Chapter 17

Hydrogeology of the Salt Basin

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Introduction

The Salt Basin of West Texas has been a significant source of groundwater to local users in West Texas for most of the last century. In a region of normally low rainfall and high evaporation, groundwater is a vital resource to municipalities, industries, and landowners in the Salt Basin. Because El Paso is facing serious water shortages in the next 20 to 30 years, city and regional planners are looking, in part, to water resources in the Salt Basin. It is therefore important to understand how pumping and drought impact the aquifers of the Salt Basin to maintain its viability for West Texans in the future.

Although many people think of the Salt Basin as being the salt flats north of Van Horn, the Salt Basin as a physiographic feature extends much farther south and includes the Salt, Wild Horse, Michigan, Lobo, and Ryan Flats (fig. 17-1). The sediments beneath these flats hold water that form part of the West Texas Bolsons aquifer (Ashworth and Hopkins, 1995). The purpose of this paper is to present a brief overview of the hydrogeology of the area and to present results of water-level and water-quality information collected between 1992 and 1994 by the Texas Water Development Board.

Physiography

The Salt Basin is located in the Trans-Pecos region of West Texas. It forms a valley that extends from just north of the New Mexico border in Hudspeth and Culberson Counties along a southeastern trend through western Jeff Davis County, where it ends in the northwest portion of Presidio County. The Salt Basin is approximately 140 miles long and 25 miles across at its widest point (fig. 17-1).

The Salt Basin is a classic expression of basin and range tectonism where a broad, flat valley trending roughly north and south is bounded on the east and west by uplifted, fault-block mountains (Underwood, 1980). The basin valley separates the Diablo Plateau and Sierra Diablo, Baylor, Beach, Carrizo, Van Horn, and Sierra Viejo Mountains in the west from the Guadalupe, Delaware, Apache and Davis Mountains to the east. The highest point in the basin is at Guadalupe Peak 8,751 ft above mean sea level (amsl), while the lowest point is 15 mi due west in the Salt Flats at 3,600 ft amsl. Along the basin

[1] Texas Water Development Board

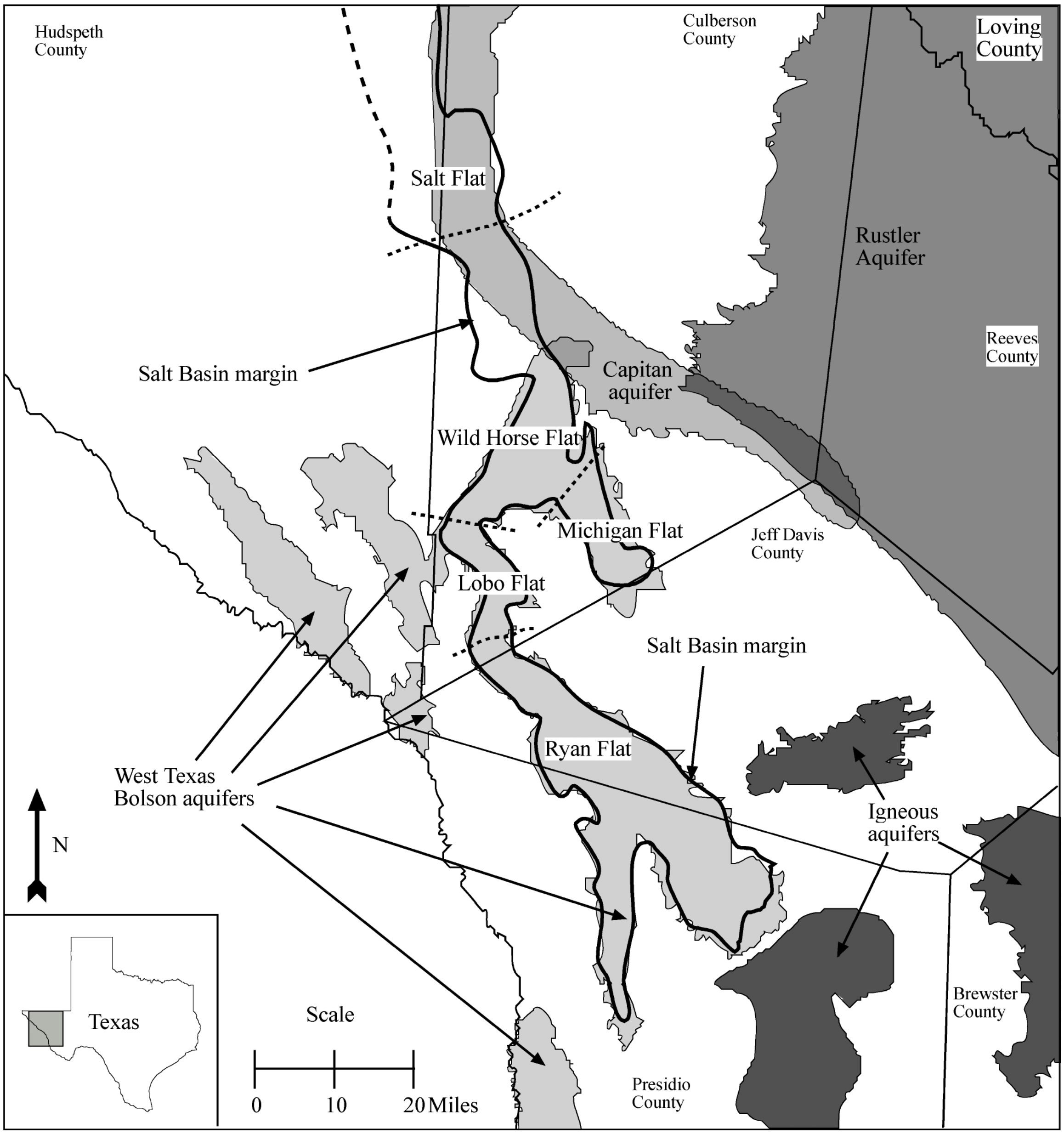

Figure 17-1: Location of the Salt Basin on base map showing the aquifer systems near the Salt Basin, the Salt Basin margins and the physiographic subdivisions of the Salt Basin.

axis from the north, the elevation of the valley floor begins at 3,600 ft amsl and remains fairly level until a midway point, where it climbs to 5,000 ft amsl in the very southern part of the basin. The basin terminates at the southern end in the Oak Hills.

Topographically the Salt Basin is a closed basin with surface drainage inward toward the center of the basin and northward to the Salt Flats (Underwood, 1980). There are no recorded perennial streams in the basin. Stream flow is often the result of rainfall activity in mountainous regions or locally intense rain showers that result in overland flow.

Climate

The climate in the Trans-Pecos region typically varies with elevation (Underwood, 1980). Below 4,000 ft amsl, climate in this region is arid to subtropical. The higher elevations tend to be cool, temperate, and humid, with warm summers. The Salt Basin has a characteristic arid environment, with hot summers and mild winters. Average daily temperatures per year are fairly constant across the basin, ranging from a low of 60°F in Marfa (period of record: 1978–1997) to a high of 63°F in Van Horn (1942–1997) (HED, 1995).

Average annual precipitation varies across the Salt Basin, although the annual amount of rainfall is low across the basin. Average rainfall totals increase with elevation and toward the southern portion of the basin. In the Salt Flats area, data collected from 1959 through 1977 show an average of 9.1 inches/yr of rainfall. In comparison, the Guadalupe Mountains, 15 mi due east, record an average of 18 inches/yr during the period 1987–1997 (HED, 1995). Farther south in the Salt Basin, the cities of Van Horn (1942–1997), Valentine (1978–1997) and Marfa (1940–1997) show an average of 10.3, 13.4 and 15.5 inches/yr of rainfall, respectively (TWDB, 2001).

Rainfall events in the Salt Basin typically occur as brief, local, high-intensity thunderstorms that deliver .05 to .2 inches of water. Three-quarters of the total yearly rainfall for the basin falls between the months of May and October. This high-rainfall period also corresponds with the period of highest temperature and evaporation. The evaporation rate is 76.2 inches/yr (TWDBEDP, 2001), five to eight times greater than average annual rainfall.

Geology

The stratigraphic record in the Salt Basin includes the Precambrian through the entire Phanerozoic, with only a few gaps between. Examples of volcanism, metamorphism, and sedimentary deposition can all be found in the Salt Basin. On the basis of geologic composition, the basin can be divided into a northern and southern portion. The basin flanks in the north consist mostly of Permian-age sedimentary formations, while the flanks in the south consist of Cretaceous and Tertiary volcanics. The basin fill in the north reflects the mostly carbonate source rock in the form of Tertiary and Quaternary alluvium, lacustrine sands, silts, muds, and evaporate deposits. The basin fill in the south reflects the volcanic sources on the flanks, as well as volcanic deposits, pyroclastic debris, lava flows, and tuffaceous deposits.

The structural history of the Salt Basin begins sometime during the Laramide orogeny, with a single-faulted monocline (Muehlberger and Dickerson, 1989). This initial fault was then later reactivated during Late Cenozoic time and subsequently evolved into the horst and graben valley we see now.

The north-trending ranges of the Guadalupe, Delaware, and Apache Mountains border the eastern side of the basin. The eastern margin of the Salt Flat is defined by the fault scarp that forms the western edge of the Guadalupe Mountains and exposes the massive, Permian-age Capitan Formation (Underwood, 1980). The Capitan Formation, composed of the Capitan Limestone and the Goat Seep Limestone, is a reef system deposited on the margins of the Delaware Basin (Bebout and Kerans, 1993). Farther south along this eastern flank, the Bell Canyon, Cherry Canyon, and Brushy Canyon Formations are exposed in the Delaware and Apache Mountains. It is in this northern area that the Salt Basin gets its name, from the numerous salt playas that have formed on the western side of the valley floor. West of the Delaware Mountains are the Sierra Diablo Mountains. These mountains are unique because an almost complete geologic record from the Precambrian through the Cretaceous can be seen here (Underwood, 1980). Only Cambrian, Triassic, and Jurassic ages are absent from this exposure. More toward the center of the basin, near the town of Van Horn, are the Beach and Baylor Mountains. These are small, up-thrown fault blocks composed of Precambrian, Ordovician, and Permian-age rocks. A third up-thrown block of Permian limestone forms the Wylie Mountains that bifurcate the valley into Lobo Flats to the west and Michigan Flats to the east.

The Tertiary volcanics of the Davis Mountains compose the eastern sides of the southern portion of the Salt Basin. The Precambrian strata of the Carrizo Mountains, the Cretaceous sandstones and limestones of the Van Horn Mountains, and the Tertiary volcanics of the Sierra Vieja Mountains form the western sides of the basin. The Van Horn Mountains act as a bridge from the Permian to the Tertiary, with exposures of the Cox Sandstone, the Bluff Mesa, Loma Plata and other Cretaceous Formations (Barnes, 1979). The southern portion of the Salt Basin is dominated by Tertiary volcanic formations. The Petan Basalt, Bracks Rhyolite, Capote Mountain Tuff, the Sheep Pasture Formation and many others make up the southern half of the Wylie Mountains, the Davis mountains in the east, and the Sierra Vieja mountains to the west (Barnes, 1979). The southern end of the basin terminates in the Tertiary conglomerates that form the Oak Hills.

Hydrogeologic Setting

Hydrostratigraphy

The Salt Basin consists mostly of late Tertiary- and Quaternary-age deposits that fill the basin. The basin fill reflects the local composition of the bordering mountains

Table 17-1. Characteristics of water-bearing units in the Salt Basin area (after Gates and others, 1980; Boyd and Kreitler, 1986).

Erthem [what?]	System	Unit	Physical and Lithologic Characteristics	Water-Bearing Characteristics
Cenozoic	Quaternary and Tertiary	Bolson deposits	Unconsolidated clay, silt, sand, and gravel derived from weathering and erosion of local rock and deposited by ancestral drainages within the Salt Basin; commonly 1,000 to 2,000 ft thick. Interbedded carbonates, gypsum, and salines of the playas derived from evaporation of groundwater originating in Permian strata of the surrounding highlands.	Supplies moderate to large quantities of fresh to saline water to the northern parts of the Salt Basin, mostly in fine-grained lacustrine and alluvial deposits.
	Tertiary	Volcaniclastic and volcanic deposits	Reworked tuffs and alluvial deposits consisting almost exclusively of volcanic debris (volcanic clastics) interbedded with ash-flow tuffs and volcanic flows up to 6,000 ft thick in Ryan Flat.	Supplies small to large quantities of fresh water in Ryan and Lobo Flats; permeable zones probably most common in the uppermost 1,000 ft and may include well-reworked tuff, well-sorted volcaniclastics, weathered zones above and below volcanic flows, and possibly fractured volcanic-flow rocks.
Mesozoic	Cretaceous	Cox Sandstone	Mostly quartz sandstone with some pebble conglomerate and siltstone, shale, and limestone; very fine to medium grained; commonly less that 200 ft thick but can be as much as 700 ft thick.	Supplies small to moderate quantities of fresh to moderately saline water in eastern and southern Wild Horse Flat.
Paleozoic	Permian	The Capitan and Goat Seep Limestone, undifferentiated limestones and sandstones, including the Delaware Mountain Group	Capitan and Goat Seep limestones are massive, thick-bedded reef limestones and dolomite; Capitan is 1,000 –2,000 ft thick in the Guadalupe Mountains and Beacon Hill area and up to 900 ft thick in the Apache Mountains area; the Delaware Mountain Group is sandstone and limestone with some siltstone; aggregate thickness is on the order of 3,000 feet. Permian gypsum deposits of the Guadalupe and Delaware Mountains contribute significant amounts of sulfate to the groundwater system.	Capitan and Goat Seep Limestones supply moderate to large quantities of fresh to slightly saline water in the Beacon Hill area. The Capitan supplies moderate to large quantities of fresh to slightly saline water in the Apache Mountain area. The sandstones and limestones of the Delaware Mountain Group supply small quantities of slightly to moderately saline water along the eastern side of the northern Salt Basin and foothills of the Delaware Mountains.

(table 17-1). In the Salt Flats, Wild Horse Flats, and Michigan Flats area, the fill is mostly lacustrine and fluviatile deposits of clay, silt, sand, gravel, caliche, and gypsum (Barnes, 1983). This fill reflects the surrounding highland Permian sedimentary deposits of similar composition. In the Ryan and Lobo Flats area the basin fill is similar to that of the northern areas, but the clay, silt, and sandstone are red in color and the conglomerates are composed of volcanic materials—pebbles and cobbles of vesicular, aphanitic, and porphyritc textures (Barnes, 1979).

Recharge

The basin fill is recharged by infiltration of precipitation along basin boundaries and by groundwater flow between flats. Groundwater recharge from surface infiltration generally occurs along the valley margins and foothill regions, where surface sediments are courser grained and more permeable (Gates and others, 1980). Some recharge might occur in ephemeral streambeds, but the majority of this recharge is likely lost to evaporation or transpiration. Because recharge is difficult to quantify in West Texas, it is generally assumed to be about 1 percent of average annual precipitation (Gates and others, 1980). Assuming 11.5 inches of rain annually and a drainage area of 2,760 mi^2, the recharge to the Salt Basin from surface infiltration could be about 17, 000 acre-ft/yr (Gates and others, 1980). Basin fill beneath the flats is also recharged by groundwater flow within the Salt Basin. Groundwater flows from Ryan Flat into Lobo Flat, from Lobo Flat into Wild Horse Flat, and from Wild Horse Flat into Michigan Flat. Water levels in the southern portion of the Salt Flat indicate that groundwater flows from the Salt Flat area into the northern portion of Wild Horse Flat.

Discharge

Discharge occurs by a variety means from the Salt Basin. Evaporation from the land surface occurs throughout the basin but is a primary means of discharge in the Salt Flat area. Cross-formational flow from the basin fill into adjacent formations is also important and seems most apparent in the Wild Horse Flat area. Groundwater pumping accounts for the majority of discharge from the entire Salt Basin.

Salt Flat

Groundwater in the Salt Flat discharges by evaporation, leakage to other formations, and pumping. Boyd and Kreitler (1986) found that groundwater in the Salt Flat area discharges by evaporation where the land surface is bare and by transpiration from phreatophytes where the land is vegetated.

Because the hydraulic conductivity in the basin fill is one or two orders of magnitude less than the underlying Capitan Reef aquifer, very little water discharges from the Salt Flat to the Capitan (Hiss, 1980).

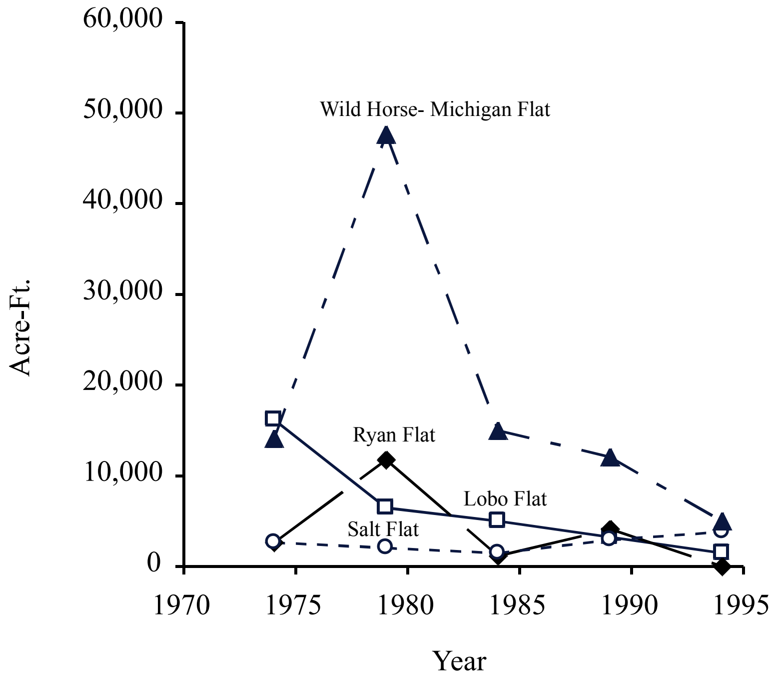

Figure 17-2. Volume of irrigation water used in Salt Basin.

The first irrigation wells were drilled in the Salt Basin area in the late 1940's. This development continued slowly until about 1973, when the last recorded irrigation well was drilled. The majority of groundwater pumped in the Salt Flat area comes from the Capitan and Goat Seep Limestones that lie under the basin fill. Pumping has been fairly steady at about 2,600 acre-ft/yr from 1974 through 1994 (fig. 17-2).

Wild Horse Flat

Groundwater in Wild Horse Flat discharges by leakage to other formations, pumping, and outflow from the bolson. Gates and others (1980) reported that water levels showed potential for discharge to the east. LaFave and Sharp (1987) suggested that a component of the spring flow in the Balmorhea area is a result of flow from the southern Salt Basin (the Michigan Flat area), through the Capitan Formation, into the Lower Cretaceous and then exiting at the springs. Although groundwater pumping for irrigation accounts for the greatest withdrawals in the Wild Horse and Michigan Flats area, it has been on the decline steadily since it peaked in 1984 (fig. 17-2). There was some pumping for industrial use at a talc-processing facility between 1972 and 1991. The yearly average of pumping at the talc plant was 5.5 acre-ft/yr. The City of Van Horn has six public supply wells that have averaged 654 acre-ft/yr of production between 1972 and 1994.

Lobo and Ryan Flat

Most of the discharge from Lobo Flat is from pumping. Gates and others (1980) reported that between 1951 and 1972 about 320,000 acre-ft, or an average of about 15,000 acre-ft/yr, of water was pumped. However, pumping has slowly declined since the 1970's (fig. 17-2). Pumping in the Ryan Flat area accounts for the majority of discharge, and since the 1970's it has been in steady decline. By 1994, there was no pumping for irrigation in Ryan Flat according to the TWDB survey.

Water Levels and Groundwater Flow

The TWDB has collected water-level information on specific wells in the Salt Basin area as far back as the 1950's. Water levels in the Salt Basin generally follow the topographic relief of the basin. The highest water levels are in the southern part of the basin, where the land surface is correspondingly high. Water levels in wells along the basin margins are generally higher that those toward the basin center. Water-level maps made from data collected by the TWDB between 1992 and1994 show that groundwater generally flows from the northern and southern ends of the basin into the central part of the basin (figs. 17-3, 17-4). Most wells in the Salt Flat area penetrate the basin fill and are completed in the underlying Capitan or Delaware Mountain Formations. Water levels in the Capitan Formation have decreased about 10 to 20 ft in the last 40 yr of measurement (fig. 17-5).

Water levels in Wild Horse Flat show that water is relatively shallow and groundwater flow is to the south (fig. 17-3). Water levels decline from 3,590 ft above mean sea level (amsl) to 3,550 ft amsl. At the midpoint of Wild Horse Flat, there appears to be a slight mounding of groundwater that forms a groundwater divide where the basin fill is bottlenecked between the Baylor Mountains and the Apache Mountains. Groundwater in the southern part of Wild Horse Flat forms a slight depression, were water levels only range about 15 ft, from 3,540 ft amsl to 3,525 ft amsl. Hydrographs from wells in Wild Horse Flat show an overall decline in water levels of about 30 ft since 1950. Groundwater also flows from Wild Horse Flat southeast into Michigan Flat. Water levels in Michigan Flat are also slightly depressed on the south and eastern sides of the basin, indicating either a shallow cone of depression or that groundwater is flowing in a easterly direction out of Michigan Flat and into the Cretaceous and Permian formations that form the basin walls.

Water levels in the southern portion of the Salt Basin indicate that groundwater flows from Lobo Flat at an elevation of 4,200 ft amsl north to Ryan Flat at an elevation of 3,600 ft amsl (fig. 17-4). From Ryan Flat, groundwater flows into Wild Horse Basin. Hydrographs in both Ryan Flat and Lobo Flat indicate that there has been a slight rise in water levels in the past 20 to 50 yr (fig. 17-5). One well shows an increase of about 20 ft in Ryan Flat since 1950, and a second well in Lobo flat shows about a 10-ft rise in water levels since 1978.

Water levels in the Salt Basin appear not to be declining as much during the last decade as they did during the 1950's through the 1980's. This is partly a result of decreased pumping due to the decline in irrigation since the 1980's.

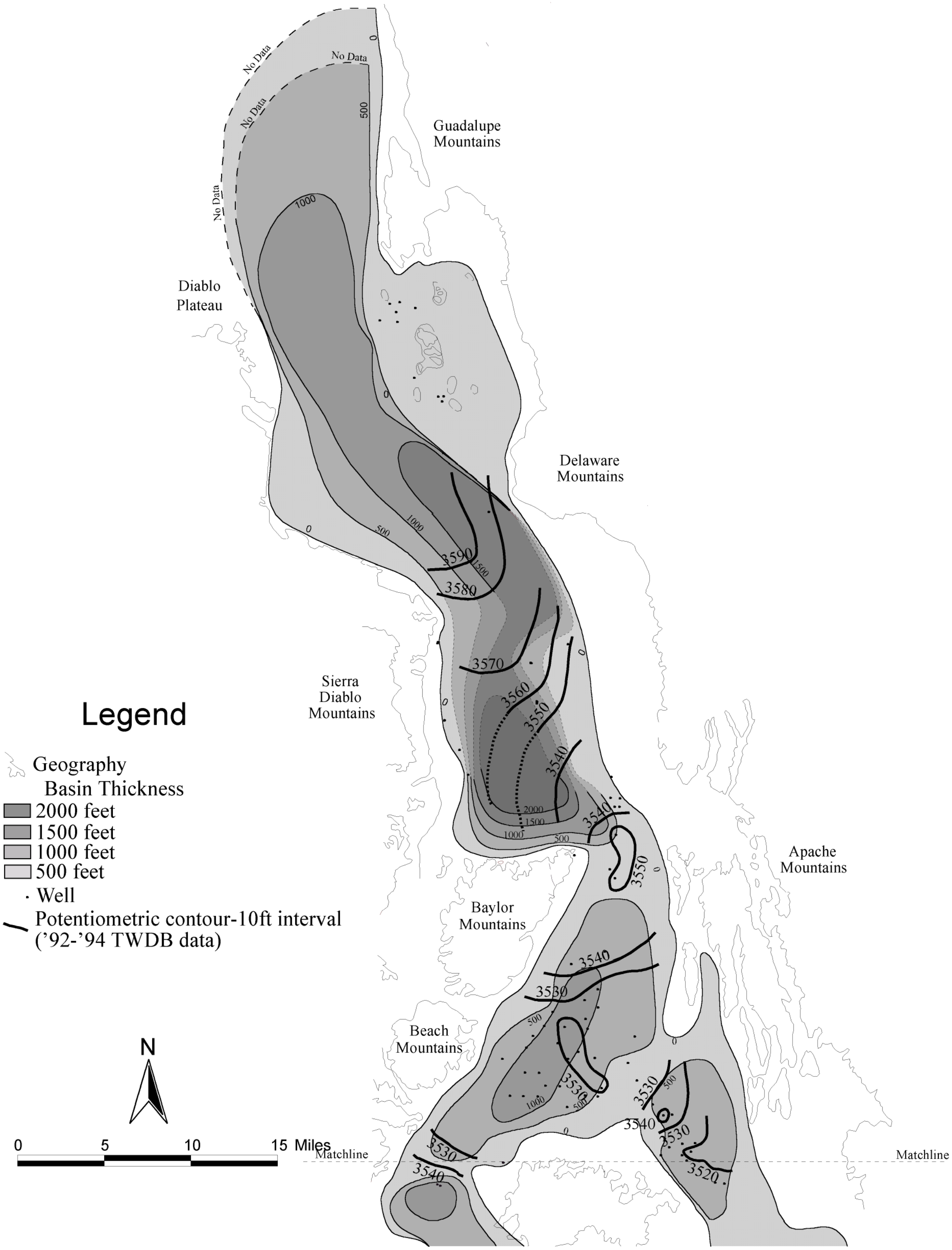

Figure 17-3: Thinkness of basin-fill and water-level contours in the northern Salt Basin (interpretation of basin fill modified from Gates and others, 1980).

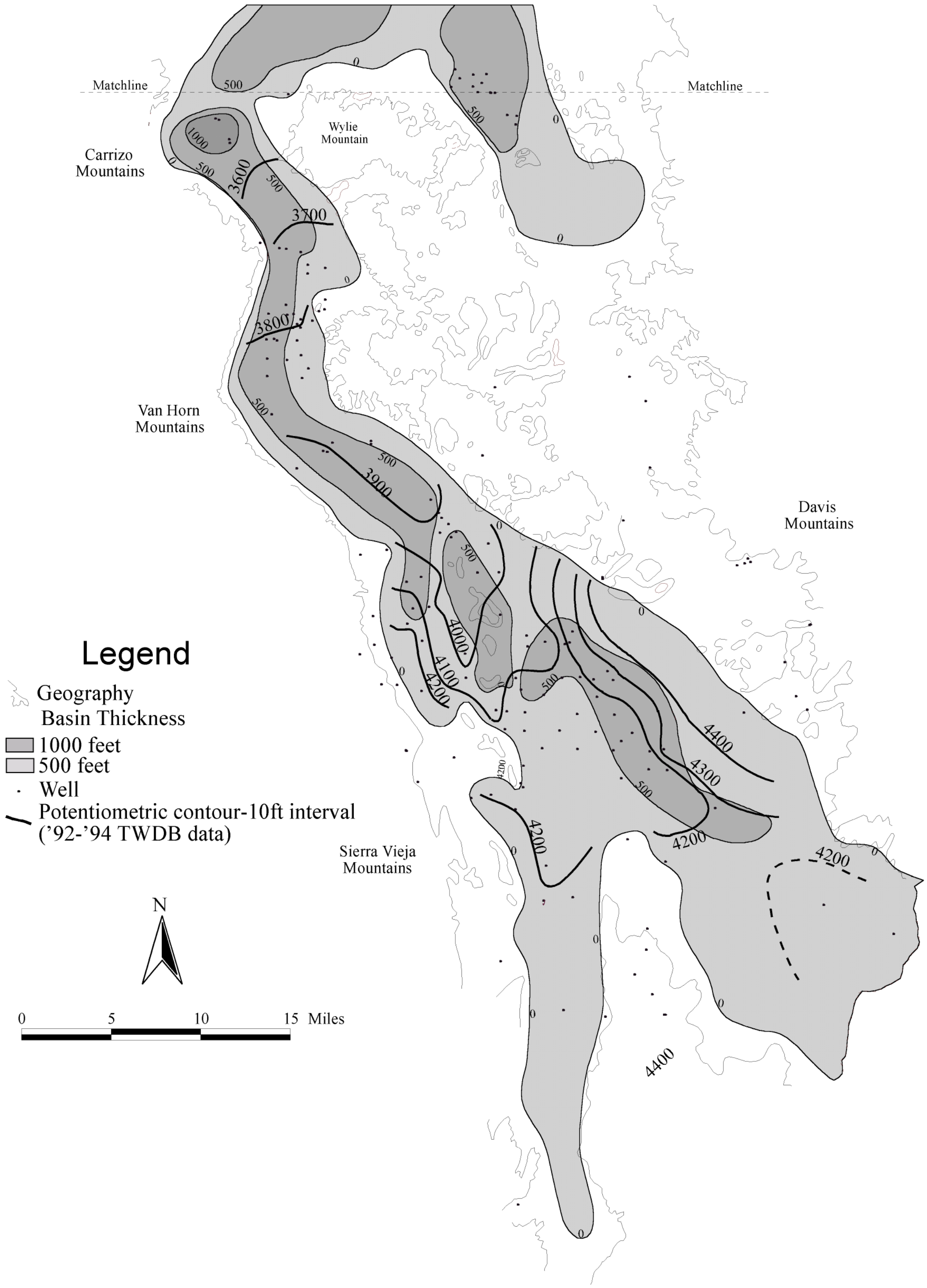

Figure 17-4: Depth of basin-fill and water-level contours in southern Salt Basin (interpretation of basin fill modified from Gates and others, 1980).

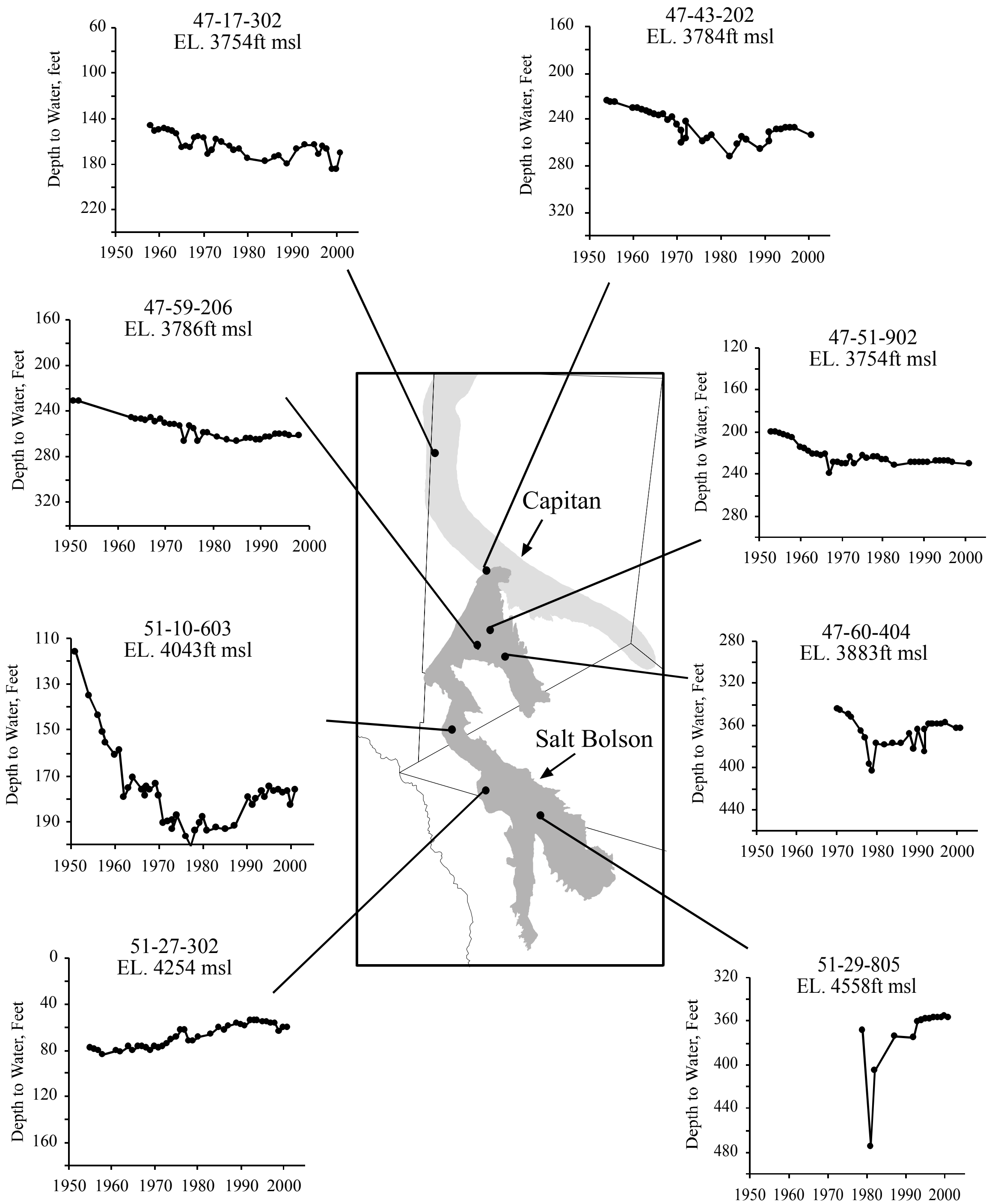

Figure 17-5: Hydrographs from various wells in the Salt Basin area. The Salt Bolson refers the bolson aquifers in the Salt Basin.

Hydraulic Properties

Hydraulic properties of the aquifer in the Salt Basin vary considerably, depending on the local depositional character of the basin fill. Wells with high transmissivity values in the Salt Flat area are almost all completed partially or entirely in the underlying Capitan Formation. The highest transmissivity of any well in the Salt Basin occurs in well 47-09-207, which is completed in the Capitan Formation with a value of 80,000 ft^2/d. Wells in the Wild Horse Flat and Michigan Flat area tend to have higher transmissivity values when they are completed in the underlying Cretaceous formations than solely in the basin fill. In the southern portion of the Salt Basin, wells completed solely in the basin fill tend to have higher transmissivity values than wells that are also completed in the underlying volcanics or solely in volcanic formations (table 17-2).

Water Quality

Water quality in the Salt Basin ranges from very saline in the northern part of the basin to fresh in the southern part. The basin fill in the Salt Flat area is thought to have little fresh or saline water, with the exception of the shallow groundwater associated with the salt playas (Gates and others, 1980). Total dissolved solids (TDS) of 3,000 to 6,000 mg/L are not uncommon in this area. With TDS values between 1,500 and 2,500 mg/L, well 47-34-603 (fig. 17-6) is representative of many wells in the Salt Flat area. Sodium, sulfate, and chloride levels are also elevated in these wells, rendering the water of limited use. Farther south in Wild Horse Flat, water quality improves slightly, where TDS is typically less than 1,000 mg/L. Wells 47-51-701, 47-59-101, and 47-60-707 are representative of average water-quality conditions for wells in Wild Horse Flat (fig. 17-6). Farther south in the Ryan Flat area, the aquifer has some of the freshest water in the Salt Basin area, with very low TDS sulfate, chloride and sodium values (fig. 17-6).

Overall, the wells in the Salt Basin show very little change in water quality over time. Only three of the six wells measured show any decrease in water quality over time, and these declines in water quality are very small (fig. 17-6). This lack of change in water quality indicates that there is very little impact from irrigation return-flow or migration of poorer quality water to the groundwater system in the Salt Basin at the present time. Although there have been several periods of intense pumping in the Salt Basin in the last 60 yr, the lack of change in water quality also indicates that up to now, there has been little impact from cross-formational flow from adjacent formations.

Groundwater Availability

Well-completion strategies in the Salt Basin are governed by the need to access all available water when drilling. Therefore, many wells are completed in the basin fill and in basement formations where water is available. In the Salt Flat and northern Wild Horse Flat area, the groundwater in the basin fill is so poor that many wells are screened in both the underlying Capitan Formation and Delaware Mountain Group. In the southern portion of Wild Horse Flat and Michigan Flat, many wells are completed in the underlying

Table 17-2. Hydrologic data from the Salt Basin area.

Location	State Well Number	Aquifer	Transmissivity ft^2/d	Source
Salt Flat	4709207	Capitan Reef Complex and Associated Limestones	80,000	CSC
	4717218	Salt Bolson	2,500	CSC
	4717317	Capitan Reef Complex and Associated Limestones	11,000	AT*
	4717321	Salt Bolson and Capitan Reef Complex	45,000	CSC
	4717903	Capitan Limestone	1,400	AT*
	4718402	Delaware Mountain Formation or Group	400	AT*
	4718404	Salt Bolson and Delaware Mountain Group	500	CSC
	4718707	Salt Bolson and Delaware Mountain Group	4,300	CSC
Wild Horse Flat	4734902	Capitan Reef Complex and Associated Limestones	10,000	AT*
	4743503	Delaware Mountain Formation or Group	1,100	CSC
	4751403	Salt Bolson and Permian Rocks	19,000	AT*
	4751807	Salt Bolson	4,100	CSC
	4752301	Capitan Reef Complex and Associated Limestones	500	CSC
	4752601	Capitan Reef Complex and Associated Limestones	11,000	CSC
	4752602	Capitan Reef Complex and Associated Limestones	2,000	AT*
	4758502	Salt Bolson	900	CSC
	4758505	Salt Bolson	1,600	CSC
	4758602	Salt Bolson	5,000	AT*
	4758602	Salt Bolson	6,300	AT*
	4759102	Salt Bolson and Cretaceous Rocks	6,000	AT*
	4759209	Cretaceous System	2,600	AT*
Michigan Flat	4759307	Salt Bolson and Cretaceous Rocks	1,900	AT*
	4759603	Cretaceous System	2,000	CSC
	4760404	Salt Bolson	1,000	CSC
	4760601	Permian System	30	CSC
Lobo Flat	5102906	Salt Bolson	8,600	CSC
	5102918	Salt Bolson	1,100	CSC
	5102923	Salt Bolson	4,900	CSC
	5102926	Salt Bolson	2,500	AT*
	5103702	Salt Bolson	6,400	CSC
	5103703	Salt Bolson	500	CSC
	5110306	Salt Bolson	1,500	CSC
	5110309	Alluvium and Tertiary Volcanics	5,800	CSC
	5110316	Salt Bolson	5,100	CSC
	5110317	Alluvium and Tertiary Volcanics	2,400	CSC
	5110321	Salt Bolson	6,900	CSC
	5110322	Salt Bolson	2,000	CSC
	5110328	Salt Bolson	4,800	CSC
	5110331	Alluvium and Tertiary Volcanics	4,200	CSC
	5110332	Salt Bolson	4,700	CSC
	5110603	Salt Bolson	3,000	AT*
	5110603	Salt Bolson	2,400	CSC
	5110624	Salt Bolson	380	CSC
	5111105	Salt Bolson	3,400	CSC
	5111106	Salt Bolson	1,600	CSC
	5114501	Volcanics	70	CSC
	5119104	Salt Bolson	3,000	CSC
	5119301	Salt Bolson	5,200	CSC
	5120403	Salt Bolson	800	CSC
	5120404	Salt Bolson	1,700	CSC
Ryan Flat	5127302	Volcanics	910	CSC
	5128303	Salt Bolson	1,900	CSC
	5128606	Salt Bolson	1,200	CSC
	5129104	Salt Bolson	30	CSC
	5129105	Salt Bolson	230	CSC
	5129403	Salt Bolson	2,000	CSC
	5128404	Salt Bolson	5,500	CSC
	5128406	Salt Bolson	3,000	CSC
	5128702	Salt Bolson	9,200	CSC
	5129704	Salt Bolson	1,900	CSC
	5129705	Salt Bolson	4,900	CSC
	5128701	Salt Bolson	10	AT*
	5136601	Salt Bolson	9,900	AT*

*AT - Aquifer Test

*CSC - Calculated from Specific Capacity

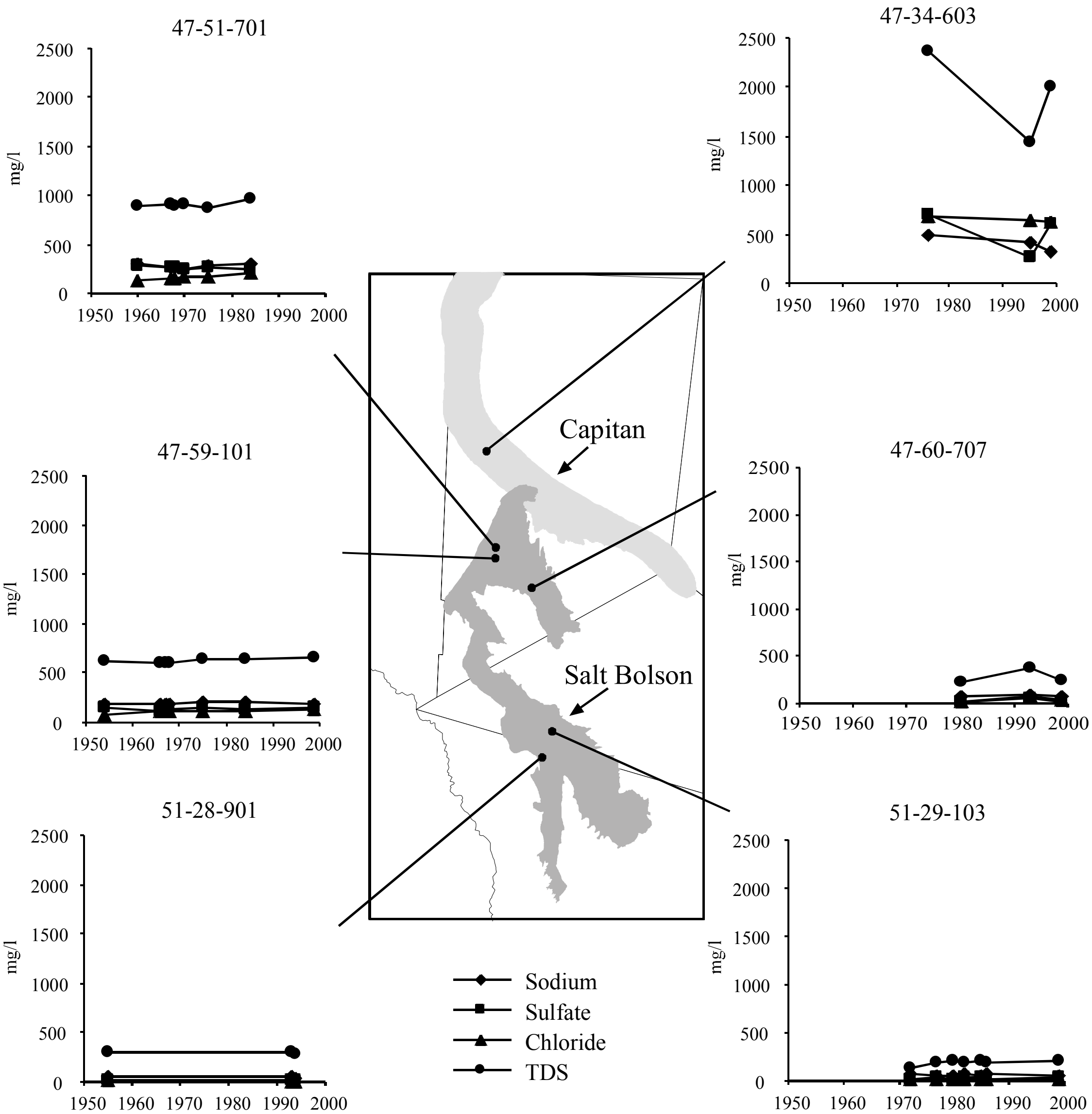

Figure 17-6: Water quality from the Salt Basin.

Cretaceous formations, as well as the basin fill. In the Lobo and Ryan Flat areas, some wells are completed in the basin fill and underlying Tertiary volcanic formations.

Gates and others (1980) investigated the availability of fresh and saline water in the West Texas Bolsons, including the Salt Basin. They concluded that the greatest amounts of fresh water were found in the Lobo and Ryan Flats area, with a combined volume of approximately 4.6 million acre-ft. However, they also noted that the development of groundwater from these basins would result in large water-level declines because of thelow recharge rate. Brown and Caldwell (2001) investigated the potential of developing 15,000 acre-ft/yr of groundwater from the West Texas Bolsons to pipe to El Paso. They noted that when the aquifer was pumped at 15, 000 acre-ft/yr between 1949 and the early 1980's, water levels declined up to 144 ft. Because pumping was greatly reduced in the 1980's, water levels have only recovered 30 percent (Brown and Caldwell, 2001). Brown and Caldwell (2001) concluded that water from Lobo and Ryan Flats may not be economically feasible owing to low recharge, declining water quality, the high cost of development, and limited availability of groundwater.

The Beldon Foundation is funding work on a model of the bolson aquifer in parts of Wild Horse, Michigan, and Lobo Flats (CCGCD, 2001). This model will be a useful tool to assess the possible impacts of increased pumping on water levels.

Conclusions

Fresh to slightly saline water in the Salt Basin aquifer occurs in the basin fills beneath the Salt, Wild Horse, Michigan, Lobo, and Ryan Flats and is part of the West Texas Bolsons aquifer recognized by the TWDB. Basin fills in the Salt Basin consist of Tertiary and Quaternary alluvium, lacustrine sands, silts, muds, evaporate deposits, pyroclastic debris, lava flows, and tuffaceous deposits. Many of the wells in the Salt Basin also penetrate and produce water from underlying formations, including the Capitan Reef and Igneous aquifers. Because of the dry climate, geology, and topography, recharge is low and focused along basin boundaries. Most of the discharge from the aquifer is by pumping, discharge to the Salt Flats, and cross-formational flow. The aquifer generally has good well yields and good water quality in the southern part. Water levels have declined in response to pumping, although the rate of decline has slowed because of decreases in irrigation. There does not appear to be a substantial decline in water quality over time.

Studies suggest that there may be a considerable amount of fresh water in the bolson fills of Lobo and Ryan Flats. However, because of low recharge rates, water pumped from these aquifers will cause large water-level declines. Recent studies suggest that producing large amounts of water from these areas may not be economically feasible.

Acknowledgments

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