Fluid pressures in the Forty-niner have been measured continuously at well H-16, approximately 13.9 m (45.6 ft) from the well of the AIS, since 1987. The pressures cycle in a sinusoidal fashion on an annual basis. These cycles correlate with cycles observed in rock bolt loads in the WIPP shafts (DOE 2002c), and presumably reflect seasonal temperature changes causing the rock around the shafts to expand and contract. From 1998 through 2002, the pressures have cycled between 40 and 70 psi (90 and 160 ft of fresh water). Given the location of the pressure transducer, the elevation of Forty-niner water level has varied between 899 to 920 m (2,950 to 3,020 ft) amsl during this period. Through April 2002, Forty-niner water levels were also measured monthly at H-3d as part of the WIPP groundwater monitoring program. Measurements were discontinued after April 2002 because of an obstruction in the well. The April 2002 Forty-niner water level elevation determined at H-3d was 942 m (3,092 ft) amsl. Differences in Forty-niner water levels at H-16 and H-3d are probably due, in part, to differences in the densities of the fluids in the wells. No other wells in the WIPP monitoring network are completed to the Forty-niner.

2.2.1.4.2 Hydrology of the Dewey Lake and the Santa Rosa

The Dewey Lake and the Santa Rosa, and surficial soils, overlie the Rustler and are the uppermost hydrostratigraphic units considered by the DOE. The Dewey Lake and overlying rocks are more permeable than the anhydrites at the top of the Rustler. Consequently, basin modeling indicates that most (probably more than 70 percent) of the water that recharges the groundwater basin (that is, percolates into the Dewey Lake from surface water) flows only in the rocks above the Rustler. As modeled, the rest leaks vertically through the upper anhydrites of the Rustler and into the Magenta or continues downward to the Culebra. More flow occurs into the Rustler units at times of greater recharge. Even though it carries most of the modeled recharge, lateral flow in the Dewey Lake is slow because of its low permeability in most areas.

A saturated, perched-water zone has been identified in the lower Santa Rosa directly below the operational area of the WIPP (DOE 1999; INTERA 1997a*; **INTERA 1997b; DES 1997). The zone occurred at a location that previously had been dry or only partially saturated. Details are provided in Appendix DATA and a summary provided in Section 2.2.1.4.2.2.***

2.2.1.4.2.1 ~~The~~ Dewey Lake

The Dewey Lake contains a productive zone of saturation, probably under water-table conditions, in the southwestern to south-central portion of the WIPP site and south of the site. Several wells operated by the J.C. Mills Ranch south of the WIPP site produce sufficient quantities of water from the Dewey Lake to supply livestock. Short-term production rates of 5.7 to 6.8 m^3/hr (25 to 30 gpm) were observed in boreholes P-9 (Jones 1978, Vol. 1., ***pp.*** 167- 168), WQSP-6, and WQSP-6a (see ***CCA*** Appendix USDW). ***Based on a single hydraulic test conducted at WQSP-6a (Figure 2-6), Beauheim and Ruskauff (1998) estimated the transmissivity of a 7.3-m (24-ft) fractured section of the Dewey Lake at 3.9 × 10^{-4} m^2/s (360 ft^2/day).*** The productive zone is typically found in the middle of the Dewey Lake, 55 to 81 m (180 to 265 ft) below ground surface and appears to derive much of its transmissivity from open fractures. Where present, the saturated zone may be perched or simply underlain by less transmissive rock. Fractures below the productive zone tend to be completely filled with gypsum. Open fractures and/or moist (but not fully saturated) conditions have been observed at similar depths north of the zone of saturation, at the H-1, H-2, and H-3 boreholes (***CCA*** Appendix HYDRO, ***p.*** 69).

Under the groundwater monitoring program (Appendix MON-2004), water levels are measured in two Dewey Lake wells, WQSP-6a and H-3d, located south of the WIPP site center (Figure 2-6). Water levels in these two wells are currently 975 and 937 m (3,198 and 3,075 ft) amsl, respectively. Water levels at WQSP-6a remain relatively constant. Over the past several years, water levels at H-3d have risen about 0.3 m/yr (1 ft/yr). Future changes in the Dewey Lake water table due to wetter conditions are part of the conceptual model discussed in Sections 6.4.6 and 6.4.9.

Similar to the six Culebra WQSP wells (WQSP-1 through WQSP-6), Dewey Lake water quality is determined semiannually at WQSP-6a. Baseline concentrations for major ion species have also been determined from ten rounds of sampling. The 95 percent confidence intervals for the major ion species presented in SNL (2001) are shown in Table 2-9 and indicate the Dewey Lake water at this location is relatively fresh. Major ion concentrations have been stable within the baseline 95 percent confidence intervals for all 14 rounds of sampling conducted through May 2002 (Kehrman 2002).

Table 2-9. Ninety-Five Percent Confidence Intervals for Dewey Lake Water-Quality Baseline

Well I.D.	***Cl^- Conc. (mg/L)***	***SO_4^{2-} Conc. (mg/L)***	***HCO_3^- Conc. (mg/L)***	***Na^+ Conc. (mg/L)***	***Ca^{2+} Conc. (mg/L)***	***Mg^{2+} Conc. (mg/L)***	***K^+ Conc. (mg/L)***
WQSP-6a	***433-764***	***1610-2440***	***97-111***	***253-354***	***554-718***	***146-185***	***1.8-9.2***

Powers (1997) suggests that what distinguishes the low-transmissivity lower Dewey Lake from the high-transmissivity upper Dewey Lake is a change in natural cements from carbonate (above) to sulfate (below). Resistivity logs correlate with this cement change and show a drop in porosity across the cement-change boundary. Similarly, porosity measurements made on eight core samples from the Dewey Lake from well H-19b4 showed a range from 14.9 to 24.8 percent for the four samples from above the cement change, and a range from 3.5 to 11.6 percent for the four samples from below the cement change (TerraTek 1996). In the vicinity of the surface structures area of the WIPP, Powers (1997) proposed the surface of the cement change is at a depth of approximately 50 to 55 m (165 to 180 ft), is irregular, and trends downward stratigraphically to the south and west of the site center.

During site characterization and initial construction of the WIPP shafts, ~~T~~ ***t***he Dewey Lake ~~has~~ ***did*** not produce~~d~~ water within the WIPP shafts or in boreholes in the immediate vicinity of the panels. ***However, since 1995, water has been observed leaking into the exhaust shaft at a depth of approximately 24.4 m (80 ft) at the location of the Dewey Lake/ Santa Rosa contact (Docket A-93-02, Item number 11-1-07, 1999; INTERA 1997a; INTERA 1997b). As described below in Section 2.2.1.4.2.2, the water is interpreted to be from an anthropogenic source, including infiltration from WIPP rainfall-runoff retention ponds and the WIPP salt storage***

area and evaporation pond located at the surface. At the site center, thin cemented zones in the upper Dewey Lake retard, at least temporarily, downward infiltration of modern waters.

Saturation of the uppermost Dewey Lake was observed for the first time in 2001 as well C-2737 was being drilled (Powers 2002c). Well C-2811 was then installed nearby to monitor this zone (Powers and Stensrud 2003). Because of the proximity of these two wells to the WIPP surface structures area, and the absence of water at this horizon when earlier wells were drilled, the saturation is assumed to be an extension of the anthropogenic waters described in the following section.

For modeling purposes, the hydraulic conductivity of the Dewey Lake, assuming saturation, is estimated to be 10^{-8} m/sec (3×10^{-3} ft/day), corresponding to the hydraulic conductivity of fine-grained sandstone and siltstone (Davies 1989, ***p.*** 110). ~~The porosity of the Dewey Lake was measured as part of testing at the H-19 hydropad. Four samples taken above the gypsum-sealed region had measured effective porosities of 14.9 to 24.8 percent. Four samples taken from within the gypsum-sealed region had porosities from 3.5 to 11.6 percent.~~

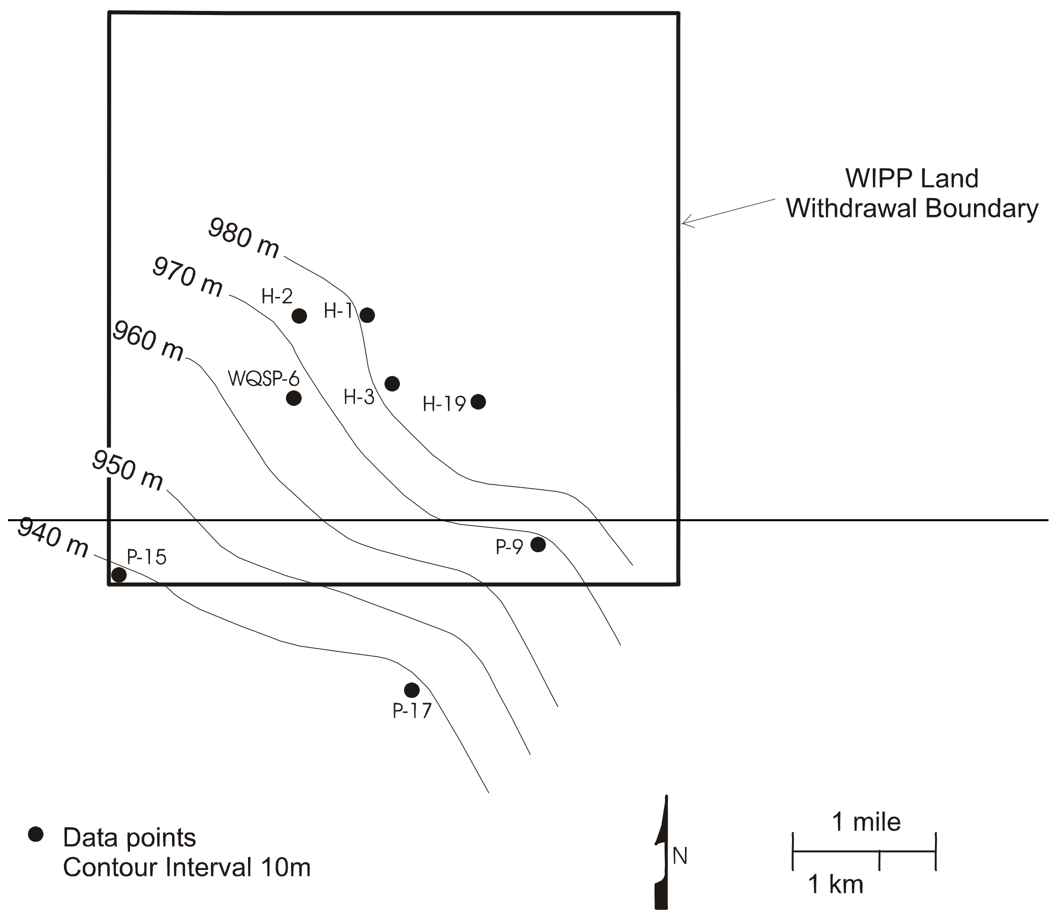
The Dewey Lake is the uppermost important layer in the hydrological model. Its treatment is discussed in Section 6.4.6.6 and Appendix **PA, Attachment** MASS, Section MASS.14.2. Model parameters are in Table 6-2~~3~~**5 and in Appendix PA, Attachment PAR, Table PAR-22**.

~~The DOE has estimated the position of the water table in the southern half of the WIPP site from an analysis of drillers' logs from three potash exploration boreholes and five hydraulic test holes. These logs record the elevation of the first moist cuttings recovered during drilling. Assuming that the first recovery of moist cuttings indicates a minimum elevation of the water table, an estimate of the water table elevation can be made, and the estimated water table surface can be contoured. This method indicates that the elevation of the water table over the WIPP waste panels may be about 3,215 feet (980 meters) above sea level, as shown in Figure 2-33. Changes in this water table in the future, due to wetter conditions are part of the conceptual model discussed in Sections 6.4.6 and 6.4.9.~~

2.2.1.4.2.2 Santa Rosa

The Santa Rosa ranges from 0 to 91 m (0 to about 300 ft) thick and is present over the eastern half of the WIPP site. It is absent over the western portion of the site. It crops out northeast of Nash Draw. The Santa Rosa near the WIPP site may have a natural-water-saturated thickness of limited extent. It has a porosity of about 13 percent and a specific capacity of 0.029 to 0.041 L/s/m (0.14 to 0.20 ***gallons per minute per foot*** (gpm/ft) of drawdown, where it yields water in the WIPP region.

In May 1995, a scheduled inspection of the WIPP exhaust shaft revealed water emanating from cracks in the concrete liner at a depth of approximately 24.4 m (80 ft) below the shaft collar. Because little or no groundwater had been encountered at this depth interval previously (Bechtel 1979; DOE 1983; Holt and Powers 1984, 1986), the DOE implemented a program in early 1996 to investigate the source and extent of the water. The program included installation of wells and piezometers, hydraulic testing (pumping tests), water-quality



Note: Meters Above Mean Sea Level

CCA-049-2

~~Figure 2-33. Interpreted Water Table Surface~~

***sampling and analysis, and water-level and precipitation monitoring (Docket A-93-02, Item number 11-1-07, DOE* 1999; INTERA 1997*a*; DES 1997; *INTERA 1997b*).**

In the initial phases of the investigation, three wells (C-2505, C-2506, and C-2507) and 12 piezometers (PZ-1 through PZ-12) were installed within the surface structures area of the WIPP site (Figure 2-39). The three wells were located near the exhaust shaft and completed to the Santa Rosa/Dewey Lake contact (approximately 15 m [50 ft] below ground surface). Similarly, the piezometers were also completed to the Santa Rosa/Dewey Lake contact (approximately 16 to 23 m [55 to 75 ft] below ground surface). All wells and piezometers, with the exception of PZ-8, encountered a saturated zone just above the Santa Rosa/Dewey Lake contact, but water did not appear to have percolated significantly into the Dewey Lake. PZ-8, the piezometer located farthest to the east in the study area, was a dry hole.

Subsequent to the well and piezometer installations, water-level, water-quality, and rainfall data were collected. In addition, hydraulic tests were performed to estimate hydrologic

properties and water production rates. These data suggest that the water present in the Santa Rosa below the WIPP surface structures area represents an unconfined, water-bearing horizon perched on top of the Dewey Lake (DES 1997). Pressure data collected from instruments located in the exhaust shaft show no apparent hydrologic communication between the Santa Rosa and other formations located stratigraphically below the Santa Rosa.

A water-level-surface map of the Santa Rosa in the vicinity of the WIPPsurface structures area indicates that a potentiometric high is located near the salt water evaporation pond and PZ-7 (Figure 2-40). The water level at PZ-7 is approximately 1 m (3.3 ft) higher than the water levels in any other wells or piezometers. Water is presumed to move radially from this potentiometric high. The areal extent of the water is larger than the 80-acre investigative area shown in Figure 2-39 (DES 1997) as evidenced by drilling records of C-2737 (Powers 2002c) located outside of and south of the WIPP surface structures area that indicate a Santa Rosa/Dewey Lake perched-water horizon at a depth of approximately 18 m (60 ft). The study of this water is ongoing.

Water-quality data for the perched Santa Rosa waters are highly variable and appear to be dominated by two anthropogenic sources: (1) runoff of rainfall into and infiltration from the retention ponds located to the south of the WIPP surface facilities, and (2) infiltration of saline waters from the salt storage area, the salt storage evaporation pond, and perhaps remnants of the drilling and tailings pit used during the construction of the WIPP salt shaft. The total dissolved solids (TDS) in the perched water range from less than 3,000 mg/L at PZ-10 to more than 160,000 mg/L at PZ-3 (DES 1997). Concentration contours are known to shift with time. For example, the high-TDS zone centered at PZ-3 moved observably to the northeast toward PZ-9 between February 1997 and October 2000 (DOE 2002b).

Hydraulic tests (Docket A-93-02, Item number 11-1-07, DOE; INTERA 1997a; DES 1997) conducted in the three wells and 12 piezometers indicate that the Santa Rosa behaves as a low-permeability, unconfined aquifer perched on the Dewey Lake. Hydraulic conductivity ranges from 2.6 $\times 10^{-8}$ to 5.5 $\times 10^{-5}$ m/s (7.4 $\times 10^{-3}$ to 16 ft/day). The wells are capable of producing at rates of about 0.3 to 1.0 gpm. The estimated storativity value for the Santa Rosa is 1 $\times 10^{-2}$.

2.2.1.5 <u>Hydrology of Other Groundwater Zones of Regional Importance</u>

The groundwater regimes in the Capitan Limestone, which is generally regarded as the northern boundary of the Delaware Basin, and Nash Draw have been evaluated by the DOE as part of the WIPP project because of their importance in some processes, notably dissolution features, that the DOE has determined to be of low probability at the WIPP site.

2.2.1.5.1 Capitan Limestone

The Capitan ***Limestone (hereafter referred to as the Capitan),*** which outcrops in the southern end of the Guadalupe Mountains, is a massive limestone unit that grades basinward into recemented, partly dolomitized reef breccia and shelfward into bedded carbonates and evaporites. A deeply incised submarine canyon near the Eddy-Lea county line has been identified (Hiss 1976). This canyon is filled with sediments of lower permeability than the Capitan and, according to Hiss (1975 ***p.*** 199)**,** restricts fluid flow. The hydraulic conductivity of

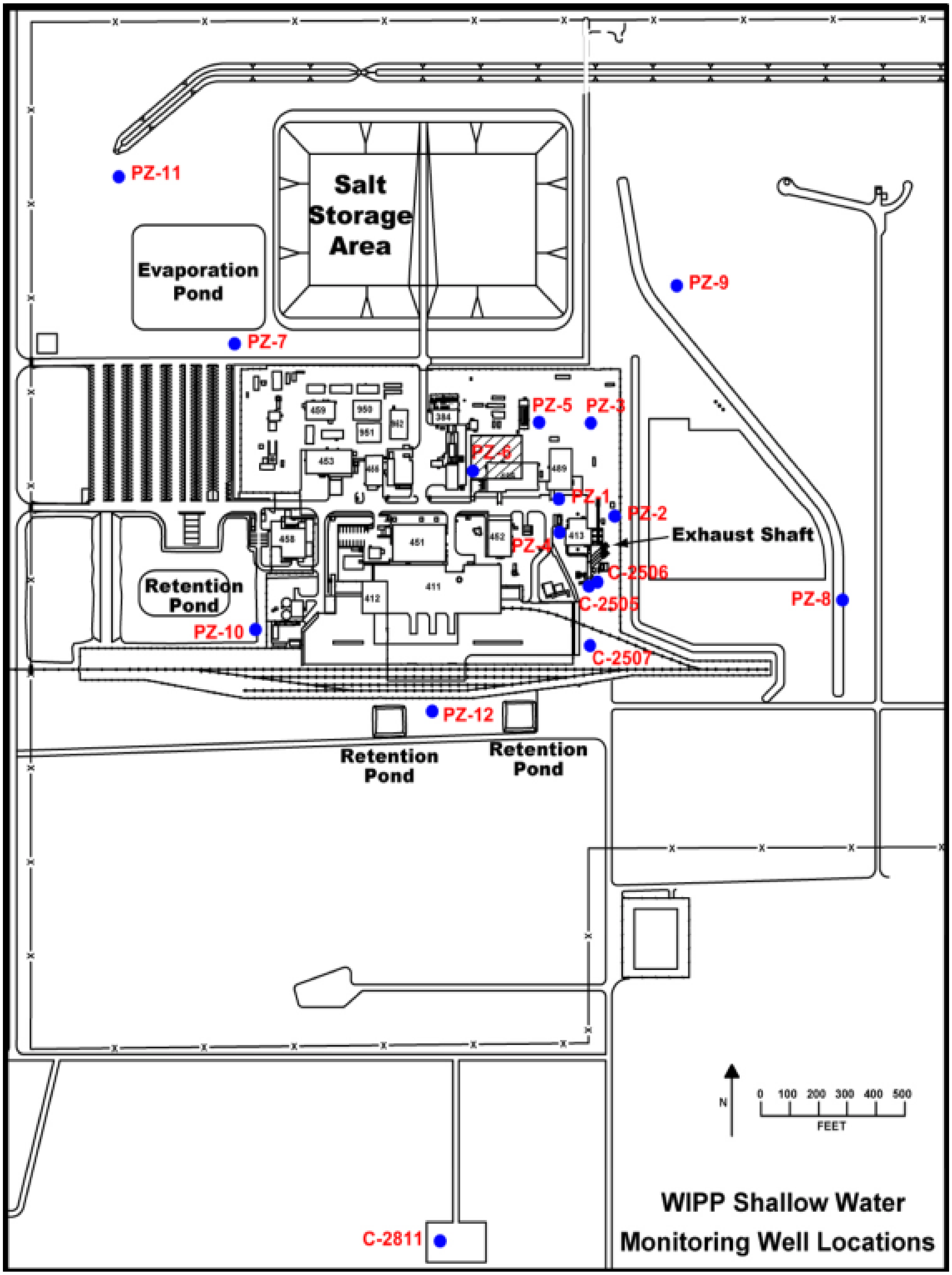


Figure 2-39. Site Map of WIPP Surface Structures Area Showing Location of Wells (e.g., C-2505) and Piezometers (e.g., PZ-1) (after INTERA 1997)

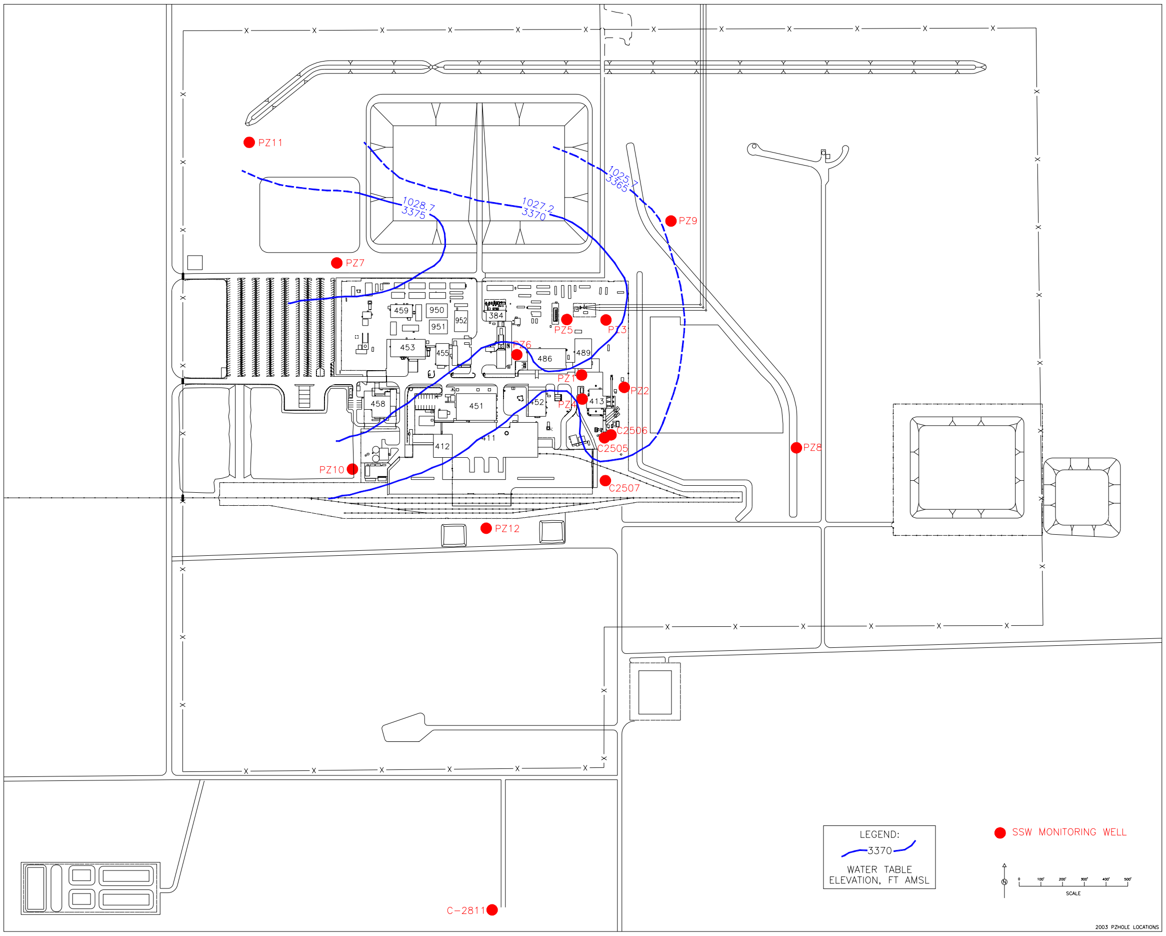


Figure 2-40. Santa Rosa Potentiometric Surface Map

the Capitan ranges from 3×10^{-6} to 9×10^{-5} m/s~~ec~~ (1 to 25 ft/day) in southern Lea County and is 1.7×10^{-5} m/s~~ec~~ (5 ft/day) east of the Pecos River at Carlsbad (***CCA*** Appendix HYDRO, ***p.*** 34). Hiss (1975, ***p.*** 199) reported in 1975 that average transmissivities around the northern and eastern margins of the Delaware Basin are 0.01 m^2/s~~ec~~ (10,000 ft^2/day) in thick sections and 5.4×10^{-4} m^2/s~~ec~~ (500 ft^2/day) in incised submarine canyons. Water table conditions are found in the Capitan aquifer southwest of the Pecos River at Carlsbad; however, artesian conditions exist to the north and east. The hydraulic gradient to the southeast of the submarine canyon near the Eddy-Lea county line has been affected by large oil field withdrawals. The Capitan is recharged by percolation through the northern shelf aquifers, by flow from the south and west from underlying basin aquifers (see information on the Bell Canyon, Section 2.2.1.2.1), and by direct infiltration at its outcrop in the Guadalupe Mountains. The Capitan is important in the regional hydrology because breccia pipes in the Salado have formed over it, most likely in response to the effects of dissolution by groundwater flowing in the Castile along the base of the Salado. See ***CCA*** Appendix DEF, Section DEF.3.1 for a more thorough discussion of breccia pipe formation.

2.2.1.5.2 Hydrology of the Rustler-Salado Contact Zone in Nash Draw

As discussed in Sections 2.1.3.4 and 2.1.6.2.1, in Nash Draw the contact between the Rustler and the Salado is an unstructured residuum of gypsum, clay, and sandstone created by the dissolution of halite and has been known as the brine aquifer, Rustler-Salado residuum, and residuum. The residuum is absent under the WIPP site. It is clear that dissolution in Nash Draw occurred after deposition of the Rustler (see ***CCA*** Appendix DEF, Section DEF.3.2 for a discussion of lateral dissolution of the Rustler-Salado contact). As described previously, the topographic low formed by Nash Draw is a groundwater divide in the groundwater basin conceptual model of the units above the Salado. The brine aquifer is shown in Figure 2-~~34~~***41***.

Robinson and Lang ***(1938)*** described the brine aquifer (Section 2.1.3.4) ~~in 1938~~ and suggested that the structural conditions that caused the development of Nash Draw might control the occurrence of the brine; thus, the brine aquifer boundary may coincide with the topographic surface expression of Nash Draw, as shown in Figure 2-~~29~~***33***. Their studies show brine concentrated along a strip from 3.3 to 13 km (2 to 8 mi) wide and about 43 km (26 mi) long. Data from the test holes that Robinson and Lang ***(1938)*** drilled indicate that the residuum (containing the brine) ranges in thickness from 3 to 18 m (10.5 to 60 ft) and averages about 24 feet (7 meters).

~~In 1954, h~~***H***ydraulic properties were determined by Hale et al.~~,~~ ***(1954)*** primarily for the area between Malaga Bend on the Pecos River and Laguna Grande de la Sal. They calculated a transmissivity value of 8.6×10^{-3} m^2/s~~ec~~ (8,000 ft^2/day) and estimated the potentiometric gradient to be 0.27 m/km (1.4 ft/mi). In this area, the Rustler-Salado residuum apparently is part of a continuous hydrologic system, as evidenced by the coincident fluctuation of water levels in the test holes (as far away as Laguna Grande de la Sal) with pumping rates in irrigation wells along the Pecos River.

In the northern half of Nash Draw, the approximate outline of the brine aquifer as described by Robinson and Lang ~~in~~ ***(1938)*** has been supported by drilling associated with the WIPP hydrogeologic studies. These studies also indicate that the main differences in areal extent occur along the eastern side where the boundary is very irregular and, in places (test holes P-14 and H-07), extends farther east than previously indicated by Robinson and Lang ***(1938)***.

Other differences from the earlier studies include the variability in thickness of residuum present in test holes WIPP-25 through WIPP-29. These holes indicate thicknesses ranging from 3.3 m (11 ft) in WIPP-25 to 33 m (108 ft) in WIPP-29 in Nash Draw, compared to 2.4 m (8 ft) in test hole P-14, east of Nash Draw. The specific geohydrologic mechanism that has caused dissolution to be greater in one area than in another is not apparent, although a general increase in chloride concentration in water from the north to the south may indicate the effects of movement down the natural hydraulic gradient in Nash Draw.

The average hydraulic gradient within the residuum in Nash Draw is about 1.9 m/km (10 ft/mi); in contrast, the average gradient at the WIPP site is 7.4 m/km (39 ft/mi) (***CCA*** Appendix HYDRO, ***p.*** 50***)***. This difference reflects the changes in transmissivity, which are as much as five orders of magnitude greater in Nash Draw. The transmissivity determined from aquifer tests in test holes completed in the Rustler-Salado contact residuum of Nash Draw ranges from

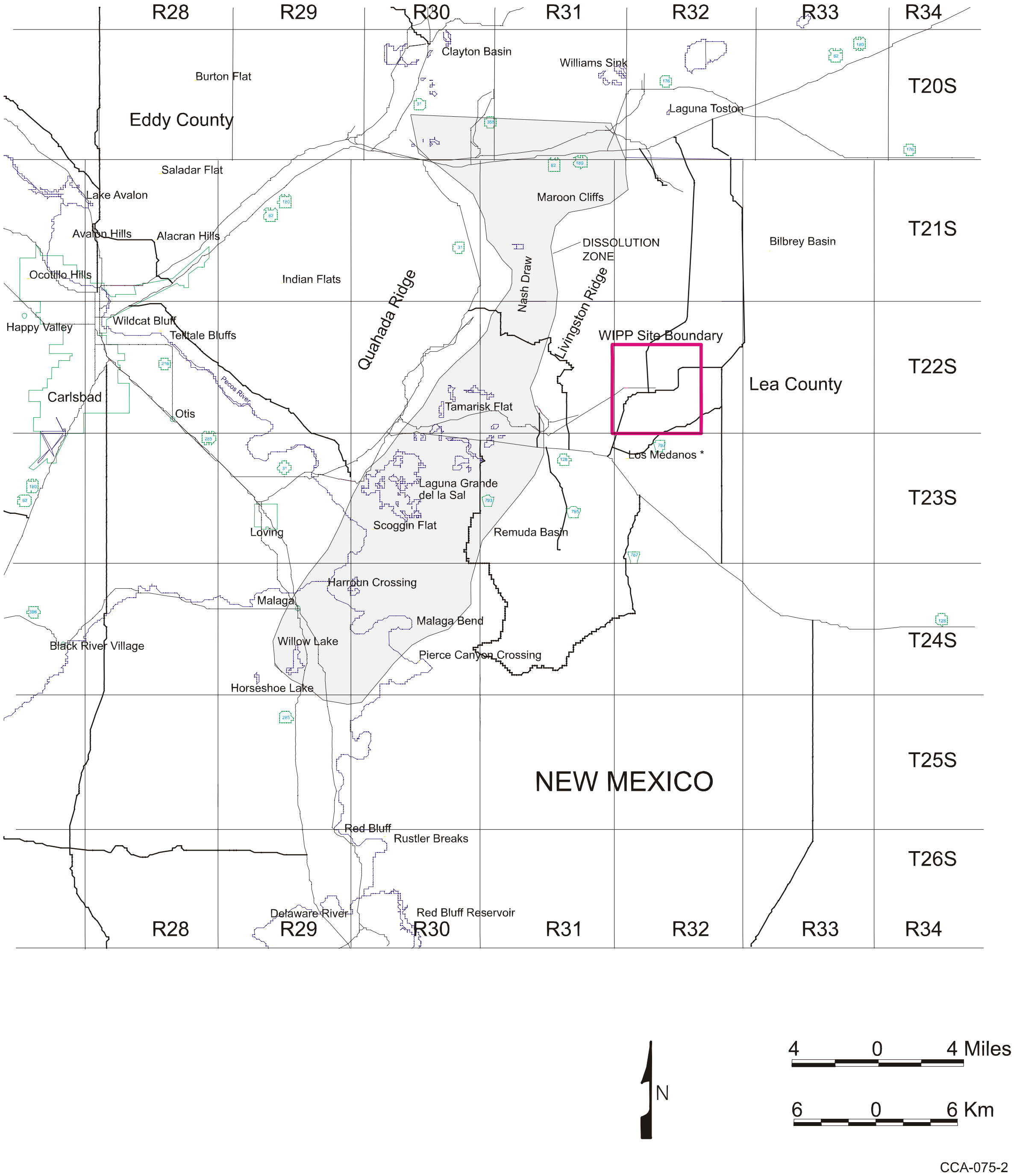


Figure 2-~~34~~*41*. Brine Aquifer in the Nash Draw (Redrawn from *CCA* Appendix HYDRO, Figure 14)

2.1×10^{-10} m^2/~~sec~~ (2×10^{-4} ft^2/day) at WIPP-27 to 8.6×10^{-6} m^2/~~sec~~ (9 8 ft^2/day) at WIPP-29. This is in contrast to the WIPP site proper, where transmissivities range from 3.2×10^{-11} m^2/~~sec~~ (3×10^{-5} ft^2/day) at test holes P-18 and H-5c to 5.4×10^{-8} m^2/~~sec~~ (5×10^{-2} ft^2/day) at test hole P-14 (***CCA*** Appendix HYDRO, ***p.*** 50). Locations and estimated hydraulic heads of these wells ***based on water-level measurements made in the 1980s (Lappin et al. 1989)*** are illustrated in Figure 2-~~35~~***42.***

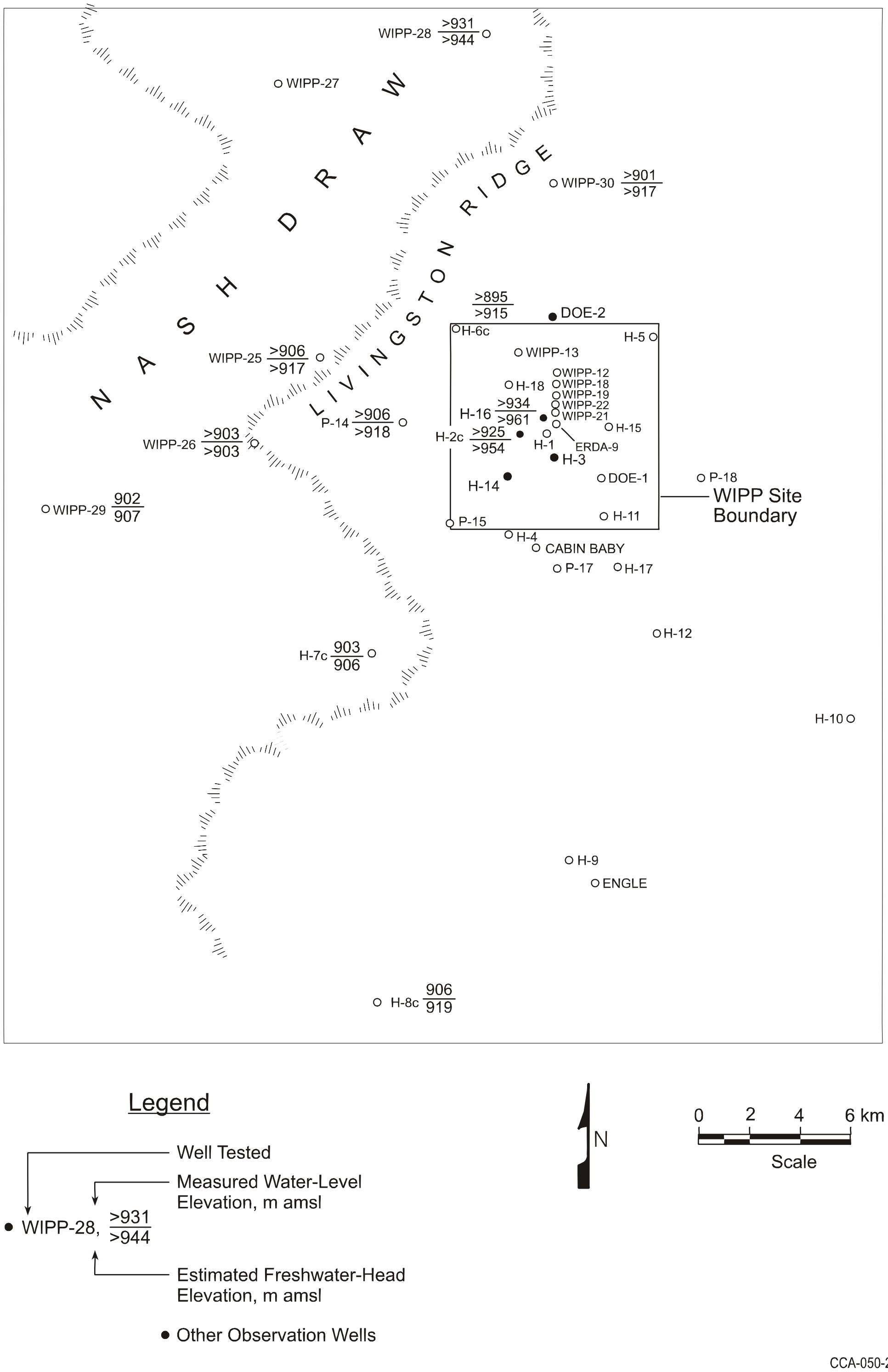
Hale et al. (1954) believed the Rustler-Salado contact residuum discharges to the alluvium near Malaga Bend on the Pecos River. Because the confining beds in this area are probably fractured because of dissolution and collapse of the evaporites, the brine (under artesian head) moves up through these fractures into the overlying alluvium and then discharges into the Pecos River.

According to ~~Mercer~~ ***CCA*** Appendix HYDRO, ***p.*** 55, water in the Rustler-Salado contact residuum in Nash Draw contains the largest concentrations of dissolved solids in the WIPP area, ranging from 41,500 mg/L in borehole H-1 to 412,000 mg/L in borehole H-5c. These waters are classified as brines. The dissolved mineral constituents in the brine consist mostly of sulfates and chlorides of calcium, magnesium, sodium, and potassium; the major constituents are sodium and chloride. Concentrations of the other major ions vary according to the spatial location of the sample, are probably directly related to the interaction of the brine and the host rocks, and reflect residence time within the rocks. Residence time of the brine depends upon the transmissivity of the rock. For example, the presence of large concentrations of potassium and magnesium in water is correlated with minimal permeability and a relatively undeveloped flow system.

The EPA's initial review of the CCA found the discussion of the Rustler/Salado contact to require clarification, particularly with respect to the possibility of the continued development and characteristics of a dissolution front along this contact, and the impact that continued dissolution within the brine aquifer residuum would have on the overlying units of the Rustler. The DOE discussed the rate and extent of dissolution processes further in supplemental information provided in a letter dated June 13, 1997 (Docket A-93-02, II-H-44). Based upon this information, the EPA concluded that, while dissolution may occur along the Rustler/Salado contact, it would not affect the WIPP's containment capabilities during the regulatory time period. Further discussion of this topic is contained in EPA Technical Support Document for Section 194.14: Content of Compliance Certification Application, Section IV.C.3 (Docket A-93-02, Item V-B-3).

2.2.2 Surface-Water Hydrology

The WIPP site is in the Pecos River basin, which contains about 50 percent of the drainage area of the Rio Grande Water Resources Region. The Pecos River headwaters are northeast of Santa Fe, and the river flows to the south through eastern New Mexico and western Texas to the Rio Grande. The Pecos River has an overall length of about 805 km (500 mi), a maximum basin width of about 209 km (130 mi), and a drainage area of about 115,301 km^2 (44,535 mi^2). (About 53,075 km^2 [20,500 mi^2] contained within the basin have no external surface drainage and their surface waters do not contribute to Pecos River flows.) Figure 2-~~36~~***43*** shows the Pecos River drainage area.



~~Figure 2-35. Measured Water Levels of the Unnamed Lower Member and Rustler-Salado Contact Zone~~

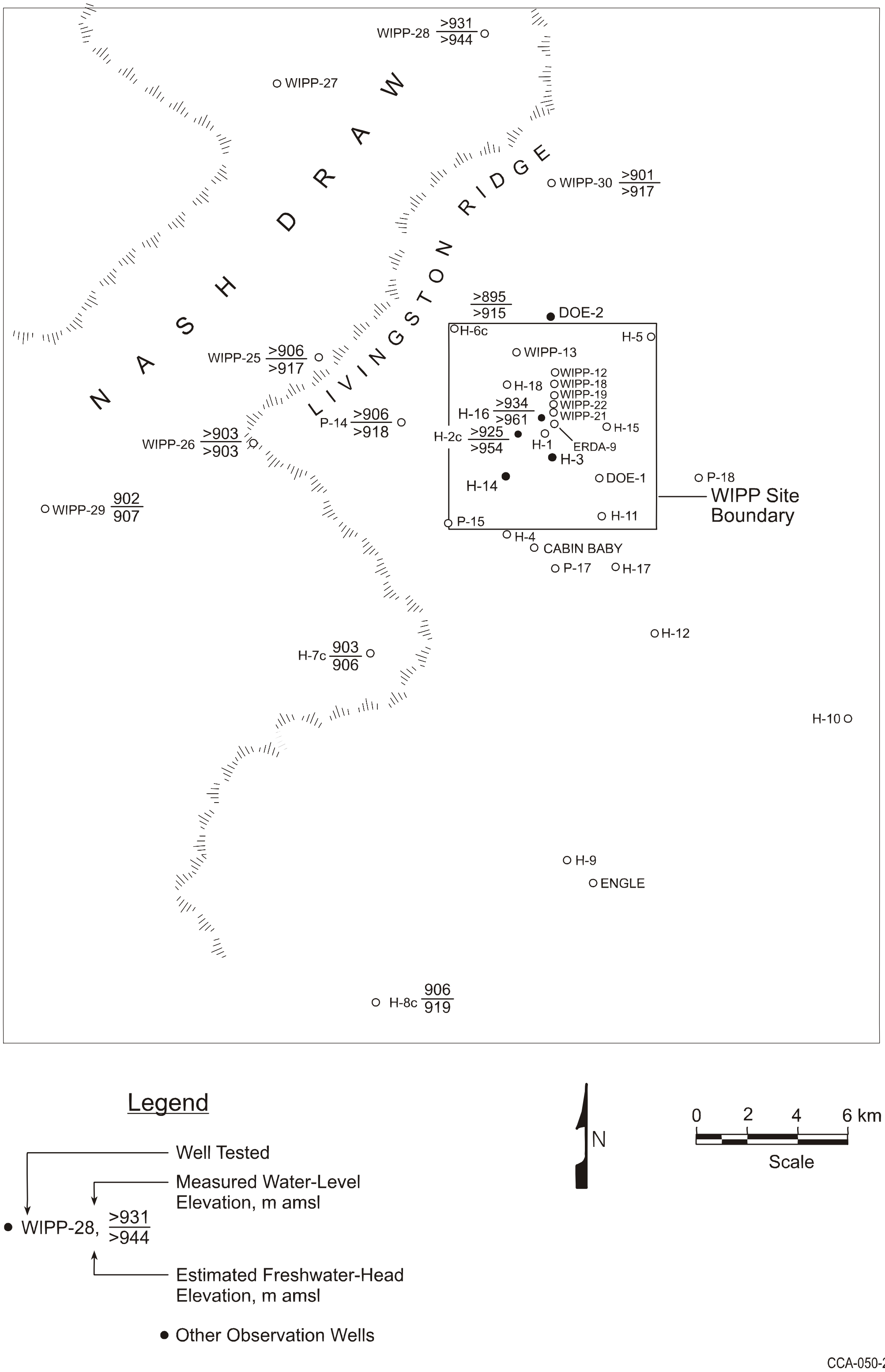


Figure 2-42. Measured Water Levels of the Los Medaños and Rustler-Salado Contact Zone (1980s)

The Pecos River generally flows year-round, except in the reach below Anton Chico ~~and between Fort Sumner and Roswell~~, where the low flows percolate into the stream bed. The main stem of the Pecos River and its major tributaries have low flows, and the tributary streams are frequently dry. About 75 percent of the total annual precipitation and 60 percent of the annual flow result from intense local thunderstorms between April and September.

There are no perennial streams at the WIPP site. At its nearest point, the Pecos River is about 19 km (12 mi) southwest of the WIPP site boundary. A few small creeks and draws are the only westward flowing tributaries of the Pecos River within 32 km (20 mi) north or south of the site. Nash Draw, the largest surface drainage feature east of the Pecos River in the WIPP region, is a closed depression and does not provide surface flow into the Pecos. ***Potash mining operations in and near Nash Draw likely contribute to the flow in Nash Draw. For example, the Mississippi Potash Inc. East operation located 11 to 13 km (7 to 8 mi) due north of the WIPP site disposes of mine tailings and refining-process effluent on its property and has done so since 1965. Records obtained from the New Mexico Office of the State Engineer show that since 1973, an average of 3 × 10^6 m^3 (2,400 acre-feet [ac-ft]) of water per year has been pumped from local aquifers (Ogallala and Capitan) for use in the potash-refining process at that location (SNL 2003b). Based on knowledge of the potash refining process, approximately 90 percent of the pumped water is estimated to be discharged to the tailings pile. Geohydrology Associates (1978) estimated that approximately half of the brine discharged onto potash tailings piles in Nash Draw seeps into the ground annually, while the remainder evaporates.*** The Black River (drainage area: 1,035 km^2 [400 mi^2]) joins the Pecos from the west about 25 km (16 mi) southwest of the site. The Delaware River (drainage area: 1,812 km^2 [700 mi^2]) and a number of small creeks and draws also join the Pecos River along this reach. The flow in the Pecos River below Fort Sumner is regulated by storage in Sumner Lake, Brantley Reservoir, Lake Avalon, and several other smaller irrigation dams.

Five major reservoirs are located on the Pecos River: Santa Rosa Lake, Sumner Lake, Brantley Reservoir, Lake Avalon, and the Red Bluff Reservoir***,*** the last located just over the border in Texas (Figure 2-~~36~~***43***). The storage capacities of these reservoirs and the Two Rivers Reservoir in the Pecos River Basin are shown in Table 2-~~6~~***10***.

With regard to surface drainage onto and off of the WIPP site, there are no major natural lakes or ponds within 8 km (5 mi) of the site. Laguna Gatuña, Laguna Tonto, Laguna Plata, and Laguna Toston are playas more than 16 km (10 mi) north and are at elevations of 1,050 m (3,450 ft) or higher. Thus, surface runoff from the site (elevation 1,010 m [3,310 ft] above sea level) would not flow toward any of them. To the northwest, west, and southwest, Red Lake, Lindsey Lake, and Laguna Grande de la Sal are more than 8 km (5 mi) from the site, at elevations of 914 to 1,006 m (3,000 to 3,300 ft). A low-flow investigation has been initiated by the USGS within the Hill Tank Draw drainage area, the most prominent drainage feature near the WIPP site. The drainage area is about 10.3 km^2 (4 mi^2), with an average channel slope of 1 to 100, and the drainage is westward into Nash Draw. Two years of observations showed only four flow events. The USGS estimates that the flow rate for these events was under 0.057 m^3/~~sec~~ (2 ft^3/~~sec~~) (DOE 1980, ***pp.*** 7***-*** 74).

As discussed in Section 2.5.2.3, the mean annual precipitation in the region is 0.33 m (13 in.), and the mean annual runoff is 2.5 to 5 mm (0.1 to 0.2 in.). The maximum recorded 24-hour

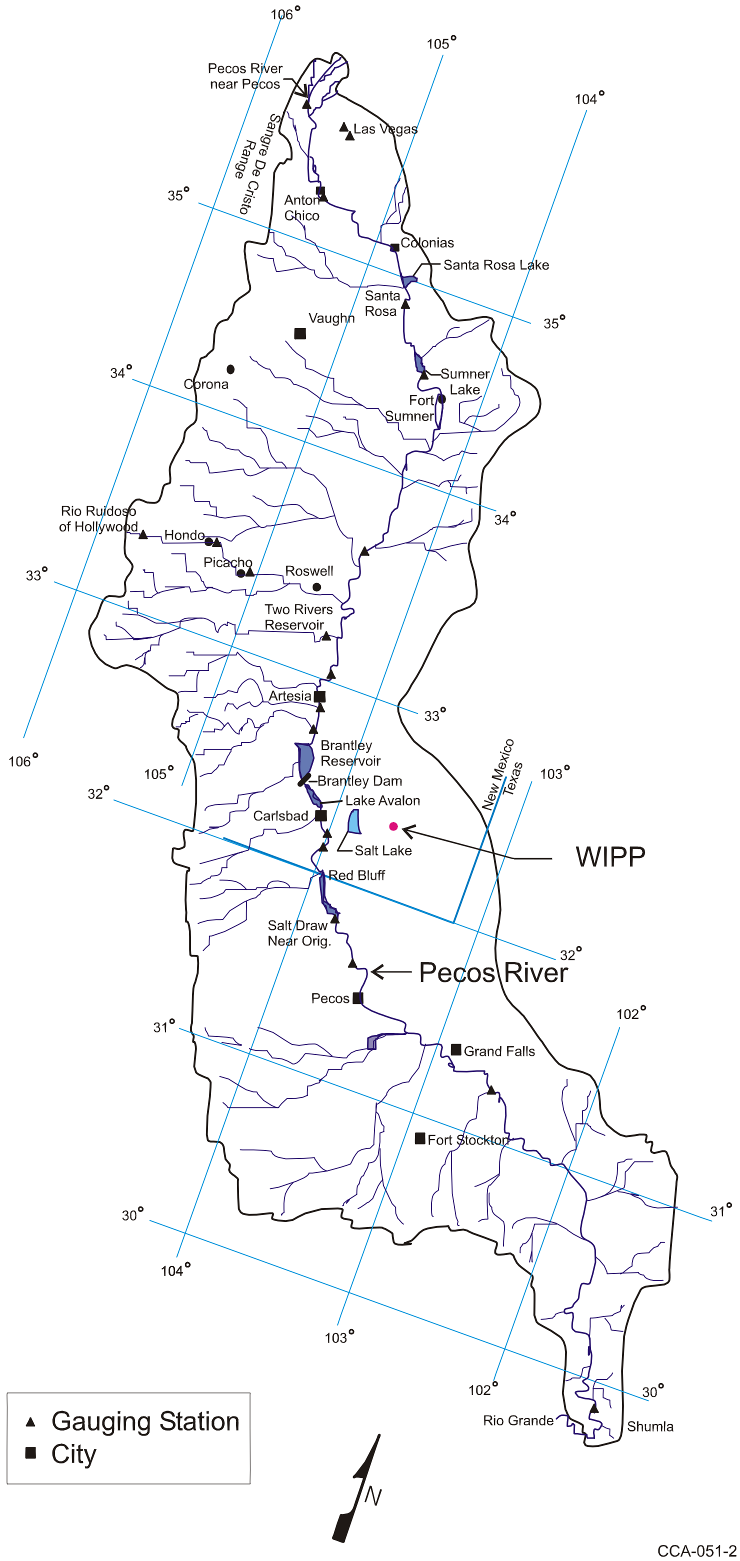


Figure 2-~~36~~*43*. Location of Reservoirs and Gauging Stations in the Pecos River Drainage Area

Table 2-~~6~~*10*. Capacities of Reservoirs in the Pecos River Drainage

Reservoir	River	Total Storage Capacity[a] (*ac-ft*)	Use[b]
Santa Rosa	Pecos	282000	FC
Sumner	Pecos	122100	IR, R
Brantley	Pecos	42000	IR, R, FC
Avalon	Pecos	5000	IR
Red Bluff	Pecos	310000	IR, P
Two Rivers	Rio Hondo	167900	FC

[a] Capacity below the lowest uncontrolled outlet or spillway.
[b] Legend:

FC flood control
IR irrigation
R recreation
P hydroelectric

precipitation at Carlsbad was 130 mm (5.12 in.) in August 1916. The predicted maximum 6-hour, 100-year precipitation event for the site is 91 mm (3.6 in.) and is most likely to occur during the summer. The maximum recorded daily snowfall at Carlsbad was 254 mm (10 in.) in December 1923.

The maximum recorded flood on the Pecos River occurred near the town of Malaga, New Mexico, on August 23, 1966, with a discharge of 3,396 m^3 (120,000 ft^3) per second and a stage elevation of about 895 m (2,938 ft) ***amsl***. The minimum surface elevation at the WIPP is over 91 m (300 ft) above the elevation of this maximum historic flood (DOE 1980, Section 7.4.1).

As discussed in the FEIS (DOE 1980, ***pp.*** 7**-** 71), more than 90 percent of the mean annual precipitation at the site is lost by evapotranspiration. On a mean monthly basis, evapotranspiration at the site greatly exceeds the available rainfall; however, intense local thunderstorms may produce runoff and percolation.

Water quality in the Pecos River basin is affected by mineral pollution from natural sources and from irrigation return flows (see Section 2.4.2.2 for discussion of surface-water quality). At Santa Rosa, New Mexico, the average suspended-sediment discharge of the river is about 1,497 metric tons/day (1,650 tons/day). Large amounts of chlorides from Salt Creek and Bitter Creek enter the river near Roswell. River inflow in the Hagerman area contributes increased amounts of calcium, magnesium, and sulfate; and waters entering the river near Lake Arthur are high in chloride. Below Brantley Reservoir, springs flowing into the river are usually submerged and difficult to sample; springs that could be sampled had TDS concentrations of 3,350 to 4,000 mg/L. Concentrated brine entering at Malaga Bend adds an estimated 64 metric tons/day (370 tons/day) of chloride to the Pecos River (***CCA*** Appendix GCR, ***pp.*** 6-7).