling, mining, and quarrying. This Plan groups the activities into two sub-categorizes, mineral and petroleum extraction, for clarity. TABLE 7-16 lists Lea County's top 15 Mining water withdrawals and the sub-category/activity that they support. TABLE 7-17 summarizes the 1995 total diversions by sub-category and the total diversions for each UWB in Lea County. Sixty-two percent of diversions for mining are for mineral extraction activities and 38 percent are for petroleum production. In the Lea County UWB mineral extraction accounts for 58 percent of mining water diversions, while oil production activities divert 42 percent. In the County, which has an active potash mill, the largest users in the mineral extraction category are potash-mining companies.[53]

TABLE 7-17: 1995 MINING DIVERSIONS (BY SUB-CATEGORY) IN LEA COUNTY

Sub-Category	Basin	Total Diversion (ac-ft)
mine and mill	Lea County	9,458.00
mine and mill	Capitan	2,091.00
total – mine and mill		11,549.00
sand and gravel	Lea County	25.00
sand and gravel	Capitan	85.00
total - sand and gravel		110.00
total - sand and gravel, mine and mill		11,659.00
oil well drilling	Lea County	243.00
oil well drilling	Capitan	56.00
oil well drilling	Carlsbad	103.55
total - oil well drilling		402.55
natural gas	Capitan	3.00
total - natural gas		3.00
secondary recovery of oil	Lea County	6,689.00
secondary recovery of oil	Capitan	221.00
total - secondary recovery of oil		6,910.00
total – oil production activity		7,315.55
Total All Sub-Categories		18,974.55

Source: data compiled by Wilson for NMOSE Technical Report 49, 1995 (Table 8.1)

7.1.3.9 Power

Power category water users include all power generating facilities that supply their own water. All diversions for

[52] Wilson (1997)

[53] New Mexico is the United State's leading producer of potash, providing 83 percent of the nation's total.

power use in the County are from the Lea County UWB. Southwestern Public Service Company is the largest. TABLE 7-18 summarizes the water withdrawals used for power in Lea County.

7.1.3.10 Reservoir Evaporation

Besides Lea County's several small natural lakes, there are at least two man-made lakes: Green Meadow Lake, covering 14-acres near the city of Hobbs, and Lovington Lake, covering 2-acres south of the City of Lovington. Ranger Lake with a surface area of 390-acres is the largest natural lake; the other natural lakes have surface areas less than 50-acres each. A 10-acre reservoir at Jal and a 5-acre reservoir at Eunice are reported,[54] although these reservoirs do not appear on USGS topographic maps.[55] Typically, playa lakes are not categorized as reservoirs and evaporation is not considered. The only New Mexico water use inventory to have a value for reservoir evaporation is 1975.[56] All the succeeding reports, up to 1990, show no water withdrawal for reservoir evaporation in Lea County. This is most likely because of the relative insignificance of the quantity. In 1990, the scope of reservoir evaporation was reduced by the NMOSE to include only reservoirs that have a capacity of approximately 5,000 ac-ft or more. TABLE 7-19 lists the water withdrawals associated with reservoir evaporation in Lea County.

7.1.3.11 Fish, Wildlife, and Recreation

The recreation diversion for Lea County in 1985 was 887 ac-ft with 602 ac-ft from ground water and 285 ac-ft from surface water. Golf courses and State Recreation Areas used 966 ac-ft and were responsible for the majority of the diversion. In 1990 the NMOSE modified the water use categories so that Recreational Facilities are now reported as Commercial, except that self-supplied golf courses owned by municipalities are included under Public Water Supply. TABLE 7-20 summarizes the water withdrawals associated with Fish, Wildlife and Recreation in Lea County.

7.1.4 Water Depletions by Category of Use

Table 7-21 summerizes 1995 depletions by water use category for all of Lea County.

TABLE 7-18: 1995 POWER DIVERSIONS AND DEPLETIONS IN LEA COUNTY

User	Total Diversion (ac-ft)	Depletion Factor	Total Depletion (ac-ft)
Lea County Co-Op	17.00	100%	17.00
Lea County Co-Op	3.00	100%	3.00
SWPSC – Cunningham	405.00	100%	405.00
SWPSC – Cunningham	2,765.00	100%	2765.00
SWPSC - Maddox	1,255.00	100%	1255.00
Total	4,445.00		4,445.00

Source: data compiled by Wilson for NMOSE Technical Report 49, 1995 (Table 9.1)

TABLE 7-19: RESERVOIR EVAPORATION DIVERSIONS IN LEA COUNTY

Reservoir	Surface Area (acre)	Net Evaporation (feet)	Total Evaporation (ac-ft)
1975	n/a	n/a	100
1980, 1985, 1990, and 1995	n/a	n/a	0[a]

Sources: Sorensen, 1977; Sorensen, 1982; Wilson, 1986; Wilson, 1992; and Wilson, 1997
[a] this does not account for minor reservoirs (capacity <5,000 acre-feet), playa lakes, or stockponds

TABLE 7-20: FISH, WILDLIFE, AND RECREATION DIVERSIONS IN LEA COUNTY

Water Use	Surface Water (ac-ft)	Ground Water (ac-ft)	Total Diversion (ac-ft)
Fish and Wildlife	0	0	0
Recreation, 1985	285[a]	602	887
Recreation, 1998	0	966	966

Sources: Wilson, 1986; NMOSE, 1998
[a] surface run-off and captured precipitation into a man-made lake (Wilson, personal communication, 9/99)

[54] The 1975 *County Profile for Lea County* by the Interstate Stream Commission and NMOSE reports.
[55] 7.5 Minute Quadrangles
[56] Sorensen, (1977)

7.1.4.1 Public Water Supply

Depletions by a public water system include water lost through ingestion/metabolizion, evaporation and/or transpiration.[57] Forty-five percent of all ground waters diverted to public water systems, in Lea County, are assumed to be depletions. TABLE 7-22 summarizes the depletions by Lea County public water systems in 1995. Data for 1998 is not available.

7.1.4.2 Domestic

Because the percentage of water consumed or lost by domestic activities is the same whether the home is on a public water system or an onsite well, the depletion factor is the same for public water systems and on-site systems. Therefore --as with public systems-- 45 percent of self-supplied domestic ground-water withdrawals are assumed to be depletions. TABLE 23 summarizes the water depletions by the on-site domestic water systems in Lea County.

7.1.4.3 Irrigated Agriculture

The water depletions by irrigated agriculture include both the consumptive irrigation requirement (CIR) of the crop and incidental depletions (ID). The CIR of a crop is that quantity of irrigation water that is consumed and metabolized by the plants or lost through evaporation. This volume is exclusive of rainfall. ID include such factors as evaporation from canals and laterals, transpiration by phreatophytes, water-supply pipe leakage, sprinkler spray evaporation and drift, and evaporation and runoff from irrigated fields and wetted crop canopies.

The CIR for each irrigation method is shown in TABLE 7-24 to vary with location. APPENDIX R describes the detailed process involved in calculating the CIR and provides other information regarding irrigated agriculture.

The ID depends on the method of irrigation used and the relative "on-farm" efficiency (EF). EFs for

TABLE 7-21: 1995 DEPLETIONS IN LEA COUNTY

Use	Surface Water (ac-ft)	Ground Water (ac-ft)	Total Depletions (ac-ft)
public water systems	0.00	7,256.73	7,256.73
domestic (self supplied)	0.00	598.83	598.83
irrigated agriculture	0.00	104,350.00	104,350.00
livestock (self supplied)	64.33	1,348.22	1,412.55
commercial (self supplied)	0.00	1,050.08	1,050.08
industrial (self supplied)	0.00	1,220.31	1,220.31
mining	0.00	10,767.15	10,767.15
power (self-supplied)	0.00	4,445.00	4,445.00
reservoir evaporation	0.00	0.00	0.00
Total	64.33	131,036.32	131,100.65

Source: Wilson, 1997

TABLE 7-22:
1995 DEPLETIONS FOR PUBLIC WATER SUPPLY IN LEA COUNTY

Water Supplier	Population Served	Depletion (gpcd)	Total Depletions (ac-ft)
Eunice Water Supply System	2,824	214	677.70
Jal Water Supply System	1,911	186	397.97
Monument WUA	175	170	33.30
Hobbs Municipal Water Supply	29,860	134	4,487.40
Lovington Municipal Water	9,322	150	1,568.25
Tatum Water System	768	104	89.10
Triple J Trailer Park – Hobbs	53	51	3.01
Total	44,913	144 (avg.)	7,256.73

Source: Wilson, 1997

TABLE 7-23:
1995 DOMESTIC DEPLETIONS IN LEA COUNTY

Water Supplier	Population Served	Depletion (gpcd)	Total Depletion (ac-ft)
rural self supplied homes	11,880	45	598.83

Source: Wilson, 1997

[57] (Wilson, 1997)

the three main irrigation methods in Lea County are:

- flood irrigation, 55 percent;
- drip irrigation, 85 percent; and
- sprinkler irrigation, 65 percent.

The incidental on-farm depletions (ID), for flood, drip, and sprinkler irrigation in Lea County for 1995 are listed in TABLE 7-25. The total depletions by irrigated agriculture in Lea County for 1995 are listed in TABLE 7-12.

TABLE 7-24: 1995 CONSUMPTIVE IRRIGATION REQUIREMENTS FOR LEA COUNTY

Type of Irrigation	River Basin	Irrigated Acreage	Consumptive Irrigation Requirement (ac-ft per ac)
flood	Pecos	165	1.798
flood	Texas Gulf	4,070	1.800
drip	Pecos	80	2.444
drip	Texas Gulf	605	2.224
sprinkler	Pecos	0	
sprinkler	Texas Gulf	46,425	1.617

Source: Wilson, 1997

7.1.4.4 Livestock

TABLES 7-12 & 7-13 summarize the water depletions by livestock in the UWB's of Lea County in 1995.

TABLE 7-25: 1995 INCIDENTAL ON-FARM DEPLETIONS IN LEA COUNTY

Type of Irrigation	River Basin	Irrigated Acreage	Incidental On-Farm Depletion (ac-ft/acre)	Depletion (ac-ft)
flood	Pecos	165	0.05	8.25
flood	Texas Gulf	4,070	0.05	203.50
drip	Pecos	80	0.05	4.0
drip	Texas Gulf	605	0.05	30.25
sprinkler	Pecos	0	0	0.00
sprinkler	Texas Gulf	46,425	0.262	12,162.35
Total Incidental On-Farm Depletion				12,409.35

Source: Wilson, 1997

7.1.4.5 Commercial

Because most commercial users do not directly meter their discharges, computation of depletions are difficult. Depletions for non-metered facilities are usually determined as a percentage of withdrawal, depending on facility type. Depletion factors for commercial use in Lea County range from 45 to 100 percent. TABLE 7-14 summarizes the water depletions by commercial use in the UWB's of Lea County in 1995.

7.1.4.6 Industrial

TABLE 7-15 summarizes the water depletions by industrial users in the UWB's of Lea County in 1995.

7.1.4.7 Mining

Depletions for mining are measured, estimated by formulas, or estimated as a percentage of withdrawals.[58] Freshwater used for secondary recovery of oil that is injected or spread on the land surface is treated as a 100 percent depletion. TABLE 7-26 summarizes the largest depletions caused by using water for mining in the declared basins of Lea County in 1995.

7.1.4.8 Power

All the power generating facilities in Lea County deplete 100 percent of their withdrawals. TABLE 7-18 summarizes the water depletions associated with power plants in Lea County in 1995.

[58] (Wilson, 1997)

7.1.4.9 Reservoir Evaporation

The only year having a value for reservoir evaporation in Lea County is 1975; total evaporation equals 100 acre-feet. All other records, including 1995 data, show no water withdrawal for reservoir evaporation. All reservoir evaporations are considered depletions. TABLE 7-27 shows the water depletions associated with reservoir evaporation in Lea County.

7.1.4.10 Fish, Wildlife, and Recreation

The only information on depletions for fish wildlife, and recreation available is for 1985. In 1985 the NMOSE assumed 100 percent of surface water withdrawals and 66 percent of ground water withdrawals would be depleted. Depletion data for recreational use (which would be listed under the commercial category) in 1998 was not available. TABLE 7-28 summarizes the water withdrawals associated with fish, wildlife, and recreation in Lea County.

7.1.5 Public Water Supply Systems Data

TABLE 7-29 summarizes water system information related to the major public water-suppliers in Lea County. TABLES 7-30 summarize average daily water consumption for 1995 and 1998 for public water supply systems in Lea County. Per capita water use varies substantially between public water systems, from under 110 gpcd at the Continental Mobile Home Village to around 476 gpcd at Eunice in 1995. In 1998, the range increased to between 180 (Continental MHV) and 525 gpcd (Eunice). Although 1998 rates are substantially higher than in 1995, the average per capita use rate remained the same at 290 gpcd.

TABLE 7-26:
TOP 15 MINING DEPLETIONS IN LEA COUNTY (1995)

User	Basin	Depletion Factor	Total Depletion (ac-ft)
Mobile Oil	Lea County	100%	726.00
Eddy Potash	Capitan	30%	627.30
City of Carlsbad – purchased rights	Lea County	100%	623.00
Western – AG-Min. – potash	Lea County	30%	586.20
I & W Inc.	Lea County	100%	541.00
New Mexico Potash Corp.	Lea County	30%	513.60
Western – AG-Min. – potash	Lea County	30%	513.60
Texaco	Lea County	100%	500.00
Yates Petroleum Corp.	Lea County	100%	448.00
Eddy Potash	Lea County	30%	423.30
Texaco	Lea County	100%	406.00
Continental Oil (Maljamar Co-Op)	Lea County	100%	358.00
Mississippi Chemical – potash	Lea County	30%	352.20
Texaco	Lea County	100%	306.00
Phillips Petroleum	Lea County	100%	255.00

Source: data compiled by Wilson for NMOSE Technical Report 49, 1995 (Table 8.1)

TABLE 7-27: RESERVOIR EVAPORATION DEPLETIONS IN LEA COUNTY

Reservoir	Surface Area (ac)	Net Evaporation (ft)	Total Evaporation (ac-ft)
1975	n/a	n/a	100
1980, 1985, 1990, and 1995	n/a	n/a	0

Sources: Sorensen, 1977, Sorensen, 1982, Wilson, 1986, Wilson, 1992, Wilson, 1997.
This does not account for minor reservoirs, (capacity less than 5000 ac-ft), playa lakes, or stockponds

TABLE 7-28: 1985 FISH, WILDLIFE, & RECREATION DEPLETIONS IN LEA COUNTY

Water Use	Surface Water (ac-ft)	Ground Water (ac-ft)	Total Diversion (ac-ft)
Fish and Wildlife	0	0	0
Recreation	285[a]	602	887

Source: Wilson, 1986
[a] surface run-off and captured precipitation into a man-made lake (Wilson, personal communication, 9/99)

TABLE 7-29: MAJOR PUBLIC WATER-SUPPLIERS IN LEA COUNTY

Municipality	Total No. of Wells	Wells In Use	Wells Out of Use	Water Rights (ac-ft)	1996 Pumping (ac-ft)	1997 Pumping ac-ft	1998 Pumping ac-ft	Notes
Hobbs	25	23	2	20,066.40	8,627.03	8,503.36	9,750.39	Wells 9 and 12 are out of use due to contamination
Lovington	22	17	5	6,017.58	3,484.00	3,339.00	3,277.05	Well #6 impacted by brine contamination
Eunice	8	6	2	3,292.00	1,767.92	1,592.16	1,663.00	Nadine 1 and Nadine 2 are no longer in use – wells located near Nadine Ground Storage Tanks
Jal	4	4		1,586.00	481.00	300.00	476.00	
Tatum				291.16	178.00	172.00	195.00	

TABLE 7-30: 1995 and1998 PUBLIC WATER SYSTEM CONSUMPTION IN LEA COUNTY

Water Supplier	1995			1998		
	Population Served	Usage (gpcd)	Daily Use (gallons)	Population Served[a]	Usage (gpcd)	Daily Use (gallons)
Eunice Water Supply System	2,824	476	1,344,224	2,824	525	1,482,600
Jal Water Supply System	1,911	413	789,243	1,911	222	424,242
Monument WUA	175	378	66,150	175	331	57,925
Hobbs Municipal Water Supply	29,860	298	8,898,280	29,860	291	8,698,629
Lovington Municipal Water	9,322	334	3,113,548	9,322	314	2,923,559
Tatum Water System	768	230	176,640	768	227	174,336
City of Carlsbad[b]	n/a	n/a	n/a	n/a	n/a	n/a
municipal – not cities[c]	n/a	n/a	n/a	n/a	n/a	n/a
Continental Mobile Home Village	25	107	2,675	25	178	4,450
Country Estates Mobile Home Park	41	261	10,701	41	239	9,799
Townsend Trailer Park	n/a	n/a	n/a	n/a	n/a	n/a
Triple J Trailer Park – Hobbs	53	113	5,989	53	n/a	n/a
Total				44,979	290.9 (avg.)	13,775,540

Source: Wilson, 1997 and NMOSE, 1995, NMOSE, 1998
[a] population figures are from Wilson, 1997 instead of NMOSE, 1998, which uses 1990 figures
[b] water for waterflood, commercial, industrial, and domestic uses
[c] public water system water sold to commercial, industrial, and other users

Several factors can affect the rate of water usage. For instance, landscape irrigation is known to increase per capita consumption by up to 100 percent over simple domestic demand (drinking/cooking, bathing, washing, etc.). Also, in large systems where there are commercial/industrial or irrigation (parks, etc.) uses, the per capita consumption is higher than in rural systems because both domestic and non-domestic demands are averaged over the residential population. Homeowners with onsite wells are said to use less water to preserve their well pumps,[59] and houses with septic tanks use less water to avoid frequent tank cleaning. In 1995 rural homes with onsite wells had an average daily use of 100 gpcd.[60]

[59] Wilson (1997)
[60] based on water requirements for landscape irrigation and evaporative cooling (Wilson, 1997)

7.1.6 Irrigation Practices

Flood, sprinkler, and drip irrigation are used throughout the Lea County, however, sprinkler irrigation is used on 90 percent of the acreage. Consumptive irrigation requirements for the three types of irrigation within the Lea County are shown on TABLE 7-24. The type of irrigation used can depend on cost, ground slope, soil type, crop type, weather, and desire for water and soil conservation.

TABLE 7-31: 1995 RETURN FLOWS FOR LEA COUNTY (BY USE CATEGORY)

Use	Surface Water (ac-ft)	Ground Water (ac-ft)	Total Return (ac-ft)
public water systems	0.00	8,869.33	8,869.33
domestic (self supplied)	0.00	731.90	731.90
irrigated agriculture	0.00	26,813.00	26,813.00
livestock (self supplied)	0.00	84.01	84.01
commercial (self supplied)	0.00	295.69	295.69
industrial (self supplied)	0.00	277.01	277.01
mining	0.00	8,207.40	8,207.40
power (self supplied)	0.00	0.00	0.00
reservoir evaporation	0.00	0.00	0.00
Total	0.00	45,278.34	45,278.34

Source: Wilson, 1997

TABLE 7-32: 1995 IRRIGATED AGRICULTURAL RETURN FLOWS IN LEA COUNTY

Type of Irrigation	River Basin	Irrigated Acreage	Total Return (ac-ft)
Flood	Pecos	165	227
Flood	Texas Gulf	4,070	5,628
sub-total		4,235	6,394
drip	Pecos	80	34
drip	Texas Gulf	605	170
sub-total		685	204
sprinkler	Pecos	0	0
sprinkler	Texas Gulf	46,425	20,754
Sub-total		46,425	20,754
Total – Pecos		245	261
Total – Texas River		51,110	26,552
Total All Classes		51,345	26,813

Source: Wilson, 1997

7.1.7 Conveyance losses

Conveyance losses are related to surface water, and are not considered for Lea County where all irrigation is from ground water.

7.1.8 Return Flows

TABLE 7-31 summarizes the 1995 return flows in Lea County by water use category. However, return flows are best analyzed by source. There are two sources of return flows irrigation and non-irrigation.

Agriculture return flows are based on the irrigation method and the number of acres irrigated with each type of irrigation. The return flow is the difference between the total quantity of ground water diverted less the quantity of water depleted. Ground-water diversions for irrigation and ground-water depletions for irrigation are shown on TABLE 7-10. TABLE 7-32 summarizes the return flows from irrigated agriculture in Lea County.

Return flow values for non-irrigation categories (e.g., municipal, domestic, livestock, commercial, industrial, mining, and power) indicate the amount of water which returns to Lea County ground water supplies via discharges from wastewater treatment and septic tank drain fields, and infiltration of landscape water, etc. The values are obtained by subtracting a category's total depletions from its total diversions. TABLE 7-33 summarizes the non-irrigation return flows in Lea County.

TABLE 7-33: 1995 NON-IRRIGATION RETURN FLOWS IN LEA COUNTY

Water Supplier	Population Served	Basin	Returns (gpcd)	Total Returns (ac-ft)
Eunice Water Supply System	2,824	Lea County and Capitan	262	828.30
Jal Water Supply System	1,911	Jal	227	486.40
Monument WUA	175	Lea County	208	40.70
Hobbs Municipal Water Supply	29,860	Lea County	164	5484.60
Lovington Municipal Water	9,322	Lea County	184	1916.75
Tatum Water System	768	Lea County	126	108.90
Triple J Trailer Park – Hobbs	53	Lea County	62	3.68
domestic	11,880	n/a	55	731.90
livestock	n/a	n/a	n/a	84.01a
commercial	n/a	Lea County	n/a	277.35
commercial	n/a	Capitan	n/a	18.34
industrial	n/a	Lea County	n/a	117.13
industrial	n/a	Capitan	n/a	75.40
industrial	n/a	Jal	n/a	40.00
industrial	n/a	unspecified	n/a	44.48
mining	n/a	Lea County	n/a	6,640.60
mining	n/a	Capitan	n/a	1,566.80
mining	n/a	Carlsbad	0.00b	0.00b
power	n/a	Lea County	0.00b	0.00b
Total	56,793		288.74	18,381.33

Source: Wilson, 1997

[a] represents return flow from ground water usage

[b] 100 percent depletion (Wilson, 1997) and data compiled by Brian Wilson

7.2 FUTURE WATER USES BY 40 YEAR PLANNING HORIZON

7.2.1 Projected Future Demographics

7.2.1.1 Population

Population projections for Lea County, at 5-year intervals from 1990 until 2020, indicate growth ranging from 1.5% to 0.8% per interval as shown in TABLE 7-34.[61] If this trend is approximated by 1% growth per 5-year interval; TABLE 7-34 predicts the population for the period 2020 to 2040 in Lea County. The predicted population is presented graphically in FIGURE 35.

Recent trends in Lea County indicate a loss of population in the smaller cities and towns and an

TABLE 7-34: POPULATION PROJECTIONS FOR LEA COUNTY

Year	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040
Population	55,942	56,793	57,580	58,289	58,891	59,417	59,913	60,512	61,117	61,728	62,346
Change (approx)	—	+1.5%	+1.4%	+1.2%	+1.0%	+0.9%	+1%	+1%	+1%	+1%	+1%

Source: UNM BBER (1990-2015), estimated for this study (2020-2040)

increase in population for the city of Hobbs. This can be attributed to the younger populous leaving agricultural areas for urban employment. The trend is common in agricultural areas of the United States and can be expected to continue.

7.2.1.2 Future Land Use

Loss of population in agricultural areas and the increase of the median age of a New Mexico farmer/rancher to 56 years,[62] indicates that future agricultural land use in Lea County will decrease while residential (urban and suburban)

[61] Population projections were prepared by the University of New Mexico Bureau of Business and Economic Research.

[62] (New Mexico Department of Agriculture)

use will increase. The rapidly growing dairy industry may partially offset this by using more land for dairy farms and increasing the need for irrigated agricultural to supply feed for their herds.

Recent increases in retail, trade, and service employment[63] indicate that the number of commercial properties will increase. Commercial properties are usually located within or near cities and towns. The development of industrial parks in Hobbs, Lovington, and Jal may be the beginning of this trend.

Future land use by the mining and the petroleum industries is expected to remain constant in the short-term and then decline gradually.[64] Market demands, particularly for oil and potash, will periodically cause deviations from this trend.

7.2.1.3 Economic Growth and Jobs

Recent growth in the retail, trade, services, and government work sectors, combined with decreases in mining and petroleum indicate that future jobs in Lea County may move away from the traditional employment areas of agriculture, mining, and oil. Recent growth includes the construction of a state prison in the City of Hobbs. Proposed growth includes construction of federal prison and expansion of an existing cheese factory in Lovington, plus construction of a horse racetrack near Hobbs.

7.2.2 Projected Water Demands by Category of Use

Future water use by category was estimated by plotting past use (1975 to 1998) and constructing trend lines through known data to obtain an estimated value for the year 2040. Other (non-NMOSE) pertinent population, economic, agricultural, and water use data and factors were obtained, evaluated, and used to finalize the estimates. Increased water use is expected to occur in all categories. By comparison, the largest use of water in Lea County occurs in the Irrigated Agricultural category; and - the water needs of Irrigated Agriculture are expected to increase due to the growing needs of the dairy industry. Unrestrained, the total annual water required by Lea County in the year 2040 is estimated to be between 342,070 acre-feet to 362,390 acre-feet.

7.2.2.1 Irrigated Agriculture

Decreases in water use by irrigated agricultural can be expected during periods of above normal precipitation, high production costs, low market prices, decreased cultivation acreage, and with the increased use of efficient irrigation methods. It is likely that, in the future, these factors will be offset by the increased demands of the burgeoning dairy industry. At present, Lea County is not able to supply the food needs of its dairy herds or the milk needs of the cheese factory located in Lovington. The cheese factory in Lovington is planning to increase future production by as much as 400%. It's estimated that there are now 16,000 mature milking cows and 14,000 immature hefers and calves in the County.[65] Dairy farmers in Lea County estimate that herds will increase by 4,000 during the next five years. Future water use predictions include an increase of 4,000 cows every five years and the resulting impact feeding these herds will have on cultivated acreage. Based on average food consumption per cow and Lea County crop yields, a total of approximately 55,000 acres of irrigated farmland is required now to feed the current dairy herd population. Herd increases of 4,000 every 5 years would require an additional 7,300 acres of irrigated farmland every 5 years.

Unrestrained, the total water use in Lea County, assuming current CRP acreage will remain fallow, is estimated to increase by 94% during the next 40 years (FIGURE 36 AND TABLE 7-35). The increase is predicted to grow at a slow rate during the first 10 years and at a faster rate during the last 30 years. Future water management and

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[63] Smith (2000)
[64] Smith (2000)
[65] Dairy Farmers

TABLE 7-35: LEA COUNTY WATER USE IN 2040
(with Current CRP Acreage Remaining Fallow)

Water Use Category	Year 1995	Year 2040	% Change
Public Water Supply	16,153	25,000	+55
Domestic	1,331	2,100	+58
Irrigated Agricultural	131,163	268,900	+105
Livestock	1,497	6,950	+364
Commercial	1,346	2,120	+58
Industrial	1,497	3,500	+134
Mining	18,975	25,00	+32
Power	4,445	27,000	+507
Recreation	n/r	1,500	+55ª
Total Use	176,407	362,070	+94

Note: n/r: not reported
a) based on change from 1998 data

TABLE 7-36:
LEA COUNTY PROJECTED WATER USE IN 2040
(with Current CRP Acreage Returning)

Water Use Category	Year 1995	Year 2040	% Change 1995-2040
Public Water Supply	16,153	25,000	+55
Domestic	1,331	2,100	+58
Irrigated Agricultural	131,163	289,220	+120
Livestock	1,497	6,950	+364
Commercial	1,346	2,120	+58
Industrial	1,497	3,500	+134
Mining	18,975	25,000	+32
Power	4,445	27,000	+507
Recreation	n/r	1,500	+55ª
Total Use	176,407	382,390	+105

Note: n/r: not reported
a) based on change from 1998 data

conservation practices, particularly for irrigated agriculture, have been applied as a reduction throughout the 40-year period. However, in response to the growing dairy industry, much of the current CRP acreage (approximately 38,000 acres) could be returned into use. If CRP acreage is returned, it will occur in the next 10 years and during that time will increase the total need for water in Lea County by 11% over today's demand. At the end of 40 years, returned CRP acreage will boost Lea County's need by 105% (FIGURE 36 AND TABLE 7-36), 19% greater than the estimated need if CRP acreage were to remain fallow.

Declining aquifer levels, new USDA financing programs, and ever increasing power costs will cause increased use of LEPA irrigation systems in Lea County. Today, 10% of the irrigated acreage uses LEPA systems. This Plan assumes that within the next 15 years most of the remaining and all the newly irrigated acreage will use LEPA systems. Those increases are projected to be at 30% over each 5-year interval, until total use occurs in 2015. A water use reduction factor of 30% (LEPA efficiency vs. center pivot efficiency) was applied to the growing portion of the irrigated acreage projected to use LEPA systems during the period of 2000 to 2015. The reduction factor was applied to both the 'CRP land returning' and the 'CRP land remaining fallow' scenarios.

7.2.2.2 Mining

Since the late 1980's a downward trend in water use by mining has occurred. This may be the result of more efficient use and more available commercially provided water. However, water use by mining, including both petroleum and mineral, is projected to increase by 32% to over 25,000 acre-feet in the next 40 years. This projection, shown on FIGURE 38., would be a return to usage levels that occurred 20 years ago. Increased petroleum demand and higher market prices, as well the availability of new, water intensive, mineral extraction technology are predicted to increase the use of water for mining by 32% in the next 40 years. The discovery of new reserves (mineral or petroleum) could also cause an increase in water use by Mining.

7.2.2.3 Public Water Supply

Public Water Supply is estimated to increase by approximately 55%, to 9,000 acre-feet per year, in the next 40 years as shown on FIGURE 39. Water use per person on Lea County public water systems is growing faster than the population. While the number of residents served by public systems in Lea County has been increasing at about 1% per year, the increase in water used by public systems has at 3% per year.

7.2.2.4 Domestic

Domestic water use has remained stable in the past (Figure 39), except for short-term increases during periods of drought. It is estimated that future water use in this category will increase 58% over the next 40 years to 2,100 acre-feet per year. Small subdivisions built near cities, industrial areas, or vacated farmland that (in order to keep housing costs low) are not connected to public systems, will be a large part of this increase.

7.2.2.5 Livestock

Livestock water use is predicted to increase in response to the previously referenced growth of the dairy industry. Livestock water use is expected to increase by 364%, to 6,950 acre-feet per year, by 2040 as shown on FIGURE 40.

7.2.2.6 Commercial

Commercial water use in Lea County is expected to increase in correspondence with the growth in commercial facilities and as increases and water sales may be used to supplement mining and industry uses (FIGURE 41). The sharp drop in Commercial water use that occurred during the 1990's may be attributed to decreases in oil and gas production. Commercial water use is estimated to increase 58%, to 2,120 acre-feet per year, by the year 2040 (Table 75).

Industrial water use is likely to increase due to future development of industry (FIGURE 42), even though declines in recent years have occurred. This estimated increase depends upon future economic growth in Lea County. Lea County has an active economic development corporation and several vacant large facilities. Due to the known limited supply of area aquifers, it is assumed that industrial growth will be limited to industries that utilize low volumes of water or are capable of recycling a majority of their process water. Industrial water use is estimated to increase 134%, to 3,500 acre-feet per year, by the year 2040.

7.2.2.7 Recreation

Water use by Recreation is expected to increase over the next 40 years as influenced by increases in urban and suburban populations. Recreation use typically includes self supplied water for campgrounds, resorts, ponds, lakes, parks, golf courses, etc., however, golf courses may also appear under Public Supply and Commercial uses. Recreation use has not been consistently recorded in the past and may not be individually recorded in the future. As a result, a use trend graph has not been prepared for Recreation use. The estimated increase of water use by Recreation to 1,500 acre-feet per year is an increase of 55% compared to incomplete 1998 NMOSE data.

Water use by Power is expected to increase in the future due to the ever-increasing electrical needs of residential and commercial entities. Development of industry requiring large quantities of power could cause additional demands by this use category. Decreases of water use by Power in past years may be attributed to more efficient uses of water, however, recent use increases have occurred. Two gas-fired electric production turbines will be constructed in Lea County within the next 3 years to supply the regional power grid.. Lea County has been chosen for this project due to the availability of natural gas from the petroleum industry. Each turbine will require 5,000 acre-feet of water per year. It is estimated that two additional turbines will also be constructed in Lea County within the next 40 years. Therefore, it is estimated that a 507% increase in water use by Power, to 27,000 acre-feet per year, will occur by year 2040.

7.2.3 Projected Changes in Water Supplies in Region

Several studies with ground-water models have been completed by the NMOSE to predict future depletion of the Lea County UWB (Ogallala Aquifer). The most recent,[66] estimated that pumping rates from 1993 to 1996 will cause drawdowns of 10 to 60 feet during the next 40 years. Estimated drawdowns in the area of Hobbs, Lovington, and Tatum by the year 2040 are approximately 35, 25, and 10 feet, respectively. The projected saturated thickness of the Ogallala Aquifer in the year 2040 at Hobbs, Lovington, and Tatum is approximately 50, 100, and 50 feet respectively. The effect of ground-water withdrawals in Texas and their affect upon Lea County was also modeled. Due mostly to Texas withdrawals, drawdowns as high as 20 feet, by the year 2040, were predicted along the New Mexico-Texas line; a drawdown of 10 feet was predicted just east of Hobbs. The report noted a high degree of uncertainty about future water use in both New Mexico and Texas, but concluded that the current rate of depletion is sustainable for the next 40 years.

Potable water supplies in the Capitan, Carlsbad, and Jal UWB's are not expected to change significantly during the next 40 years as predicted population, commercial, and industrial growth in these areas is expected to be minimal.

7.3 SUMMARY OF PRESENT & FUTURE WATER DEMAND

Water demand in Lea County increased 33% from 1985 to 1995 and is presently about 180,000 acre-feet per year.[67] Similar increases in water use from 1985 to 1995 occurred in Irrigated Agriculture (33%), Public Supply (26%), Domestic (40%), Livestock (106%), and Commercial (21%) use categories.[68] During 1995 to 1998 Industrial use increased 69%. Decreases in water use occurring during 1985 to 1995 in the Mining (-26%) and Power (-22%) categories; these declines are attributed increases to process efficiency. Present water use by category, as a percentage of Lea County's total, is 78% Irrigated Agricultural, 10% for Public Water Supply, 7% Mining, and 3% Power. Present water use by Domestic, Livestock, Commercial Reservoir Evaporation, and Recreation uses are all less than 1% of the total use. This increase in water use is far in excess of the County's population growth. The disparity is perhaps best portrayed by the direct relationship between population a residential use; the County's population is increasing at only about 1% a year, but residential use is increasing annually at 10%.

Over the next 40 years --if unrestrained-- the water use in Lea County is estimated to increase to approximately 360,000 acre-feet, 105% greater than the 1995 total; this assumes the current CRP acreage returns to irrigated farmland. The largest part of this increase is anticipated to come from Irrigated Agricultural, which is projected to require 290,000 acre-feet in 2040, in response to demands for feed from Lea County's expanding dairy industry. If the current CRP acreage remains fallow, the estimated total annual water use in year 2040 is estimated to be a 340,000 acre-feet per year (of which Irrigated Agricultural will require about 270,000 acre-feet), a 94% increase compared to 1995.

All other water use categories are expected to increase in Lea County over the next 40 years. Specifically, 55% Public Supply, 58% Domestic, 364% Livestock, 58% Commercial, 134% Industrial, 32% Mining, 57% Power, and 55% Recreation are estimated above 1995 uses. These other categories account for a total of approximately 70,000 acre-feet per year of the total annual 2040 estimate.

[66] Musharrafieh and Chudnoff (1999)
[67] incomplete 1998 NMOSE data)
[68] Recreation water use was not calculated because of a lack of data.

8. WATER PLAN ALTERNATIVES

8.1 WATER PLAN ALTERNATIVES

Water supply alternatives for Lea County contained in this Plan are intended to accomplish one or more of three things: **1) conserve water, 2) develop additional water supplies, and 3) improve water management.** The LCWUA has carefully selected and crafted each alternative listed herein for possible implementation according to the schedule given in Section 8.3. Areas where water can be saved through conservation include: irrigated agriculture, urban and suburban landscaping, indoor use, and the systems of large users. Alternatives that increase supplies are: developing deep aquifers, treatment of lower quality water, importing water, recharging aquifers, and seeding clouds. Each of these alternatives must be carefully planned and managed to assure the best results, the lowest cost, and the least adverse impact on the quality of life enjoyed by Lea County residents.

TABLE 8-1: WATER CONSERVATION MEASURES

Conservation Measure	Suitability	Annual Water Savings (ac-ft)	Implementation Time
Irrigated Agriculture	Very Good	35,000	5years
Urban/Suburban Landscaping	Moderate	5,000	20 years
Residential	Moderate	2,500	20 years
Wastewater Reuse[a]	Good	7,000	3 years
Large User	Good	5-20%	3 years

[a]4,500 ac-ft of effluent is already being reused.

8.1.1 Water Conservation

Reduction of demand through conservation does not create new water, but does provide a way to extend or sustain the life of aquifers by consuming less water. Water rights holders often view conservation as an effort to reduce their right –when instead– it is an enhancement that allows their right to become a long-term benefit. A summary of the water conservation measures discussed here is presented in TABLE 8-1.

8.1.1.1 Irrigated Agriculture

Since irrigated agriculture is the largest single use of ground water in Lea County, reducing the water used for irrigation is essential to preserve the Ogallala Aquifer as a resource. Alternatives to be implemented include the items listed below.

- use LEPA attachments on center pivots
- monitor soil moisture so that water is applied only when needed
- use tillage methods which promote soil water retention
- use crop types compatible with the climate and soil type
- encourage dryland farming

New high efficiency drop tube apparatuses known as Low Energy Precision Applicators (LEPA) are now available to retrofit existing center pivot systems. Retrofitting center-pivot irrigation systems with LEPA attachments will most likely be the single most significant conservation measure undertaken in Lea County. More than 90% of the irrigated acreage of Lea County uses center pivot sprinkler systems. The estimated efficiency of a traditional center pivot system is 60%.[1] LEPA fitted center-pivot systems are capable of achieving efficiencies as high as 95%. For this

[1] Efficiency measures the amount of applied water that makes it into the soil ,where it is available for plants.

reason, converting to LEPA attachments should be one the LCWUA main priorities. Today, less than 10% of these center pivot systems are equipped with LEPAs. Converting to LEPA attachments should cause few technical problems. Assuming all 1998 irrigation water in the Lea County UWB was applied by center pivot systems, a conversion of those systems to LEPA systems would result in a water savings of 35,000 acre-feet per year. Since about 10% of agricultural irrigation users already utilize LEPA systems,[2] the actual annual savings would be closer to 31,000 acre-feet. Although funding specifically for such conversions is currently not available, cost sharing programs are in the process of being developed by the Farm Service Agency[3] and low interest loans can be made available.

Soil moisture data can be used by farmers to determine the necessary irrigation frequency. Soil monitoring can occur on-site at each farm parcel or by a network of stations located strategically throughout the County. Network derived soil moisture can be disseminated to farmers via daily public service announcements and/or Internet bulletin boards. The small amount of monitoring for soil moisture that is being performed in Lea County today is not coordinated. A network project could be financed by federal or state grants with the assistance of universities or local soil and water conservation districts. Rebates or other incentives could be provided for on-site monitoring stations.

Farmers are becoming more and more aware of age-old methods for collecting and storing precipitation in the soil. This together with soil monitoring and modern/efficient techniques for soil working can allow irrigation requirements to be offset by natural soil moisture. Information on techniques for optimizing natural soil moisture will be made available throughout the County with updates on the latest research and innovative methods being highlighted. When precipitation collection and soil management are done correctly, large decreases in the amount of irrigation water that is required to produce a crop are realized. For instance - if 33% of the average annual rainfall (in the area between Hobbs and Tatum) is retained in the soil, a wheat crop can be grown with a yield that is 70% of what would be produce by an adjacent irrigated field using 10-times as much water.[4]

Collecting and storing precipitation in the soil is an essential component of dryland farming. Many eastern parts of Lea County were at one time dryland farmed. Conserving irrigation water will mean that large portions of the County's agricultural lands will be returned to dryland farming and/or producing irrigable crops that require substantially less water. Because these changeovers will result in very significant water savings, everything possible will be done to facilitate their implementation. Dryland farming can reduce the amount of irrigation water required by 50 to 100 percent per acre converted. Much research is currently occurring in the field of dryland farming and many new strains of low water use crops are being introduced. With the recent advent of dryland farming as a separate agricultural discipline, significant technical resources are now available to assist dryland endeavors. New dryland farming technology and crop strains continue to be developed by various universities[5] and agencies as many western agricultural areas face decreasing water supplies.

Because conserving irrigation water will also reduce power costs for operating pumps and sprinkler systems, economics will be a positive contributing influence for all alternatives design to lower irrigation use. To specifically encourage the conversion of acreage to dryland farming, lower tax rates may be set for parcels that use little or no irrigation. On a federal level, New Mexico's legislative delegation will be informed of the irrigation savings that are occurring because of the USDA's CRP program, in an attempt to keep the program funded. Also, subsidies for crops produced by dryland methods will be proposed.

It should be mentioned Lea County farmers have invested large amounts of money in pumps and irrigation equipment. As much as we would like to convert the irrigated farms to dryland operations, it has to rain to make this possible. Unfortunately, the recent trend in precipitation has been less rainfall rather than more. Because of this, the objective here should be one of conservation rather than one of mandating or requiring farmers to cease irrigating all together.

[2] Lea County Farm Service Agency (1999)
[3] This may qualify for federal funding as an energy conservation program, because pumping less water means using less energy.
[4] Widstoe (1999)
[5] especially Texas Tech University in Lubbock.

8.1.1.2 Municipal & Industrial

Urban/Suburban Landscaping

TABLE 8-2: INCLINING-BLOCK RATE STRUCTURE

Water Quantity (gallons/month)	Cost of Water in the Specified Quantity Range ($ per 1000 gallons)	Maximum Monthly Bill
0-25,000	0.50	$12.50
25,000-50,000	0.75	$31.25
50,000-75,000	1.00	$56.25
75,000-100,000	1.25	$87.50
Over 100,000	1.5	$125.00+

By far the most effective way to encourage residents to reduce the water they use on landscaping, is to develop an Inclining-Block rate structure. An Inclining-Block structure increases rates in steps, which correspond to increasing amounts of water used. The cost of water for each tier of use is more expensive. Water bills for residents who use water for essential household activities are not increased. However, homeowners who use larger than average amounts of water (usually as a result of inefficient landscape irrigation) will have water bills that are much larger than average. A sample Inclining-Block rate structure is shown in TABLE 8-2.

The first step in implementing the inclining-block rate structure is a thorough audit of the existing water uses. Several residential users currently "sell" a large portion of their water to industrial users in Lea County and elsewhere. The system audit will determine actual usage and create a better picture of where the water is actually being consumed.

Landscaping and watering ordinances together with efficient landscaping and irrigation practices and incentive programs are another effective way to assure conservation of landscaping irrigation. The most common conservation ordinances include restrictions on the size of areas that may be planted in turf and the hours during which watering may occur. However, establishing regulations that restrict people's choice is politically unpopular and often difficult. Efficient landscaping practices include xeri-scaping, using other appropriate plants, using mulches, and performing regular irrigation system maintenance. Efficient landscaping irrigation methods include conversion from sprinkler to drip systems, daily public service announcements during summer months regarding appropriate watering rates, and irrigating only when needed and during nighttime hours.

If half the homes in Lea County were to change out their turf and install drip irrigation systems about 500 acre-feet of water a year would be saved. These savings will accumulate slowly over time if incentives are given to residents. But large, timely, savings would occur if all municipal facilities and new suburban development installed more water efficient grass and shrubs. Studies indicate that the use of buffalo grass in the City of Hobbs, as compared to Kentucky bluegrass and Bermuda grass, results in a water savings of 26 and 12 gallons per square foot per year, respectively.[6] Changing from Kentucky bluegrass to Bermuda grass results in a water savings of 14 gallons per square foot per year, or a savings of 1.9 acre-feet per year per acre changed. Effects of using drip irrigation, rather than flood or sprinkler irrigation, for trees and horticulture results in a water savings of 9 to 10 gallons per square foot per year.

Indoor Residential

Reduction of indoor water use is a readily accepted and significant means of water conservation. The National Energy Policy Act of 1992, requires that toilets manufactured for residential use after January 1994 use no greater than 1.6 gallons per flush. In comparison with toilets manufactured prior to the 1950's that used 7 to 8 gallons per flush and toilets manufactured in the 1980's that used 3.5 gallons per flush. The new toilets can save 1.9 to 6.4 gallons per flush. Reduction of indoor water can also occur by reducing flowrates at showerheads and faucets. New showerheads with flows of 2.5 gpm are more efficient than the 3 gpm and 5 to 8 gpm showerheads of yesteryear.

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[6] Wilson (1996)

The federal flow requirement for new bathroom and kitchen faucets is 2.5 gpm, and faucets with even lower flowrates are available. Former bathroom and kitchen faucets had flows of 3 to 7 gpm. Indoor water use can also be reduced by the installation of new appliances including: dish washers, hot water heaters, and washing machines. Education is an important step in obtaining conservation by using efficient fixtures and appliances.

Reducing indoor water use is compatible with Lea County, as with most any community in the southwest, because of a heightened public awareness about water supply issues.[7] Since the majority of the County's houses and buildings were constructed prior to 1980 and since major appliances are costly to replace, the most feasible way to conservation indoor water is by replacing older toilets, showerheads, and faucets with new low flow/low volume alternatives. Approximately 21,000 housing units in Lea County were built prior to 1980. Assuming 90% of these households have older toilets, an average household population of 3 people, 6 flushes per capita per day, and an excess flush (greater than 1.6 gallons) of 6.4 gallons, approximately 2.2 million gallons of water could be conserved per day by retrofitting with low flow toilets. This volume of water is equivalent to 6.8 acre-feet per day, or approximately 2,500 acre-feet per year. A conservation plan for replacement of older toilets could result in significant water savings within a year of implementation, but the full benefit will only be realized over time - as homes exchange hands or are remodeled. This type of conservation plan is best implemented with some type of user incentive, such as matching funds or rebates applied to customer water bills. Lea County governments should aggressively seek federal dollars for programs that encourage conservation. Several communities in New Mexico similar to those in Lea County have been very successful in obtaining federal funds for conservation programs.

Large Users

Many municipalities have devised strategies and established/installed programs to promote conservation amongst large water users, including water use auditing and reuse infrastructure. Cities in low rainfall areas have established programs that create conservation incentives for large water users. One of these programs, water audits, examines a facility to find ways to conserve water without substantially changing the facility's processes and without reductions to production efficiency.

A common large user of water for any community is the parks and recreation department. Methods of conservation for recreation facilities include adjusting watering rates, times, and intervals and changing the variety of trees, shrubs, and turf. Another method used to conserve water is to provide infrastructure so that wastewater treatment plant effluent can be used for irrigation at golf courses and parks, thereby allowing large amounts of fresh water to be conserved.

With few exceptions, water user fees in Lea County do not promote conservation and water use audits of large users are not performed. Special inclining-block rates can be set to meet the needs of commercial and industrial users and at the same time promote water conservation. If water fees are based on an inclining-block rate structure, the increased proceeds could be used to offset the cost of water audits, reuse and disinfection facilities, and improved metering. There is no current estimate of water use by large users in Lea County. However, water savings of approximately 5 to 20% of total use for appropriate categories have been achieved with similar "Large User" programs at other locations within New Mexico.

8.1.2 Water Development

[7] The Southern Public Service Company (SPS) sponsored a recent indoor water use conservation program in southeastern New Mexico and West Texas. Owners of electric water heaters were offered kits containing low flow showerheads and low flow kitchen and bathroom faucet aerators. A spokesman reported that approximately 36,000 kits were sent out to SPS customers but the number sent to Lea County was unknown. This type of program increases public awareness and allows for greater acceptance of additional programs.

Lea County's existing ground-water sources include the four UWBs: Lea County, Capitan, Carlsbad, and Jal. The primary water deposits in these basins include the Ogallala Aquifer, the Capitan Aquifer, the Santa Rosa Aquifer and the Alluvial Aquifer. Each of these sources will continue to be used in the future. Methods which can be used to increase future supplies may include piping water to Lea County, developing aquifers that are currently not used, offsetting withdrawals through aquifer storage and recovery (ASR) projects, and increasing precipitation through cloud seeding. Water stored in portions of the undeclared basin north of Tatum may also be tapped. Water saved through conservation measures, while originating in existing water sources, can be considered a new water supply, but conservation is addressed separately in Section 8.1.1 of this Plan. Surface supplies of a size large enough to provide water for distribution cannot be developed by traditional methods. However, increasing precipitation through cloud seeding is been proven to be a means of increasing water supply in arid agricultural areas.

8.1.2.1 Development of Deep Aquifers

While the Ogallala is the primary aquifer in Lea County, there exist several others that could produce quality water with some effort. One of these is the Santa Rosa, located under the Ogallala. The Dockum Group, Rustler, and Capitan Reef are other aquifers that may provide a new water source in the Lea County. In particular, areas where faulting may have fractured the rocks and increased the effective porosity of these aquifers should be investigated. Wells at these locations may prove more productive and sustainable. The Dockum Group aquifer has the potential to provide adequate quantities of water to wells for domestic and stock uses, even in areas where it is essentially unfractured. The Dockum Group, Rustler, Capitan Reef, and other deep aquifers in Lea County will need to be characterized in more detail, before the feasibility of using these deposits can be know and before large-scale water production can begin; oil company drilling records can provide much of the needed information. Costs to recover water from deep aquifers will depend on the production available from each well and the pumping level. Exploration costs to drill and complete wells in deep aquifers may range from $50 to $60 per foot

8.1.2.2 Treatment of Lower Quality Water

Lea County has two significant sources of lower quality water. These are produced waters associated with oil and natural gas deposits and aquifers high in saline. Produced waters in Lea County are generally high in hydrocarbons and other solubles. Poor quality water usually contains high amounts of total dissolved solids (TDS): Most dissolved solids are ionic compounds called salts. While salts vary in chemical composition, they act the similarly and have the much the same affects when dissolved in water. In Lea County large quantities of saline water occur in both the Rustler and Capitan aquifers. These waters can be used in place of higher quality water for activities with low sensitivity. If the quality of these waters can be increased sufficiently, they can meet a variety of other needs.

For instance, produced or saline water could be supplied to non-potable users serviced by the City of Carlsbad's Double Eagle System. Large amounts of high quality water from the Double Eagle are now used to re-pressurize deep, saline oil-production zones.[8] Once the water is injected into these oil zones it becomes contaminated. If produced water or saline water could be used for oil pressurization instead of Double Eagle water, then the quality water would remain available for more sensitive uses. Incentives may be given to encourage Double Eagle or petroleum companies to drill deeper wells into saline aquifers. Alternately, the County may drill wells and supply water to Double Eagle or may compete for the system's customers.

Desalinization refers to reducing the TDS concentration of water. Desalination of poor quality water is commonly practiced throughout the world and is becoming more widespread in the U.S., particularly in Florida and California. Alamogordo, New Mexico is considering such a program to provide for future needs. In 1998 there were over 10,000

[8] NMOSE records tabulated by Miller (1994) indicate that of the 38 water-supply wells used for secondary recovery of oil in the Capitan UWA, 17 produced water containing potable levels of chloride. Many of the 21 others have chloride concentration of less than 500 ml/l. The wells are primarily located immediately east of Eunice and south of Eunice along Monument Draw and Cheyenne Draw.

desalination plants worldwide with more than 80% of them treating brackish water, not seawater. The Rustler and Capitan aquifers store large quantities of high TDS water that, without treatment, will continue to have limited uses.

8.1.2.3 Importing Water

Occasionally, it has been proposed to pipe water to Lea County from Ute Reservoir or from the Pecos River. Recently, a project called the La Mesa Pipeline[9] (which is intended to convey water from the Ogallala, north of Amarillo, Texas to El Paso – passing near or through Lea County) has been posed as a water importing opportunity. It is possible that these waters could be injected into the Ogallala Aquifer in areas experiencing the greatest drawdowns. However, pipeline projects, by their nature, are very expensive. The quantity of water still available (or unclaimed) from Ute Reservoir is limited and treatment will be required prior to potable use. Treating the water will add to its cost. To acquire rights to Ute water a beneficial use needs to be identified and the NMOSE does not recognize the storage of water in an aquifer as a beneficial use. The La Mesa Pipeline is still seeking financial backing and regulatory permitting, but the quality is excellent and little treatment would be required.

8.1.2.4 Aquifer Recharge

Aquifer recharge refers to taking water from the surface and injecting it into an aquifer for storage. The water may be withdrawn at a later time for irrigation, municipal, or other use. Storing water in an aquifer allows for a vast quantity of water to be deposited without evaporation losses or the construction of surface lakes or tanks. Aquifer recharge is being performed in neighboring states to limit water-table declines, replenish areas where declines have been severe, and to increase supplies. Potential sources of recharge water in Lea County include, treated wastewater streams and storm runoff. Treated municipal wastewater could be re-injected up-gradient of well fields to reduce ground-water drawdowns and infiltration galleries can be installed to help detained storm water or runoff in drainages percolate into the Ogallala or other aquifers.[10] Imported water from outside the County can be injected, and --while expensive-- poor quality water found in various shallow formations in Lea County, can be pumped to the surface, desalinized, and injected into source aquifers.

If 50% of the average annual rainfall (about 8 of the 16 inches) in the Lea County UWB was collected and stored in the Ogallala Aquifer, approximately 0.7 feet of water per acre of surface collection area could be added to the aquifer annually. Under this scenario, a series of surface collection areas totaling 18 square miles could recharge about one-half of the 1998 Public Water Supply use in Lea County. Aquifer recharge in the Lea County UWB from runoff collection will most likely occur in existing or constructed storm channels and be placed into the Ogallala Aquifer via infiltration wells which penetrate the overlying caprock. Recharge would have to be carefully executed to ensure that local users would reap the benefit of the efforts of the recharge and not the users of the aquifer in distant areas.

8.1.2.5 Cloud Seeding

Cloud seeding is the process of stimulating clouds to enhance rainfall. Since 1971 cloud seeding has been used in portions of Texas to augment runoff to its reservoirs.[11] Cloud seeding experiments in the Big Spring area of Texas indicated that silver iodide more than doubled the amount of rain, the seeded clouds lived 36 percent longer, and the rain fell over an area 43 percent larger than clouds that were not.[12] Experimental cloud seeding in Thailand and Cuba also had positive results with precipitation increases of 27 and 65 percent, respectively.[13] Because of Lea County's caprock formation, little natural recharge may occur from cloud seeding, but the additional precipitation would reduce the need for pumping ground water for irrigation. In addition, aquifer recharge areas can be developed

[9] Mesa Water, Inc., 8117 Preston Road, Suite 260W, Dallas, TX 75225, (214)265-4165, FAX (214)750-9773
[10] Environmental concerns regarding potential changes to habitat sometimes need to be addressed, when natural drainage patterns are altered.
[11] Bomar (1997)
[12] Bomar (1997)
[13] Bomar (1997)

along drainage ways and playas to capture the runoff and infiltrate it into the underlying aquifers. The High Plains Underground Water Conservation District No. 1 in Western Texas,[14] operates a successful cloud seeding program. Several New Mexico Counties already participate in this program (i.e. Quay, Curry, & Roosevelt). Lea County will explore the possibility of working with the High Plains District to expand its program to cover Lea County. The cost for Lea County's participation is estimated to be $40,000 (or 10 cents per acre), based on what the current New Mexico participants are paying.

8.1.3 Water Management

In order to preserve the area's water supply and –thereby– the residents quality of life, Lea County water users will take an active roll in managing their remaining ground water resources, especially in the Lea County UWB. The available water in Lea County will not be able to sustain the current withdrawal rates indefinitely. If in the future withdrawal rates increase, as projected by this Plan, the lives of the area's aquifers will be reduced even more quickly. Of particular concern is the pressure being placed on the Ogallala Aquifer by pumping in Texas and the possibility that Ogallala water may be piped out of the County. Proper management of the remaining water and the available water rights will allow the life of the aquifer to be extended or even preserved.

8.1.3.1 Interstate Alternatives

Along the Lea County-Texas Line, water in the Ogallala Aquifer is flowing from New Mexico into Texas. While Ogallala water has historically flowed into Texas, however, because of extensive pumping in Texas, the ground-water gradient from New Mexico into Texas has become more steep. Unlike the allocation of surface water use via interstate compacts, there is no agreement to coordinate the interstate use of ground water. It seems reasonable to assume that the same kind of equitability should be applied to the use of ground water along the State Line. Therefore, the creation of a Regional Management Plan with the neighboring counties in Texas (Cochran, Yoakum, Gaines, and Andrews), which details the future use of the remaining water in the Ogallala Aquifer, would be advantageous for Lea County and Texas. Cooperative regional management of the remaining Ogallala water will help extend the life of (or preserve) the aquifer and assure its future availability to both New Mexico and Texas. An interstate water management plan for the Ogallala Aquifer along the Lea County-Texas line is envisioned to be essentially a "good neighbor agreement" arrived at by mutual analysis of water use and its impacts on the Ogallala. A Regional Management Plan should include coordination on at least the following issues: well spacing along the line, distance of wells from the line, pumping rates and scheduling, and restricting use in large drawdown areas.

The LCWUA has already initiated this effort by attending several ground water resource meetings in Texas. Also, in combination with the New Mexico Interstate Stream Commission, the LCWUA has meet with representatives from the High Plains Groundwater Conservation District No.1 and the Texas Water Development Board. As a first step in interstate water management the LCWUA and the attending Texas interests have agreed to work towards better understanding the Ogallala by exchanging information. To date, the first seven chapters of this Plan have been provided to the Texas interests and many maps and reports issued by the High Plains District have been provided to the LCWUA.

8.1.3.2 State Involvement

The future demand for water, as predicted by this report, will drastically deplete Lea County's water supply. Even at demands of 40% less than those predicted herein, models show the Ogallala Aquifer will be completely dewatered in areas by the year 2040.[15] In response, the water users of Lea County (by this report and other steps) are preparing to take action to stop the depletion, especially in areas overlying the Ogallala. Since the Ogallala lies almost completely within the Lea County UWB, effective administration of the Basin by the NMOSE can contribute to the

[14] High Plains Underground Water District No. 1, 2930 Avenue Q, Lubbock, TX 79405-1499, (806)762-0181, FAX (806)762-1834
[15] Musharrafieh and Chudnoff (1999)

County's efforts. This Plan and subsequent water planning within the County will be based on predictions of future withdrawals from the Ogallala. These predicted withdrawals are based on currently held water rights and water diversions. The accuracy of these predictions and the ability of the County to plan for water usage will be impaired if additional water rights are attained in the Lea County UWB. To prevent the development of additional rights in the Lea County UWB, the NMOSE should immediately close the Basin to new appropriations.

8.1.3.3 County-Wide Programs

If the Lea County UWB is not closed, another issue of concern is created when a farmer (or other user) uses new more efficient application methods which causes less water to be used. The amount of water saved or artificially recharged by the farmer could be available for appropriation by new users. Closing the basin will allow the County to develop alternatives to increase supply and decrease demand, without having to be concerned about new appropriators developing water made available through conservation or diverting water added through artificial recharge projects. Basin closure will help extend the life of the aquifer, with the ultimate goal being to develop a sustainable supply. In addition to basin closure, the County should also consider passing ordinances discouraging exportation of appropriated water to users outside the county. Other municipalities have been successful in passing such ordinances and they have reported a significant reduction in exportation of their water.

The residents of Lea County have already initiated management of the County's water by the forming the LCWUA. The LCWUA will play a major role in future water management. However, the work required to manage water throughout the County will be extensive and continuous. In order to implement county-wide water management programs, it will be necessary for the LCWUA to have technical assistance. A few options to accomplish this include the following. Engineering consultants could be utilized much as they are now. The level of their involvement would depend on the funding available and could vary from year to year. Another option is a full-time technical employee. This person may be an employee of the LCWUA[16] or an employee of Lea County. A County employee could direct a Lea County Water Resources Department under the administration of the Lea County Manager and coordinate water management efforts between the many water-using entities within the County. Such entities will include municipalities who will likely wish to manage portions of any water management plan at their local level. Other local entities include domestic water systems and cooperatives, the local soil conservation district, and large water users and water using industry associations. Some of the water resource programs, which are anticipated to require management on a county-wide basis, are listed below.

<u>*Aquifer Monitoring*</u>

Measurement of ground water supplies can be performed by periodically recording depth to water in selected wells across the County. Since such a method may be sporadic and unreliable if left to individual well owners, implementation would be most effective if performed under a countywide program with trained personnel. This way the information would be more precisely and consistently measured, recorded, analyzed, and disseminated. Areas where ground-water declines are large should be monitored most often. Monitoring should include comprehensive geographical locating and water source (i.e. aquifer) referencing, perhaps with GIS computer software. If changes in water depth information are recorded correctly, updating numerical models to simulate and predict water-level changes can be performed more quickly, allowing changes to be made in the management of the aquifer, if necessary. Making information available on the fluctuations in ground water will help all parties in Lea County understand how the aquifers are responding to conservation efforts.

Water quality is also important to assess the amount of water resources available in the County. While measuring aquifer levels regular water samples can be taken and subsequently tested in a laboratory, or making field measurements of specific conductance, and other parameters. Such a sampling/testing program would describe the

[16] In which case, LCWUA's legal status will need to change.

aquifer's quality. The complete program to monitor aquifer storage and quality is more specifically described in TABLE 8-3.

Ground-Water Flow Modeling

Future ground water availability and saturated thickness of the aquifers in the Lea County can be estimated using the ground water flow model developed by the NMOSE.[17] Model simulation can be performed to assess different pumping scenarios and account for existing and potential wells in Texas and New Mexico, as well as the addition of water to the aquifer via artificial storage projects. The model will allow for informed management when deciding where ground water development should be increased or decreased in order to make the supply sustainable.

Well Inventorying & Sealing

By constructing an inventory of producing and abandoned water and oil wells across Lea County many instances of aquifer contamination can be avoided. Abandoned wells need to be plugged because their completions may be poor. Deeper wells with poor completions can allow high-head, poor-quality water to discharge into overlying aquifers of high quality water. A plugging and abandonment program will reduce the mixing of water between aquifers. The goal of a well plugging program is to prevent contamination and restore, as far as possible, the aquifer to original hydrogeologic conditions. A well inventory can recorded wells with latitude and longitude locations in a GIS format to help geographically identify possible sources when contamination is detected. A well inventory in GIS format will also facilitate the Aquifer Monitoring and Ground-Water Flow Monitoring programs as described above.

Irrigation Efficiency

Several County-wide programs can help conserve irrigation water. Any program to make irrigation more efficient will need to be coordinated with the Lea County Soil Conservation District, because the District has already developed channels of communication and rapport within the area's irrigation industry. A program to find and disseminate funding to farmers for changing center-pivot sprinklers to LEPA systems will be important. Monitoring soil moisture throughout the County and reporting the data to farmers so they can adjust their irrigation rates will also be important. In addition, information on the most recent methods for efficient irrigation and drought-resistant crops need to continue to be made available.

Public Information/Education

A public awareness program can inform the public of the need and methods for water management and conservation. The program will need to include public information announcements for various conservation programs, soil moisture reports, and suggested irrigation frequencies. The program should be organized in such a way that facilitates individual water management and conservation plans for the towns and cities located within Lea County.

8.1.3.4 Municipal Management

Fundamental municipal water management practices include accurate measurement of water use and water supplies, and establishing water rates to pay for system maintenance. Progressive water management will occur when individual water systems take responsibility for not only obtaining and supplying water, but for making sure it is efficiently used as well. The water use audit that this plan advocates will be the first step the municipalities can take in better tracking the water consumption in Lea County. Conservation measures such as inclining-block rate

[17] Musharrafieh and Chudnoff (1999)

structures and elimination of leaks in distribution systems are often managed best by each municipality or water association. In addition, effluent reuse is best administered by each treatment facility.

Water Pricing

While inclining-block rate structures have shown to be one of the best means to conserve water, it will be up to each municipality to determine what those rates are. An inclining-block rate structure, as well as an accompanying water system audit, is discussed in Section 8.1.1.2 above.

Reducing System Losses

Infrastructure maintenance and operation, which must be performed by local water systems, can also be important conservation programs. Water systems need to monitor quantities of water pumped verses quantities of water metered (at the point of use) and look for areas that have high discrepancies between the two. Differences between what's pumped and what's used indicate leaking distribution lines or fittings. Areas where leaky lines are known or suspected should be repaired or replaced. In addition, some systems have reported leaking storage tanks and high (>250 gpd) per capita water use. High per capita water use can indicate inadequate metering. Many municipal water systems in Lea County have recently performed major upgrades/repairs or are planning such improvements. Close contact between the various water systems in Lea County and municipal personnel will be maintained in order to compare quantities of per capita water use and the effectiveness of different water conservation measures. In addition, Lea County communities can work together to obtain utility upgrade funding grants that are available from state and federal agencies.

Wastewater Reuse

There are six WWTPs in Lea County that serve over 500 people each. Combined they serve a population of about 55,000 and produce somewhere between 6,000 to 7,000 acre-feet of effluent per year. If this effluent can be used to replace high quality water, currently used for irrigation, the high quality water can be saved. About 5,500 acre-feet of municipal wastewater effluent in Lea County is now being used for non-edible crop irrigation, so reuse is not a new idea to residents. However, to deliver effluent to places of application, pumps and pipelines are usually required. In addition, before effluent can be used on golf courses or parks, or any other place with public access, it must be disinfected. Maintenance and operation must be performed on pumps and disinfection facilities. Communities will need to alter their staffing and budgets to provide manpower and money. Several communities in New Mexico make use of readily available federal dollars for these types of expenses. If the remaining effluent and any new effluent were diverted to irrigation uses an additional 1,500 acre-feet of high quality water will be saved per year.

TABLE 8-3: WATER MONITORING PROGRAM

The following is a plan to monitor ground-water levels and ground-water quality throughout the Lea County UWB. The County may eventually expand the monitoring program to cover other UWAs of concern.

Water Level Monitoring		
1.) To allow for comparisons with historical data, the monitoring program should initially focus on all wells that have been used for monitoring by the USGS. Monitoring can be expanded to include other wells, based on need for data. 2.) Forms should be developed that allow for the consistent recording of data in the field. The data should be maintained in a computer spreadsheet so it will be available for analysis and modeling. 3.) To allow the aquifer time to stabilize after irrigation season, water-level measurements should be made in the months of December and January. 4.) A ground-water level monitoring program could be implemented for peak periods during the irrigation season. However, the monitoring well network cannot include wells that are being used for irrigation or wells within irrigation well cone-of-depressions.		
Water Quality Monitoring		
1.) Water-quality monitoring should be performed during the irrigation season, because purging will not be required if the wells are regularly in use. 2.) When collecting ground-water samples for water quality analysis from inactive wells, make sure that at least three well volumes of water are purged from the well prior to collection. A well volume is the quantity of water stored in the casing from the water table to the total well depth		
Background Well Data	**Water-Level Monitoring Data**	**Water-Quality Monitoring Data**
• verify or record location (latitude and longitude) of each well using a Global Positioning System (GPS) • use a GPS to determine the measuring point elevation to the nearest 1 foot, or 0.1 foot if possible • record the elevation of the land surface adjacent to the well, by measuring to the nearest 0.1 foot below the measuring point elevation • describe the precise location at each well from which the depth to water will be measured during each monitoring event • research well completion data for each well: include date drilled, total depth, casing size, and screened interval	• use a calibrated instrument (well sounder) to measure the non-pumping depth to water to the nearest 0.1 foot below the designated measuring point[a] • subtract the depth to water from the measuring point elevation to obtain the elevation of the water surface • record any changes to the measuring point elevation, if applicable, and provide new elevation if necessary • monitoring of all wells should be performed within a relatively short period of time (1 to 3 weeks) • record the time the year, month, day, and time each measurement is made	• calibrate pH and specific conductance meters at the beginning of each day • purge (pump) three well volumes from the well, if the well is not already in use • use a one-liter beaker to collect the water sample (make sure the beaker is clean, and rinse it several times with the water from the well to be sampled) • measure and record pH, specific conductance, and temperature[b] • include visual observation of water color and sediment content (i.e. hazy, clear, cloudy) • record the time the year, month, day, and time each measurement is made

[a]The cost for a good well sounder, calibrated in 0.01 foot increments, ranges from $600 to $1,000.

[b]Field-grade Specific Conductance and pH meters cost from $350 to $500 and from $400 to $600 respectively. Temperature can be measured with a good $35 thermometer or a $115 thermocouple.

8.2 ALTERNATIVE EVALUATIONS

8.2.1 Conservation Alternatives

Because of their similarity, the conservation alternatives for irrigated agriculture and municipal and industrial use are evaluated together below. Their evaluations are summarized individually in TABLE 8-4.

Technical Feasibility

Whether it be for irrigated agriculture, urban landscaping, indoor residential use, or large water users, the conservation alternatives discussed in this Plan are non-complicated, technically feasible steps that have the potential to save large amounts of water.

Political Feasibility

Political resistance to new initiatives is often directly related to the inconvenience residents feel or anticipate from a program. The inconvenience felt by most Lea County residents will be small for many of the conservation programs with the highest returns, such as such as those for irrigation and large users. Careful education and aggressive funding incentives will help to make such initiatives feasible not only to urban/suburban residents, but to farmers and large water using business owners as well.

Social And Cultural Impacts

The replacement of high water consuming landscaping with low water vegetation can have an unpleasant aesthetic impact on some residents. Many inhabitants of the western United States have come to associate green, lush landscaping with affluence and a high quality of living. However, if care is taken when designing and placing new landscaping, particularly at public facilities, people will see and appreciate the beauty and tastefulness that can be embodied in southwestern landscaping.

Conflicts can occur when some users spend time and expenses to implement conservation methods, while their neighbor(s) does not.

Financial Feasibility

In the long run most all conservation methods are financially feasible, because future savings in pumping energy and water supply longevity offset initial costs. Aggressively seeking funding and finding innovative ways to finance or subsidize conservation investments can help to reduce the impact of initial costs. For instance, tax rebates or cash-back programs for installing LEPA systems or for changing out high water using appliances and residential water fixtures can lesson the financial blow. The public must be educated and informed about the financial assistance available for conservation programs to be effective.

Implementation Schedule

Conservation measures can be implemented over a range of intervals. LEPA conversions, dryland-cropping changes, landscaping irrigation changes, water pricing structures and residential water fixture/appliance replacements can be planned and initiated within several years of acceptance of a water management plan. The programs setup to facilitate these occurrences will need to be actively pursued for many years, as changes in use will take time to occur. Other programs such as public education, moisture monitoring and irrigation frequency announcements will need to be a permanent fixture in the lives of Lea County residents.

Physical, Hydrological, and Environmental Impacts

Reducing the amount of water used for irrigation will reduce the quantity of return flow. As a 35% reduction in water use may be obtained through the use of LEPA systems, and as the application of excess water will be minimized through irrigation modifications based on soil moisture monitoring, it is conceivable that the return flow from agricultural irrigation could be reduced by more than 35%. However - instead of being pumped and returned to the aquifer, this water (the reduced return flow amount) will simply remain stored in the aquifer because it was never pumped in the first place.

TABLE 8-4: EVALUATION OF WATER CONSERVATION ALTERNATIVES

Entity	Technical Feasibility	Political Feasibility	Adverse Social and Cultural Impacts	Financial Feasibility	Suggested Implementation Schedule (year)	Adverse Physical, Hydrological, and Environmental Impacts
Irrigated Agriculture	Good - non-complicated, technically feasible	Good – potential energy savings will act as an incentive	Low – no impact expected	Fair - Costs to change to LEPA can be prohibitive to some	2002 - planning period in initial year, pilot programs may be required	Low - none expected
Urban/ Suburban Landscaping	Good - non-complicated, technically feasible	Fair – conservation measures can cause inconvenience for users	Medium – southwestern landscaping is not aesthetically pleasing to some people	Good - cost to change watering system is moderate, cost to change landscaping is moderate	2002 - planning period should identify priority areas	Low - none expected
Residential	Good - non-complicated, technically feasible	Fair – conservation measures can cause inconvenience for users	Medium – low water flow can cause inconvenience for users	Good - costs are low and can be funded	2002 - educational programs in year 2001 can precede implementation	Low - none expected
Large Users	Good – can be complicated, technically feasible	Good - potential savings in cost and energy will act as an incentive	Low – no to little impact expected	Fair - depending on scale required, impact to overhead costs can be phased	2003 to 2005 - audits conducted in 2002	Low - none expected

8.2.2 Development Alternatives

The alternatives dealing with increased water supply (saline aquifers, importing water, aquifer recharge, deep aquifers, and cloud seeding) are discussed separately below, because of their uniqueness. Their evaluations are summarized in TABLE 8-5.

8.2.2.1 Deep Aquifers

Technical Feasibility

Development of deep aquifers, such as the Dockum Group and Capitan Reef aquifers, is technically feasible through the use of common drilling techniques. Some hydrogeological investigation will be required, however, as little is known about these aquifers. For instance, there is conflicting data on the yields that can be expected.

Political Feasibility

Since the Dockum Group is not developed, the political problems associated with its use are believed to be few. However, there are some indications that areas of the aquifer may have been contaminated. Political issues could arise if development of the aquifer is hindered due to contamination by the oil and gas or other industries.

Social And Cultural Impacts

Social and cultural impacts associated with the development of this aquifer should be positive, as it could improve the longevity of other water sources in Lea County.

Financial Feasibility

Since wells may have to be drilled to over 700 feet, the cost of developing deep aquifers will be more expensive than the Ogallala. While this depth is greater than most current wells in Lea County, the cost is still much cheaper than a few of the alternatives that will be mentioned later. While data indicates that the water quality of the Dockum Group is good, if treatment is required it will lessen the financial feasibility of this option.

Implementation Schedule

In order to determine the potential for future development of the Dockum Aquifer pilot studies at several locations should begin in the next 5 years. If pilot studies indicate that development will be beneficial, the observed depletion rates of the Ogallala could determine an implementation schedule.

Physical, Hydrological, and Environmental Impacts

Physical impacts caused by development of the Dockum Aquifer will most likely be limited to areas of well and pipeline installations. A hydrological impact that could occur is drawdown of the Ogallala Aquifer in areas where the two aquifers are connected. This effect can be observed by monitoring the Ogallala in areas of Dockum development. Environmental impacts that might occur include mobilization of existing contamination in the aquifer, if it exists.

8.2.2.2 Treatment of Lower Quality Water

Technical Feasibility

The technology for drilling wells into deep saline water deposits has been around for many years and is commonly used. Wells could also be dug into deposits known to be contaminated with hydrocarbons and other solubles. Care must be taken that the wells are completed properly so that mixing of water between different aquifers does not occur by short-circuiting through the well annulus. A pilot project is proposed early on to determine the technical feasibility of treating produced waters.

Desalinization processes are an established and well-used technology. Many pre-packaged plants are sold pre-assembled or with minor assembly are available for small to medium flow rates.

Political Feasibility

Because of the extra costs involved, oil and gas companies may resist initiatives to use lower quality aquifers for secondary oil recovery water. However, transitioning to lower quality water sources would give the companies good public exposure.

Since Lea County would like to ensure that all the high quality waters in the County are used for appropriate purposes, an agreement may be required between the LCWUA and end users regarding the exchange of water from within the County.

Social And Cultural Impacts

The use of lower quality water for non-potable uses will have no impact on social or cultural aspects of the lives of Lea County residents. However, lower quality water may have unpleasant tastes and odors when compared to the "sweet" waters of the Ogallala.

Financial Feasibility

Wells that go deeper are more expensive, but with the oil and gas industry and its associated deep drilling ability already present in Lea County, prices for drilling deep wells will be much more reasonable than for most other locations. Actual costs will vary depending on location and depth.

Water desalinization is expensive. Current costs for desalination plants range from $300K for 25,000 gpd (28 ac-ft/yr) to $20 million for a 10 mgpd (11,200 ac-ft/yr) Los Angeles built a $15.5 million plant and raised household bills from $11/month to $29 a month. In St. Petersburg, Florida the $20 million plant producing 10 mgpd is expected to cost users about $5 per 1000 gal. (The original estimate was $1.50 per 1000 gal.).

Implementation Schedule

A state funded pilot project will determine the feasibility and possible implementation of the treatment of produced waters.

Physical, Hydrological, and Environmental Impacts

Installation of new wells could result in some short-term physical and environmental impact.

The waste brine will have to be disposed from a desalination plant. Deep well injection of brine is a common alternative, although lined evaporative and disposal pits or landfills may be more cost effective.

Hydrologically, the extent of groundwater depletions in the area of secondary recovery of oil would subside or cease to exist. Reduction in use by the Double Eagle system would reduce the rate of groundwater decline in the system's well field area. However, installation of an adjoining or competitive system would likely cause some short-term environmental impacts during system construction.

8.2.2.3 Importing Water

Technical Feasibility

It is technically feasible to pipe water to Lea County from an outside source, such as the Ute Reservoir or the Pecos River; however, appropriations are not available from either of locations. There are few appropriations available from other UWAs outside of Lea County.

Political Feasibility

Piping water to Lea County from outside sources will be politically difficult, as depleting water tables throughout New Mexico has made water a sensitive public and legal issue. Attempts to move water from one area to another have typically met with strong opposition.

Social And Cultural Impacts

No direct social or economic impacts are foreseen. However, such a project could cause indirect social impacts as the economic gain from additional water in one area may result in an economic loss where the water supply is decreased.

Financial Feasibility

The costs for such a project are very high and would require outside funding. Costs have been estimated to be $4 to $6 for every 1000 gallons. Environmental impacts studies for similar projects have approached $1 million alone.

Implementation Schedule

Piping water on a large scale will take many years of planning and funding preparation.

Physical, Hydrological, and Environmental Impacts

Physical impacts of such a project would most likely be limited to construction phase of an underground pipeline. Hydrological impact would occur to the area from which water would be withdrawn. Environmental impacts would most likely occur during the construction phase and might require mitigation.

8.2.2.4 Aquifer Recharge

Technical Feasibility

Increasing available water supply through aquifer recharge is widespread throughout the southwestern United States. El Paso, Texas and Tucson, Arizona are now injecting treated wastewater into their aquifer supply. If recharge is performed with wastewater, care needs to be taken to assure the water has been treated well, including removal of any pathogenic organisms or viruses. Chemical compatibility between water in the aquifer and reclaimed effluent is also a concern. Wastewater treating technology is common, well understood, and widely used. For either wastewater or stormwater, the major problem that occurs is clogging the subsurface soil surrounding injection wells with fines that settle/filter out of the injection water. A carefully engineered system must be used to avoid this problem. Proper operation and maintenance of the system is required to keep the system working. Since the average rainfall is 12 to 16 inches throughout the county and there are large expanses of vacant land at locations where the aquifer is within 200 feet of the land surface, storm water recharge seems particularly feasible. Storm recharge areas can be large or small scale and should be sited in areas of natural runoff or accumulation and, ideally, near high water use areas, such as irrigated farmland and municipal well fields.

Political Feasibility

Public fear of contagious disease may hinder recharge with wastewater. If this occurs as an obstacle, public education can be used to ease concerns. Coordination with landowners is the only political obstacle foreseen for recharge from storm water.

Social And Cultural Impacts

No significant social or cultural impacts are anticipated.

Financial Feasibility

The construction cost of an unlined system that could capture and recharge 40 ac-ft/yr is about $250,000. This system would use 4 injection wells and a 200-gpm-injection pump with filter system. The use of a 40-acre gravity system will have decreased recharge ability, due to evaporation losses, and will cost about $180,000 to construct.

Implementation Schedule

A 5 to 10 acre pilot study project could be implemented. If this were to occur in the next two years, then 24 months of data could be obtained and made available for full-scale design by the year 2005. Land/right-of-way acquisition, design, and construction can be performed within 18 to 24 months.

Physical, Hydrological, and Environmental Impacts

Loss of habitat and environmental concerns should be studied prior to siting recharge areas. Recharge should be studied to assure that the existing water quality of the aquifer and recharge area is not adversely impacted.

8.2.2.5 *Cloud Seeding*

Technical Feasibility

Cloud seeding weather modifications have been performed in parts of the U.S. for over 30 years. Many western states currently have active programs. Roosevelt, Curry, and Quay Counties, New Mexico have been part of the Texas High Plains Underground Water Conservation District No. 1 precipitation enhancement program since 1997. Although it is difficult to fully identify and measure the effects of cloud seeding programs, most report positive results.

Political Feasibility

Political opposition may be generated if it is felt that precipitation is being taken from one area and given to another. If cloud seeding is performed according to specific regulations, as is the case in Texas and many other states, the political feasibility is greatly increased. Texas considers the recent expansion of the cloud seeding into the three previously referenced New Mexico counties as a benefit to farms located in Texas near the border with New Mexico.

TABLE 8-5: EVALUATION OF WATER DEVELOPMENT ALTERNATIVES

Alternative	Technical Feasibility	Political Feasibility	Adverse Social and Cultural Impacts	Financial Feasibility	Suggested Implementation Schedule (year)	Adverse Physical, Hydrological and Environment Impacts
Development of Deep Aquifers	Good - deep drilling is commonplace in Lea County	Good - would be a benefit to those served	Low - none expected	Good - costs for deep well drilling in Lea County are competitive	Pilot Study (2001) - a pilot study should prove effectiveness for future program	Low - impacts not expected
Treatment of Lower Quality Waters	Good - used extensively throughout the world	Good - no adverse responses to this topic during public meetings	Medium - taste and odor of public supply would change and some might find objectionable	Poor - small scale desalination plants are affordable, large scale systems may be cost prohibitive	Pilot study (2001) – results of pilot study to determine costs in order to determine feasibility of future programs.	Medium – brine from process must be disposed. Specific hydrologic effects of pumping saline aquifers are not known.
Importing Water	Good - pipeline transport is common	Poor - impacts the area from which water is taken	High - transporting water from an area can impact its socioeconomic outlook	Poor - costs exceed the capability of Lea County, outside funding required	Long-term, a lot of planning, funding, and construction required.	High - impacts would occur as result of pipeline construction.
Aquifer Recharge	Good - properly engineered systems are used throughout the U.S.	Good - would be a benefit to all areas served	Low - use of precipitation is much less objectionable than treated wastewater	Good - small to medium scale projects are affordable	Pilot study (2003) - a pilot study should prove effectiveness for future program	Medium - landforms would be altered for collection areas.
Cloud Seeding	Good - most western states have had active plans for a number of years	Good - Texas has been seeding for 30 years, all farming areas in LCUWA should be included	Medium - some view cloud seeding as un-natural or water robbing.	Fair to Good – participation in Texas High Plain program is affordable. Implementation of new program is cost prohibitive.	2002 - The Texas High Plain program should first be contacted regarding the potential for Lea County to become a participant	Medium - increased precipitation can cause damaging runoff in unprotected areas.

Social And Cultural Impacts

Opponents to cloud seeding may arise due to philosophical issues of altering natural weather patterns.

Financial Feasibility

Curry, Roosevelt, and Quay counties pay a percentage of the cost of the Texas program based on the number of acres each has in the whole target area. If Lea County were to target 400,000 acres for clouding seeding and was able to enter the Texas-based program, the Lea County target area would comprise approximately 4 percent of the total Texas program target area. At an estimated $1 million cost per season for the entire cloud seeding program, the cost to Lea County would be $40,000 per year or $0.10 per acre. If Lea County were required to start its own program the costs would likely be too high to implement. Funding for the program in the other referenced New Mexico counties is through the Soil Conservation Service. Funding may also be available for Lea County.

Implementation Schedule

The Texas High Plains Underground Water Conservation District No. 1 precipitation enhancement program should be contacted during 2001 to determine if Lea County could become a member of the program. It is possible that Lea County could be part of a precipitation program as early as year 2002.

Physical, Hydrological, and Environmental Impacts

Potential impacts include flooding and silver iodide residues; however, a properly regulated and managed program will minimize the potential for either of these impacts to occur.

8.2.3 Management Alternatives

Probably the most important role to be played by water resource management in Lea County will be the securing of funding for the required programs and initiatives. Support will be available from state and federal agencies, but the County - and the municipalities, businesses, and people of Lea County must pay for a large portion. Each layer of management is discussed separately. Evaluations of the management alternatives are summarized in TABLE 8-8.

8.2.3.1 Interstate Alternatives

Technical Feasibility

There is no technical reason why interstate management of the Ogallala cannot take place. It would be beneficial to both Lea County and adjoining Texas counties if ground-water information were shared. Cooperation between all entities would produce the best results.

Political Feasibility

Arranging for an interstate compact is complicated and time consuming. Many people need to be involved, including politicians, engineers/hydrogeologists, bureaucrats, and lawyers. Many issues have the potential to create roadblocks. Still more benefits than impacts are available – even for Texas.

Social And Cultural Impacts

No social or cultural impacts are known.

Financial Feasibility

Since Texas pumps more water than New Mexico, the largest financial impact will be in Texas. However, technical and legal consultants will need to be employed and County staff will need to commit considerable resources.

Implementation Schedule

Planning for interstate discussion can begin immediately.

Physical, Hydrological, and Environmental Impacts

No negative impacts are foreseen.

8.2.3.2 State Involvement

Technical Feasibility

The State has been pro-active in creating models of known aquifers in Lea County.

Political Feasibility

This 40-Year Water Plan in being prepared in response to State recommendations. State agencies are very eager for municipalities to become more active in conserving water.

Social and Cultural Impacts

No social or cultural impacts are foreseen.

Financial Feasibility

The Interstate Stream Commission and the State Engineer have appropriated funds for Plans such as this one and other programs to encourage water conservation.

Implementation Schedule

Approval of this Plan is anticipated to occur later this year.

Physical, Hydrological, and Environmental Impacts

No Impacts are foreseen.

8.2.3.3 County Management

The LCWUA, or Lea County itself, is ideal to implement and oversee a water use management program for the County. Personnel, either consultants or county staff, will be required to address future water issues and implement the program, including (but not limited to) conservation practices, aquifer monitoring, testing for water quality, soil moisture and drought monitoring, and implementing drought contingency plans.

Technical Feasibility

There will be technical obstacles to overcome in piecing together a County-wide management program, such as making sure collected data is in a format that can be used by hydraulic and geographic computer software. However, all of the technology required is used and proven.

Political Feasibility

The biggest political problem will likely occur if propositions for increasing taxes to raise needed money are made. For other issues, the LCWUA consists of representatives from most all water resource stakeholders in Lea County, so communication pathways are established if political conflicts should arise within the County. Further, incentive is given to all segments of the County's business and civic enterprises to cooperate towards water resource goals, because they all will benefit from dependable long-term water supplies. Together the County and the LCWUA have the tools required to pull together the area's varied political and business interests to achieve effective water management.

Social And Cultural Impacts

Water management and conservation can foster a wide variety of reactionary attitudes within the populace affected. This can be especially true in rural areas. It will be more difficult to get education and public information programs to the rural parts of Lea County than it will be to get those same programs to residents of municipalities or members of water cooperatives. Keeping the rural population informed and educated will likely fall to the County/LCWUA.

Financial Feasibility

Costs to staff a fulltime water resources department are substantial and recurring. Some of the items include salary ($35-45K), transportation, office space, office equipment, laboratory space and equipment or independent laboratory fees, and tools. These costs can be shared by all in Lea County through the use of water bill surcharges, property taxes, or sales taxes, to name a few.

Implementation Schedule

A ground-water data collection program can be implemented within the first year of plan approval, but it may take 3 to five years to develop a sufficient well network. Ground-water flow modeling should be implemented within 2 years after a preliminary well network is arranged.

Physical, Hydrological, and Environmental Impacts

Hydrologically, a better understanding of the Lea County aquifers will result from this alternative. Information obtained will greatly increase the ability of hydrogeologists/engineers to assess the sustainability of water supplies in Lea County.

Management and conservation measures afforded by a County staff person(s) are expected to decrease the rate at which aquifers in Lea County are depleting. Environmental impacts are unclear, but a technical staff person will be able to perform/coordinate their identification and mitigation if necessary.

8.2.3.4 *Municipal*

Technical Feasibility

Reduction of municipal water use is very feasible, as illustrated by many cities in the U.S. over the last 10-15 years.[18] Water efficient fixtures and appliances are now commonly available and even required in many cases by federal law. Several cities across the southwest have also offered incentives for homeowners to remove high-water use landscaping and replace it with xeri-scaping. The challenge in Lea County is to get older established homeowners to make the effort to change out existing fixtures and established landscaping. The municipal water audits that will

[18] Maybe the best example is Tucson, Arizona.

occur in 2001 will help the LCWUA see where the water is being consumed and will be an invaluable tool in encouraging conservation.

Political Feasibility

Each community will face resistance to increasing prices of water. Large users who will be especially hard hit by an escalating Inclining-Block pricing scheme may be especially vocal. However, if all the municipal systems in Lea County set rates in a like manner price increases will appear fair.

Social And Cultural Impacts

No social or cultural impacts are expected.

Financial Feasibility

Methods of reducing municipal water use tend to be low cost alternatives. The more expensive programs may offer financial incentives to users, such as water bill reductions, so the city does not need to come up with cash in advance. The impact of water bill reductions needs to be figured into water rates when establishing a new Inclining-Block rate system. State and federal grants are available for education programs and a large amount of educational information is available free on the Internet.

Implementation Schedule

City specific analysis will need to be made before introducing many of the suggested alternatives. However, municipal waster use reduction programs should begin as soon as possible after they are planned. Once initiated, reductions can normally be measured within the first year of an implementing the programs.

Physical, Hydrological, and Environmental Impacts

Negative impacts are not foreseen.

TABLE 8-6: EVALUATION OF WATER MANAGEMENT ALTERNATIVES

Entity	Technical Feasibility	Political Feasibility	Adverse Social and Cultural Impacts	Financial Feasibility	Suggested Implementation Schedule (year)	Adverse Physical, Hydrological, and Environmental Impacts
Interstate	Good - Texas and New Mexico are both working towards the same goals, using the same technology	Fair - legal issues concerning water have occurred between New Mexico and Texas in the past. Local prejudices must be overcome.	Low - impacts to social and cultural groups are not expected.	Good - interaction between entities in Texas & New Mexico has occurred. Costs for future coordination should be low.	2002 - Meetings and planning should be conducted in 2001.	Low - none are expected
State	Good - The NMOSE has already prepared historic and future models of the LC-UWA	Good - The Regional Water Plan is being prepared in response to the ISC/NMOSE.	Low - impacts are not expected	Good - The ISC and NMOSE have a mandate and funding to be involved in such programs.	2001 - Approval of the Water Plan and closure of the LC-UWA are essential steps.	Low - none are expected
County	Good – Continued utilization of consultants or addition of an in-house technical professional will solidify the County's and the LCWUA's capabilities.	Good – Most local political interests are represented on the LCWUA.	Low - impacts are not expected	Fair – while Lea County/LCWUA are capable of supporting and soliciting funding, tax increases are never popular.	2001 - The acceptance and implementation of the Water Plan will be the County's first step to managing the County's water.	Low - none are expected
Municipal	Good - experienced staff and consultants serve Lea County municipalities.	Good - Lea County municipalities are small scale well operated entities.	Low – resistance will occur, but education will increase need awareness & gain support	Fair - Management programs will impact local budgets. Funding may best be provided at the county level.	2001 - Management at local levels can begin even before approval of the Water Plan.	Low - none are expected

8.3 SAMPLE IMPLEMENTATION SCHEDULE

Major tasks and timetable for the recommended plan is as follows. This schedule is provided as an example only. The LCWUB will determine actual implementation schedule. All capital projects implementation will depend on available funding.

Year	Task
2000	1) Final approval and acceptance of the 40-Year Water Plan.
2001	1) Prioritize alternatives and schedule implementation. 2) Assess and pursue funding for prioritized alternatives. 3) Perform municipal water usage audits. 4) Begin public awareness educational program. 5) Begin assessment of deep aquifer development. 6) Assess oil recovery water use in Lea County 7) Address ownership of manufactured water 8) Assess groundwater data collection and flow modeling program
2002	1) Assess municipal water conservation measures 2) Assess County Drought Management Plan 3) Start Water Plan implementation funding measures 4) Pursue entrance into existing cloud seeding program 5) Assess audit results and make recommendations. 6) Add possible technical staff.
2003	1) Implement municipal water conservation measures 2) Implement County Drought Management Plan 3) Plan best-method irrigation practices program 4) Start cloud seeding program if viable option in 2001 5) Plan alternatives for oil recovery water use in Lea County
2004	1) Pursue best-method irrigation program pilot studies 2) Plan precipitation collection and aquifer recharge pilot study 3) Pursue alternatives for oil recovery water use in Lea County
2005	1) Plan small-scale desalination plant. 2) Conduct additional best-method irrigation program pilot studies 3) Construct precipitation collection and aquifer recharge pilot study 4) Continue implementation of alternatives for oil recovery water use in Lea County
2006	1) Construct small-scale desalination plant with new well(s). 2) Begin precipitation collection and aquifer recharge pilot study

8.4 DROUGHT MANAGEMENT PLAN

Acute periods of drought have occurred in Lea County during 1917, 1924, 1938, 1945, 1954, 1967, and 2000, once every decade. But, longer less intense variances occur also. Precipitation records for Hobbs and Tatum indicate that rainfall has been below average for Hobbs during the past 10 years and for Tatum during the past 25 years (FIGURE 43). The most recent acute drought in Lea County occurred in 1998; correspondingly a sharp rise in water use occurred during that same year (FIGURE 34). Because Lea County relies on ground water for its water supply, acute droughts have less immediate impact on supplies than they do in surface water dependent areas. However, long-term affects of drought, acute or chronic, are just as real for Lea County as anywhere, and their mitigation should be carefully planned.

The American Water Works Association (AWWA) and the State of New Mexico have developed drought management planning guidelines. Primary tasks involved in developing a drought plan are: defining mitigation goals and objectives, researching historical drought conditions to define drought indicators and the amount of mitigation required, identifying and evaluating mitigation alternatives, seeking public input, and establishing actions required by various drought levels. Implementing a drought plan includes formally adopting the plan, providing for public information and education, and enforcing the plan's restrictions.

Mitigation alternatives should include --at a minimum-- public education and information, a phased or staged approach to water use restrictions, contingency plans for large water users, alternative pricing structures, rationing schemes, and steps to implement and enforce compliance with the Drought Plan. Application of the alternatives may vary depending on the type of water use.[19] Feasible alternatives should be evaluated against: economics, legality, public acceptance, and liability. Typical drought management phases/stages with their corresponding actions are shown in TABLE 8-7.

Drought indicators used in drought plans include the Palmer Index (PI) and ground water levels in supply wells.[20] The PI, a widely used and accepted scale for measuring drought conditions, is based on soil moisture and long term climatic data. PI values typically range from -6 to 6. Normal weather conditions have a PI value of zero. Values greater than zero indicate moist spells and values less than zeros indicate dry spells. Major drawbacks of the PI are its inability to detect fast-emerging droughts and neglecting the effect of snowpack.

Using historical ground-water levels in supply wells, monthly predictions of water-table elevation can be made. Considering both monthly ground-water levels and the storage capacity of the aquifer, percentiles of normal elevation can be assigned with which to indicate drought action levels. For example, a drought warning may be issued when stored water drops below the 75th percentile[21] of normal, and a drought emergency may be declared when a monthly level drops below the 50th percentile.

The State of New Mexico has created a Drought Plan and a Drought Task Force (DTF). The Drought Plan is State resource document intended to compliment local and regional water planning efforts.[22] The DTF includes two assigned groups of water planning professionals. The Monitoring Work Group (MWG) monitors climatic and other data provided by federal and state agencies. The Impact Assessment Work Group (IAWG) assesses and mitigates vulnerabilities to drought.

TABLE 8-7: DROUGHT PLAN PHASING

Phase/ Stage	Action Level	Action
1	Watch	Voluntary water conservation measures
2	Warning	Voluntary water conservation measures
3	Emergency	Mandatory water use restrictions
4	Critical	Water rationing

The MWG assesses collected data and determines the status of drought in each of the eight climatic zones occurring within New Mexico. Drought status phases include Normal, Advisory, Alert, Warning, and Emergency. Lea County is located in climatic zone No. 7. Smaller subzones are to be delineated within each climatic zone sometime in the near future. A Drought Status/Monitoring report is published weekly.

During periods of drought, the IAWG assesses and acts to alleviate drought impacts. The IAWG is comprised of four subgroups that focus on specific impact sectors. The four sectors include 1) Agriculture, 2) Drinking Water, Health, and Energy, 3) Wildlife and Wildfire Protection, and 4) Tourism and Economic Impact. The IAWG is responsible for initiation of all drought responses and drought mitigation actions, including public service announcements and emergency funding. A copy of the New Mexico Drought Plan is provided in Appendix S and can be accessed via the internet at *http://weather.nmsu.edu/drought*.

[19] Types of water use include: residential, commercial, and industrial. Water conservation measures may be different for each classification during plan implementation, depending on specific needs and requirements.
[20] Other indicators of drought are also used for planning and management purposes. The National Drought Mitigation Center (NDMC) constantly monitors drought conditions in the United States. Drought monitor indices used by the NDMC include the Palmer Drought Severity Index (PDSI), the Surface Water Supply Index (SWSI), the Standardized Precipitation Index (SPI), the Crop Moisture Index, (CMI), and the National Rainfall Index (RI). Drought monitor index maps are updated daily and are viewable on the NDMC website at *enso.unl.edu/monitor/monitor.html*. The current and future drought monitor forecasts provided by NDMC are valuable tools in drought management and planning.
[21] Seventy-fifth percentile means that the amount of water calculated to be in storage is less than or equal to 75% of what would normally be expected.
[22] New Mexico Drought Plan

In conjunction with the Drought Plan, and of particular interest in Lea County, the New Mexico Department of Agriculture provides a weekly and monthly statewide analysis of crop status and soil moisture information. This data may be found in a published newsletter or at the web site http://www.nass.usda.gov.nm.

The Lea County Drought Management Plan is to be monitored and implemented within the areas and municipalities of Lea County to address drought conditions. The Drought Management Plan is intended to be coordinated with the State of New Mexico Drought Plan and the National Drought Mitigation Center.

TABLE 8-8: DROUGHT MANAGEMENT PLAN OUTLINE

Phase	Action Level	Determinants (State of New Mexico)	Actions
1	Advisory	1) State designation 2) Palmer Drought Severity Index 3) Crop Moisture Index (CMI) 4) Groundwater levels 5) Standard Precipitation Index	1) Public notifications 2) Voluntary conservation measures
2	Alert	same as above	1) Public notifications 2) Enact Alert level mandatory water use ordinances
3	Warning	same as above	1) Public notifications 2) Enact Warning level mandatory water use ordinances 3) Enact State response actions
4	Emergency	same as above	1) Public notifications 2) Enact Emergency level water use ordinances 3) Enact State response actions

TABLE 8-9: RECOMMENDED ACTION LEVEL DETERMINING FACTORS

Phase-Action Level	New Mexico Drought Monitoring Work Group Designation	Palmer Drought Severity Index (PDSI)	Crop Moisture Index (CMI)	Ground Water Levels (% below normal)	Standard Precipitation Index (SPI)
1-Advisory	as reported	-1.00 to -1.99 for 4 weeks minimum and 8 weeks maximum	0.00 to -0.99 for 4 weeks	3	0 to -0.99, or less than 0.25 for 8 weeks, or continuously declining for 6 months
2-Alert	as reported	-2.00 to -2.99 for 4 weeks or Advisory PSDI for more than 8 weeks	-1.00 to -1.99 for 3 weeks	5	-1.0 to -1.49 for 8 weeks or Advisory status for 6 months
3-Warning	as reported	-3.00 to -3.99 for 4 weeks, or Alert PDSI for 8 weeks, or Advisory PDSI for 9 months	-2.00 to -2.99 for 2 weeks	10	-1.5 to -1.99, or a 6 month declining Alert SPI
4-Emergency	as reported	-4.00 or less for 4 weeks, or Warning PDSI for 8 weeks, or Alert PDSI for 9 months	-3.00 or less for one week	15	-2.00 or less, or a 6 month declining Warning SPI

Note: CMI is a short-term indicator for developing crops during the growing season and should not be used for long term monitoring

TABLE 8-10: RECOMMENDED ACTIONS

Phase/Action Level	Actions
1-Advisory	1) Notify public and State of Phase 1 Advisory drought condition 2) Issue public request for voluntary reductions in water use 3) Implement county ordinance for landscape watering interval of twice per week only between the hours of 7:00 pm to 10:00 am 4) Increase public announcements for water conservation
2-Alert	1) Notify public and State of Phase 2 Alert drought condition 2) Implement county ordinance for mandatory reductions of water use: Landscape watering interval of once per week only between the hours of 7:00 pm to 10:00 am No ornamental water use that doesn't incorporate recycling Wash cars only from bucket or at commercial car wash Fire hydrants used for fire fighting only No watering of golf course fairways with potable water No water use for dust control No surface (sidewalks, parking lot, building, etc.) washdowns No use of herbicides No filling of swimming pools Water only served by request at restaurants 4) Continue public announcements for water conservation 5) Expand municipal leak detection, surveillance, and repair programs
3-Warning	1) Notify public and State of Phase 3 Warning drought condition 2) Implement other county ordinances in addition to Alert level mandatory reductions of water use: Landscape watering interval of once every two weeks only between the hours of 7:00 pm to 10:00 am No water use for fountains, ponds, lakes, etc. All water user allocations reduced by 20%. Billing surcharge imposed for exceeding allocations. No watering of golf courses with potable water. Reduce elevations in water tanks and throttle at pumping stations to reduce line pressure by 5 psi 3) Continue public announcements for water conservation 4) Coordinate with State of New Mexico Drought Task Force to Implement State of New Mexico Planned Mitigation Actions
4-Emergency	1) Notify public and State of Phase 4 Emergency drought condition 2) Implement other county ordinances in addition to Alert and Warning level mandatory reductions of water use: No landscape watering allowed All water user allocations reduced by 30%. Billing surcharge imposed for exceeding allocations. No new connections to water systems allowed 3) Continue public announcements for water conservation 4) Coordinate with State of New Mexico Drought Task Force to Implement State of New Mexico Planned Mitigation Actions

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