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)

BEFORE THE OIL CONSERVATION COMMISSION
Santa Fe, New Mexico
Case No. 13589 Exhibit No. 5
Submitted by:
DUKE ENERGY FIELD SERVICES, LP
Hearing Date: February 9, 2006

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.

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]	$2 \pm .8$ to 5.4 ± 1.4[h]	$1.6 \pm .8$ to 5.8 ± 1.2[h]	$5.4 \pm .9$[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