Montana Bureau of Mines and Geology

Open-file Report

Evaluation of Non-Point Source Pollution in the Red River Watershed Glacier and Toole Counties, Montana

MBMG 396

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Evaluation of Non-Point Source Pollution in the Red River Watershed Glacier and Toole Counties, Montana

by

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Sponsored by the Glacier County Conservation District

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EVALUATION OF NON-POINT SOURCE POLLUTION IN THE RED RIVER WATERSHED, GLACIER AND TOOLE COUNTIES, MONTANA

I. INTRODUCTION

A. Purpose and Scope

The purpose of the evaluation is to determine whether petroleum and agricultural activities are degrading ground- and surface-water quality in the Red River watershed and, if so, to select sites for remediation. The Red River watershed is located in northern Glacier County and northwestern Toole County (figure 1). Oil-field brines, saline seeps, petroleum pipeline leaks, and feedlots are among perceived threats to water quality in shallow aquifers used for domestic supplies and stock water. To determine if any of the above sources of contamination might be affecting the water resources of the Red River watershed, an extensive hydrogeologic investigation was conducted. Land-use practices that might affect the quality of ground water or surface water were also investigated. Because the Red River and tributaries are ephemeral, only limited surface-water data could be collected.

B. Acknowledgments

This project was funded by the 319 Non-Point Source Pollution Program administered by the Montana Department of Environmental Quality and sponsored by the Glacier County Conservation District. The cooperation and assistance of Gloria Mason of the Glacier County Conservation District and of well owners in Glacier and Toole Counties are gratefully acknowledged. In addition to the authors, other employees who worked on the project include Katie McDonald, Research Specialist at the Montana Bureau of Mines and Geology (MBMG), and Montana Tech students Roger Torgerson and Heather Dusterhoff. Herb Thackery provided valuable consulting support in preparing a report on the status of injection wells in the Red River watershed.

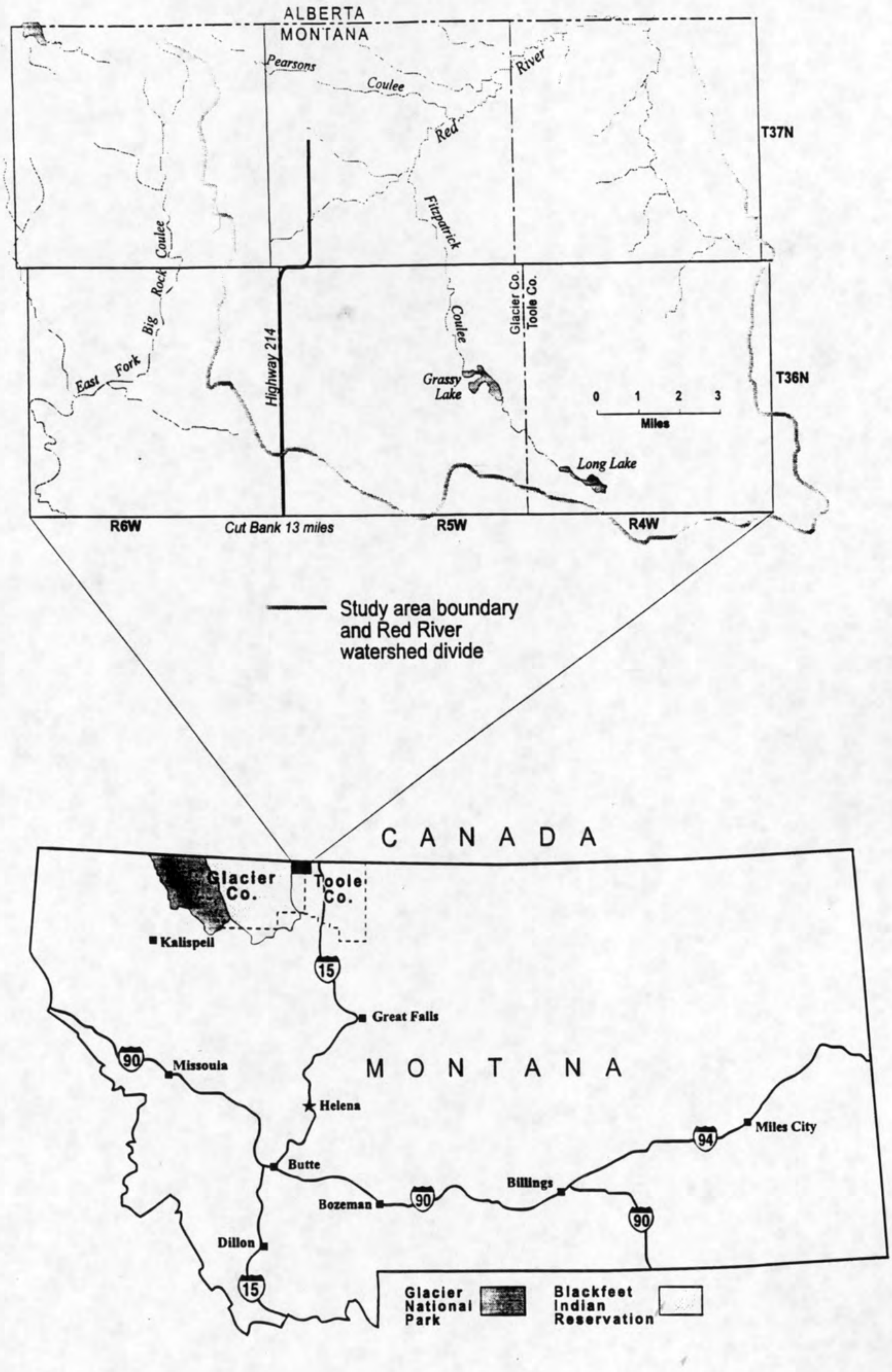

Figure 1. Location of study area.

C. Previous Investigations

Alden and others published a map in 1913 showing the glacial geology of the area, including the Red River drainage. In 1946, Nordquist and others published a structure contour map of the Cut Bank-West Kevin-Border district. Numerous articles discussing oil and gas fields in the area have been published in Montana Geological Society guidebooks. The first ground-water study of the area was a Montana Bureau of Mines and Geology publication by E. A. Zimmerman in 1967, which discussed the geology and hydrology of the Cut Bank area.

D. Numbering System for Inventoried Sites

The system of numbering data points in this report is based on the U.S. Bureau of Land Management system of subdivision of public lands. The project lies within the Montana Principal Meridian system: data-point numbers are ascribed that identify specific locations within the system. The first two digits of a data-point number indicate the township north of the baseline; the next two, the range west of the principal meridian; and the fifth and sixth digits, the section in which the data point is located (figure 2). The letters A, B, C, and D, following the section number, locate the point within the section. The first letter denotes the 160-acre tract; the second, the 40-acre tract; the third, the 10-acre tract; the fourth, the 2.5-acre tract; and so on to as small a tract as can be identified for a particular data point (up to 6 tracts for this project). The letters are assigned in a counterclockwise direction, beginning in the northeast quadrant. If two or more data points are located in the same tract, numbers are added as suffixes. It is important to note that the order of quarter-tract designations is exactly reversed from that commonly used by surveyors; here the order begins with the largest quarter and progresses to the smallest. Thus in figure 2, the designation 020316ABDA identifies the first data point in the NE1/4 SE1/4 NW1/4 NE1/4 of sec. 16, T. 2 N., R. 3 W.

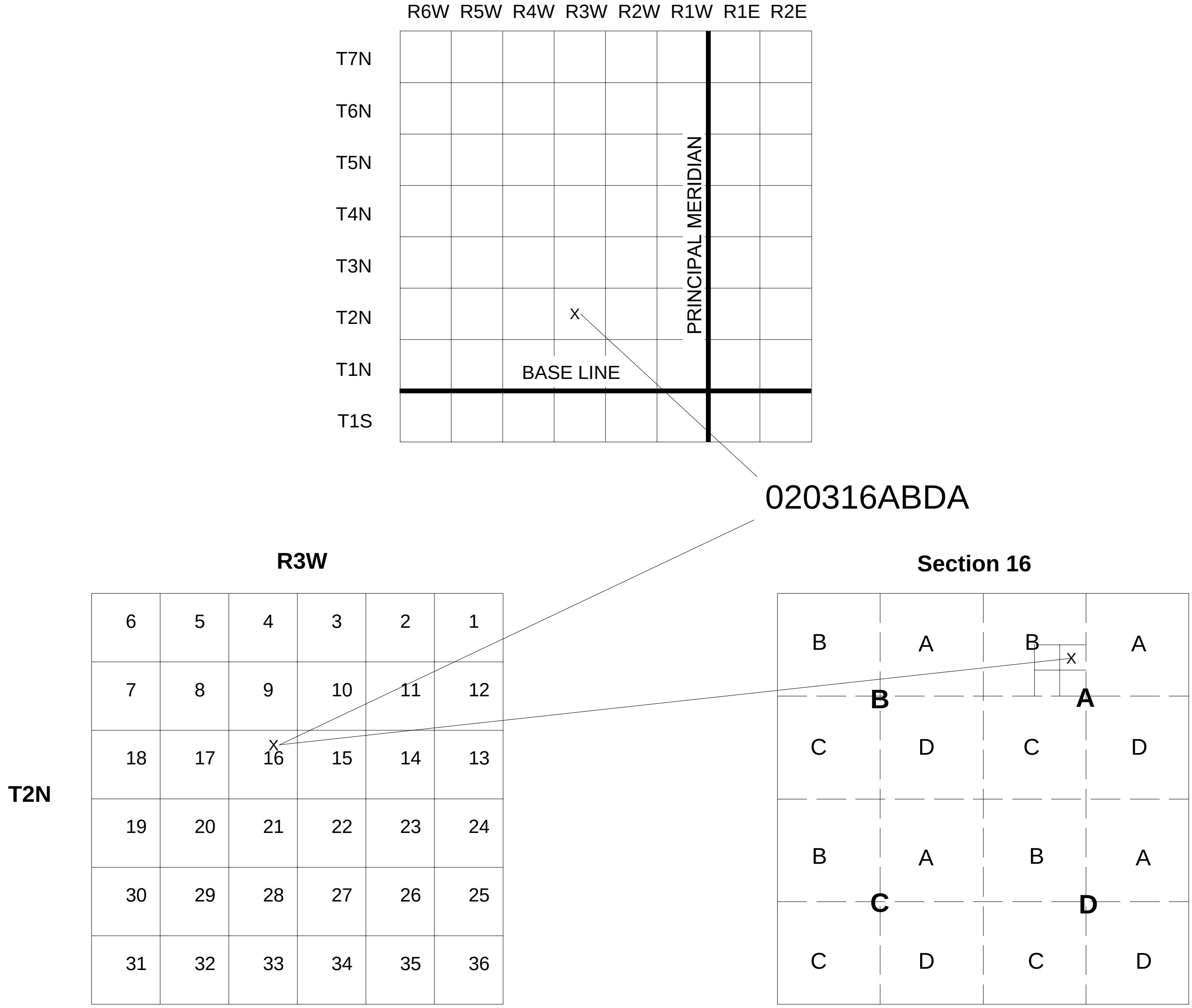

Figure 2. Data-point numbering system.

E. Location, Physiography, and Climate

The Red River drainage (T. 36 and 37 N., R. 4, 5, and 6 W.) is located about 12 miles due north of the town of Cut Bank and can be accessed by Highway 214. The drainage area includes Pearsons Coulee, Long Lake, Grassy Lake, and Fitzpatrick Coulee (figure 1). The drainage is located at the eastern edge of the Blackfeet Indian Reservation and along the U.S. – Canada border. The Red River flows north into Alberta, Canada, where it joins the Milk River.

The primary industries in the area are dryland agriculture (mostly small grains) and petroleum development. Most of the agricultural operations that had cattle in the past are now raising grain. Oil fields in the drainage include the Cut Bank, Reagan, Blackfoot, Graben Coulee, Red Creek, Darling and Border. Gas fields include the Cut Bank, Reagan, Bradley and Fitzpatrick. The topography of the 138,000-acre project area is rolling plains with many small, un-drained depressions. An escarpment about 200-feet high marks the outcrop of the Virgelle Sandstone along an irregular line extending from a point about 5 miles east of Cut Bank to a point near the town of Sweetgrass. The total relief is about 1,000 feet (Zimmerman, 1967). Drainage is poorly developed in much of the project area, and features numerous small, undrained depressions and ephemeral streams.

The climate is semi-arid. As shown on figure 3, annual precipitation varies widely from year to year. The average annual precipitation for the Cut Bank area for the period between the years 1912 and 1994, was 11.71 inches (NOAA, 1996). In an average year, most of the precipitation can be expected to occur in the months of May, June, and July, corresponding with the growing season for small grains.

Temperatures vary widely; extremes range from over 100°F in the summer to less than –45°F in the winter. The average frost-free season is 116 days. Evaporation, enhanced by strong winds, is about 50 inches per year (Zimmerman, 1967).

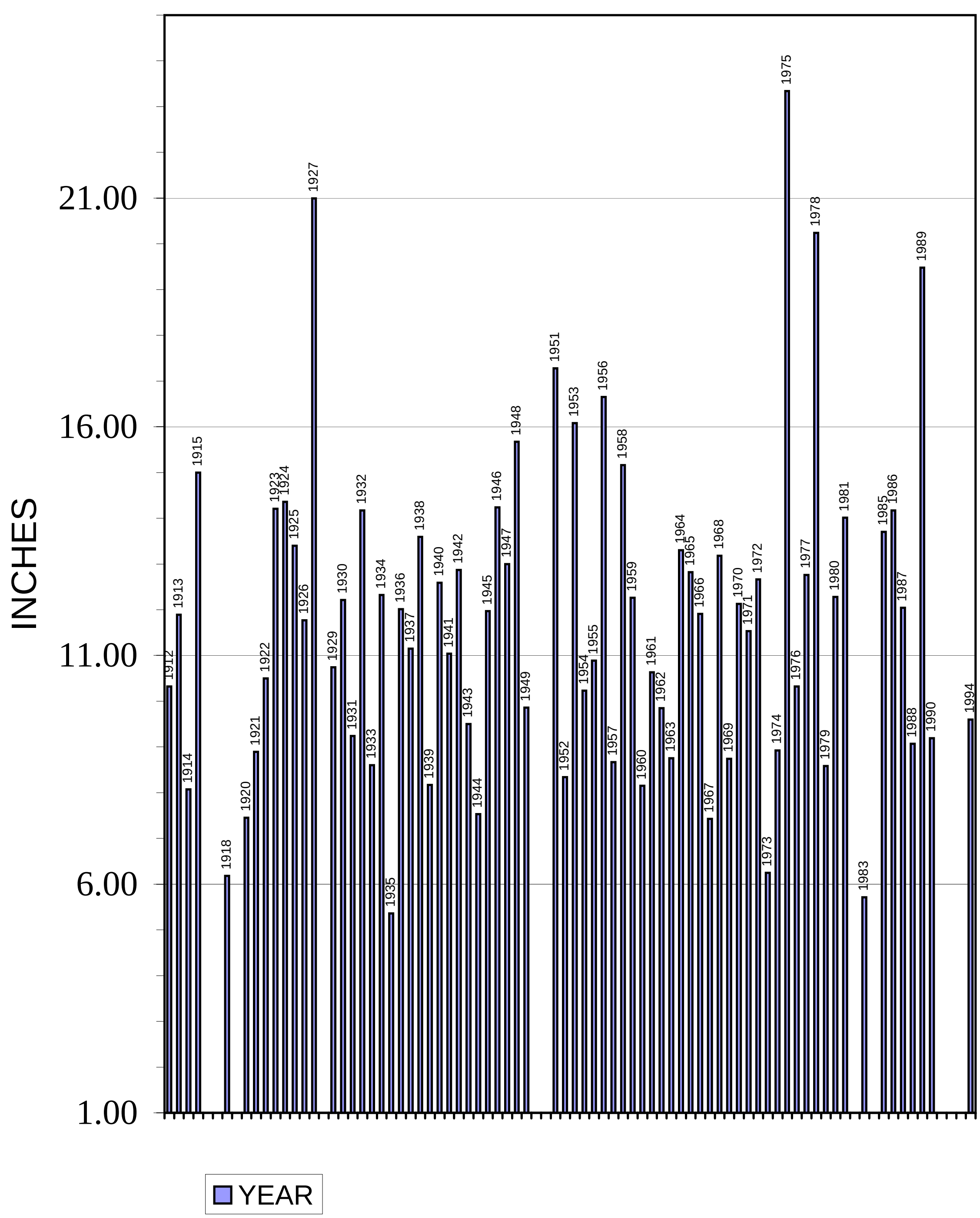

Figure 3. Annual precipitation for the Cut Bank area for the years 1912 to 1994 (NOAA, 1996)

II. GEOLOGIC SETTING

A. Stratigraphy

1. Quaternary surficial deposits

Glacial till, consisting of heterogeneous deposits of unconsolidated clay, silt, sand, and gravel, blankets much of the study area (plate 1). As reported by Zimmerman (1967), the till was deposited as the continental ice sheet retreated during Pleistocene time.

Quaternary alluvial deposits were mapped from aerial photos (USDA–FSA, 1996) in conjunction with field observations and information obtained from well logs (plate 1). The alluvium consists of unconsolidated clay, silt, sand, and gravel derived mainly from reworked glacial till along with material eroded from Cretaceous sediments. For the most part, alluvium within the Red River drainage occurs as narrow, thin bands along the main water courses.

2. Bedrock units

a. Nomenclature

Formation names used in this report are those commonly used for geologic mapping, and for mineral and water studies, all of which deal primarily with surficial or relatively shallow geologic strata (table 1). The petroleum industry addresses the same units, but with slightly different nomenclature and at depths far beneath the surface. The difference arises because the petroleum industry nomenclature is based on well logs and various geophysical techniques. Parts of this report do discuss petroleum wells, however, so a cross reference of the two nomenclatures (table 2) is also presented.

In the Red River watershed, glacial till directly overlies the Two Medicine Formation or the Virgelle Sandstone, both of Cretaceous age (plate 1, and table 1).Other Cretaceous units present in the subsurface are the Telegraph Creek Formation, the Marias River Shale, the Blackleaf Formation, and the Kootenai Formation. Below the Cretaceous sediments are the Jurassic Ellis Group and the

<table>
<tr><td colspan="7">Table 1. Stratigraphic summary of rocks in the Red River watershed (modified from Zimmerman, 1967)</td></tr>
<tr><th>System</th><th>Series</th><th colspan="2">Stratigraphic unit</th><th>Maximum thickness (feet)</th><th>Physical characteristics</th><th>Hydrologic Characteristics</th></tr>
<tr><td rowspan="2">Quater-nary</td><td>Recent</td><td colspan="2">Alluvium</td><td>25</td><td>Clay, silt, sand, with some lenses of gravel</td><td>Limited aerial extent
Few wells produce water from alluvium</td></tr>
<tr><td>Pleisto-cene</td><td colspan="2">Glacial deposits undifferentiated</td><td>100</td><td>Includes: outwash deposits, gravel & sand; glacial till, granite & limestone fragments in a sandy clay matrix; glacial lake deposits, clay, sand, gravel</td><td>Sand and gravel deposits locally yield sufficient water for stock or domestic use</td></tr>
<tr><td rowspan="6">Creta-ceous</td><td rowspan="4">Upper Creta-ceous</td><td rowspan="3">Mon-tana Group</td><td>Two Medicine Formation</td><td>500</td><td>Sandy shale and mudstone, some thin sandstone beds: lower 250 feet is mostly massive fine-grained sandstone</td><td>Widely used aquifer
Well yield adequate for domestic and stock use, generally less than 10 gpm</td></tr>
<tr><td>Virgelle Sandstone</td><td>180</td><td>Massive gray to buff sandstone, occasional shale beds</td><td>Widely used aquifer, Reported yields of up to 250 gpm for properly constructed, fully penetrating wells</td></tr>
<tr><td>Telegraph Creek Formation</td><td>170</td><td>Gray sandy shale interbedded with thin beds of gray or buff shale</td><td>Generally impermeable, not an aquifer in the Red River watershed</td></tr>
<tr><td rowspan="2">Colo-rado Group</td><td>Marias River Shale</td><td rowspan="2">1995</td><td rowspan="2">Dark-gray shale with a few limestone layers and bentonite beds in the upper part; the lower 800 feet is dark-gray shale interbedded with bentonite, sandstone, & concretionary beds</td><td rowspan="2">Not an aquifer in the Red River watershed, reportedly produces water in petroleum test holes</td></tr>
<tr><td rowspan="2">Lower Creta-ceous</td><td>Blackleaf Formation</td></tr>
<tr><td colspan="2">Kootenai Formation</td><td>725</td><td>Red & green mudstone & siltstone interbedded with medium- to coarse-grained sandstone</td><td>Not used as an aquifer in the Red River watershed, produces water in petroleum test holes but quality is unacceptable</td></tr>
<tr><td>Jurassic</td><td>Upper & Middle Jurassic</td><td colspan="2">Ellis Group</td><td>350</td><td>Gray calcareous shale interbedded with discontinuous sandstone beds</td><td>Not an aquifer in the Red River watershed, produces water in petroleum test holes</td></tr>
<tr><td>Mississ-ippian</td><td>Upper & Lower Mississ-ippian</td><td colspan="2">Madison Group</td><td>1060</td><td>Massive dense crystalline limestone in upper part, gray and dark-gray limestone alternating with shale in lower part</td><td>Not used as an aquifer in the Red River watershed, water quality is unacceptable, source of water for oil-field waterfloods</td></tr>
</table>

Table 2. Correlation between mapped stratigraphic nomenclature and petroleum nomenclature

System	Series	Stratigraphic unit		Petroleum usage
Quaternary	Recent	Alluvium		
	Pleistocene	Glacial deposits undifferentiated		
Cretaceous	Upper Cretaceous	Montana Group	Two Medicine Formation	Judith River Claggett Eagle
			Virgelle Sandstone	
			Telegraph Creek Formation	Telegraph Creek
		Colorado Group	Marias River Shale	Kevin Ferdig Cone
	Lower Cretaceous		Blackleaf Formation	Base Fish Scales
		Kootenai Formation		Kootenai Moulton Sunburst Cut Bank
Jurassic	Upper & Middle Jurassic	Ellis Group		Swift Rierdon Sawtooth
Mississippian	Upper & Lower Mississippian	Madison Group		Madison Sun River Dolomite

Missippian Madison Group. Only the Two Medicine Formation and the Virgelle Sandstone are discussed below because they are the most widely used aquifers in the watershed.

The Two Medicine Formation, which in this area includes equivalents of the upper part of the Eagle Sandstone, consists of mudstone and siltstone interbedded with lenticular, massive, commonly calcareous fine to very coarse-grained sandstone. The Two Medicine is hydraulically connected with the underlying Virgelle Sandstone in many places (Zimmerman,1967). Only the lowermost 500 feet of the Two Medicine Formation is present in the study area. The Virgelle

Sandstone, consisting of fine- to medium-grained arkosic and slightly calcareous sandstone, is the basal member of the Eagle Sandstone in other parts of Montana (Zimmerman,1967). Where it crops out, it forms prominent cliffs such as the east-facing cliffs immediately east of the Red River watershed.

Bedrock units found in the subsurface below the Virgelle include, in descending order, the Telegraph Creek Formation, the Colorado Group, the Kootenai Formation, the Ellis Group, and the Madison Group. These units are described by Zimmerman (1967).

B. Structure

Bedrock units underlying the study area dip generally northwestward at about 50 feet per mile away from the Sweetgrass Arch. Numerous small folds are superimposed on this regional dip (figures 4a and 4b, and plate 2). Cross sections based on formation tops from petroleum drilling logs contained in the GWIC (Ground Water Information Center) data base and from American Petroleum Institute files are shown on figures 4a and 4b. Locations of cross sections are shown on plate 2, which also shows the locations of petroleum wells.

III. SURFACE WATER

Within the project area, the Red River drains about 138,000 acres in northern Glacier and Toole Counties. The stream is ephemeral, flowing only in response to spring runoff or precipitation events. Parts of the drainage are characterized by numerous ponds and lakes, including Grassy Lake, Long Lake, and Fitzpatrick Lake. Ponds and lakes are used for stock water when they are not dry. Zimmerman (1967) reported that Grassy Lake, Long Lake, and Fitzpatrick Lake have supplied irrigation water in the past. Water levels fluctuate widely, with many ponds drying up in late summer.

A. Methods

A surface-water gaging and sampling site was established at 370404ABDCDC. Discharge

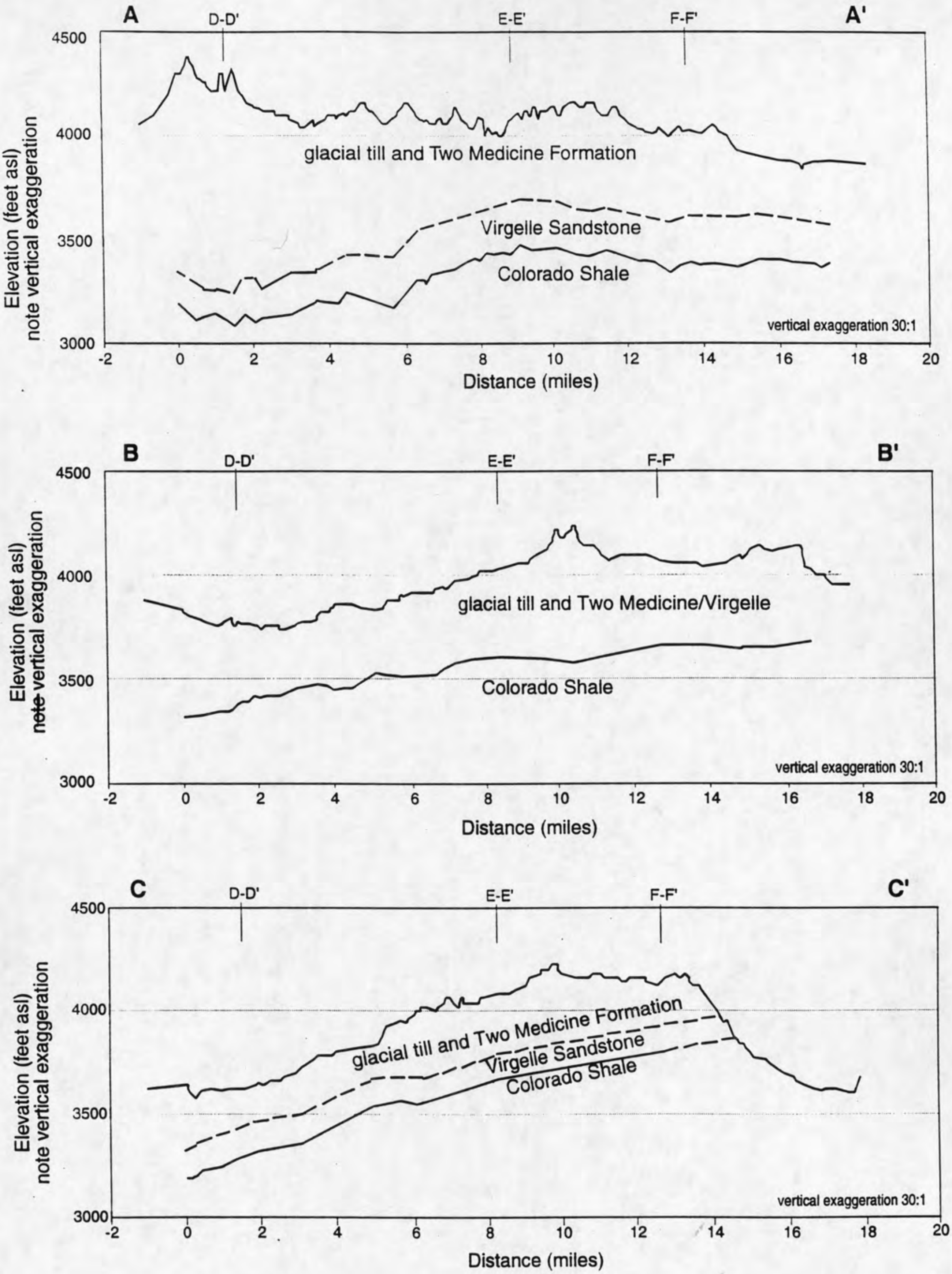

Figure 4a. Geologic cross sections in the Red River watershed area. Section traces and data points shown on plate 2.

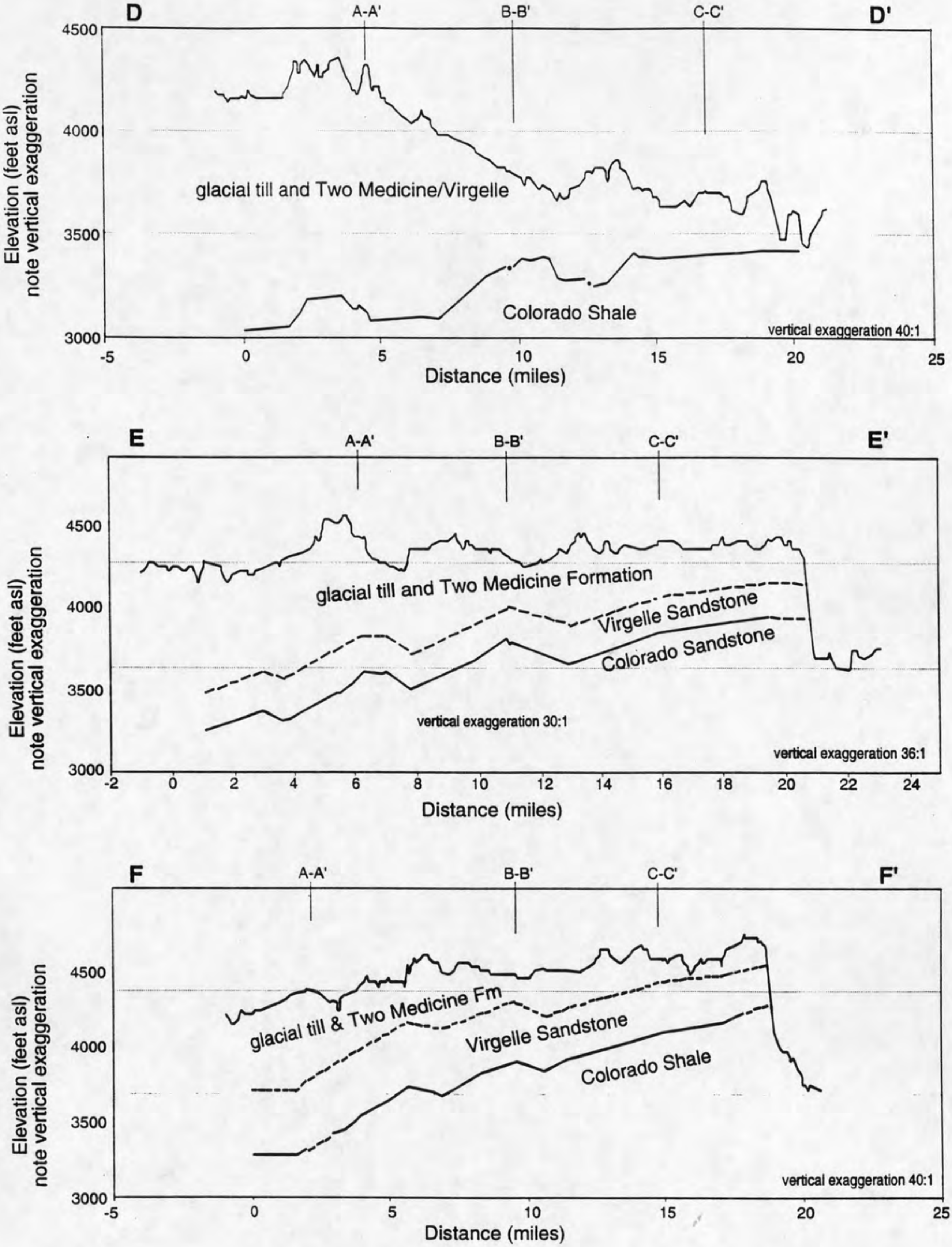

Figure 4b. Geologic cross sections in the Red River watershed area. Section traces and data points shown on plate 2.

volume and field parameters (temperature, pH and, specific conductance) were measured periodically from 1995-97. Samples were collected for chemical analysis in 1995-97. Montana Bureau of Mines and Geology (MBMG) also calculated peak discharge based on channel geometry and high water marks for three other locations (370512DCD, 370522AA, and 370510DDC on table 3, locations shown on figure 5) during spring runoff. The exact date(s) of the peak discharge for these sites is not known.

B. Results

Surface-water inventory data and analytical results are presented in appendices A and B, and results are also shown on a tri-linear diagram (figure 6). These data include two springs (370416AAACC and 360529ACBBA) feeding the Red River or its tributaries. Discharge rates for those springs are included in table 3. During the summers of 1996 and 1997 there was no measurable flow in Red River at 370412DCD or 370422AA, or in Pearsons Coulee at 370410DDC. Samples collected from the Red River at site 370404ABDC were dominated by sodium, magnesium, calcium and sulfate (figure 6). In 1991, after a petroleum pipeline burst at a Red River crossing, the USGS collected a sample from 370403BDC, downstream of the spill. However, unlike the MBMG samples taken in 1995-97, the 1991 USGS sample was dominated by sodium, bicarbonate, and chloride as are petroleum waters in the area during spring runoff. The marked difference in water chemistry may be reflective of the pipeline spill that had occurred upstream of the 1991 sampling site. TDS for Red River water ranged from 1515 to 6849 mg/L with a mean of 2933 mg/L. A sample collected from a stock reservoir at 370522CCAC was a calcium-sulfate type water with a TDS concentration of 646 mg/L.

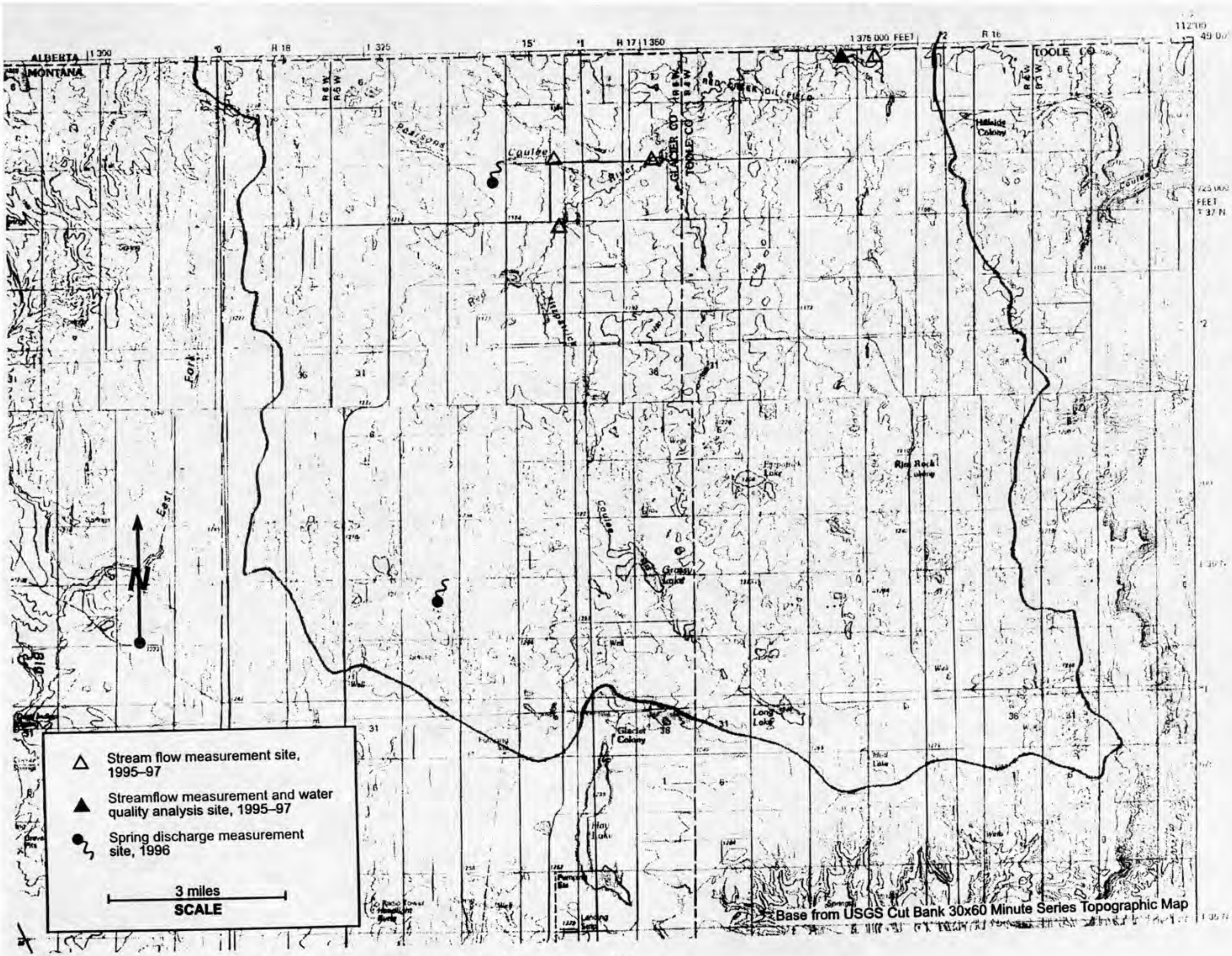

Figure 5. Locations of streamflow measurement and sampling sites.

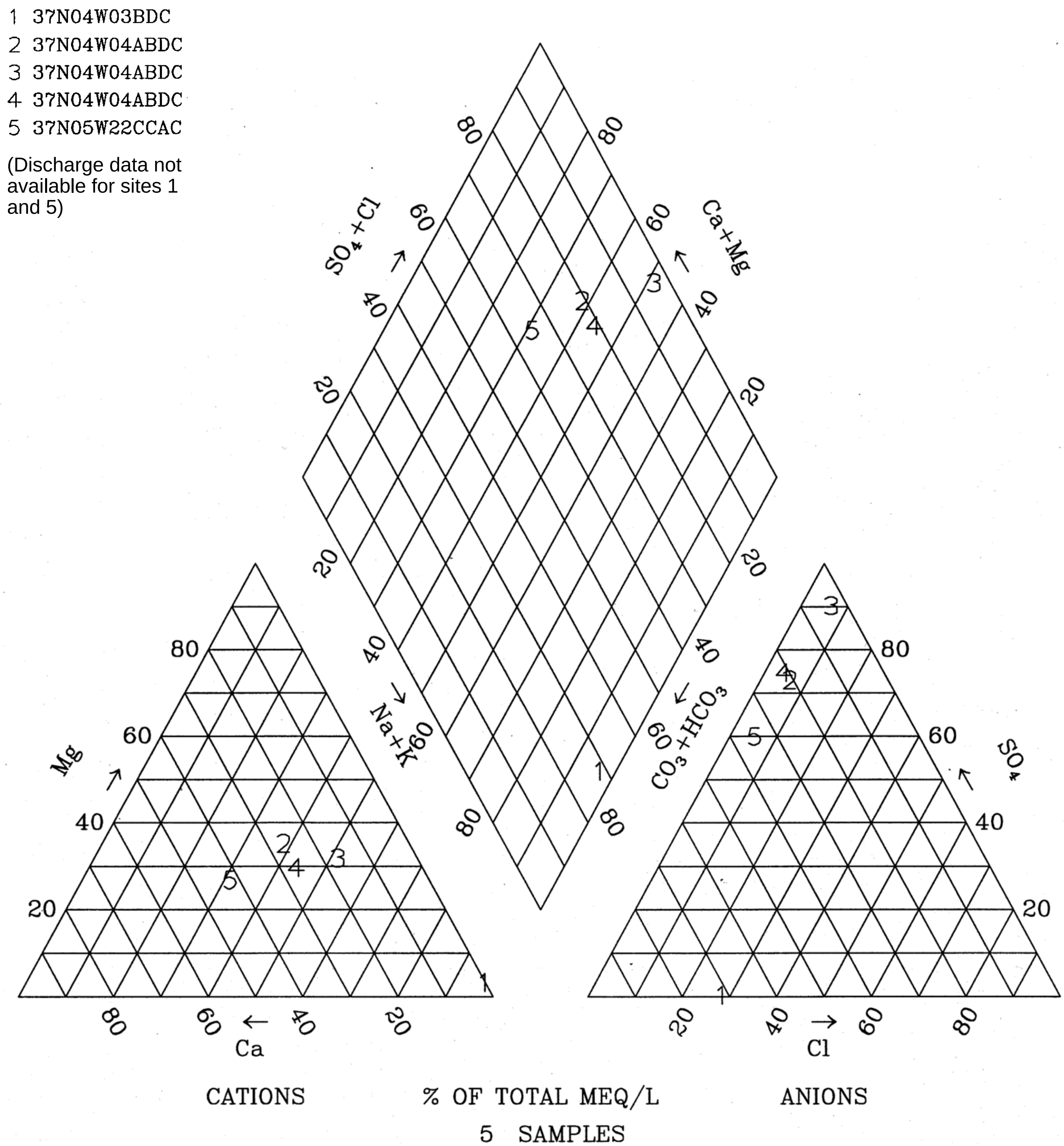

Figure 6. Ionic percentages in surface-water samples.

Table 3. Surface-water discharge measurements							
Description	Location	Date	Discharge (cfs)	Method	SC µmho	pH	Temp deg C
Red River, USGS	370404ABDCDC	07/26/95	2.5	1	2350	8.4	20.5
Red River, USGS	370404ABDCDC	09/07/95	.4	1	2280	8.2	19
Red River, MBMG	370404ABDCDC	06/11/96	.3	2	2270	7.6	19
Red River, MBMG	370404ABDCDC	07/14/97	.08	2	1970	8.8	26
Red River, MBMG	370404ABDCDC	08/12/97	.04	2	2060	7.9	22
Red River at International border	370403BACCAB	06/12/96	.4	2	2550	7.2	19
Red River at county road	370512DCD	Spr 96	1447	3			
Red River at county road	370512DCD	Spr 97	290	3			
Red River at county road	370522AA	Spr 96	270	3			
Red River at county road	370522AA	Spr 97	60	3			
Pearsons Coulee	370510DDC	Spr 96	275	3			
Pearsons Coulee	370510DDC	Spr 97	79	3			
Spring	370516AAACC	07/13/96	.05	2	5520	7.3	19
Spring	360529ACBBA	07/13/96	.05	2	4410	7.6	21

Method: 1 – Current meter
2 – Float and stop watch
3 – Discharge calculated from channel geometry and high water mark, exact date of peak discharge not known

IV. HYDROGEOLOGY

A. Methods

Wells and springs in the Red River drainage, including all or part of T. 35, 36, and 37 N., R. 4, 5, and 6 W., were inventoried during the 1995, 1996, and 1997 field seasons. Sites were located on USGS 7.5-minute quadrangle maps, and the locations were subsequently transferred to base maps used for Plates 1-9. Information including total depth, static and pumping water levels, yield, casing diameter, and water use was recorded on field forms. Whenever possible, field parameters (water temperature, pH, and specific conductance) were measured and a sample was collected for a full inorganic analysis by the Analytical Division of the Montana Bureau of Mines and Geology.

Total depths and water levels in wells were measured using a weighted steel tape or an electric sounder. Measurements were corrected to ground surface and recorded on field inventory sheets along with appropriate comments.

Sampling procedures were designed to ensure collection of representative samples. Detailed sampling procedures are discussed in Chapter V, Ground-Water Quality.

Water-quality data and inventory information were entered into a database developed for the project (Appendices C and D), and have been entered into the Ground-Water Information Center

(GWIC) database housed at MBMG. The database also includes some historical ground-water quality data. Contributing aquifers were determined from Zimmerman's geologic map (1967), and from petroleum well data and water-well drillers' reports. For many wells, neither total depths nor logs of penetrated formations were available, so the contributing aquifers could not be determined. Some of these wells were completed in such a manner that measurement of water levels or depths was not possible. If a sample could be obtained, the contributing aquifer was interpreted on the basis of water chemistry. However, this was not possible in some cases owing to similarities in water quality between aquifers and/or the mixing of water between aquifers.

B. Aquifer Characteristics

An aquifer is any geologic material that can both store and transmit water. Properties that are important in defining the ability of rocks and sediments to store and transmit water include porosity, hydraulic conductivity, transmissivity and storativity. Porosity is the ratio of the volume of void space in a material to the total volume of the material and is unitless. Hydraulic conductivity is a measure of the rate at which water would flow, in cubic feet per day (ft^3/d) for this report, through a unit cross-section of aquifer material, under a unit hydraulic gradient of one foot of fall per one foot of flow path length, and is expressed in units of feet per day (ft/d). Transmissivity is the rate of flow (ft^3/d) of water through a unit cross-section of aquifer and is equivalent to the hydraulic conductivity multiplied by the saturated thickness of the aquifer. Units for transmissivity for this report are square feet per day (ft^2/d). Storativity is a unitless measure of the amount of water released from or taken into storage when the water level falls or rises one foot. Specific capacity is the well yield per unit of drawdown, usually expressed as gallons per minute per foot of drawdown (gpm/ft) after a given pumping time has elapsed.

Aquifer tests, consisting of pumping tests where drawdown is measured over time, were conducted on a number of wells to determine transmissivity and storativity (table 4). Transmissivities are low to moderate (averages are 51 ft^2/d for the Two Medicine, 2,342 ft^2/d for the Virgelle, and 1,170 ft^2/d for Quaternary deposits) and support low to moderate well yields (less than 5 to 250 gpm). Storativity averages were 0.003 for the alluvium, 0.2 for the Two Medicine Formation, and 0.0005 for the Virgelle Sandstone. The lower values suggest confined conditions,

Table 4. Aquifer Test Data								
Location	Date	Transmissivity (ft^2/d)	Storativity	Pumping Rate (ft^3/d)	Pumping Rate (gpm)	Pumping Period (min)	Aquifer	Comments*
370624CDADB	06/29/95	25	$7x10^{-3}$	2310	12	34	Two Medicine	Theis
360521ABBDB	06/29/95	14	$4x10^{-1}$	1050	5.5	28	Two Medicine	Theis
360521ABBDB	06/29/95	162		1588	8.2	33	Two Medicine	Theis
AVERAGES		51	$2x10^{-1}$					
370402DDDBC	07/16/95	46	$2x10^{-4}$	740	3.8	51	Virgelle	Theis
360411CAAAC	08/09/95	4527	$4x10^{-6}$	14439	75	60	Virgelle	Theis
360411BBADC	08/09/95	6266	$1x10^{-3}$	3850	20	30	Virgelle	Theis
AVERAGES		2342	$5x10^{-4}$					
370304DCABD	07/16/95	1549 790	$3x10^{-3}$	1963	10.2	38	Alluvium or glacial till	Theis Recovery
AVERAGES		1170	$3x10^{-3}$					
* Technique used for test evaluation (Todd, 1967).								

where water will rise above the top of the aquifer in a well bore. Most recharge to unconfined aquifers is vertical infiltration of precipitation, whereas most recharge to confined aquifers is lateral inflow from outcrop areas.

1. Quaternary deposits

a. Glacial till

Glacial deposits are found at the surface over most of the Red River drainage. Twenty-seven wells and two springs producing water from glacial deposits were inventoried. Information from the Ground Water Information Center (GWIC) data base for two additional wells and one spring are included in Appendices C and D. Well depths range from 9 to 63 feet and yields range from less than 1 to 14 gpm. The two springs that were inventoried were flowing 23 and 28 gpm.

Recharge to glacial deposits occurs as a result of infiltration of precipitation and surface water, and lateral and vertical inflow from adjacent aquifers including overlying alluvium and underlying bedrock units. Glacial deposits discharge to surface water, and to adjacent aquifers, and they also lose water through evapotranspiration by plants. Water-level data suggest a downward hydraulic gradient, implying that most discharge from the glacial deposits is vertically downward to underlying Cretaceous rocks. Monitoring wells were installed on suspected saline seeps by the Montana Salinity Control Association and sampled by MBMG during the project. Logs of these wells are found in Appendix F. Analytical results are discussed on pages 35 and 36.

b. Alluvium

During the course of the field work, 9 wells completed in alluvium were inventoried. Data from 6 additional wells listed in the GWIC data base are included in Appendices C and D. Wells completed in alluvium have depths ranging from 10 to 27 feet. Measured or reported yields range from 10 to 100 gpm. A transmissivity of 1170 ft^2/d and a storativity of 0.003 were calculated from an aquifer test on well 370304DCABD. Alluvium is not a widely used aquifer in the Red River drainage.

Recharge to the alluvium occurs from infiltration of precipitation, lateral subsurface inflow from adjacent bedrock or glacial till, vertical flow (where upward) from underlying aquifers, and infiltration through the stream bed. Discharge occurs through evapotranspiration by plants, lateral subsurface outflow to adjacent aquifers, vertical downward flow to underlying aquifers, and discharge to streams.

2. Cretaceous sediments

Cretaceous age sediments were the sources of water for 29 wells inventoried in northern Glacier County. Information on an additional 18 wells was derived from the GWIC data base. Appendices C and D also include information on 93 petroleum wells completed in Cretaceous sediments.

a. Two Medicine Formation

The Two Medicine Formation is widely used for stock and domestic supplies in the Red River Drainage. Field inventories provided data on 13 wells, and GWIC provided data for 15 additional wells completed in the Two Medicine Formation. Of these, 16 wells are used for domestic and/or stock water supplies, 3 are public supply wells, 1 is a monitoring well, 4 are abandoned or unused, and 4 are petroleum wells. The Two Medicine Formation subcrops under glacial till in the western part of the drainage. Well depths range from 29.5 to 452 ft, and yields range from less than 1 to 75 gpm. Reported drawdowns range from 3.5 ft at 75 gpm, to 28 ft at 15 gpm. Estimated transmissivities range from 5.1 to 162 ft^2/d with an average of 51 ft^2/d (table 4). Storativities range from 0.007 to 0.4 with an average value of 0.2.

b. Virgelle Sandstone

The Virgelle Sandstone is a commonly used Cretaceous aquifer in the eastern and southeastern part of the study area. The unit crops out in the prominent bluffs that border the east edge of the drainage. The Virgelle is the water source for 22 wells (16 inventoried during this study) with depths ranging from 50 to 520 feet and yields ranging from 1.5 gpm for a flowing well to a reported 250 gpm for a pumped well. Drawdowns range from 0.22 feet at 18 gpm to 48 feet at 250 gpm. Transmissivities for the Virgelle range from 17 to 6266 ft^2/d with a mean value of 2337 ft^2/d (table 4). Storativities range from 0.0002 to 0.001 with a mean value of 0.0005.

The Two Medicine Formation and the Virgelle Sandstone are hydraulically connected in many places, have similar flow patterns, and similar water quality. Further, the contact between the two is not easily recognizable in driller's logs. In this report, most references to them will be as a combined aquifer system, the Two Medicine/Virgelle aquifer.

3. Other aquifers

Cretaceous sediments below the Virgelle Sandstone have been targeted by numerous petroleum test wells. These include the Moulton, Cut Bank, and Sunburst sands. Water produced with oil or gas is mostly reinjected either to maintain pressure in producing horizons or to dispose of the produced water. Appendices C and D have data on 77 petroleum wells completed in Cretaceous sands, and 30 wells completed in the Madison Formation. The only use of water from these deeper aquifers is for petroleum-related activities such as water flooding for secondary recovery in oil or gas fields.

C. Ground-water Use

Of the wells that were inventoried, 36 percent were used for stock or domestic supply, 29 percent were abandoned or unused, 24 percent were installed for monitoring saline seep or petroleum-related activities, 6 percent were public supply wells, 4 percent were unknown, and 1 percent were used for water-flooding hydrocarbon reservoirs.

D. Ground-water flow

Plate 3 shows generalized contours of the potentiometric surface for the unconsolidated alluvial and glacial deposits. Recharge is from direct infiltration of precipitation and infiltration from streamflow and ponds or lakes. Ground water in the Quaternary deposits discharges: a) to springs, b) vertically downward to underlying Cretaceous sediments, and c) laterally to the Red River and tributaries, and d) to evapotranspiration by plants where the water table is near the surface. The direction of ground-water flow is generally northeastward, perpendicular to the contour lines on plate 3. The estimated horizontal ground-water flow through the glacial till is approximately 1 acre-foot per day, based on an estimated permeability of 25 ft/d for glacial till (Todd, 1967) and an average saturated thickness of 22 feet from data in Appendix C. Ground water in the glacial till and Quaternary alluvium discharges a) as ground-water flow, b) to the Red River, c) to evapotranspiration by plants, and d) vertically downward to deeper formations. Only one well that withdraws water from alluvium, a stock well (370304DCABDC) which is used seasonally, was inventoried during this project. All other wells completed in alluvium are unused, abandoned, or are monitoring wells installed near petroleum facilities and sampled infrequently.

Plate 4 shows a configuration of the potentiometric surface of the Two Medicine/Virgelle aquifer that is similar to that of the Quaternary deposits with a similar flow pattern. The estimated ground-water flow through the aquifer is 55 acre-feet per day (1 acre-foot per day through the Two Medicine and 54 acre-feet per day through the Virgelle). Recharge occurs as a result of direct infiltration of precipitation on outcrops of the Virgelle Sandstone along the east and south sides of the drainage, infiltration from streamflow where streams cross outcrops of the Two Medicine or Virgelle, and vertical recharge from the overlying glacial till or alluvium. An estimated 61 percent (34 acre-feet per day) of the ground-water flow through the Two Medicine / Virgelle aquifer enters the watershed as lateral flow from the west and southwest. Ground water in the Two Medicine/Virgelle aquifer discharges a) to wells, b) to springs, c) to surface water, d) to evapotranspiration by plants where the water table is near the surface, and e) vertically downward.

The total estimated ground-water flow rate through the shallow aquifers is 56 acre-feet per day, some of which is recharge from precipitation, and some from lateral inflow through the Two Medicine/Virgelle from the west and southwest. The estimated recharge to the watershed from precipitation is 56 acre-feet less 34 acre-feet per day lateral inflow or 22 acre-feet per day. This is equivalent to 0.7 inches annually.

V. GROUND-WATER QUALITY

A. Methods

Sampling procedures were designed to ensure the collection of water samples that are representative of ground water in the aquifer supplying the well or spring. Wells were pumped until the field water-quality parameters (temperature, pH and specific conductivity) were stable, i.e. parameter measurements were within 10 percent for three consecutive readings taken about 5 minutes apart. Water to be analyzed for trace metal and nitrate analysis was filtered in the field through a 0.45 micron filter. Sample containers were rinsed three times with the water to be collected before filling, and samples were preserved immediately according to lab specifications and placed on ice for transport. Analyses for inorganic constituents were performed according to EPA SW846 procedures at the MBMG laboratory in Butte. Analytical quality assurance / quality control procedures include sample duplicates, sample matrix spikes, and blanks and check samples every 10 samples. Table 5 lists the constituents that comprise the full inorganic analyses. Analyses for total petroleum hydrocarbons (TPH) were performed by a commercial laboratory in Billings, Montana. Major chemical constituents in natural water are the cations calcium (Ca), magnesium (Mg), and sodium (Na), and the anions sulfate (SO_4), bicarbonate (HCO_3), and chloride (Cl). These, plus numerous trace elements and chemical parameters (table 5) were analyzed in all water samples. The water-quality discussion for springs and wells will focus on the major inorganic constituents and any

Table 5: Constituents comprising complete inorganic analyses

Major Elements	Parameters	Trace Elements
Bicarbonate	Calculated Dissolved Solids	Aluminum
Calcium	Langlier Saturation Index	Antimony
Carbonate	pH	Arsenic
Chloride	Ryznar Stability Index	Barium
Fluoride	Sodium Adsorption Ratio	Beryllium
Iron	Specific Conductivity	Boron
Magnesium	Sum of Dissolved Constituents	Bromide
Manganese	Total Alkalinity	Cadmium
Nitrate	Total Hardness	Cobalt
Orthophosphate		Copper
Potassium		Lead
Silica		Lithium
Sodium		Molybdenum
Sulfate		Nickel
		Nitrite
		Phosphate
		Selenium
		Silver
		Strontium
		Titanium
		Vanadium
		Zinc
		Zirconium

notable trace elements or other parameters that were found. Water-quality information which was evaluated includes not only analytical data produced from this project, but also data available through the Ground-Water Information Center at the MBMG. Information compiled by previous investigators, such as Zimmerman (1967) have also been included in this report. All inorganic analyses were reviewed with respect to the Montana Department of Health and Environmental Sciences (DHES / DEQ) Department Circular PWS-1, Standards and Monitoring Requirements for Volatile Organic, Inorganic, and Synthetic Organic Chemicals (public drinking water supply standards), 1994 Edition. The only exceedences of PWS-1 Maximum Contaminant Levels (MCLs) are noted in the text. Appendix E contains inorganic Maximum Contaminant Levels as set forth in PWS-1.

B. Results

Spring and well locations with generalized water-quality plots (Stiff diagrams) are shown on plates 6 through 8. Plate 6 illustrates water-quality information for wells and springs in Quaternary sediments and surface water. Plate 7 shows water quality information for the Cretaceous Two Medicine Formation and Virgelle Sandstone. Plate 8 contains data from petroleum wells. Complete inventory and analytical data for ground water are found in Appendix D. Appendix E presents public water supply MCLs and explains the significance of water-quality constituents.

Ionic percentages for all ground-water samples are plotted on figure 7, which also shows water-quality trends resulting from cation exchange and sulfate reduction. Concentrations of TDS, sodium, bicarbonate and chloride tend to increase with depth, whereas concentrations of calcium and sulfate tend to decrease with depth as the dominant ions in ground water change from calcium and sulfate to sodium and bicarbonate.

Hydrocarbons were detected in only 3 of the 31 ground- or surface-water samples analyzed for total petroleum hydrocarbons (TPH). Results are tabulated in table 6 and sample locations are shown on figure 8. Wells 360411BBADCD and 360435ADAADA are not located in areas close to petroleum wells, and occurrences of TPH can not be easily associated with petroleum activities. Comparing the locations of petroleum wells on plate 2 (Petroleum Information Center, 1992) with the locations of these two wells (figure 8), it is clear that they are not located in areas most vulnerable to surface or subsurface leakage. Well 360411BBADCD is a public water supply well located in a well house with no evidence of surface contamination at or near the well. Hydrocarbons have been detected on one other occasion in samples from that well. In a sample collected on 07/08/96, 1.7 parts per billion (ppb) toluene, 0.84 ppb m+p xylene, and 1.1 ppb total xylene were reported. Hydrocarbons were not detected in any other samples from well 360411BBADCD (Camden, 1999). Well 360435ADAADA is a stock well that had not been used for about two years and appeared to have dead mice floating on the water. Residual animal fat from the decay of these rodents cannot be ruled

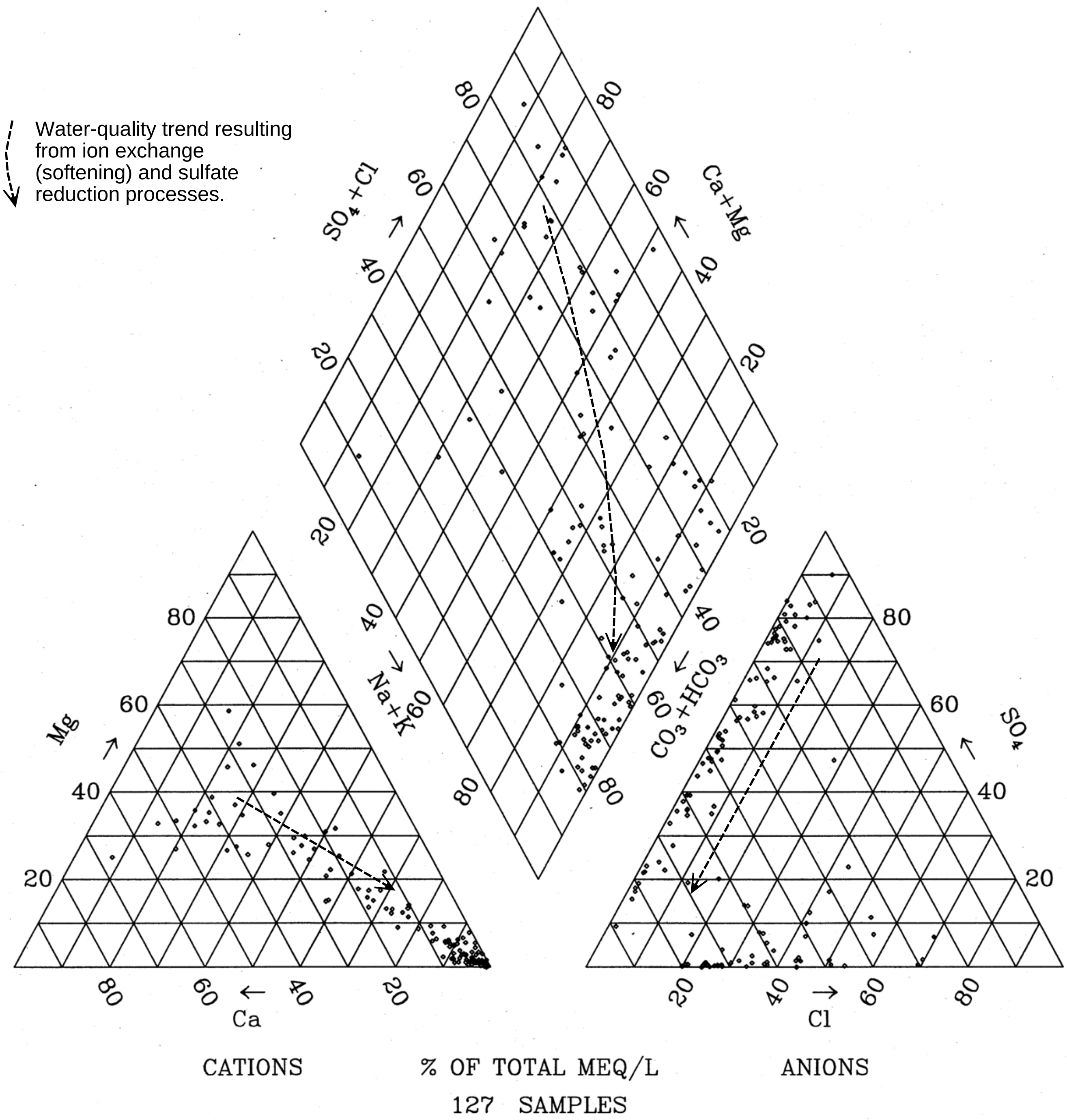

Figure 7. Ionic percentages in ground-water samples, Red River watershed, all data.

Table 6. Total petroleum hydrocarbons in ground water				
Location	Date	Total Petroleum Hydrocarbons (TPH) (mg/l)	Aquifer	Comments
350401ABDDBA	07/12/96	<0.1	211VRGL	
360411BBADCD	08/02/95	0.9	211TMDC	
360430BBBDB	03/30/95	<0.1	211VRGL	
360435ADAADA	07/12/96	2.8	211VRGL	Dead mice on water
360501DCCCDB	07/13/95	<0.1	211VRGL	
360514ACDDDD	08/04/95	<0.1	211VRGL	
360518DAABAA	07/12/95	<0.1	211TMDC	
360523AABDB	06/30/95	<0.1	211VRGL	
360523ADDBDA	06/30/95	<0.1		
360524DADCAA	06/30/95	<0.1		
360532BCDACC	08/24/95	<0.1	211TMDC	
360601ABADCA	07/12/95	<0.1	211TMDC	
360612BCACAC	07/03/95	<0.1	211VRGL	
360625DDADCA	08/25/95	<0.1	211TMDC	
370402DDDBCC	06/30/95	<0.1	211VRGL	
370403BACCDB	07/15/95	<0.1	211TMDC	
370403BCDDBB1	07/11/96	<2.5	110ALVM	
370403BCDDBB2	07/11/96	<2.5	110ALVM	
370403CDCABC	07/17/95	<0.1	211TMDC	
370404ABDCDC	07/07/95	<0.1	Red River	Surface water
370405BDBDDC	08/24/95	<0.1	112TILL	
370412DBCDAB	07/16/97	<0.1	211TMDC	
370415BCCBBB	07/14/95	<0.1	211TMDC	
370504DDDDBD	08/11/95	<0.1	112TILL	
370509CCCACA	08/10/95	<0.1	211TMDC	
370510DCDADA	08/03/95	<0.1	211TMDC	
370512ACADDA	07/17/95	<0.1	211TMDC	
370535DCABBB	08/02/95	<0.1	211VRGL	
370601ADDDDA	07/14/95	<0.1	211TMDC	
370601ADDDDA	07/14/95	<0.1	211TMDC	
370611BCADDC	08/08/95	45.5	330MDSN	Pumped for waterflood

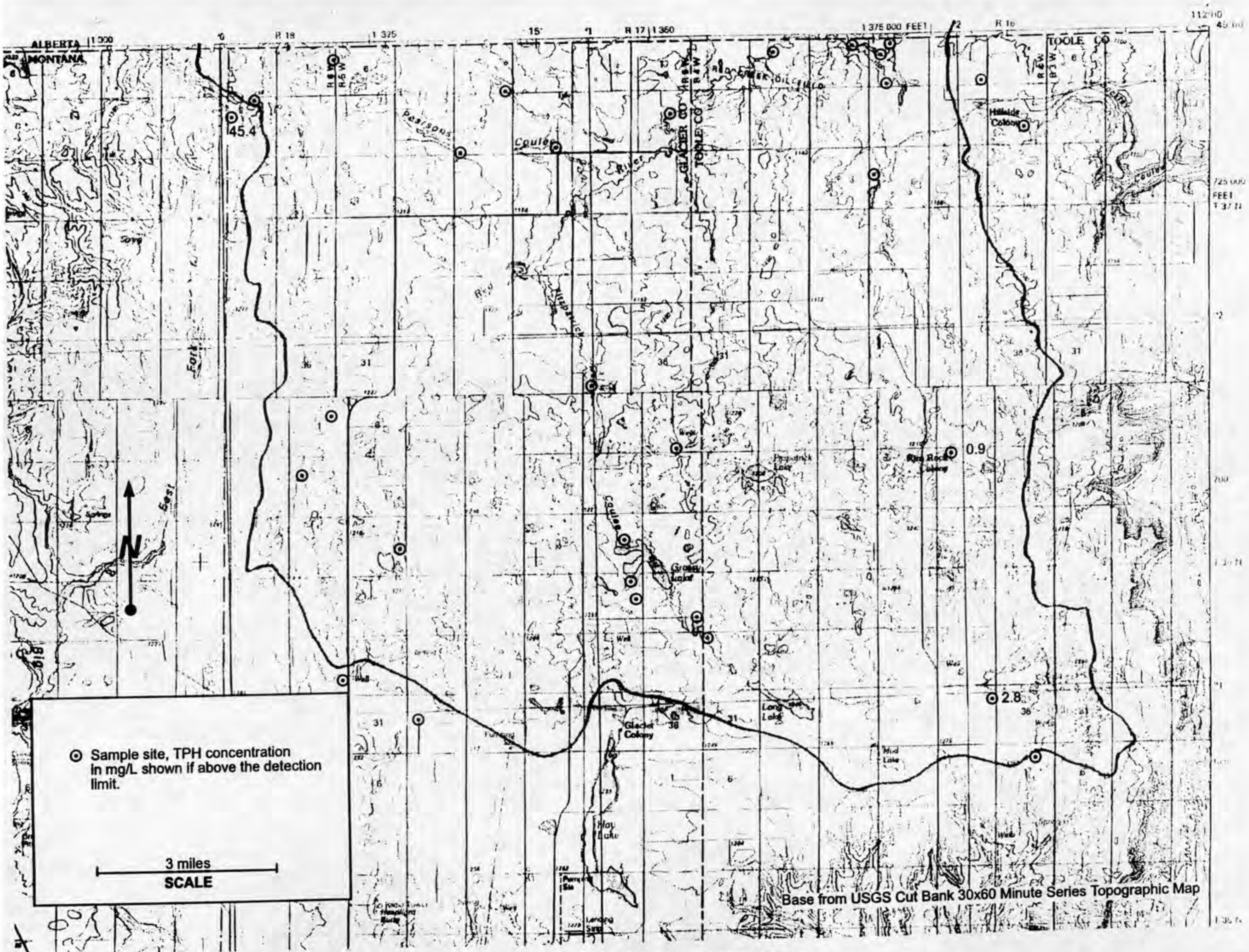

Figure 8. Locations of water samples analyzed for total petroleum hydrocarbons (TPH).

out as the cause of the TPH detected in that well (Pippen, 1999). These wells should be re-sampled. Well 370611BCADDC is completed in the Madison Formation in an area of closely spaced petroleum wells. Occurrences of TPH there would not be unexpected because of naturally occurring petroleum in the Madison Formation and the proximity of other petroleum wells.

1. Quaternary sediments

Water from Quaternary deposits is generally a calcium-magnesium-sulfate type (plate 6, figures 9 and 10). Ground-water quality parameters are listed in table 7 and Appendix D. Total dissolved solids (TDS) concentrations range from 319 to 6405 mg/L and have an average concentration of 2909 mg/L. Sulfate concentrations range from 27.5 to 4101 mg/L and have an average concentration

of 1605 mg/L.

The Stiff diagrams on plate 6 show that water samples collected from sites in T. 37 N., R. 4, 5, and 6 W. are dominated by the cations calcium and/or magnesium, and the anion sulfate. Samples showing elevated TDS in T. 37 N., R. 5 W., section 30 and T. 36 N., R. 4 W., sections 8 and 17 are from wells installed by the Montana Salinity Control Association to evaluate developing or suspected saline seeps. Elevated TDS and sulfate in ground-water samples from 370504DDDD, 370516AAAA, and 360529ACBB suggest that these sites may also be affected by salinization.

Saline seep formation has been related to "*...land-use practices that allow excess moisture to migrate downward through the soil profile beneath the root zone. The alternate crop-fallow (summer-fallow) farming system particularly aggravates the problem, in contrast to the natural system of native vegetation or sod where grasses and forbs use most of the precipitation, leaving little to percolate beneath the root zone .... Seep formation begins when excess water percolates downward beneath the root zone picking up soluble salts. Water then accumulates over shallow, less-permeable layers such as shale or clay and forms a local ground-water flow system. The flow system moves saline water from the recharge to the discharge area or seep, where it evaporates, depositing the salts on the surface*." (Miller, 1983).

Figure 11 is a probability plot of TDS concentrations in water samples from Quaternary deposits. TDS concentrations show two populations, the lower line represents natural water, and the

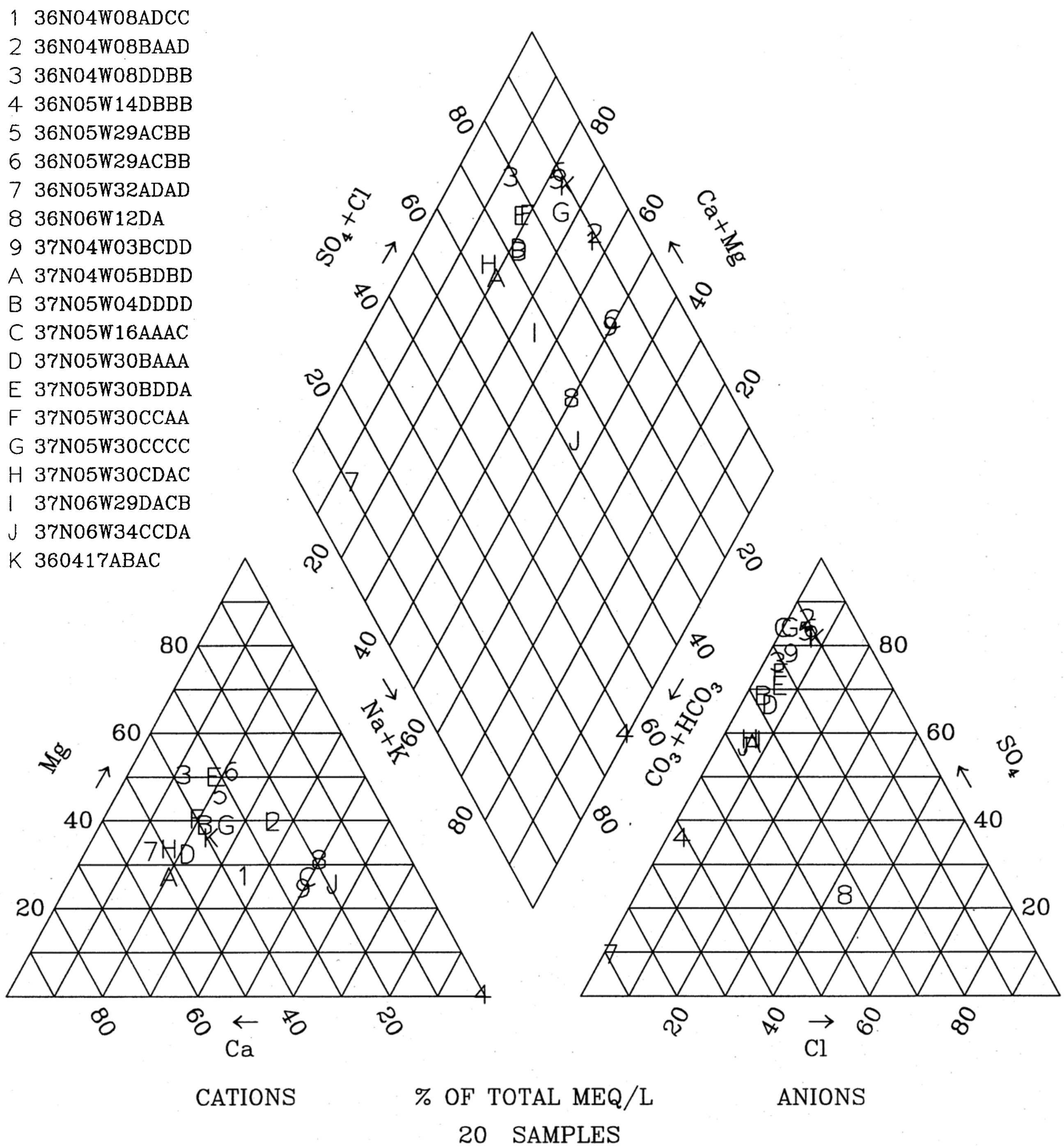

Figure 9. Ionic percentages in ground water, Quaternary deposits.

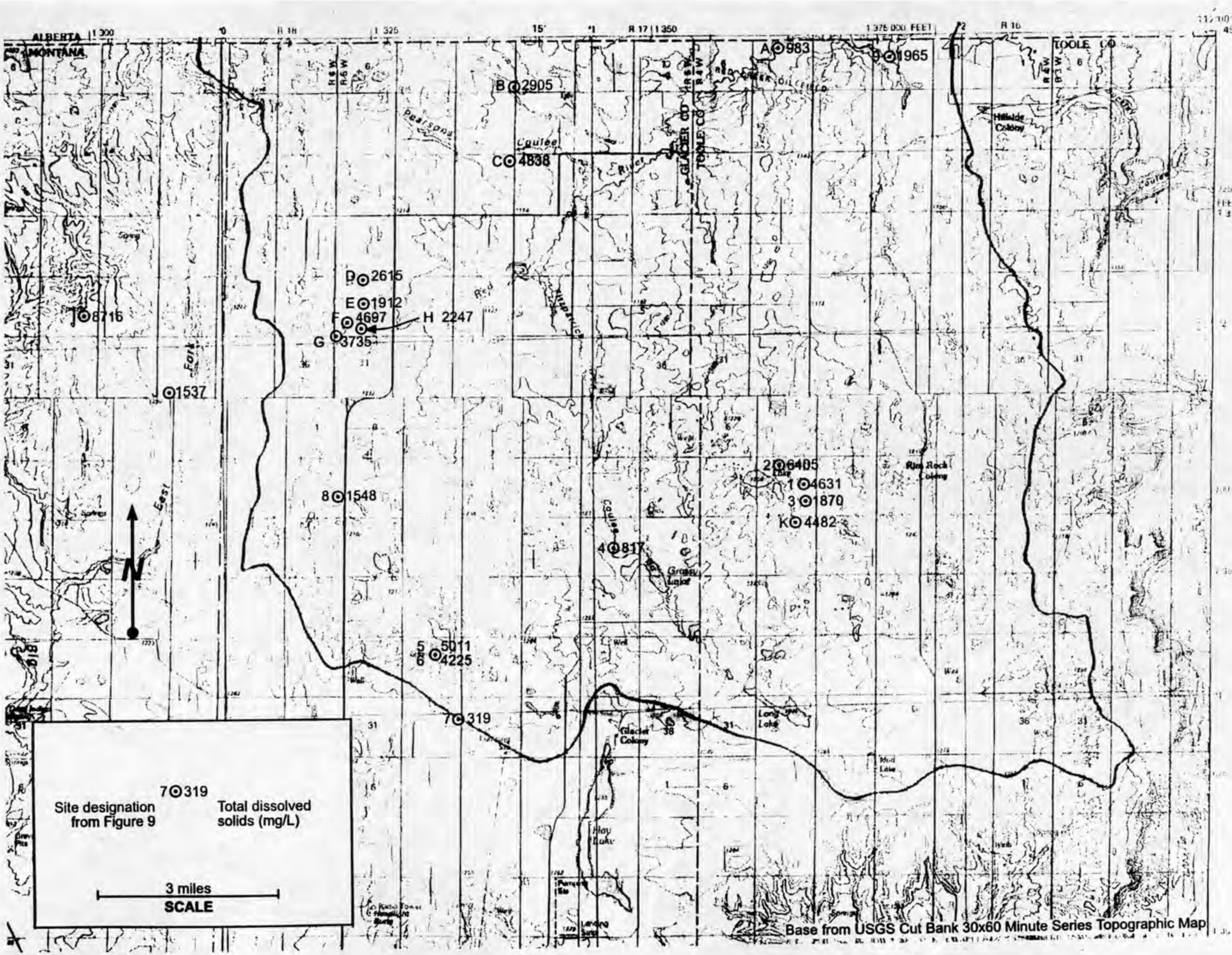

Figure 10. Locations and total dissolved solids concentrations, ground-water samples from Quaternary deposits.

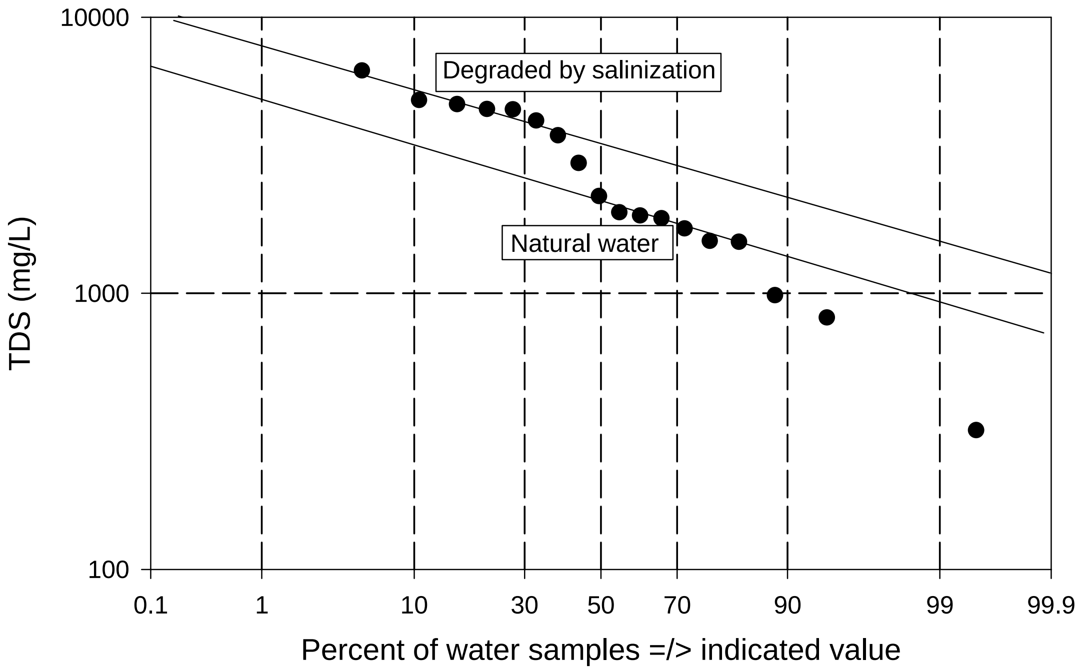

Figure 11. Total dissolved solids in ground water from Quaternary deposits

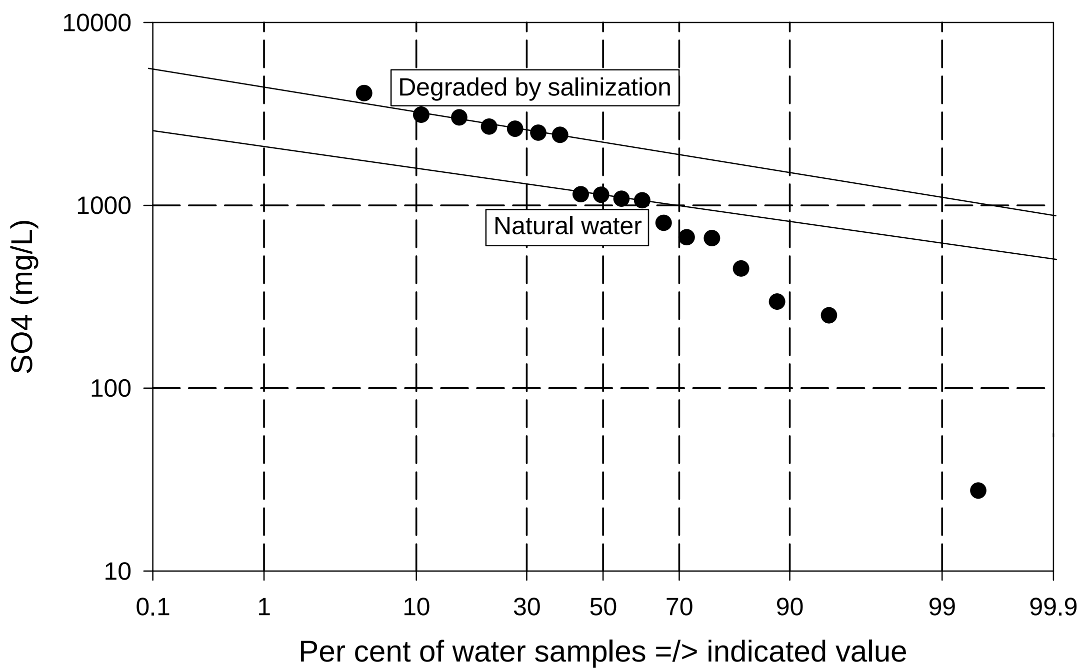

Figure 12. Sulfate in ground water from Quaternary deposits

Table 7. Water quality parameters, ground water samples from Quaternary deposits.														
LOCATION	GEOLOGIC SOURCE	SOURCE	SAMPLE DATE	CALCIUM MG/L	MAGNESIUM MG/L	SODIUM MG/L	POTASSIUM MG/L	BICARBONATE MG/L	CARBONATE MG/L	CHLORIDE MG/L	SULFATE MG/L	TOTAL DISSOLVED	CONDUCTANCE	pH
36N 04W 08 ADCC	112TILL	MON WELL	25-Feb-98	545	245	607	17.8	476		164	2689	4631	2380	6.69
36N 04W 08 BAAD	112TILL	MON WELL	24-Feb-98	488	479	811	17.5	604		139	4101	6405	3220	7.19
36N 04W 08 DDBB	112TILL	MON WELL	24-Feb-98	248	200	82.6	10.8	383		29.2	1084	1870	1359	7.27
36N 04W 17 ABAC	112TILL	MON WELL	24-Feb-98	546	304	386	20.0	444		209	2769	4482	2250	6.31
36N 05W 14 DBBBCB01	112TILL	WELL	17-Jul-95	0.95	0.40	276	0.66	436	51.2	16	250	817	1360	
36N 05W 29 ACBBAC	112TILL	SPRING	17-Aug-97	457	518	408	12.7	488	0	165	3125	5011	4410	7.59
36N 05W 29 ACBBAC	112TILL	SPRING	28-Apr-82	444	381	337	12	470	0	121	2620	4225	7190	
36N 05W 32 ADADCB01	112TILL	WELL	1-Jul-95	63.5	23.6	13.8	8.2	336		3.5	28	319	556	7.61
36N 06W 12 DA 01	110ALVM	WELL	10-Jul-80	109	106	316	13.7	556	0	417	297	1548		
37N 04W 03 BCDDBB17S	110ALVM	WELL	11-Jul-96	156	89.5	337	12.5	322	0	48.6	1140	1965	2270	7.61
37N 04W 05 BDBDDC	112TILL	WELL	24-Aug-95	172	53.5	71.8	7.6	355		40	450	983	1325	6.82
37N 05W 04 DDDDBD 01	112TILL	SPRING	11-Aug-95	393	237	246	13.1	778		60	1500	2905	3790	
37N 05W 16 AAACCD	112TILL	SPRING	31-Jul-96	352	244	843	8.3	734		<100	3020	4838	5520	7.26
37N 05W 30 BAAABB	112TILL	MON WELL	14-Aug-97	684	291	363	13	605	0	79	1147	2962	4240	7.08
37N 05W 30 BDDA1	112TILL	MON WELL	25-Feb-98	206	197	136	4.5	444		66.9	1062	1912	1370	7.56
37N 05W 30 BDDA2	112TILL	MON WELL	25-Feb-98	312	178	157	11.3	390		68.3	1373	2319	1590	7.51
37N 05W 30 CCAA	112TILL	MON WELL	25-Feb-98	653	397	355	17.8	943		115	2492	4647	2750	6.4
37N 05W 30 CCCC	112TILL	MON WELL	25-Feb-98	384	260	329	12.4	536		29.7	2426	3735	2210	7.26
37N 05W 30 CDACDD	112TILL	MON WELL	14-Aug-97	691	284	270	11.8	519	0	49.9	668	2247	4030	6.9
37N 06W 29 DACBBC	112TILL	SPRING	15-Jul-95	150	140	230	3	593		80	800	1716	2440	7.38
37N 06W 34 CCDADB	112TILL	SPRING	15-Jul-95	100	80	330	3.1	559		46	660	1537	2480	7.65

upper line is thought to represent water affected by saline seep. Figure 12 is a probability plot of sulfate in Quaternary water which also shows two populations. The upper line represents water possibly affected by saline seep, the lower line represents natural water, while the points below the lower line may represent dilution of shallow ground water by recharge from precipitation. Locations of samples with low and high concentrations of TDS and sulfate are shown on figure 13. High sulfate concentrations correlate with observed or suspected seeps.

Exceptions are wells 370403BCDD - sodium-sulfate (sample 9, figure 9), 370629DACB - sodium-magnesium-sulfate (sample I, figure 9), and 370634CCDA - sodium-sulfate (sample J, figure

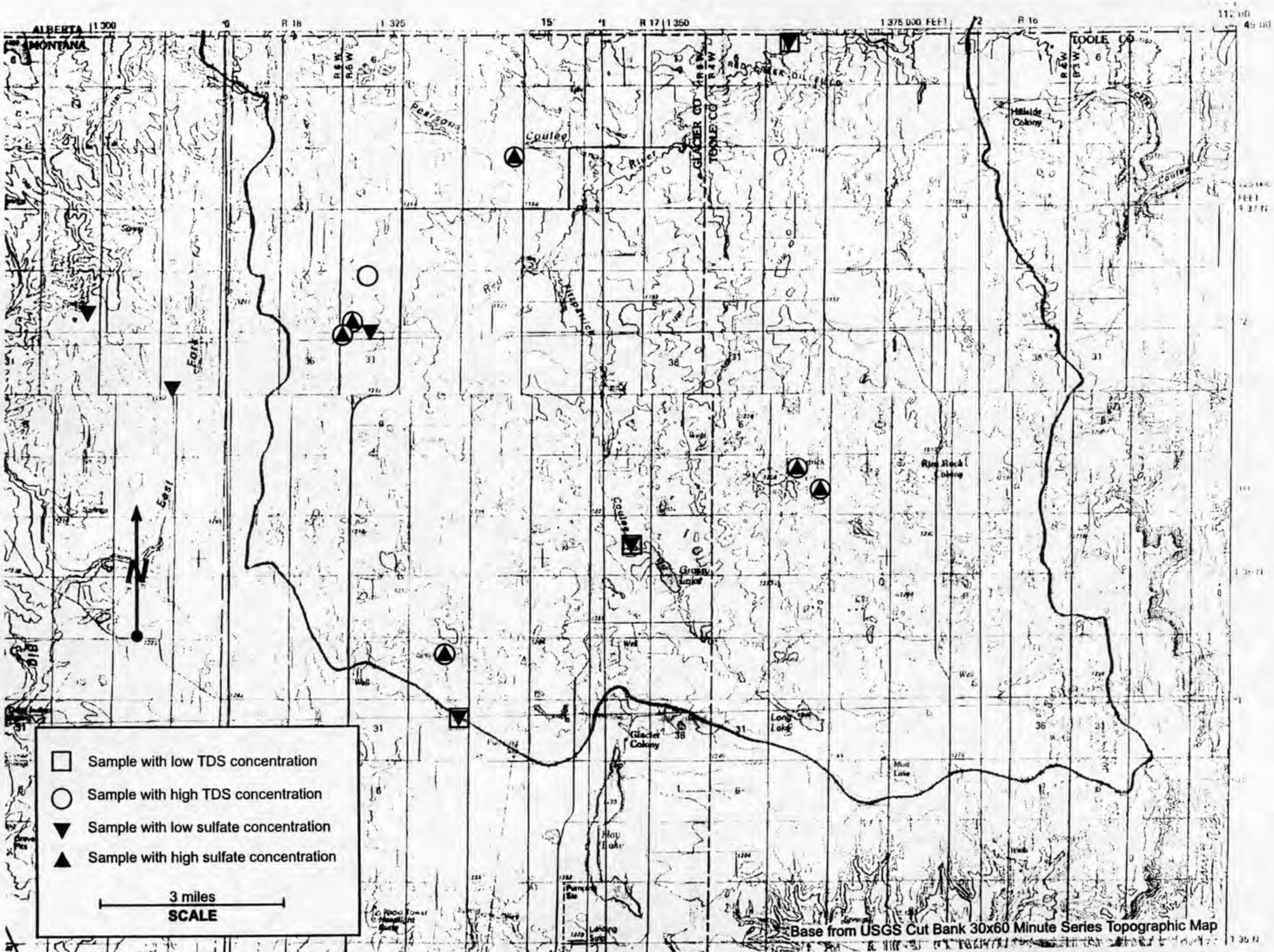

Figure 13. Locations of high and low TDS and sulfate concentrations from Quaternary ground-watersamples; relative to values on figures 11 and 12.

9). Water samples from Quaternary deposits in T. 36 N. , R. 4, 5, and 6 W., are dominated by the cations sodium and magnesium, and the anion sulfate. Exceptions are wells 360408ADCC - sodium-calcium-sulfate (sample 1, figure 9), 360417 - calcium-magnesium-sulfate (sample K, figure 9), 360514DBBB - sodium-bicarbonate (sample 4, figure 9), 360532ADAD - calcium-bicarbonate (sample 7, figure 9), and 360612DA - sodium-chloride (sample 8, figure 9).

2. Cretaceous sediments

The Two Medicine Formation and Virgelle Sandstone supply most domestic and stock wells in the drainage. Dominant constituents in ground water from these formations range from calcium, magnesium and sulfate to sodium and bicarbonate (figure 14 and plate 7). The trends drawn in figure 14 illustrate the natural processes of cation exchange and sulfate reduction that are occurring in the bedrock aquifers as water moves through the ground-water system. The final product of these geochemical processes in the unsaturated ground water of the Red River watershed is very soft water that has increased TDS while containing little sulfate, calcium, or magnesium. TDS concentrations range from 528 to 5753 mg/L and have a mean concentration of 1621 mg/L. Sulfate concentrations range from 38.5 to 3250 mg/L and have a mean of 719 mg/L. Figures 15 and 16 are probability plots for TDS and sulfate in water from the Two Medicine Formation and Virgelle sandstone. TDS concentrations along the upper line on figure 15 are from wells with a median depth of 125 feet, and are thought to represent relatively young water, possibly impacted by saline seep. Sulfate concentrations along the upper line on figure 16 are likewise interpreted as being younger water from shallower wells (possibly affected by saline seep), and those values along the lowest line are interpreted as representing deeper, older water, which is depleted in sulfate because of natural sulfate reduction. Degradation of ground water in the Two Medicine Formation and Virgelle Sandstone by petroleum should be identifiable by low sulfate and high TDS. The low sulfate concentrations on figure 16 are all associated with low TDS concentrations. Figure 17 shows locations of samples with high and low concentrations of TDS and sulfate.

A possible explanation for high TDS in water from some Two Medicine Formation wells may be vertical leakage induced by pumping of wells completed in relatively thin sands with low

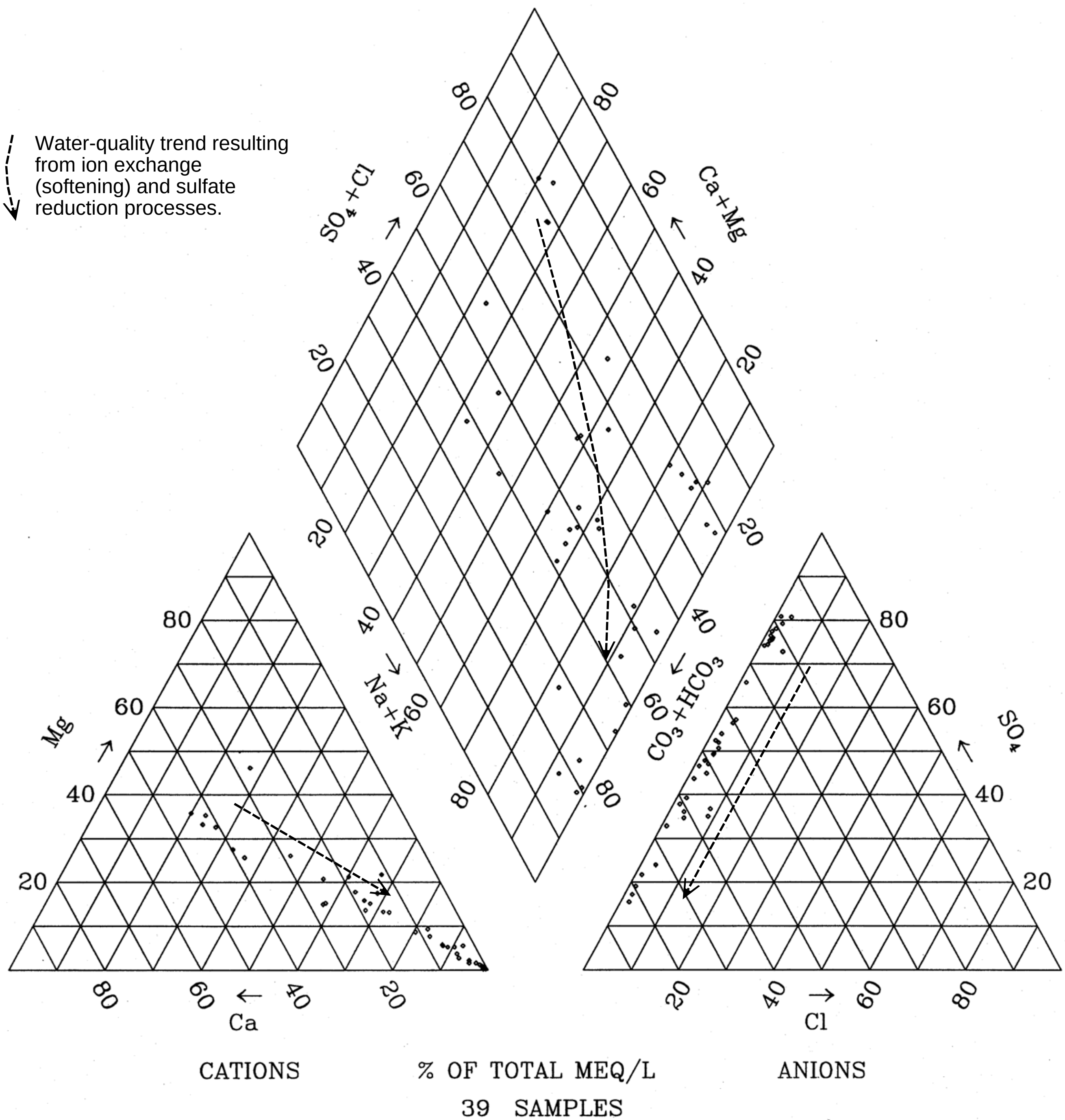

Figure 14. Ionic percentages, Two Medicine / Virgelle aquifer.

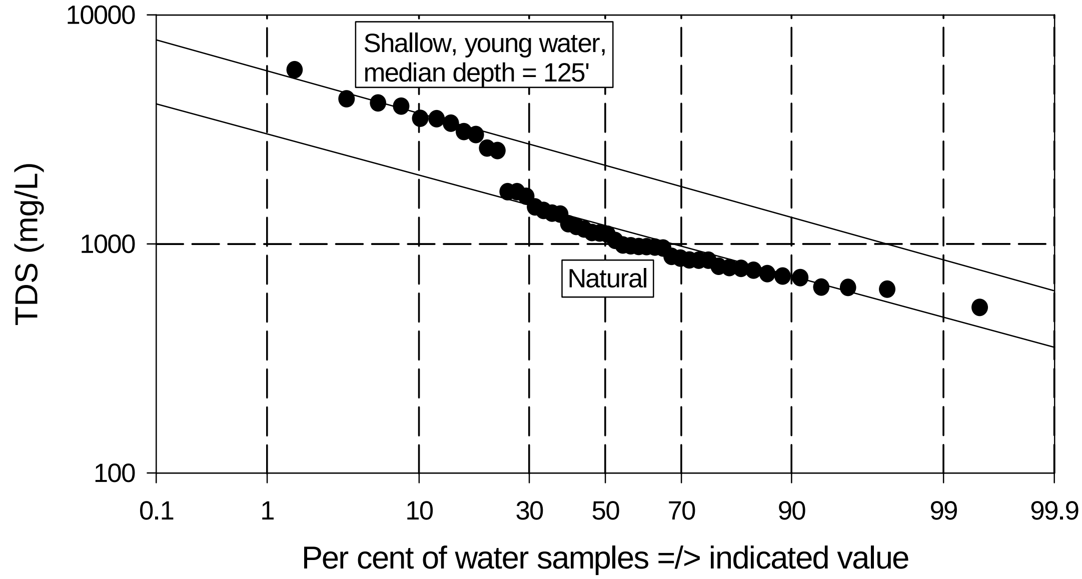

Figure 15. Total dissolved solids in ground water from the Two Medicine / Virgelle aquifer.

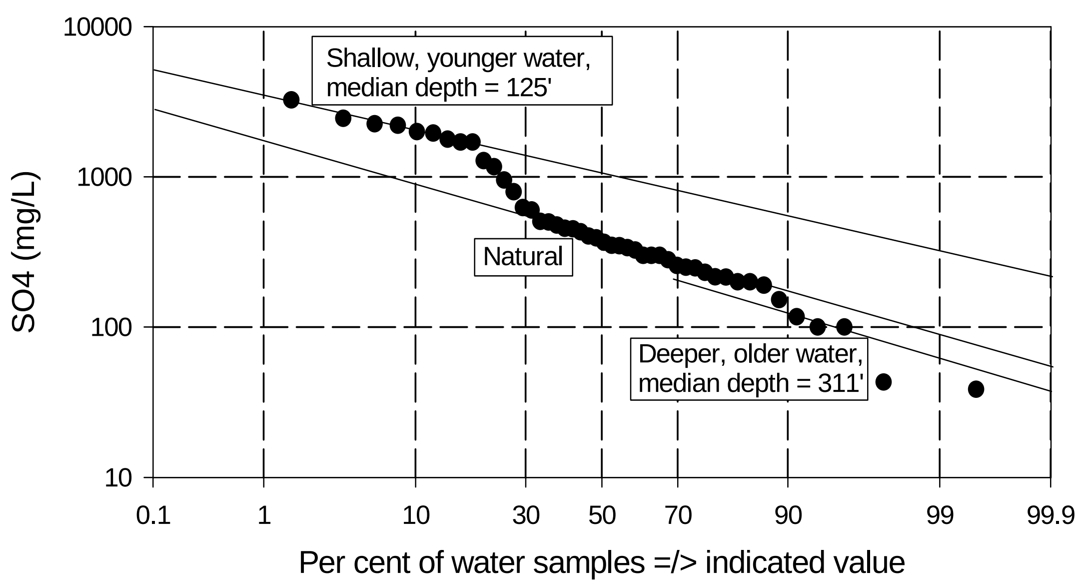

Figure 16. Sulfate in ground water from the Two Medicine / Virgelle aquifer.

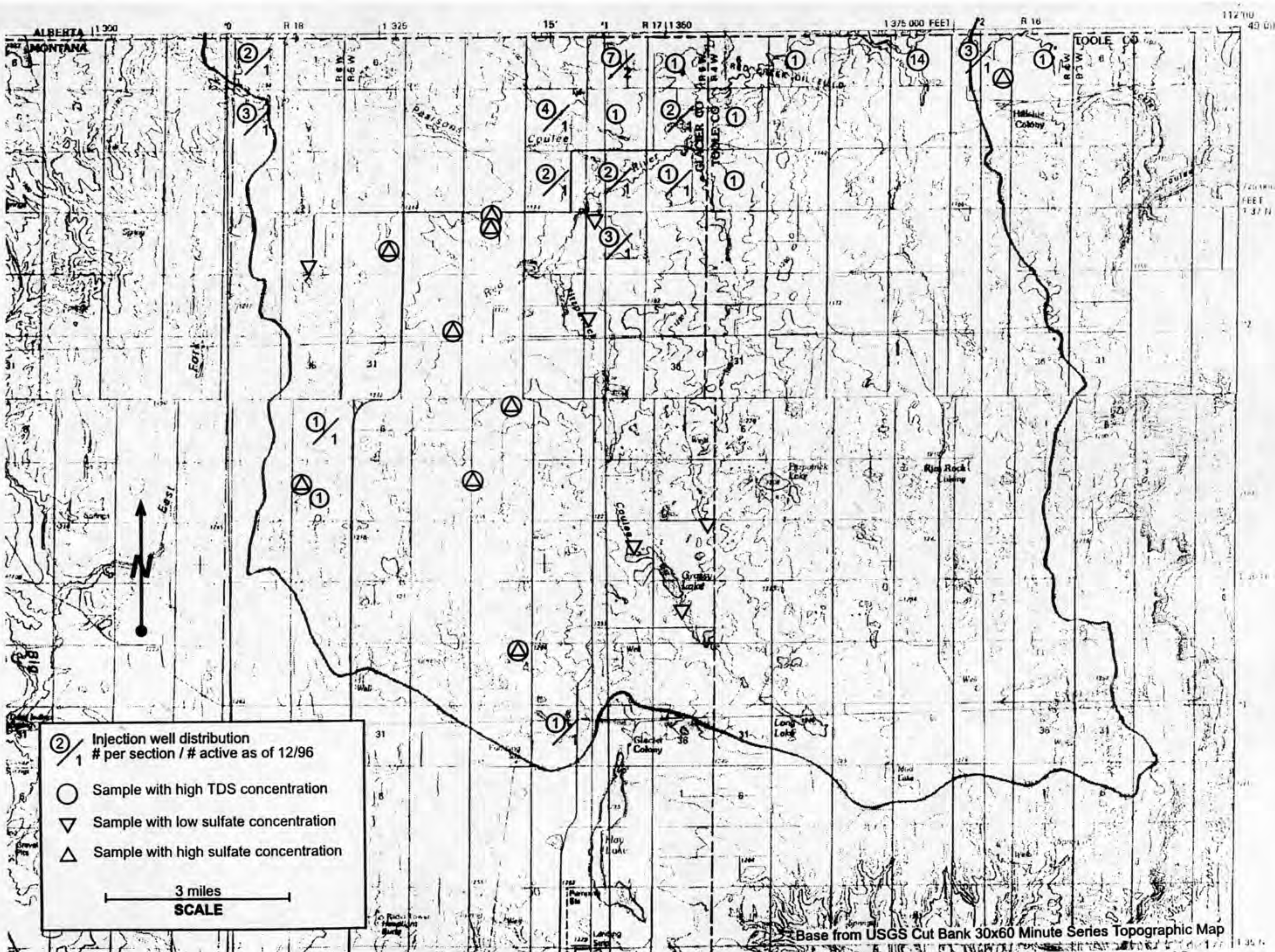

Figure 17. Locations of high TDS and high and low sulfate concentrations in ground water from the Two Medicine/Virgelle aquifer; relative to values on figures 15 and 16.

hydraulic conductivity that are recharged by lateral flow from distant recharge areas. Pumping might lower the pressure in the sands enough to induce vertical flow from adjacent shales or mudstones containing high TDS water. Water-quality data from finer grained sediments within the Two Medicine Formation are not available to test this hypothesis.

3. Other aquifers

Most water samples from petroleum wells in the Red River watershed are sodium-bicarbonate type water (figure 18); only about 17 percent of the samples are sodium-chloride type water. These water samples represent formations below the Virgelle including the Moulton Sand, Sunburst Sand, Cut Bank Sand, and Madison Formation. The higher proportions of sodium relative to calcium and magnesium, and of bicarbonate relative to sulfate are the result of cation exchange and sulfate reduction as water moves downward through the geologic column. Chloride is a residual constituent from the marine origin of the aquifer materials.

Box plots, which show ranges of concentrations of TDS, sodium, bicarbonate, chloride and sulfate in water from Quaternary sediments, the Two Medicine / Virgelle aquifer, and from petroleum wells, are presented in figure 19. Petroleum waters exhibit elevated TDS, sodium, bicarbonate and chloride along with lower concentrations of sulfate than are found in water from Quaternary sediments or from the Two Medicine / Virgelle aquifer. Figure 19 and plate 8 suggest that in the southern and western portions of the watershed, elevated sodium and chloride along with lower relative concentrations of sulfate might serve as indicators of leakage of petroleum water to shallower aquifers providing stock and domestic supplies. In the central and northeastern portion of the watershed, elevated sodium, bicarbonate and chloride along with lower concentrations of sulfate might be the most appropriate indicators.

VI. AQUIFER VULNERABILITY

Aquifer vulnerability can be characterized as the susceptibility of a water bearing zone to non-naturally occurring contamination. Physical characteristics that affect susceptibility include: depth

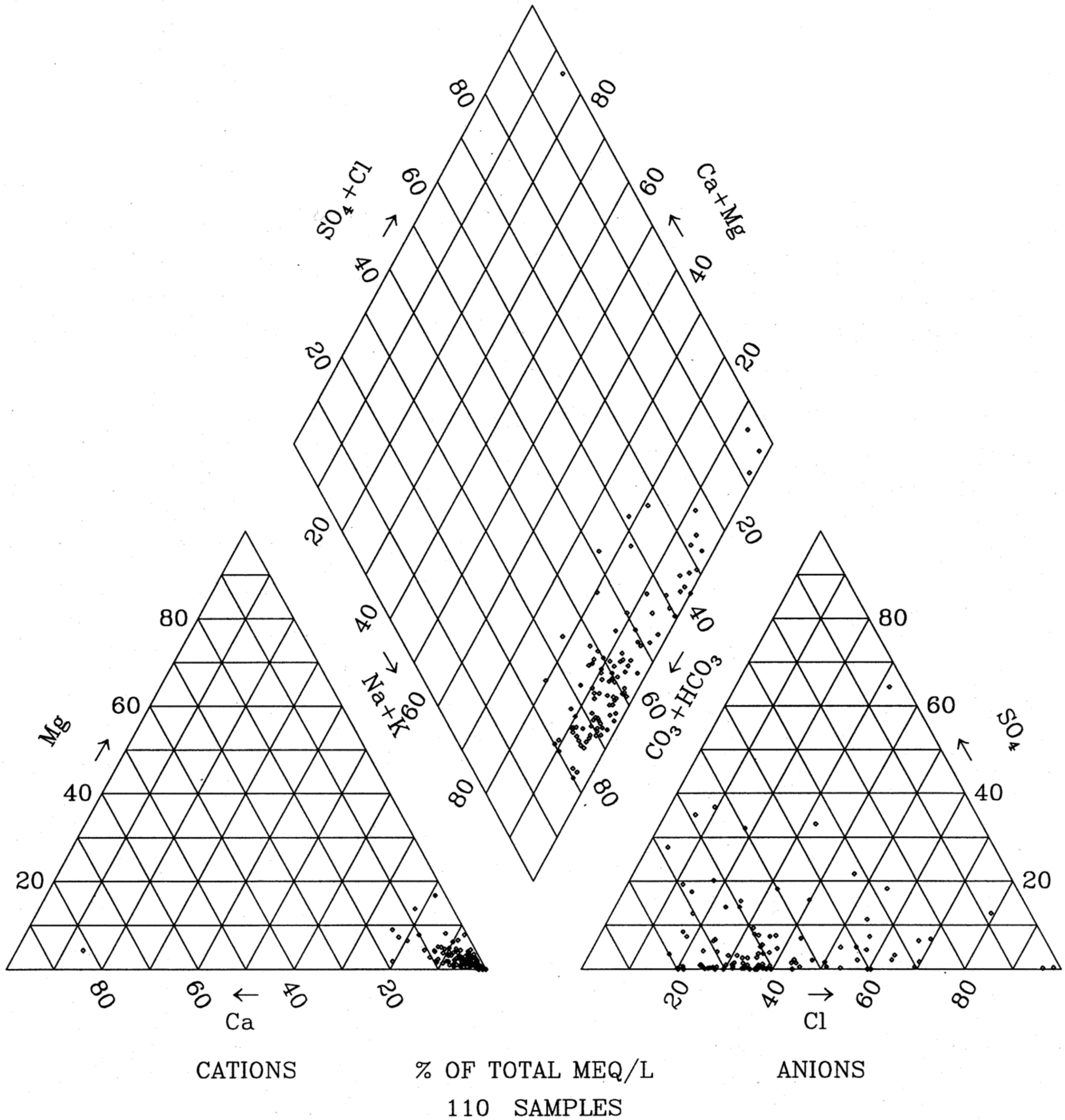

Figure 18. Ionic percentages in water samples from petroleum wells.

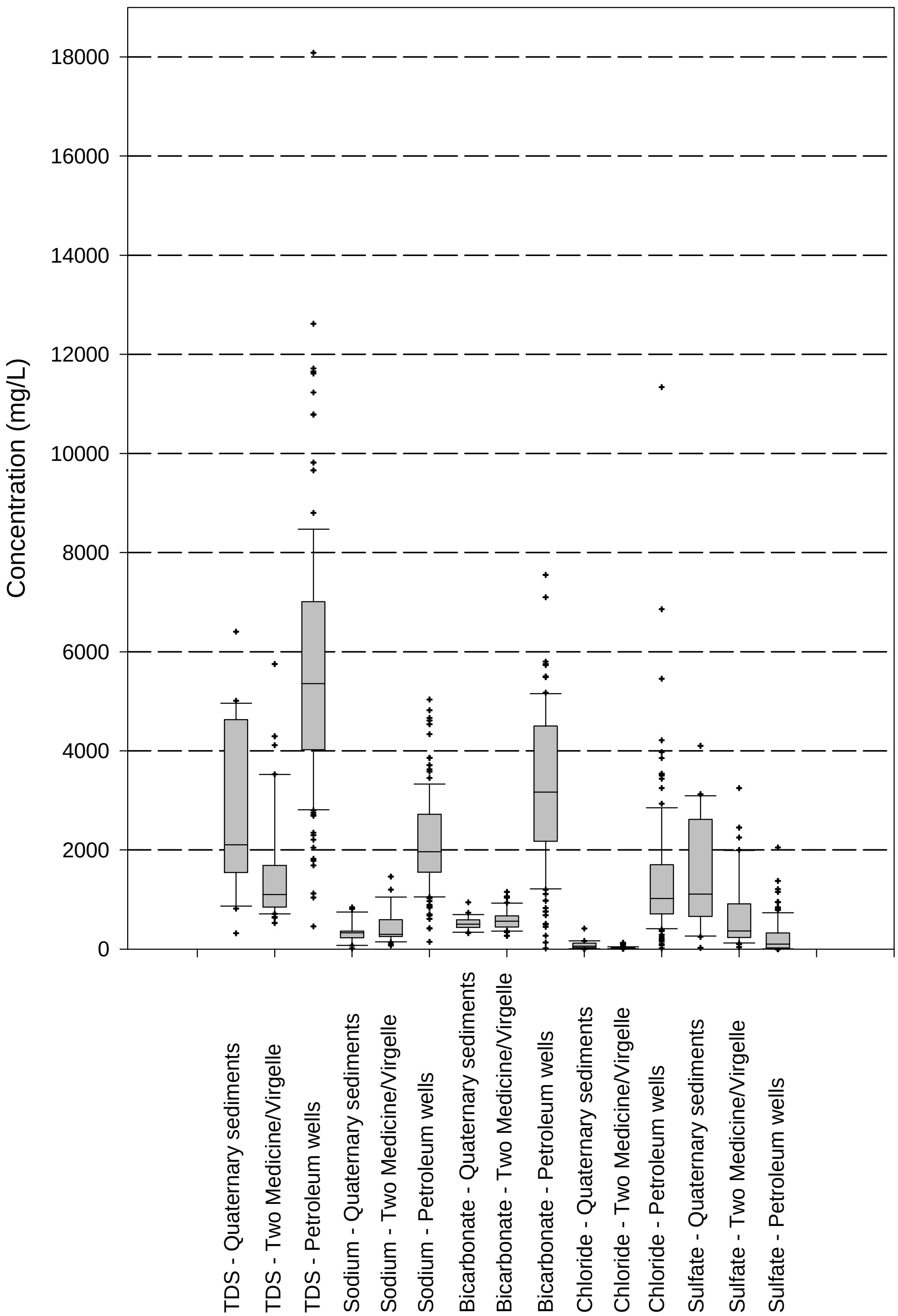

Figure 19. Box diagrams comparing concentrations of TDS, sodium, bicarbonate, chloride and sulfate in water from Quaternary sediments, the Two Medicine / Virgelle aquifer and from petroleum wells in the Red River watershed.

to water, porosity, transmissivity, recharge rate, source of recharge, soil type, aquifer material, and vegetation type and amount. The two primary land-use practices in the Red River watershed are agriculture, mainly dryland small-grain production, and petroleum development.

Quaternary sediments, till and alluvium, are surficial deposits that in places are relatively coarse grained, and may have a near-surface water table. Where coarse sediments occur at the surface, water from precipitation or runoff can infiltrate readily. In these areas, mostly along streams, any surface contamination could enter the ground-water flow system. Few water supplies are obtained from Quaternary sediments, but ground water from these shallow zones is a source of recharge to deeper aquifers such as the Two Medicine Formation and Virgelle Sandstone.

The Two Medicine / Virgelle aquifer is the most heavily utilized aquifer in the watershed for domestic, public, or stock-water supplies. Hydrogeologic data for the Two Medicine / Virgelle indicate confined or semi-confined conditions under most of the watershed, suggesting that recharge to these units is from lateral inflow from outcrops and from vertical downward flow from the overlying glacial deposits. Aquifer vulnerability is greatly reduced where confined conditions exist. However, where these formations are directly overlain by glacial till, they could be affected by downward percolating water contaminated by activities such as agriculturally induced dryland salinity, or by petroleum sources including leaking waste water pits, leaking tank batteries, or leaking pipelines. Figures 15 and 16 suggest that salinized water, probably due to dryland salinity, may have infiltrated downward into the Two Medicine / Virgelle aquifer.

A. Agriculture

Most small grain production in the Red River watershed utilizes the crop-fallow (summer fallow) farming system which was originally developed to minimize the effects of the occasional dry year. However the practice has been shown to contribute to dryland salinity and the accompanying water-quality degradation in shallow ground water. Most soils can store only 4 - 8 inches of water in the root zone during the fallow period. Additional water over that amount entering the soil of a fallow strip is not utilized by vegetation, and therefore migrates downward to the water table. A close relationship between local precipitation patterns and water table fluctuation indicates that water is moving through the soil profile beneath the root zone and accumulating on the underlying, relatively impervious Cretaceous bedrock. Water table rises of 0.2 inches to 10 feet have been documented under fallow areas during wet springs. The rising water table results in dissolution of salts in previously un-wetted sediments and development of saline seeps where the higher water table intercepts the ground surface. High water tables will decline during the rest of the year, but normally do not reach the previous year's low, resulting in a continued buildup of water over the years. As a result, each succeeding annual wet cycle intensifies the dryland salinity problem (Holzer, 1996).

The Cretaceous Judith River and Claggett Formations can contain numerous beds of shale, and mudstone which perch most of the shallow ground water. Undoubtedly some of the perched water leaks through to the next impermeable layer, or possibly joins a deeper ground-water flow system, such as the Telegraph Creek Formation. Also, the glacial till that covers much of the project area, provides a swell and swale topography typical of glaciated terrains, which allows water to pond for extended periods of time. Extensive vertical joints and fractures in the glacial till allow water to percolate vertically, and because the till and weathered bedrock have low horizontal permeability, lateral drainage of excess water is slow. The mantle of glacial deposits provides an excellent soil-moisture storage reservoir ideally suited for intensive dryland farming. Unfortunately, it also provides an effective ground-water reservoir in which water can slowly accumulate until it appears at the surface as a seep (Holzer, 1996).

Prevention or mitigation of saline seep development involves utilization of precipitation where and when it falls before it moves beneath the root zone. Control practices include growing deep rooted perennial crops, intensive annual cropping, reduced tillage, and alternative crops such as oil seeds and annual legumes (Miller, 1981).

A saline seep evaluation was conducted by the Montana Salinity Control Association (MSCA). Hydrogeologic investigations were conducted for three known or suspected salinized sites, and farm plans to mitigate the sites were prepared and given to the farmers for their implementation. Boring logs of monitoring wells installed by MSCA are found in appendix H, water levels are found in appendix C, and analytical results are found in appendix D.

B. Petroleum Development

Petroleum drilling and production in the Red River drainage first started in earnest during the twenties with the development of the Kevin-Sunburst Field (Darrow, 1955). The Darling Field (T. 37 N., R. 4.and 5 W.) was developed by Glacier Production Co. during the 1930's with gas and oil production from the Cretaceous age Cut Bank and Moulton sands (Reid, 1955). The Reagan Field (T. 37 N., R. 7 W.) was developed during the 1940's and 1950's with oil production from the Madison Formation (McCourt, 1955). Several wells were drilled for oil in the Madison Formation in the North Cut Bank Field under T. 36 N., R. 6 W. during this period (Lynn, 1955).

Other oil and gas discoveries were the Border Field north of T. 37 N., R. 4 W. in 1929, the McGuinness pool in 1942 in T. 35 N., R. 5 W., the Blackfoot pool in T. 36 N., R. 6 W. in 1945, the Hay Lake pool in T. 36 N., R. 5 W. in 1947, the Moulton oil pool in T. 37 N., R. 4 W. in 1952, the Graben Coulee Field in T. 37 N., R. 5 W. in 1953, the Blackfoot Nose Field in T. 37 N., R. 6 W. in 1956, and the Red Creek Field in T. 37 N., R. 5 W. in 1958 (Oakes, 1966).

Producing formations in the Red River watershed include the Cretaceous Sunburst sand, Cut Bank sand, Moulton sand, and the Missippian Madison Formation. Locations and other data for petroleum wells in and adjacent to the Red River drainage are given in Appendices C and D. Shut-in pressures from drill-stem tests on petroleum wells demonstrate that the normal gradient is downward, so up-hole migration of formation water from deeper petroleum producing horizons is not expected. If the gradient were to be reversed because of deep hole injection of water for secondary petroleum recovery, it is possible that water-quality degradation might be seen in shallow aquifers.

One water well, 370403CDCABC, was impacted by natural gas injection in the Cobb storage unit which utilizes the Moulton sand. The problem was traced to casing problems in nearby petroleum wells. Natural gas escaping to the surface of a wheat field also temporarily affected grain production. The leakage stopped when the wells with the casing problems were plugged and abandoned. Wheat production came back after two to three years and no hydrocarbons were detected in well 370403CDCABC when it was sampled in July, 1995 (Sasaki, 1998).

In 1988, USEPA commissioned a study of the potential for contamination of aquifers used for drinking water supplies under the Graben Coulee Field located in sections 10, 11, 14, and 15 of T. 37 N., R. 5 W. (Engineering Enterprises, Inc., 1988). Most production in the field is from the Cretaceous Cut Bank Sand. During the study, the four Cut Bank production wells listed below were verified to have water flowing to surface from casing annuli.

Well Name	**Location**
Cobb 3	370514BBA
Cobb 5	370514BAC
Swenson 12	370510DAC
Thompson 3	370511CCD

Another well 370514ABB had reportedly flowed water to the surface in about 1986, but had been repaired by 1988. Water samples from drinking water wells and from the Cut Bank sand taken in October, 1987 were consistent with historical water quality data. The following excerpts from that study summarize their findings:

> *"…the fluid flow from these wellbores is confined to normal flow conduits (i.e. tubing or tubing annulus)."*

> *Well bore construction is of the utmost importance in areas where injection activity exists, largely due to the fact that reservoir pressures*

in such areas are frequently elevated to the extent that artesian conditions are created. When wellbores are not constructed in anticipation of these elevated pressures, problems can occur.

In the case of the Graben Coulee Field, such problems have been manifested in the GHGS – Cobb 3 and GHGS – Cobb 5, which each flow considerable volumes of water from their surface casing annuli. As discussed in the hydrogeologic summary, the water flowing to the surface in the Cobb Nos. 3 and 5 is believed to be Cut Bank water.

Assuming that this is the case, several possible flow conduits. Flow along the Cobb 3 and 5 surface casing could be occurring due to:

1. *Poor cement quality in the production and surface casing annuli of the flowing producers, thus enabling pressurized Cut Bank formation water to migrate from the subsurface to the surface.*

2a. *Poor cement quality in one or more offsetting injection wellbores, thus enabling Cut Bank injection fluid to migrate upward and into formations which are exposed to the uncemented annuli of the flowing production wellbores.*

2b. *Vertical fractures induced within the injection wellbore by excessive injection pressures, thus, allowing injection fluid to migrate upward into formations exposed in the production* *wellbores.*

3. *Naturally occurring or induced vertical fractures at the producers which are sufficient to allow flow from the Cut Bank reservoir to the surface.*

Based solely on wellbore construction characteristics, it is difficult to speculate with regard to which of these situations is occurring."

Well construction diagrams in the report show that only the bottom few hundred feet of the casing were cemented. The annular space outside the casing above the cement could then allow inter-aquifer communication. Owing to the normal downward gradient (plates 3 and 6, Croft, 1996, and Sasaki, 1998), introduction of oilfield water into the Virgelle or Two Medicine will not occur except near injection wells. Injection in the Graben Coulee field stopped shortly after the report was written, and pressures have returned to static conditions (Sasaki, 1998).

Possible pathways for contamination of shallow ground water by oil field water include upward leakage of high TDS water near injection wells, leaking waste-water pits, leaking above-ground tanks, etc. A study for MBMG by a consultant found no evidence of leaking injection wells based on reports filed with the Oil and Gas Commission and on inquiries to operators (Thackeray, 1997). The report (included as Appendix F) outlines possible mechanisms for contamination of shallow aquifers by oil field water and recommends measures to help determine whether ground-water degradation is due to re-injection of oil field water.

To further characterize the potential for shallow ground-water contamination from petroleum activities, soil samples were collected from 9 locations in the watershed where contamination was visible or had been documented. The samples were analyzed for total petroleum hydrocarbons (TPH) by a commercial laboratory in Billings and the results are presented in table 8. Sample sites were selected based on observations by MBMG personnel during the ground-water inventory or because of concerns voiced by residents of the area.

Photos of the site at 370417DCBDBB showed oil-stained soil devoid of vegetation around the well (Boxwell, 1996). When the site was visited in August of 1996, the surface contamination had been removed or covered and vegetation was growing around the well, but the TPH level in the soil sample was 33,400 micrograms per gram (ug/g). The well has a bonded operator who is responsible for maintenance and cleanup.

A sample was collected from an area of sparse vegetation in a wheat field at the site of a reclaimed brine pit (370501CBBDD). The pit was filled in and is now being farmed over. Although the TPH level in the soil sample was 2,040 ug/g, the landowner is satisfied with the reclamation.

A soil sample was collected at the site of a well that is rumored to be a waterflood well with a leaking casing (370516AAACCD). The TPH level was 2,580 ug/g. The site warrants further investigation for possible petroleum contamination and also for saline seep because it is in a cropped area that appears to have developing seeps. A soil sample (370523ACBDA) from below two ponds in a stream channel bottom had 170 ug/g TPH. The well has a bonded operator who is responsible for maintenance and cleanup.

TPH results for ground water were negative (table 6) except for three samples, one from the Madison Formation, one possibly caused by decaying animals in the well bore, and a third sample from a public supply well in which volatile organic compounds at low concentrations were detected on one other date. Data in tables 6 and 8 suggest that contamination from soil is localized at the ground surface and has apparently not affected ground or surface water at most of these sites.

VII. CONCLUSIONS AND RECOMMENDATIONS

Objectives of this project were to determine whether farming practices or petroleum operations have impacted the quality of ground or surface water in the Red River drainage. Analysis of water-quality data suggests that ground water in the glacial till has been locally degraded

Table 8. Soil Sampling Summary		
Site	**Description**	**TPH** (μg/g)
370510ADDDCD	Soil sample from between an active brine pit in an unnamed tributary to the Red River.	<10
370417DCBDBB	Soil sample about 25' ESE of MPCO St #2 (990' FSL—2310' FEL).	33,400
370501CBBDD	Soil sample from an area of stressed vegetation at the site of a brine pit that was filled in and is now farmed over.	2,040
370512BBDBB	Soil sample from an area of stressed vegetation at about the west side of a brine pit that was filled in and is now farmed over.	<10
370503DBDBA	Soil sample from the stream channel bottom below an active brine pit located on the south side of the channel and immediately above the road crossing.	<10
370503DBBAC	Soil sample from the stream channel bottom immediately below the lowest of what appeared to be two old brine pits (now breached) just east of a petroleum well - MSR/EXXON McAlpine 10.	<10
370514CBAAD	Soil sample from about ten feet downslope (east) of the lowest of two active brine pits.	<10
370516AAACCD	Soil sample – 3’ due east of a petroleum well (MSR State.17-172-75 #16-2) rumored to be a waterflood well with brine leaking around the casing. Breached brine pit just northeast of well water discharging at 23 gpm, SC = 5520 umho, pH = 7.26, T = 19C.	2580
370523ACBDA	Soil sample taken from the channel bottom about 20 feet down- stream of the top of the berm of the lowest (northwest) pond next to a petroleum well (Gypsy Highview Marie Kruger “A”).	170
All samples were collected at a depth of about one foot below grade.		

by dryland salinity. Water quality in the glacial till and Quaternary alluvium was characterized by calcium, magnesium and bicarbonate ions. TDS levels range from 319 to 6,400 milligrams per liter (mg/L). Few wells are completed in Quaternary deposits, because of limited water availability (i.e. low saturated thickness or low hydraulic conductivity).

Ground water in the Two Medicine Formation and Virgelle Sandstone exhibits natural changes in chemistry attributable to cation exchange and sulfate reduction as water moves downward through the geologic section. The water was dominated by calcium, sodium, bicarbonate and sulfate with TDS levels ranging from 530 to 5,750 mg/L. Samples with high TDS and sulfate may represent ground water degraded by saline seep or by pumping that may have induced vertical leakage of high TDS water from adjacent formations.

Although leakage of oil field water from injection wells is known to have occurred in the past, the existing data do not provide conclusive evidence of contamination by oil field water of aquifers supplying water to wells in the drainage.

The total estimated ground-water flow rate through the shallow aquifers is 56 acre-feet per day, some of which is recharge from precipitation, and some from lateral inflow through the Two Medicine/Virgelle from the west and southwest. Estimated average annual recharge from precipitation is 0.7 inches for the Red River watershed. Estimated ground-water flows were 0.1 acre feet per day through the Quaternary deposits and 55 acre feet per day through the Two Medicine / Virgelle aquifer. Most ground water leaves the watershed as lateral flow to the northeast, but about 1.5 percent discharges to surface water, and an unknown amount is used by plants or flows vertically downward to deeper formations.

Data collected during the project were used to select sites for saline seep evaluation. Farm plans have been prepared by MSCA for the operators. Adherence to these plans will prevent the spread of the seeps and should reduce or eliminate the problem at those sites.

A Department of Natural Resources and Conservation-funded Resource Development Grant Program (RDGP) that follows this project will use information developed from this evaluation to choose various sites for saline seep mitigation and form the remediation of surface contamination by petroleum activities. MSCA is preparing numerous farm plans for saline seep mitigation on the basis of their extensive monitoring-well drilling and hydrogeologic evaluation. MBMG is contracting remedial work for numerous petroleum waste pits, a petroleum storage tank battery, and an orphaned (no bonded operator) well. The forthcoming RDGP work is also sponsored by the Glacier County Conservation District.

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APPENDIX A

SURFACE-WATER INVENTORY INFORMATION

Surface-water inventory data

LOCATION	DATE INVENTORIED	SURF ELEV (ft)	FLOW RATE (gpm)	WATER USE	SAMPLE SOURCE	SAMPLE DATE	SAMPLE TAKEN	MBMG QW #	MBMG SITE #
36N 05W 29 ACBBAC	12-Aug-97	4038	23	UNUSED	SPRING	17-Aug-97	Y	98Q0173	M:6835
37N 04W 03 BDC	13-Jul-90	3560		STOCKWATER	RIVER	13-Jul-90	Y	90Q0230	M:120904
37N 04W 04 ABDCDC	26-Jul-95			STOCKWATER	RIVER	26-Jul-95	Y		
37N 04W 04 ABDCDC	7-Sep-95			STOCKWATER	RIVER	7-Sep-95	Y		
37N 04W 04 ABDCDC	16-Jul-97	3978		STOCKWATER	RIVER	16-Jul-97	Y	98Q0048	
37N 05W 04 DDDDBD 01	11-Aug-95	3865		UNUSED	SPRING	11-Aug-95	Y	96Q0243	M:150358
37N 05W 16 AAACCD	31-Jul-96	3860	28	UNUSED	SPRING	31-Jul-96	Y	97Q0166	M:156033
37N 05W 22 CCACAC	16-Jul-95	3790		STOCKWATER	RESEVOIR	16-Jul-95	Y	96Q0092	M:149826
37N 06W 29 DACBBC	15-Jul-95	4160		STOCK	SPRING	15-Jul-95	Y	96Q0090	M:149828
37N 06W 34 CCDADB	15-Jul-95	4070	7R	DOM/STK	SPRING	15-Jul-95	Y	96Q0095	M:149825

APPENDIX B

SURFACE-WATER QUALITY DATA

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	TDS (mg/L) CALCULATED	TDS SUM OF DIS CONST (mg/L)	FLD SC (umho/cm)	LAB SC (umho/cm)	FIELD pH	LAB pH	HRDNS AS CaCO3 (mg/L)	ALK AS CaCO3 (mg/l)	RYZNAR STAB IND	LANGLIER SAT IND	SAR	AIR TEMP (deg C)	WATER TEMP (deg C)
36N 05W 29 ACBBAC	17-Aug-97	SPRING	98Q0173	5011	5259	4410	4510	7.59	7.81	3272	400	4.67	1.57	3.1	25.	21.
37N 04W 03 BDC	13-Jul-90	RIVER	90Q0230	6849	9127		10055		9.05	202	4567	5.02	2.02	82.61		
37N 04W 04 ABDCDC	26-Jul-95	RIVER			1860		2350		8.4	870				3.	22.	20.5
37N 04W 04 ABDCDC	7-Sep-95	RIVER			1870		2280		8.2	750				4.	20.	19.
37N 04W 04 ABDCDC	16-Jul-97	RIVER	98Q0048	1515	1540	1970	1957	8.8	8.22	587	41	7.73	0.24	5.06	28.	26.
37N 05W 04 DDDDBD 01	11-Aug-95	SPRING	96Q0243	2905	3300	3790	3330		8.17	1956	638	4.03	2.07	2.42	21.	11.
37N 05W 16 AAACCD	31-Jul-96	SPRING	97Q0166	4838	5211	5520	4920	7.26	7.3	1883	602	5.05	1.13	8.45	28.5	19.
37N 05W 22 CCACAC	16-Jul-95	RESEVOIR	96Q0092	646	741	984	949	9.06	8.68	355	154	5.92	1.38	1.54		18.5
37N 06W 29 DACBBC	15-Jul-95	SPRING	96Q0090	1716	2017	2440	2270	7.38	7.97	951	486	5.3	1.33	3.25		10.
37N 06W 34 CCDADB	15-Jul-95	SPRING	96Q0095	1537	1821	2480	2280	7.65	7.81	579	458	5.87	0.97	5.97		10.

Surface-water quality data - major elements

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Cl (mg/l)	SO4 (mg/l)	NO3 (mg/l)	F (mg/l)	PO4 (mg/l)
36N 05W 29 ACBBAC	17-Aug-97	SPRING	98Q0173	457.	517.6	407.5	12.7	<.005	.021	12.7	488.	0	165.1	3125	73.5	0	<.05
37N 04W 03 BDC	13-Jul-90	RIVER	90Q0230	6.4	45.3	2700.	64.	.112	.018	2.8	4490.	530.	1280.	7	.09	.84	<.1
37N 04W 04 ABDCDC	26-Jul-95	RIVER		150.	120.	240.	15.	.063	.07	1.5	347.	0	60.	950		.2	<.05
37N 04W 04 ABDCDC	7-Sep-95	RIVER		140.	94.	260.	9.	.019	.028	2.7	343.	0	40.	950		.3	<.01
37N 04W 04 ABDCDC	16-Jul-97	RIVER	98Q0048	81.6	93.	281.4	8.9	.041	.007	.3	49.8	0	51.1	974	.3	0	<.05
37N 05W 04 DDDDBD 01	11-Aug-95	SPRING	96Q0243	392.7	236.9	246.4	13.1	.08	1.8	15.9	778.4		60.	1500	55.	<.1	<1
37N 05W 16 AAACCD	31-Jul-96	SPRING	97Q0166	352.	244.	843.	8.3	.012	.819	8.3	734.4		<100	3020	<.05	<1	
37N 05W 22 CCACAC	16-Jul-95	RESERVOIR	96Q0092	87.1	33.5	66.6	13.4	.026	.049	15.3	187.4	17.3	20.	300	.05	.141	<.1
37N 06W 29 DACBBC	15-Jul-95	SPRING	96Q0090	150.	140.	230.	3.	<.02	.009	8.4	593.		80.	800	12.5	.395	<.1
37N 06W 34 CCDADB	15-Jul-95	SPRING	96Q0095	100.	80.	330.	3.1	.007	<.002	9.6	559.		46.	660	32.5	.294	<.1

Surface-water quality - trace elements

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Al (ug/l)	Sb (ug/l)	As (ug/l)	Ba (ug/l)	Be (ug/l)	B (ug/l)	Br (ug/l)	Cd (ug/l)	Cr (ug/l)	Co (ug/l)	Cu (ug/l)	Pb (ug/l)	Li (ug/l)	Mo (ug/l)	Ni (ug/l)	NO2 as N (mg/l)	P tot dis (mg/l)	Se (ug/l)	Ag (ug/l)	Sr (ug/l)	Ti (ug/l)	Va (ug/l)	Zn (ug/l)	Zr (ug/l)
36N 05W 29 ACBBAC	17-Aug-97	SPRING	98Q0173	<30	<2	8.4	23.9	<2	471.2	<25	<2	10.6	<2	5.1	<2	38	<10	44.7	<.05	<.2	294.3	<1	7022	<10	<5	5.9	<20
37N 04W 03 BDC	13-Jul-90	RIVER	90Q0230	<40			595.		1700.	4400	<5	<5		<4		2560	<40	<20		0.2		<4	929	<4	<4	125.	<6
37N 04W 04 ABDCDC	26-Jul-95	RIVER		<30		6.	100.		310.	150	<2	2.	<2	4.	<2	42	<10	7.	<.05	<.2	3.	<1	1000		<5	2.	
37N 04W 04 ABDCDC	7-Sep-95	RIVER		<30		2.	62.		280.	200	<2	3.	<2	3.	<2	42	<10	5.	<.05	<.2	3.	<1	1600		<5	<8	
37N 04W 04 ABDCDC	16-Jul-97	RIVER	98Q0048	<30	<2	3.2	23.1	<2	187.	255	<2	<2	<2	4.8	<2	52	<10	10.4	<.05	<.2	4.	<1	1071	<10	<5	<2	<20
37N 05W 04 DDDDBD 01	11-Aug-95	SPRING	96Q0243	<80	<2	4.8	124.2		316.	<200	<2	<2	<2	3.5	<2	33	<10	13.4	0.05	<.2	70.1	<1	4076	<10	<5	10.6	<20
37N 05W 16 AAACCD	31-Jul-96	SPRING	97Q0166	<30	<2	8.8	12.4	<2	739.	<250	<2	24.9	2	14.8	<2	59	<10	38.2	<.05		169.5	<1	13000	<10	7.4	8.8	<20
37N 05W 22 CCACAC	16-Jul-95	RESERVOIR	96Q0092	<30	<2	6.9	150.9		80.	<50	<2	<2	<2	2.5	<2	10	<10	5.1	<.05	0.28	2.3	<1	397	<10	<5	<2	<20
37N 06W 29 DACBBC	15-Jul-95	SPRING	96Q0090	<30	<2	3.1	36.4		157.	650	<2	<2	<2	8.7	<2	58	<10	7.	<.05	<.2	24.4	<1	3039	<10	<5	8.3	<20
37N 06W 34 CCDADB	15-Jul-95	SPRING	96Q0095	<30	<2	3.1	23.2	<2	166.		<2	<2	<2	10.6	<2	26	<10	3.7	<.05	<.2	34.6	<1	1752	<10	<5	13.8	<20

APPENDIX C

GROUND-WATER INVENTORY INFORMATION

LOCATION	DATE INVENTORIED	DATE DRILLED	PUMP?	GEOLOGIC SOURCE	SURF ELEV (ft)	TOTAL DEPTH (ft)	BOTTOM ELEV (ft)	CASING DIAM (ft)	PWL (ft)	SWL (ft)	WL ELEV (ft)	Q (gpm)	WATER USE	SAMPLE SOURCE	SAMPLE DATE	SAMPLE TAKEN	MBMG QW #	MBMG SITE #
35N 04W 01 ABDDBA01	12-Jul-96	Oct-41	Y	211VRGL	4185	160R	4025.	6.		90R	4095R	9	DOMESTIC	WELL	12-Jul-96	Y	97Q0038	M:126967
35N 04W 01 ACAABA	12-Jul-96	Jul-63	Y	211VRGL	4185	230.	3955.	4.	230R	120R	4065R	3R	STOCKWATER	WELL		N		89568
35N 04W 02 BCAADA	12-Jul-96		N		4185	152.7	4032.3	5.		151.1	4033.9		UNUSED	WELL		N		
35N 04W 03 AABACB	12-Jul-96	1947	Y		4195	146.3	4048.7	5.		144.1	4050.9	10R	UNUSED	WELL		N		
35N 04W 03 DADC		May-05	Y		4170	227.	3943.	6.		219R	3951R	40R	DOM/STK	WELL		N		
36N 04W 04 AAC		1963				255.		6R	60.			2R	STOCKWATER					M:89917
36N 04W 04 ADB		1973				252.		7R	252.	192.		10R	DOM/STK					M:89918
36N 04W 07 ACA		1960				178.		5R		30.		15R	STOCKWATER					M:89919
36N 04W 08 AABC	24-Feb-98	1997	N	112TILL	4080	45.	4035.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ABAD	24-Feb-98	1997	N	112TILL	4120	20.	4100.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ABCC	24-Feb-98	1997	N	112TILL	4080	43.	4037.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ACAD	24-Feb-98	1997	N	112TILL	4082	30.	4052.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ACAD	24-Feb-98	1997	N	112TILL	4082	38.	4044.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ACBC	24-Feb-98	1997	N	112TILL	4060	30.	4030.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ADAA	24-Feb-98	1997	N	112TILL	4090	30.	4060.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 ADCC	25-Feb-98	1997	N	112TILL	4040	38.	4002.	2.		31.	4009		SEEP WELL	MON WELL	25-Feb-98	Y	98Q0815	
36N 04W 08 BAAA	24-Feb-98	1997	N	112TILL	4050	23.	4027.	2.		DRY			SEEP WELL	MON WELL		N		
36N 04W 08 BAAD	24-Feb-98	1997	N	112TILL	4040	38.	4002.	2.		20.2	4019.8		SEEP WELL	MON WELL	24-Feb-98	Y	98Q0820	
36N 04W 08 DDAD	24-Feb-98	1997	N	112TILL	4010	18.	3992.	2.		7.8	4002.2		SEEP WELL	MON WELL	24-Feb-98	Y		
36N 04W 08 DDBB	24-Feb-98	1997	N	112TILL	4000	18.	3982.	2.		6.3	3993.7		SEEP WELL	MON WELL	24-Feb-98	Y	98Q0819	
36N 04W 09 BBB		1961				149.		6R		149.		10R	STOCKWATER					M:89920
36N 04W 11 BBADCD	2-Aug-95	Nov-59	Y	211TMDC	4005	205R	3800R	6.	153.2	153.4	3851.6	18R	DOMESTIC	WELL	2-Aug-95	Y	96Q0179	M:89921
36N 04W 11 CAAACA01	2-Aug-95	40'S-50'S	Y	211VRGL	3870	142.4	3727.6	12.		130.2	3739.8	70-75R	DOM/STK		2-Aug-95	Y	96Q0178	M:89922
36N 04W 11 CAAACA01	8-Aug-95	40'S-50'S	Y	211VRGL	3870	140.9	3729.1	12.	129.7	124.9	3745.1	70-75R	DOM/STK			N		M:89922
36N 04W 14 AAADCD	8-Aug-95	1940	N	211VRGL	4030	103.8	3927.	12.		77.9	3952.1	75R	PWS-UNUSED			N		M:89923
36N 04W 14 AACCCC	14-Jul-95	1951	Y	211VRGL	4020	159R	3861R	12.5	98R	49.2	3970.8	250R	PWS	WELL	14-Jul-95	Y	96Q0100	M:89924
36N 04W 14 AACCCC		1951	Y	211VRGL	4020	159R	3861R	12.5	98R	89R	3931R	250R	PWS	WELL	10-Feb-54	Y	54Q0001	M:6822
36N 04W 14 AADDDC	9-Aug-95	1940	N	211VRGL	4050	143.	3907.	12.		97.	3953	40R	PWS-UNUSED			N		M:89926
36N 04W 14 AADDDC		1940	N	211VRGL	4050	171R	3879R	12.5		116.8	3933.2	40R	PWS-UNUSED	WELL	8-Sep-54	Y	54Q0002	M:6821
36N 04W 14 ADCBDC	14-Jul-95	1936	INOP	211VRGL	4040	155R	3885R	12.	141R	130R	3910R	120R	PWS-UNUSED			N		M:89925
36N 04W 14 ADCBDC		1936		211VRGL	4040	155R	3885R	12.5	141R	130R	3910R	120R	PWS-UNUSED	WELL	30-Jun-65		65Q0007	M:6823
36N 04W 17 AACA	24-Feb-98	1997	N	112TILL	4060	38.	4022.	2.		33.6	4026.4		SEEP WELL	MON WELL		N		
36N 04W 17 ABAC	24-Feb-98	1997	N	112TILL	4020	38.	3982.	2.		22.	3998		SEEP WELL	MON WELL	24-Feb-98	Y	98Q0817	
36N 04W 17 ABDD	24-Feb-98	1997	N	112TILL	4060	38.	4022.	2.		16.8	4043.2		SEEP WELL	MON WELL		N		
36N 04W 17 AC 01				217CBNK									UNUSED	PETWELL			77Q0025	M:895446
36N 04W 21 DDC		1919				240.		6.				10R	DOMESTIC					M:89927
36N 04W 22 ADCCCB01	2-Aug-95	1940	Y	211TMDC	4125	201.	3924.	6.		190R	3935R	10R	DOM/STK	WELL	2-Aug-95	Y	96Q0175	M:89928
36N 04W 22 DCA	20-Oct-65	1920		211TMDC		145.		5.		118.4		4R	STOCKWATER	WELL	20-Oct-65		65Q0023	M:6824
36N 04W 23 DBBCDD	9-Aug-95	1961	INOP		4130	225R	3805R	6.		6.6	4123.3	10R	UNUSED			N		M:89930
36N 04W 26 BBA		1987			4140	108.		7.	5.	2.	4142R	15R	DOM/STK					M:89931
36N 04W 26 CAAC		1938			4160	160.		5.		60.	4100R	4R	STOCKWATER					M:89932
36N 04W 28 B 01				330MDSN		2990.							UNUSED	WELL			30Q0002	M:6825
36N 04W 28 DBB				210CLRD										PETWELL	10-Jul-30	Y		
36N 04W 28 DBB				330MDSN										PETWELL	27-Jul-30	Y		
36N 04W 28 DBB				330MDSN										PETWELL	22-Jul-30	Y		
36N 04W 28 DBB 01				211EGLE									UNUSED	PETWELL			30Q0009	M:895497
36N 04W 30 BBBDB 01	30-Jun-95	1986	Y	211VRGL	4010	168R	3842R	9.6		FLOW		45R	PWS	WELL	30-Jun-95	Y	96Q0008	M:89933
36N 04W 33 BBBB		1943	N		4125	157R	3968R	8->5R				5R	P&A					M:89934
36N 04W 35 AAAAAA	12-Jul-96		N		4223	114.	4109.	8.		DRY >11	4			WELL		N		
36N 04W 35 AB 01	24-Sep-65			211VRGL		225.		7.		125.			UNUSED	WELL	24-Sep-65		65Q0004	M:6826
36N 04W 35 ABABAA	31-Jul-96		N		4180	217.	3963.	8.		112.2	4067.8			WELL		N		
36N 04W 35 ADAADA	12-Jul-96		Y	211VRGL	4155			8.		100.9	4054.1	2	STOCKWATER	WELL	12-Jul-95	Y	97Q0037	M:155871
36N 04W 35 BABCAD	10-Jul-96		N	112TILL	4137	10.1	4126.9	72.		4.4	4132.6		ABANDONED			N		
36N 04W 35 BABDBC	10-Jul-96		N	112TILL	4135	9.2	4125.8	48.		2.2	4132.8		UNUSED	WELL		N		
36N 04W 35 DAAAAA	12-Jul-96		N		4155	70.3	4084.7			DRY >70			UNUSED	WELL		N		
36N 04W 35 DDAADB	10-Jul-96		Y	112TILL	4155			5.		6.8	4148.2		UNUSED	WELL		N		
36N 04W 36 DADBD	12-Jul-96		N		4195	219.	3976.	8.		116.1	4078.9		UNUSED	WELL		N		
36N 05W 01 ABB				217MLTN										PETWELL		Y		
36N 05W 01 ABB				217MLTN										PETWELL	14-Apr-70	Y		
36N 05W 01 ACC		1937			4014	525R	3489R	10R				5R	STOCKWATER	WELL				M:89936
36N 05W 01 DCCCDB	13-Jul-95	1945	Y	211VRGL	4050	475R	3575.	12.5		219.	3831	250R	PWS	WELL	13-Jul-95	Y	96Q0108	M:6827
36N 05W 01 DCCCDB		1945	Y	211VRGL	4050	475R	3575.	12.5		219.	3831	250R	PWS	WELL	18-Mar-54	Y	54Q0005	M:6827
36N 05W 02				217DRLG										PETWELL	7-Sep-33	Y		
36N 05W 04 ABABDD01	15-Oct-65	1915		211TMDC	3920	137.	3783.	4.		123.7	3796.3		STOCKWATER	WELL	15-Oct-65		65Q0022	M:6828
36N 05W 04 ABABDD01	1-Jul-95	1915	Y	211TMDC	3920	136.	3784.	6.		112.1	3807.9	11	DOM/STK	WELL	1-Jul-95	Y	96Q0014	M:89938
36N 05W 04 DB 01				217CBNK	3970								UNUSED	PETWELL			39Q0006	M:895242
36N 05W 04 DBA 01				217KOTN	3980	2814.	1166.						UNUSED	WELL	14-Feb-40		40Q0001	M:6829
36N 05W 05 ACBDBB01	13-Jul-95	1968	Y	211TMDC	3900	160R	3740.	7.		115R	3760R	5R	DOMESTIC	WELL	13-Jul-95	Y	96Q0103	M:89939
36N 05W 07 CC				330MDSN										PETWELL		Y		
36N 05W 09 BC 01				211TMDC		130.							STOCKWATER	WELL	2-Dec-76		76Q1455	M:6830
36N 05W 09 DBDCC	14-Aug-97		Y		4050	200R	3850R	5.		9.1	4040.9		UNUSED	WELL		N		
36N 05W 09 DBDCC		1936			4050			5R		200R	3850R		STOCKWATER	WELL				M:89940
36N 05W 11 BBDDDA		1955			3975	152R	3823R	5R		10R	3965R	284R	STOCKWATER	WELL				M:89941
36N 05W 11 BCAA		1912			3970	170R	3800R	6R		14R	3956R	15R	DOM/STK					M:89942
36N 05W 11 CBC				217MLTN										PETWELL	17-Apr-70	Y		
36N 05W 12 ACCCAA	12-Jul-96		Y		4090			12.					STOCKWATER	WELL		N		
36N 05W 12 DCCCAD01	12-Jul-96	1943	Y	211VRGL	4020	407R	3613R	12.5R		74.3	3945.7	85R	PWS-UNUSED	WELL	21-Jun-54	N	54Q0004	M:6831
36N 05W 13 AAAAAD	13-Jul-95	1945	INOP	211VRGL	4084	520R	3564R	12.5R		299R	3785R	100R	PWS-UNUSED			N		M:89944
36N 05W 13 AAAAAD		1943		211VRGL	4084	520.	3564.	12.5		299.		100	PWS	WELL	21-Jun-54	Y	54Q0003	M:6832
36N 05W 14 ACDDDD	17-Jul-95	1942	Y	211VRGL	3995	450R	3545R	6.	FLOW	FLOW	>3995	1.5FL	STK/IRR	WELL	4-Aug-95	Y	96Q0182	M:6833

LOCATION	DATE INVENTORIED	DATE DRILLED	PUMP?	GEOLOGIC SOURCE	SURF ELEV (ft)	TOTAL DEPTH (ft)	BOTTOM ELEV (ft)	CASING DIAM (ft)	PWL (ft)	SWL (ft)	WL ELEV (ft)	Q (gpm)	WATER USE	SAMPLE SOURCE	SAMPLE DATE	SAMPLE TAKEN	MBMG QW #	MBMG SITE #
36N 05W 14 ACDDDD		1942	Y	211VRGL	3995	450R	3545R	6.		60R	3935R	5	STK/IRR	WELL	24-Sep-65	Y		M:6833
36N 05W 14 DBBBCB01	17-Jul-95	1924	Y	112TILL	3985	43.	3942.	6.	FLOW	FLOW	>3985	<1	DOM/STK	WELL	17-Jul-95	Y	96Q0106	M:149822
36N 05W 14 DBBBCB01	8-Aug-95	1924	Y	211TMDC	3985	77.	3908.	6.	FLOW	FLOW	>3985	<1	DOM/STK	WELL		N		
36N 05W 14 DBBBCB01		1924		211TMDC	3985	105R	3880.	6.		7.8		3R	DOM/STK	WELL	24-Oct-64	Y	64Q0063	M:6834
36N 05W 15 D 01				217CBNK									UNUSED	PETWELL			37Q0006	M:895564
36N 05W 18 B				330MDSN										PETWELL	2-Jul-70	Y		
36N 05W 18 BB				330MDSN										PETWELL		Y		
36N 05W 18 DAABAA01	12-Jun-95	1969-70		211TMDC	4070	134R	3936R	5.		70.4	3999.7	6	DOMESTIC	WELL	12-Jun-95	Y	96Q0091	M:149812
36N 05W 19 AC				330MDSN										PETWELL	8-Sep-59	Y		
36N 05W 19 AC				330MDSN										PETWELL	1-Oct-59	Y		
36N 05W 19 BC				330MDSN										PETWELL	2-Jul-70	Y		
36N 05W 23 01				217CBNK									UNUSED	PETWELL			35Q0007	M:895673
36N 05W 23 AABDB 01	30-Jun-95	1993	N	211VRGL	3980	450R	3530R	9.7		FLOW	>3980	38	DOMESTIC	WELL	30-Jun-95	Y	96Q0017	M:137340
36N 05W 23 ACCBDA	30-Jun-95	Oct-46	Y	211TMDC	4050	110R	3940R	6.		40R	4010R	85R	DOM/STK	WELL	30-Jun-95	Y	96Q0005	M:89947
36N 05W 23 CABBB														PETWELL	21-Oct-35	Y		
36N 05W 24				211EGLE										PETWELL	7-Jul-36	Y		
36N 05W 24 DBCDAA	30-Jun-95	1924	N	211TMDC	3990			6.	FLOW	FLOW	>3990		STOCKWATER	WELL	30-Jun-95	Y	96Q0010	M:89948
36N 05W 25 CD 01				217CBNK									UNUSED	PETWELL			54Q0031	M:895269
36N 05W 26 BAAACA	13-Jun-96		INOP		4120			3.		2.	4118		UNUSED	WELL		N		
36N 05W 26 BD 01				217CBNK									UNUSED	PETWELL			43Q0011	M:895176
36N 05W 27 AD		1961				85R		4R		40R		85R	STOCKWATER	WELL				M:89949
36N 05W 27 ADDCCA	14-Aug-97		N		4075	76.4	3998.6	5.		39.2	4035.8		UNUSED	WELL		N		
36N 05W 27 BD				210CLRD										PETWELL		Y		
36N 05W 28 AB				211TMDC/EGLE										PETWELL	28-Jul-33	Y		
36N 05W 28 DD														PETWELL	9-Mar-33	Y		
36N 05W 29 ACBBAC	12-Aug-97		N/A	112TILL	4038	N/A	N/A	N/A	N/A	N/A		23	UNUSED	SPRING	17-Aug-97	Y	98Q0173	M:6835
36N 05W 29 ACBBAC			N/A	112TILL									SPRING	SPRING	28-Apr-82	Y	82Q0195	M:6835
36N 05W 30 CBCCDA	24-Aug-95		Y	112TILL	4115	73.3	4041.7	5.		33.8	4081.2			WELL		N		
36N 05W 31 BCCCAA	13-Jun-96	1944	Y		4050	230R	3820R	6.		15.8	4034.2	10R	DOMESTIC	WELL		N		M:89951
36N 05W 31 BCCCAD	13-Jun-96	1947	Y		4050	230R	3820R	6.		11.3	4038.7	20R	DOMESTIC	WELL		N		M:89950
36N 05W 32 AA		1915								16R			DOM/STK	WELL				M:89952
36N 05W 32 ADABCD	1-Jul-95	1950	N/A		4120	140R	3980R	6R		30R	4090R		P&A					M:89954
36N 05W 32 ADADCB01	1-Jul-95	1934	Y	112TILL	4120	14R	4106R	72.		6R	4114R	2R	DOM/STK	WELL	1-Jul-95	Y	96Q0019	M:89953
36N 05W 32 BCDACC	24-Aug-95	1978	Y	211TMDC	4105	102R	4003R	4R	96R	35R	4070R	9	DOMESTIC	WELL	24-Aug-95	Y	96Q0286	M:89955
36N 05W 32 DA				217DRLG										PETWELL	25-Oct-32	Y		
36N 05W 33 A														PETWELL	9-Mar-33	Y		
36N 05W 33 CA				217MLTN										PETWELL	9-Mar-33	Y		
36N 05W 33 CBBBDB01	1-Jul-95	1981	Y	211VRGL	4120	360R	3760R	6.3		84.	4036	30	DOMESTIC	WELL	1-Jul-95	Y	96Q0006	M:89956
36N 05W 33 CBBC 01	1-Jul-95	1911		211TMDC		130R		5.		30R		DRY	ABANDONED	WELL	2-Dec-76		76Q1454	M:6836
36N 05W 33 CBBCAA01	1-Jul-95	1973	Y	211TMDC	4120	120R	4000R	4.		57.	4063	15	DOM/STK	WELL	1-Jul-95	Y	96Q0007	M:149532
36N 05W 33 DCDDDB	22-Aug-95	1931	INOP	211EGLE	4110	121.	3989.	4.		115?	3995	6R	UNUSED	WELL		N		M:89958
36N 05W 34				330MDSN										PETWELL		Y		
36N 05W 34 AA				330MDSN										PETWELL	2-Jul-70	Y		
36N 05W 35 ACDDCC01	30-Jun-95	1981	Y		4154	258R	3896R	6.3	240R	100R	4054R	10	STOCKWATER	WELL	30-Jun-95	Y	96Q0011	M:89959
36N 06W 01 ABAADB	12-Jul-95	1930	N		4060	110R	3950R	6.		64.	3996	100R	UNUSED	WELL		N		M:89960
36N 06W 01 ABADCA01	12-Jul-95	1982	Y	211TMDC	4060	460R	3600R	6.3	160.	71.8	3988.2	6	DOM/STK	WELL	12-Jul-95	Y	96Q0097	M:89961
36N 06W 02 DA 01				211VRGL		170.							UNUSED	WELL	23-Feb-33		33Q0004	M:6837
36N 06W 04 DC				330MDSN										PETWELL	24-Aug-55	Y		
36N 06W 11 AC				330MDSN										PETWELL	28-Jul-46	Y		
36N 06W 11 D		1944				190.		6.				3	DOM/STK					M:89963
36N 06W 12 AC				330MDSN										PETWELL	18-Mar-47	Y		
36N 06W 12 AC 01				330MDSN		3125.8							UNUSED	WELL	18-Mar-47		47Q0012	M:6838
36N 06W 12 BBCDDD	12-Jul-95	1944	INOP		4110	190R	3920R	6.		120.8	3989.3	3R	UNUSED	WELL		N		M:89963
36N 06W 12 BC				330MDSN										PETWELL	11-Dec-47	Y		
36N 06W 12 BCABDA01	12-Jul-95	Nov-94	N		4090	153.	3937.	6.3		96.3	3993.7	2R	UNUSED	WELL	12-Jul-95	Y	96Q0094	M:149814
36N 06W 12 BCACAC01	3-Jul-95	1940	Y	211VRGL	4090	452R	3638R	6.	103.6	80R	4010R	6+	DOMESTIC	WELL	3-Jul-95	Y	96Q0016	M:89964
36N 06W 12 CA				330MDSN										PETWELL		Y		
36N 06W 12 CB				330MDSN										PETWELL		Y		
36N 06W 12 DA 01														WELL			84Q0847	M:6839
36N 06W 12 DA 01														OIL_BRINE	10-Jul-80		80Q1616	M:6842
36N 06W 12 DA 01				110ALVM									OTHER	WELL	10-Jul-80		80Q1613	M:6839
36N 06W 12 DA 01													OTHER	WELL	10-Aug-80		80Q1614	M:6840
36N 06W 13 ADBDAA	17-Jul-97		INOP		3996	20.7	3975.4	5.		19.4	3976.6		UNUSED	WELL		N		
36N 06W 13 ADBDAC	17-Jul-97	1969-70	N		3998	75.8	3922.3	5.		19.2	3978.8		UNUSED	WELL		N		
36N 06W 13 DD				330MDSN										PETWELL	19-Sep-56	Y		
36N 06W 13 DD				330MDSN										PETWELL	17-Sep-56	Y		
36N 06W 14 BDDADA	12-Jul-95	1961	N		4052	161R	3891R	5.	140R	57.3	3994.7	6R	STOCKWATER	WELL		N		M:89965
36N 06W 14 DC				217CBNK										PETWELL	23-Aug-36	Y		
36N 06W 16 DD				330MDSN										PETWELL	8-Nov-61	Y		
36N 06W 17 01		1964				259R		4R	250R	180R		7R	DOMESTIC	WELL				M:129521
36N 06W 17 DBD		1962				115R		4R	100R	20R		20R	DOMESTIC	WELL				M:89966
36N 06W 17 DC		1967				44R		7R	21R	9R		3R	STOCKWATER	WELL				M:89967
36N 06W 20		1961				44R		6R	15R	15R		50R	STOCKWATER	WELL				M:89968
36N 06W 23 CA				217CBNK										PETWELL		Y		
36N 06W 23 CA 01				217CBNK									UNUSED	PETWELL			55Q0071	M:895125
36N 06W 25 CBA				217CBNK										PETWELL	16-Jan-74	Y		
36N 06W 25 DDA		1930				32R						3	P&A	WELL				M:89969
36N 06W 25 DDADCA	25-Aug-95	1963	Y	211TMDC	4090	136R	3954R	4.		22.9	4067.1	1	DOMESTIC	WELL	25-Aug-95	Y	96Q0285	M:89969
36N 06W 26 DC 01				217CBNK									UNUSED	PETWELL			39Q0007	M:895005
36N 06W 28 DA 01				217CBNK									UNUSED	PETWELL			60Q0028	M:895231

LOCATION	DATE INVENTORIED	DATE DRILLED	PUMP?	GEOLOGIC SOURCE	SURF ELEV (ft)	TOTAL DEPTH (ft)	BOTTOM ELEV (ft)	CASING DIAM (ft)	PWL (ft)	SWL (ft)	WL ELEV (ft)	Q (gpm)	WATER USE	SAMPLE SOURCE	SAMPLE DATE	SAMPLE TAKEN	MBMG QW #	MBMG SITE #
36N 06W 28 DA 01				217CBNK									UNUSED	PETWELL			61Q0030	M:895086
36N 06W 33 AC 01				217CBNK									UNUSED	PETWELL			61Q0031	M:895296
36N 06W 33 AC 01				217CBNK									UNUSED	PETWELL			61Q0032	M:895014
36N 06W 33 AC 01				217CBNK									UNUSED	PETWELL			61Q0033	M:895215
36N 06W 34 01				217CBNK									UNUSED	PETWELL			36Q0010	M:895617
36N 06W 35 AB				217CBNK ?										PETWELL	31-Aug-39	Y		
36N 06W 35 CA 01				217CBNK									UNUSED	PETWELL			39Q0008	M:895177
36N 06W 35 DD 01		1990				200R		6R	140R	40R		20R	DOMESTIC	WELL				M:120757
36N 06W 35 DDA		1910				90R		6R		18R		1R	DOM/STK	WELL				M:89970
36N 06W 35 DDB		1935				140R		6R		20R		1R	DOM/STK	WELL				M:89971
36N 07W 03 CB				330MDSN										PETWELL	16-Jul-54	Y		
36N 07W 03 CB				330MDSN										PETWELL	16-Jul-54	Y		
36N 07W 03 CB				330MDSN										PETWELL	15-Jul-54	Y		
36N 07W 03 CB				330MDSN										PETWELL	15-Jul-54	Y		
36N 07W 12 DD				330MDSN										PETWELL	12-Nov-55	Y		
36N 07W 36 CB				330MDSN										PETWELL		Y		
37N 03W 04 DCABDC	15-Jul-95		Y	110ALVM	3430	27.	3403.	6.		11.7	3418.3	10	STK	WELL	15-Jul-95	Y		
37N 03W 07 BACAAC	13-Aug-97		N		3525	50.	3475.	6.5		45.4	3479.6		UNUSED	WELL		N		
37N 03W 19 BCBADB	13-Jul-95		Y											WELL	13-Jul-95	Y	96Q0098	M:149814
37N 04W 01 ACCCCA	28-Jun-95	1948	Y		3610	142.5	3467.5	6.		99.	3511	8R	UNUSED STK	WELL		N		M:90388
37N 04W 01 BCCCCC	28-Jun-95	1930	INOP		3630	160R	3470R	6.		83.4	3546.6	5R	UNUSED DOM	WELL		N		M:90387
37N 04W 01 CBBBAD	28-Jun-95	1948	INOP		3635	338R	3297R			180R	3450R	8R	UNUSED			N		M:90386
37N 04W 02 AACDCB	28-Jun-95		N	112TILL	3600	53.5	3546.5			47.4	3552.6			WELL		N		
37N 04W 02 DDDBCC	28-Jun-95		Y	211VRGL	3640	118.6	3521.4	8.		87.	3553	8R	DOMESTIC	WELL	30-Jun-95	Y	96Q0012	M:6857
37N 04W 02 DDDBCC			Y	211VRGL	3640	118.	3522.	8.				8	DOMESTIC	WELL	2-Dec-76	Y	76Q1456	M:6857
37N 04W 03				217MLTN										PETWELL	3-Feb-69	Y		
37N 04W 03 01				217CBNK									UNUSED	PETWELL			63Q5024	M:895670
37N 04W 03 03		1991		110ALVM	3615	9R	3606R	4R					MONITORING	WELL				M:123742
37N 04W 03 10		1991		110ALVM	3615	10R	3605R	4R					MONITORING	WELL				M:123743
37N 04W 03 14		1991		110ALVM		5R		NONE					MONITORING	WELL				M:123738
37N 04W 03 16		1991		110ALVM	3613	9R	3604R	2R					MONITORING	WELL				M:123739
37N 04W 03 BACCDA 01				211TMDC									PUB. SUPPLY	WELL	8-Dec-81	Y		
37N 04W 03 BACCDA01	15-Jul-95	1970'S	Y	211TMDC	3580	42.	3538.	12.	10.5	10.7	3574R	75	PUB. SUPPLY	WELL	15-Jul-95	Y	96Q0107	M:149823
37N 04W 03 BACCDA01		1970'S	Y	211TMDC	3580	42.	3538.	12.	10.5	6R	3574R	75	PUB. SUPPLY	WELL	13-Jul-90	Y	90Q0232	M:120907
37N 04W 03 BCDBDD9	11-Jul-96	1991	N	110ALVM	3613	12.5	3600.8	2.		3.9	3609.4		MONITORING	WELL		N		M:123734
37N 04W 03 BCDCCD12	11-Jul-96	1991	N	110ALVM	3625	13.	3611.5	2.		8.6	3615.9		MONITORING	WELL		N		M:123737
37N 04W 03 BCDCCD8D	11-Jul-96	1991	N	211TMDC	3614	37R	3577R	4.		3.5	3610		MONITORING	WELL		N		M:123735
37N 04W 03 BCDCCD8S	11-Jul-96	1991	N	110ALVM	3613	10R	3603R	2.		3.9	3609.2		MONITORING	WELL		N		M:123736
37N 04W 03 BCDDBB17D	11-Jul-96	1991	N	211TMDC	3611	30R	3581R	4.		1.6	3608.9		MONITORING	WELL	11-Jul-96	Y	97Q0040	M:123746
37N 04W 03 BCDDBB17D	11-Jul-96	1991	N	211TMDC	3611	30R	3581R	4.		1.6	3608.9		MONITORING	WELL	11-Jul-96	Y	97Q0041	M:123746
37N 04W 03 BCDDBB17S	11-Jul-96	1991	N	110ALVM	3612	10R	3602R	4.		3.8	3607.8		MONITORING	WELL	11-Jul-96	Y	97Q0039	M:123740
37N 04W 03 BCDDCC13	11-Jul-96	1991	N	110ALVM	3620	21R	3599R	2.		7.9	3612.4		MONITORING	WELL		N		M:123741
37N 04W 03 BDCCCC15D	11-Jul-96	1991	N	211TMDC	3612	17R	3595R	4.		1.7	3610.5		MONITORING	WELL		N		M:123745
37N 04W 03 BDCCCC15S	11-Jul-96	1991	N	110ALVM	3611	10R	3601R	2.		1.1	3610.3		MONITORING	WELL		N		M:123744
37N 04W 03 CA				217MLTN										PETWELL	8-Feb-70	Y		
37N 04W 03 CBA 01		1969		217MLTN		2510.		9.					UNUSED	WELL	3-Feb-69		65Q0059	M:6858
37N 04W 03 CDCABC01	17-Jul-95	1990	Y	211TMDC	3610	60R	3550R	6.		28.5	3581.5	15R	DOMESTIC	WELL	17-Jul-95	Y	96Q0105	M:122382
37N 04W 03 CDCD 01		1990	Y	211TMDC	3610	60.	3550.	6.	60.	32R	3578R	15	DOMESTIC		4-Jan-94	Y	95Q0590	M:122382
37N 04W 03 DC				217MLTN										PETWELL	16-May-60	Y		
37N 04W 03 DC				217MLTN										PETWELL	16-May-60	Y		
37N 04W 03 DC 01				217CBNK									UNUSED	PETWELL			60Q0029	M:895094
37N 04W 03 DC 01				217CBNK									UNUSED	PETWELL			60Q0030	M:895479
37N 04W 03 DC 01				217CBNK									UNUSED	PETWELL			60Q0031	M:895578
37N 04W 03 DC 01				217CBNK									UNUSED	PETWELL			60Q0032	M:895381
37N 04W 03 DC 01				217CBNK									UNUSED	PETWELL			60Q0072	M:895399
37N 04W 03 DCD 01				217CBNK									UNUSED	PETWELL			61Q0034	M:895126
37N 04W 04 DAA				217MLTN										PETWELL	10-Jun-65	Y		
37N 04W 05 BDAAAB	24-Aug-95	1950	N	110ALVM	3616	5.	3611.	60.		1.7	3614.3	10R	UNUSED	WELL		N		M:90389
37N 04W 05 BDBDDC	24-Aug-95	1954	Y	112TILL	3622	22.	3600.	36.		16.5	3605.6	14	DOM/STOCK	WELL	24-Aug-95	Y	96Q0284	M:90390
37N 04W 05 CBA		1967			3650	2947R	703R	10R		785R	2865R	30R	INDUSTRIAL	WELL				M:90391
37N 04W 07 DBA		1968			3820	3183R	637R	10R		1200R	2620R	120R	INDUSTRIAL	WELL				M:90392
37N 04W 09				330MDSN										PETWELL	18-Sep-59	Y		
37N 04W 09 ADB				217MLTN										PETWELL	10-Apr-70	Y		
37N 04W 10 AC 01				217CBNK									UNUSED	PETWELL			59Q0034	M:895267
37N 04W 10 AC 01				217CBNK									UNUSED	PETWELL			60Q0073	M:895505
37N 04W 10 BBC				217MLTN										PETWELL		Y		
37N 04W 10 CA 01				217CBNK									UNUSED	PETWELL			62Q0031	M:895074
37N 04W 11 AB	31-Jul-96		Y		3645				2400R	1800R	1845R		INDUSTRIAL	PETWELL		Y	97Q0165	M:912773
37N 04W 11 BBCA	31-Jul-96		INOP		3642	60.	3582.1			59.2	3582.9		UNUSED	WELL		N		
37N 04W 12 BAC		1930			3620	120R	3500R			60R	3560R		STOCKWATER	WELL				M:90393
37N 04W 12 DB 01				211VRGL		50.		6.		24.6			DOMESTIC	WELL	21-Oct-65		65Q0008	M:6859
37N 04W 03 BACCDA01				211TMDC		117R		6.					DOM/STK	KIT TAP	13-Jul-90		90Q0231	M:892136
37N 04W 12 DBCDAB	15-Jul-95	1950	Y	211TMDC	3660	117R	3543R	6.	72.8	107R	3553R	13R	DOM/STOCK	WELL	16-Jul-95	Y	96Q0101	M:90394
37N 04W 03 BACCDA01				211TMDC									DOM/STK	WELL	23-Feb-85	Y		
37N 04W 03 BACCDA01				211TMDC									DOM/STK	WELL	2-Jun-88	Y		
37N 04W 12 DBCDAB-2	16-Jul-97	1997	Y	211TMDC	3755	130R	3625R	6.		62R	3693R	25R	DOMESTIC	WELL	16-Jul-97	Y	98Q0049	M:160564
37N 04W 12 DCAACC	13-Aug-97		Y	211TMDC	3685					90.7	3594.3		UNUSED	WELL		N		
37N 04W 14 BDDDCC	13-Aug-97		Y		3770					35.	3735		UNUSED	WELL		N		
37N 04W 15 BA				330MDSN										PETWELL	31-May-66	Y		
37N 04W 15 BA 01				217CBNK									UNUSED	PETWELL			66Q0045	M:895268

LOCATION	DATE INVENTORIED	DATE DRILLED	PUMP?	GEOLOGIC SOURCE	SURF ELEV (ft)	TOTAL DEPTH (ft)	BOTTOM ELEV (ft)	CASING DIAM (ft)	PWL (ft)	SWL (ft)	WL ELEV (ft)	Q (gpm)	WATER USE	SAMPLE SOURCE	SAMPLE DATE	SAMPLE TAKEN	MBMG QW #	MBMG SITE #
37N 04W 15 BB 01				211EGLE						185.				WELL			73Q0151	M:6860
37N 04W 15 BCCBBB01	17-Jul-95		Y	211TMDC	3700	130R	3570R	6R				15R	DOMESTIC	WELL	17-Jul-95	Y	96Q0093	M:149813
37N 04W 16 ACB				217MLTN										PETWELL	5-May-73	Y		
37N 04W 16 BCD 01				217CBNK									UNUSED	PETWELL			74Q5022	M:895436
37N 04W 16 BDDD				217MLTN										PETWELL	19-Jul-59	Y		
37N 04W 16 BDDD				217MLTN										PETWELL	19-Jul-59	Y		
37N 04W 17				217MLTN										PETWELL		Y		
37N 04W 18 BBA		1954			3730	2985R	745R	10R		950R	2780R	70R	INDUSTRIAL	WELL				M:90395
37N 04W 18 BBB				217MLTN										PETWELL	15-Sep-59	Y		
37N 04W 18 BC		1953				140R				70R		3R	DOM/STK	WELL				M:90396
37N 04W 19 AD 01				217CBNK									UNUSED	PETWELL			39Q0009	M:895107
37N 04W 19 CACAAD	31-Aug-97		N		3755	79.	3676.	5.		DRY			UNUSED	WELL		N		
37N 04W 27 CBDA 01				211VRGL		170.		6.		135.			DOMESTIC	WELL	22-Oct-65		65Q0002	M:6861
37N 04W 27 CBDABB01	18-Jul-95	1958-59	Y		3790	140R	3650R	6.		62.5	3727.5		DOMESTIC	WELL	18-Jul-95	Y	96Q0109	M:149824
37N 04W 28 C 01				211EGLE										WELL			73Q0152	M:6862
37N 04W 29 DADBDC	9-Aug-95	1973	N		3870	210R	3660R	4.		4.2	3865.8		UNUSED	WELL		N		M:90397
37N 04W 29 DADDAC		Feb-41			3850	250R	3600R	6R		195R	3645R	3R	UNUSED	WELL		N		M:90398
37N 04W 29 DBCCBB	9-Aug-95	1939	Y		3910	60R	3850R	6R		24.7	3885.3	5R	UNUSED	WELL	8-Aug-95	Y	96Q0241	M:90399
37N 04W 31 C				217MLTN										PETWELL	17-Apr-70	Y		
37N 04W 34 DDCDCD	16-Jul-95	1957	INOP		3925	207R	3718R	5.		139.	3786.1	30R	UNUSED	WELL		N		M:90401
37N 05W 01 CD				217CBNK										PETWELL		Y		
37N 05W 02 01				330MDSN									UNUSED	PETWELL	12-Mar-59		59Q0028	M:895209
37N 05W 02 02				217CBNK									UNUSED	PETWELL	12-Mar-59		59Q0029	M:895665
37N 05W 02 DDD		1984				203R		7R	165R	165R		30R	UNKNOWN	WELL				M:90402
37N 05W 03 ACC 01				217CBNK									UNUSED	PETWELL			73Q5015	M:895162
37N 05W 03 CBA				217CBNK										PETWELL		Y		
37N 05W 03 CBA 01				217CBNK									UNUSED	PETWELL			73Q5014	M:895644
37N 05W 03 DB 01				217CBNK									UNUSED	PETWELL			74Q5023	M:895593
37N 05W 04 DDDDBD 01	11-Aug-95		N/A	112TILL	3865	N/A		N/A	N/A	N/A			UNUSED	SPRING	11-Aug-95	Y	96Q0243	M:150358
37N 05W 06				217SBRS										PETWELL		Y		
37N 05W 06 CBDDCA01	14-Jul-95	1940?	Y	211TMDC	4080	80.	4000.		FLOW	FLOW	>4080		DOMESTIC	WELL	14-Jul-95	Y	96Q0096	M:149815
37N 05W 06 DA 01				217SBRS									UNUSED	PETWELL			56Q0043	M:895179
37N 05W 07 ADB 01		1965		211TMDC		155.		6.		24.7			DOM/STK	WELL	19-Oct-65		65Q0029	M:6863
37N 05W 08 BABDAA	13-Jun-96		Y	112TILL	4055	78.2	3976.8	6.		16.4	4038.6			WELL		N		
37N 05W 08 DBB		1944				137R				40R			FARMED OVER	WELL				M:90404
37N 05W 08 DDCBBD	29-Aug-95	1933	Y	112TILL	3970	80R	3890R	6R		34.5	3935.6		UNUSED	WELL		N		M:90405
37N 05W 09 CCCACA01	10-Aug-95	1953	Y	211TMDC	3930	85R	3845R	4.				7	DOMESTIC	WELL	10-Aug-95	Y	96Q0242	M:150357
37N 05W 09 CCCDBA	10-Aug-95	1959		211TMDC	3935	135R	3800R	6R				22R	UNUSED	WELL				M:90407
37N 05W 10 AC 01				217CBNK									UNUSED	PETWELL			62Q0032	M:895279
37N 05W 10 AC 01				217CBNK									UNUSED	PETWELL			62Q0033	M:895032
37N 05W 10 AD				217CBNK										PETWELL		Y		
37N 05W 10 DC		1957		211TMDC		157R		5R		42R		20R	STOCKWATER	WELL				M:90408
37N 05W 10 DCDADA	3-Aug-95	1949	Y	211TMDC	3765	142R	3623R	6.		18R	3747R	5	DOM/STK	WELL	3-Aug-95	Y	96Q0177	M:6864
37N 05W 10 DCDADA	2-Oct-95	1949		211TMDC	3765	142R	3623R	6.		125.	3640	15R	DOM/STK	WELL				M:6864
37N 05W 10 DDD				330MDSN										PETWELL		Y		
37N 05W 10 DDD 01				217CBNK									UNUSED	PETWELL			58Q0025	M:895257
37N 05W 11 ABC				330MDSN										PETWELL		Y		
37N 05W 11 BC 01				217CBNK									UNUSED	PETWELL			74Q5024	M:895347
37N 05W 11 DC 01				217SBRS									UNUSED	PETWELL			39Q0010	M:895433
37N 05W 11 DCA		1932				120R		6R		120R		8R	DOM/STK	WELL				M:90410
37N 05W 12				217BILD										PETWELL	8-Jul-63	Y		
37N 05W 12 ACADDA01	17-Jul-95		Y	211TMDC	3660	120R	3540R	6.		90R	3570R		DOM/STK	WELL	17-Jul-95	Y	96Q0104	M:149820
37N 05W 12 ADBCDC	17-Jul-95	1916	N	110ALVM	3650	13.6	3636.4	60.		2.7	3647.3	100R	UNUSED	WELL		N		M:90411
37N 05W 12 ADCABC		1916		110ALVM	3660	15R	3645R			15R	3645R	100R	ABANDONED	WELL				M:90412
37N 05W 12 BB 01				217CBNK									UNUSED	PETWELL			58Q0026	M:895061
37N 05W 12 BB 01				217CBNK									UNUSED	PETWELL			58Q0028	M:895067
37N 05W 12 BB 01				217CBNK									UNUSED	PETWELL			58Q0027	M:895180
37N 05W 12 BC				330MDSN										PETWELL	11-Dec-58	Y		
37N 05W 12 DC		1913				70R				16R		9R	DOM/STK	WELL				M:90413
37N 05W 13 A		1980				150R		6R	100R	85R		6R	UNKNOWN	WELL				M:90414
37N 05W 13 ADA		1966				125R		4R	110R	100R		10R	DOMESTIC	WELL				M:90415
37N 05W 13 DAB		1939				120.		6.		40.		5	DOM/STK					M:90416
37N 05W 14 CC				217DRLG										PETWELL	4-Oct-33	Y		
37N 05W 15 AAA 01				217CBNK									UNUSED	PETWELL			59Q0035	M:895022
37N 05W 15 AD 01				217CBNK		2650.							UNUSED	PETWELL			66Q0071	M:895216
37N 05W 15 ADA 01				217CBNK									UNUSED	PETWELL			61Q0035	M:895280
37N 05W 15 DAA 01				211VRGL		132.9		6.		113.2		7	DOM/STK	WELL	18-Oct-65		65Q0016	M:6865
37N 05W 15 DDABCB	1-Aug-96	1912	N	211VRGL	3762	127.5	3634.5	6.		78.3	3683.7		DOM/STK	WELL		N		M:90417
37N 05W 16 AAACCD	31-Jul-96		N/A	112TILL	3860	N/A		N/A		N/A		28	UNUSED	SPRING	31-Jul-96	Y	97Q0166	M:156033
37N 05W 19 DAC 01		1965		211TMDC		115.		6.		72.9			STOCKWATER	WELL	19-Oct-65		65Q0028	M:6866
37N 05W 19 DADBDB01	3-Aug-95		Y		4000	125R	3875R	4.		50.9	3949.1	5	DOM/STK	WELL	3-Aug-95	Y	96Q0180	M:150154
37N 05W 20 DCCCDC	13-Jun-96	Jun-63	Y	211TMDC	3935	134R	3801R	6.		134R	3801R		DOM/STK	WELL	13-Jun-96	Y	96Q0786	M:90418
37N 05W 21 ABB		1949				80R		6R		80R			P&A	WELL				M:90421
37N 05W 21 ABBACB	11-Jul-96		Y	211TMDC	3925	120.	3805.	6.		35.9	3889.1	5	DOMESTIC	WELL	11-Jul-96	Y	97Q0042	M:155873
37N 05W 21 ABBDBA	29-Jun-95	1972	Y	211TMDC	3890	72R	3818R	4.		10.6	3879.5	6	DOMESTIC	WELL	29-Jun-95	Y	96Q0015	M:90419
37N 05W 21 ABBDBC	29-Jun-95	1960	Y	211TMDC	3895	120R	3775R	6R		12.2	3882.8	9	STOCKWATER	WELL	29-Jun-95	N		M:90420
37N 05W 22 CDA		1987				210R		6R	150R	140R		20R	DOMESTIC	WELL				M:90422
37N 05W 23 BB				210CLRD/217KOTN										PETWELL	16-Apr-33	Y		
37N 05W 23 BB				217DRLG										PETWELL	27-Jun-33	Y		
37N 05W 23 BB 01				211EGLE									UNUSED	PETWELL	23-Mar-33		33Q0020	M:895675

LOCATION	DATE INVENTORIED	DATE DRILLED	PUMP?	GEOLOGIC SOURCE	SURF ELEV (ft)	TOTAL DEPTH (ft)	BOTTOM ELEV (ft)	CASING DIAM (ft)	PWL (ft)	SWL (ft)	WL ELEV (ft)	Q (gpm)	WATER USE	SAMPLE SOURCE	SAMPLE DATE	SAMPLE TAKEN	MBMG QW #	MBMG SITE #
37N 05W 23 BB 01				217CBNK									UNUSED	PETWELL			35Q0008	M:895256
37N 05W 23 BC		1971				155R		7R	105R	50R		5R	DOMESTIC	WELL				M:90423
37N 05W 23 CDD 01				217CBNK									UNUSED	PETWELL			56Q0044	M:895068
37N 05W 23 CDD 01				217CBNK									UNUSED	PETWELL			56Q0045	M:895336
37N 05W 23 CDD 01				217CBNK									UNUSED	PETWELL			56Q0071	M:895163
37N 05W 23 CDD 01				217CBNK									UNUSED	PETWELL			56Q0072	M:895659
37N 05W 23 DA 01				217SBRS									UNUSED	PETWELL			65Q0065	M:895052
37N 05W 23 DA 01				217SBRS									UNUSED	PETWELL			65Q0066	M:895201
37N 05W 24 A		UNK				125R		6R					STOCKWATER	WELL				M:90424
37N 05W 24 AA 01				217CBNK									UNUSED	PETWELL			40Q0009	M:895519
37N 05W 24 AAB		1981				35R		7R				15R	STOCKWATER	WELL				M:90425
37N 05W 24 BA 01				217CBNK									UNUSED	PETWELL			74Q5025	M:895539
37N 05W 24 BB				217CBNK ?										PETWELL	19-May-41	Y		
37N 05W 24 BB 01				217CBNK/SBRS									UNUSED	PETWELL			41Q0005	M:895400
37N 05W 24 CB 01				217SBRS									UNUSED	PETWELL			39Q0011	M:895594
37N 05W 24B														PETWELL	5-Jul-39	Y		
37N 05W 25 01				217SBRS									UNUSED	PETWELL			61Q0036	M:895037
37N 05W 25 BC 01				217CBNK									UNUSED	PETWELL			39Q0012	M:895348
37N 05W 25 BC 01				217SBRS									UNUSED	PETWELL			39Q0013	M:895540
37N 05W 26 CCBCAC01	3-Aug-95	1960	Y	211VRGL	3822	172R	3650R	4.		125.8	3696.3	9	DOM/STK	WELL	3-Aug-95	Y	96Q0181	M:6867
37N 05W 26 CCBCAC02	3-Aug-95	UNK	N		3820	181.4	3638.6	6.		162.5	3657.5		UNUSED	WELL		N		M:90426
37N 05W 29 A		1980				325R		6R	40R	28R		40R	UNKNOWN	WELL				M:90427
37N 05W 29 ABBBAA	13-Jun-96		Y		3930	76.8	3853.2			25.3	3904.7		UNKNOWN	WELL		N		
37N 05W 29 DA		1945				83.				83.		6	DOM/STK					M:90428
37N 05W 29 DAB		1954				86R				86R		7R	STK/IRR	WELL				M:90429
37N 05W 29 DD 01		1965		211TMDC		90.		4.		42.3			DOM/STK	WELL	19-Oct-65		65Q0027	M:6868
37N 05W 30 BAAABB	14-Aug-97	1997	N	112TILL	4050	53.8	3996.2	2.		11.7	4038.3		SEEP WELL	MON WELL	14-Aug-97	Y	98Q0174	
37N 05W 30 BAAABB	23-Feb-98	1997	N	112TILL	4050	53.	3997.	2.		9.1	4040.9		SEEP WELL	MON WELL		N		
37N 05W 30 BBBB	23-Feb-98	1997	N	112TILL	4040	51.5	3988.5	2.		48.8	3991.2		SEEP WELL	MON WELL		N		
37N 05W 30 BCAA	23-Feb-98	1997	N	112TILL	4050	58.	3992.	2.		22.9	4027.2		SEEP WELL	MON WELL		N		
37N 05W 30 BCCC	23-Feb-98	1997	N	112TILL	4080	60.2	4019.8	2.		48.	4032.1		SEEP WELL	MON WELL		N		
37N 05W 30 BDDA	25-Feb-98	1997	N	112TILL	4050	13.	4037.	2.		3.6	4046.4		SEEP WELL	MON WELL	25-Feb-98	Y	98Q0813	
37N 05W 30 BDDA	25-Feb-98	1997	N	112TILL	4030	58.	3972.	2.		3.6	4026.4		SEEP WELL	MON WELL	25-Feb-98	Y	98Q0812	
37N 05W 30 CBAD	23-Feb-98	1997	N	112TILL	4050	63.	3987.	2.		29.1	4020.9		SEEP WELL	MON WELL		N		
37N 05W 30 CCAA	25-Feb-98	1997	N	112TILL	4050	38.	4012.	2.		33.5	4016.5		SEEP WELL	MON WELL	25-Feb-98	Y	98Q0818	
37N 05W 30 CCCC	25-Feb-98	1997	N	112TILL	4080	39.9	4040.1	2.		12.4	4067.6		SEEP WELL	MON WELL	25-Feb-98	Y	98Q0814	
37N 05W 30 CDACDD	14-Aug-97	1997	N	112TILL	4015	39.	3976.1	2.		9.1	4005.9		SEEP WELL	MON WELL	14-Aug-97	Y	98Q0175	
37N 05W 30 CDACDD	23-Feb-98	1997	N	112TILL	4015	38.	3977.	2.		6.2	4008.8		SEEP WELL	MON WELL		N		
37N 05W 30 DDACDD	17-Jul-97		N		3968								UNUSED	WELL		N		
37N 05W 31 CCCCAA	3-Aug-95	1977	INOP		3965	142R	3823R	6.		44.4	3920.6	4R	STOCKWATER	WELL		N		M:90430
37N 05W 34 DC		1965				257R		4.5R	257R	110R		4R	DOMESTIC	WELL				M:90431
37N 05W 35 AB				330MDSN										PETWELL		Y		
37N 05W 35 BAB 01				217SBRS/CBNK									UNUSED	PETWELL			54Q0032	M:895641
37N 05W 35 BAB 01				217SBRS/CBNK									UNUSED	PETWELL			54Q0033	M:895151
37N 05W 35 BAB 01				217SBRS/CBNK									UNUSED	PETWELL			54Q0034	M:895674
37N 05W 35 CDABBB01	2-Aug-95	1939	Y	211VRGL	3870	185R	3685R	6.				4	DOM/STK	WELL	4-Aug-95	Y	96Q0176	M:6869
37N 05W 35 CDABBB01		1939	Y	211VRGL	3870	185.	3685.	6.					DOM/STK	WELL	1939	Y	65Q0018	M:6869
37N 05W 35 DC				330MDSN										PETWELL		Y		
37N 05W 35 DC				330MDSN										PETWELL	12-Sep-59	Y		
37N 06W 01 ADDDDA01	14-Jul-95	1983	N	211TMDC	4120	85R	4035R	4.3		FLOW	>4120	20	STOCKWATER	WELL	14-Jul-95	Y	96Q0102	M:90433
37N 06W 02 CAC 01				217CBNK									UNUSED	PETWELL			62Q0034	M:895164
37N 06W 03 DC 01				217CBNK									UNUSED	PETWELL			55Q0072	M:895297
37N 06W 11 ABDABB01	8-Aug-95		Y	211TMDC	4215	85R	4130R	6.				12	DOMESTIC	WELL	8-Aug-95	Y	96Q0244	M:150359
37N 06W 11 BA				330MDSN										PETWELL		Y		
37N 06W 11 BA				330MDSN										PETWELL		Y		
37N 06W 11 BA				330MDSN										PETWELL		Y		
37N 06W 11 BA 01				217CBNK									UNUSED	PETWELL			56Q0073	M:895323
37N 06W 11 BA 01				217CBNK									UNUSED	PETWELL			56Q0074	M:895633
37N 06W 11 BA 01				217CBNK									UNUSED	PETWELL			56Q0075	M:895202
37N 06W 11 BCADDC01	8-Aug-95		Y	330MDSN	4175							27B/H	WATERFLOOD	WELL	8-Aug-95	Y	96Q0240	M:150356
37N 06W 23 AD				330MDSN										PETWELL	11-Nov-57	Y		
37N 06W 24 ABAAAB01	29-Jun-95	Oct-37	Y		4045	142R	3903R	6R		40.7	4004.3	4	STOCKWATER	WELL	29-Jun-95	Y	96Q0009	M:90434
37N 06W 24 CDADBC01	29-Jun-95	1935	Y	211TMDC	4030	124.1	3905.9	6R		13.6	4016.5	12	STOCK	WELL	29-Jun-95	Y	96Q0013	M:90435
37N 06W 24 CDDADB01	29-Jun-95	1948	Y		4039	136R	3903R	6.		12.8	4026.2	5R	DOM/STK	WELL	29-Jun-95	Y	96Q0018	M:90436
37N 06W 25 01				217SBRS									UNUSED	PETWELL			61Q0037	M:895139
37N 06W 26 BDBACA	16-Jul-97	1917	Y		3968	138R	3830R	5.		98.4	3869.6	5R	STOCKWATER	WELL		N		M:90437
37N 06W 29 DACBBC	15-Jul-95	1982-83	N	112TILL	4160	9R	4151R	48.		FLOW	>4160		STOCK	SPRING	15-Jul-95	Y	96Q0090	M:149828
37N 06W 34 CCDADB	15-Jul-95	1919	Y	112TILL	4070		4064.	72.		FLOW	>4070	7R	DOM/STK	SPRING	15-Jul-95	Y	96Q0095	M:149825
37N 06W 36 DC 01				217CBNK									UNUSED	PETWELL			74Q5026	M:895447

APPENDIX D

GROUND-WATER QUALITY DATA

LOCATION	SAMPLE DATE	SAMPLE SOURCE	GEOLOGIC SOURCE	TDS CALC'D (mg/l)	TDS SUM OF DIS CONST (mg/l)	FLD SC (umho/cm)	LAB SC (umho/cm)	FIELD pH	LAB pH	HRDNS AS CaCO3 (mg/l)	ALK AS CaCO3 (mg/l)	RYZNAR STAB IND	LANGLIER SAT IND	SAR	AIR TEMP (deg C)	WATER TEMP (deg C)
35N 04W 01 ABDDBA01	12-Jul-96	WELL	211VRGL	1484	1675	2130	2140	7.43	7.5	923	308	6.01	.74	2.29	17.	9.
36N 04W 08 ADCC	25-Feb-98	MON WELL	112TILL	4631	4873	2380	4390	6.69	7.92	2370	390	4.43	1.75	5.43	-8.3	4.
36N 04W 08 BAAD	24-Feb-98	MON WELL	112TILL	6405	6712	3220	5150	7.19	8.09	3190	495	4.14	1.97	6.25	-3.8	6.
36N 04W 08 DDBB	24-Feb-98	MON WELL	112TILL	1870	2064	1359	2340	7.27	8.08	1442	314	5.14	1.47	.95	-3.8	5.
36N 04W 11 BBADCD	2-Aug-95	WELL	211TMDC	1158	1465	1715	1669	7.4	8.19	301	496	5.95	1.12	7.38	11.	11.
36N 04W 11 CAAACA01	2-Aug-95		211VRGL	781	1031	1151	1183	7.2	8.2	368	419	5.78	1.21	3.17	11.	10.
36N 04W 14 AACCCC	14-Jul-95	WELL	211VRGL	797	981	1296	1279	7.26	7.34	529	297	6.6	.37	1.36		8.
36N 04W 14 AACCCC	10-Feb-54	WELL	211VRGL	711	821					367	379	14.05	-7.03	0.0		
36N 04W 14 AADDDC	8-Sep-54	WELL	211VRGL	766	844					309	400	14.2	-7.1	0.0		
36N 04W 14 ADCBDC	30-Jun-65	WELL	211VRGL	970	920					239	338	14.95	-7.47	0.0		7.8
36N 04W 17 AACA		MON WELL	112TILL													
36N 04W 17 ABAC	24-Feb-98	MON WELL	112TILL	4482	4708	2250	3980	6.31	8.	2617	364	4.4	1.8	3.28	-8.3	5.
36N 04W 17 ABDD		MON WELL	112TILL													
36N 04W 17 AC 01		PETWELL	217CBNK	9662	10900				8.3	464	2006	4.86	1.72	75.02		
36N 04W 22 ADCCCB01	2-Aug-95	WELL	211TMDC	928	1205	1444	1431	7.12	8.37	273	448	5.82	1.27	6.29		8.
36N 04W 22 DCA	20-Oct-65	WELL	211TMDC	849	884					425	281	14.34	-7.17	0.0		
36N 04W 28 B 01		WELL	330MDSN	2883	3893					265	1632	13.27	-6.64	29.3		
36N 04W 28 DBB 01		PETWELL	211EGLE	1101	1408					0	497			0.0		
36N 04W 30 BBBDB 01	30-Jun-95	WELL	211VRGL	928	1165	1431	1420	7.83	8.18	108	383	6.87	.65	12.09		10.
36N 04W 35 AB 01	24-Sep-65	WELL	211VRGL	634	700					232	350	14.8	-7.4	0.0		46.
36N 04W 35 ADAADA	12-Jul-95	WELL	211VRGL	527	760	832	851	4.82	8.2	55	378	7.58	.31	11.02	17.	9.
36N 05W 01 ABB		PETWELL	217MLTN	460					10.2							
36N 05W 01 ABB	14-Apr-70	PETWELL	217MLTN	1041					8.9							
36N 05W 01 DCCCDB	13-Jul-95	WELL	211VRGL	972	1258	1718	1595	9.18	8.92	10	463	7.99	.46	44.43		10.
36N 05W 01 DCCCDB	18-Mar-54	WELL	211VRGL	980	859					28	416	16.51	-8.25	0.0		
36N 05W 04 ABABDD01	15-Oct-65	WELL	211TMDC	3528	2718		4000			216	517	15.06	-7.53	0.0		
36N 05W 04 ABABDD01	1-Jul-95	WELL	211TMDC	4116	4550	5350	4540	7.37	7.93	500	702	5.34	1.29	23.35		9.
36N 05W 04 DB 01		PETWELL	217CBNK	7098	10015					306	4716	11.83	-5.91	71.33		
36N 05W 04 DBA 01	14-Feb-40	WELL	217KOTN	7098	7149					306	4716	11.83	-5.91	0.0		
36N 05W 05 ACBDBB01	13-Jul-95	WELL	211TMDC	2729	3021	4450	3530	7.23	7.63	505	473	6.11	.76	14.1		12.
36N 05W 07 CC		PETWELL	330MDSN	4235					8.3							
36N 05W 09 BC 01	2-Dec-76	WELL	211TMDC	3985	4443	4732	5153	7.35	7.62	583	741	5.41	1.1	19.82		8.
36N 05W 11 CBC	17-Apr-70	PETWELL	217MLTN	3316					7.4							
36N 05W 12 DCCCAD01	21-Jun-54	WELL	211VRGL	882	763					21	401	16.95	-8.48	0.0		
36N 05W 13 AAAAAD	21-Jun-54	WELL	211VRGL	867	748					11	504	17.35	-8.68	0.0		
36N 05W 14 ACDDDD	4-Aug-95	WELL	211VRGL	848	1051	1370	1340	8.23	8.29	76	328	7.27	.51	13.93		8.
36N 05W 14 ACDDDD	24-Sep-65	WELL	211VRGL	528	495					5	304	17.1	-8.55	0.0		8.9
36N 05W 14 DBBBCB01	17-Jul-95	WELL	112TILL	817	1038	1360	1341		9.19	4	358	8.57	.31	60.06		8.
36N 05W 14 DBBBCB01	24-Oct-64	WELL	211TMDC	849	801		1290			20	443	15.74	-7.87	0.0		
36N 05W 15 D 01		PETWELL	217CBNK	11229	14020					0	4515			0.0		
36N 05W 18 B	2-Jul-70	PETWELL	330MDSN	4370					8.2							
36N 05W 18 BB		PETWELL	330MDSN	4046					9.							
36N 05W 18 DAABAA01	12-Jun-95	WELL	211TMDC	2267	2526	3020	2730	7.35		967	420	5.26	1.38	5.26	17.	8.5
36N 05W 19 AC	8-Sep-59	PETWELL	330MDSN	6046					8.1							
36N 05W 19 AC	1-Oct-59	PETWELL	330MDSN	6019					8.							
36N 05W 19 BC	2-Jul-70	PETWELL	330MDSN	4338					7.3							
36N 05W 23 01		PETWELL	217CBNK	12618	14698					153	3363	12.4	-6.2	177.19		
36N 05W 23 AABDB 01	30-Jun-95	WELL	211VRGL	1548	1763	2580	2290	7.88	8.44	125	347	6.6	.92	19.62		8.
36N 05W 23 ACCBDA	30-Jun-95	WELL	211TMDC	3000	3562	4340	3640	7.36	7.56	279	908	6.	.78	24.85		10.
36N 05W 23 CABBB	21-Oct-35	PETWELL		12446												
36N 05W 24	7-Jul-36	PETWELL	211EGLE	644												
36N 05W 24 DBCDAA	30-Jun-95	WELL	211TMDC	1449	1786	2100	2000	7.35	7.65	270	545	6.4	.62	10.95		8.
36N 05W 25 CD 01		PETWELL	217CBNK	1687	2324				8.4	58	1030	6.19	1.11	38.79		
36N 05W 26 BD 01		PETWELL	217CBNK	7800	8668					0	1402			0.0		
36N 05W 27 BD		PETWELL	210CLRD	8189												
36N 05W 28 AB	28-Jul-33	PETWELL	211TMDC/EGLE	4294												
36N 05W 28 DD	9-Mar-33	PETWELL		8096												

LOCATION	SAMPLE DATE	SAMPLE SOURCE	GEOLOGIC SOURCE	TDS CALC'D (mg/l)	TDS SUM OF DIS CONST (mg/l)	FLD SC (umho/cm)	LAB SC (umho/cm)	FIELD pH	LAB pH	HRDNS AS CaCO3 (mg/l)	ALK AS CaCO3 (mg/l)	RYZNAR STAB IND	LANGLIER SAT IND	SAR	AIR TEMP (deg C)	WATER TEMP (deg C)
36N 05W 29 ACBBAC	17-Aug-97	SPRING	112TILL	5011	5259	4410	4510	7.59	7.81	3272	400	4.67	1.57	3.1	25.	21.
36N 05W 29 ACBBAC	28-Apr-82	SPRING	112TILL	4225	4463	7190	5782		7.36	2677	385	5.17	1.09	2.83	15.6	9.
36N 05W 32 ADADCB01	1-Jul-95	WELL	112TILL	319	489	556	550	7.61	7.93	256	275	6.59	.67	.38		11.
36N 05W 32 BCDACC	24-Aug-95	WELL	211TMDC	2834	3241	4230	3420	6.97	7.49	538	658	5.96	.76	14.4	28.	9.5
36N 05W 32 DA	25-Oct-32	PETWELL	217DRLG	11654												
36N 05W 33 A	9-Mar-33	PETWELL		1827												
36N 05W 33 CA	9-Mar-33	PETWELL	217MLTN	2207												
36N 05W 33 CBBBDB01	1-Jul-95	WELL	211VRGL	2323	2505	2860	2560	7.2	7.6	1399	294	5.46	1.07	2.27		8.
36N 05W 33 CBBC 01	2-Dec-76	WELL	211TMDC	1689	1873	1933	2213	7.2	7.43	990	297	5.94	.75	2.24		9.5
36N 05W 33 CBBCAA01	1-Jul-95	WELL	211TMDC	1087	1350	1799	1670	8.64	8.52	73	426	6.76	.88	18.77		8.
36N 05W 34 AA	2-Jul-70	PETWELL	330MDSN	4011					7.8							
36N 05W 35 ACDDCC01	30-Jun-95	WELL		1473	1786	2200	2140	8.7	8.61	38	506	7.14	.74	36.		10.
36N 06W 01 ABADCA01	12-Jul-95	WELL	211TMDC	3876	4243	4880	4260	7.16	7.43	1371	596	4.88	1.28	9.01	16.	10.
36N 06W 04 DC	24-Aug-55	PETWELL	330MDSN	3870					8.8							
36N 06W 11 AC	28-Jul-46	PETWELL	330MDSN	4262												
36N 06W 12 AC	18-Mar-47	PETWELL	330MDSN	7260												
36N 06W 12 AC 01	18-Mar-47	WELL	330MDSN	7263	5961					363	2322	12.73	-6.37	0.0		
36N 06W 12 BC	11-Dec-47	PETWELL	330MDSN	4349												
36N 06W 12 BCABDA01	12-Jul-95	WELL		6632	7064	8800	6940	6.9	7.4	5457	699	4.26	1.57	2.68	14.	8.5
36N 06W 12 BCACAC01	3-Jul-95	WELL	211VRGL	5753	6339	6710	5360	6.77	7.75	3618	947	3.85	1.95	4.4		9.
36N 06W 12 CA		PETWELL	330MDSN	4198					7.7							
36N 06W 12 CB		PETWELL	330MDSN	1784					8.3							
36N 06W 12 DA 01		WELL				876	802		7.7	0	470			0.0	28.	
36N 06W 12 DA 01	10-Jul-80	POND		20345	22592				9.43	316	3675	4.16	2.64	208.59		
36N 06W 12 DA 01	10-Jul-80	POND		6036	7112				8.88	310	1743	5.36	1.76	55.42		
36N 06W 12 DA 01	10-Jul-80	OIL_BRINE		4484	5483				8.66	134	1616	6.57	1.04	69.63		
36N 06W 12 DA 01	10-Jul-80	WELL	110ALVM	1548	1830				7.26	708	456	6.35	.46	5.17		
36N 06W 12 DA 01	10-Aug-80	WELL		5183	5547				7.68	927	588	5.51	1.09	21.09		
36N 06W 13 DD	19-Sep-56	PETWELL	330MDSN	2815					8.5							
36N 06W 13 DD	17-Sep-56	PETWELL	330MDSN	3231					8.2							
36N 06W 14 DC	23-Aug-36	PETWELL	217CBNK	6656												
36N 06W 16 DD	8-Nov-61	PETWELL	330MDSN	4432					7.							
36N 06W 23 CA		PETWELL	217CBNK	3090					8.8							
36N 06W 23 CA 01		PETWELL	217CBNK	5561	7271				8.9	131	2772	4.36	2.27	86.84		
36N 06W 25 CBA	16-Jan-74	PETWELL	217CBNK	10785					7.4							
36N 06W 26 DC 01		PETWELL	217CBNK	6783	9117					0	3773			0.0		
36N 06W 28 DA 01		PETWELL	217CBNK	7173	9710				8.5	119	4104	4.32	2.09	117.57		
36N 06W 28 DA 01		PETWELL	217CBNK	7225	10132				8.	80	4700	4.65	1.68	146.39		
36N 06W 33 AC 01		PETWELL	217CBNK	8388	10027				8.2	171	2649	4.89	1.65	109.34		
36N 06W 33 AC 01		PETWELL	217CBNK	8274	9710				8.4	143	2323	4.83	1.79	117.14		
36N 06W 33 AC 01		PETWELL	217CBNK	8192	9486				8.6	182	2093	3.95	2.32	100.6		
36N 06W 34 01		PETWELL	217CBNK	6878	9364					87	4019	12.6	-6.3	131.97		
36N 06W 35 AB	31-Aug-39	PETWELL	217CBNK ?	7240												
36N 06W 35 CA 01		PETWELL	217CBNK	8471	12302					30	6192	13.16	-6.58	284.77		
36N 07W 03 CB	16-Jul-54	PETWELL	330MDSN	3326					8.							
36N 07W 03 CB	16-Jul-54	PETWELL	330MDSN	2048					8.7							
36N 07W 03 CB	15-Jul-54	PETWELL	330MDSN	2350					8.7							
36N 07W 03 CB	15-Jul-54	PETWELL	330MDSN	2299					8.2							
36N 07W 12 DD	12-Nov-55	PETWELL	330MDSN	4370					7.6							
36N 07W 36 CB		PETWELL	330MDSN	7913					7.4							
37N 03W 19 BCBADB	13-Jul-95	WELL		3338	3615	4920	4070	8.19	8.22	241				29.03		
37N 04W 02 DDDBCC	30-Jun-95	WELL	211VRGL	2996	3284	4170	3660	7.66	8.02	271	466	6.1	.96	23.61		10.
37N 04W 02 DDDBCC	2-Dec-76	WELL	211VRGL	3089	3410	3982	4186	7.85	7.95	291	519	6.03	.96	23.85		9.
37N 04W 03	3-Feb-69	PETWELL	217MLTN	3867					7.6							
37N 04W 03 01		PETWELL	217CBNK	5414	7862				8.3	230	3957	3.89	2.2	63.13		
37N 04W 03 BACCDA 01	8-Dec-81	WELL	211TMDC						7.4		337	6.5	.4			
37N 04W 03 BACCDA01	15-Jul-95	WELL	211TMDC	1349	1831	1529	1634	7.42	7.79	271	779	5.91	.94	6.87		8.

Ground-water parameters

LOCATION	SAMPLE DATE	SAMPLE SOURCE	GEOLOGIC SOURCE	TDS CALC'D (mg/l)	TDS SUM OF DIS CONST (mg/l)	FLD SC (umho/cm)	LAB SC (umho/cm)	FIELD pH	LAB pH	HRDNS AS CaCO3 (mg/l)	ALK AS CaCO3 (mg/l)	RYZNAR STAB IND	LANGLIER SAT IND	SAR	AIR TEMP (deg C)	WATER TEMP (deg C)
37N 04W 03 BACCDA01	13-Jul-90	WELL	211TMDC	1034	1288		1642		7.61	290	410	6.58	.51	6.61		
37N 04W 03 BCDDBB17D	11-Jul-96	WELL	211TMDC	1397	1674	2550	1820	7.64	7.6	473	447	5.94	.83	6.01	19.	9.
37N 04W 03 BCDDBB17D	11-Jul-96	WELL	211TMDC	1360	1637	2560	1820	7.62	7.4	464	447	6.14	.63	5.86	19.	9.
37N 04W 03 BCDDBB17S	11-Jul-96	WELL	110ALVM	1965	2129	2270	2290	7.61	7.4	758	264	6.37	.52	5.33	19.	16.5
37N 04W 03 BDC 01	13-Jul-90	STREAM	SURFACE H20	6849	9127		10055		9.05	202	3691	5.02	2.02	82.58		
37N 04W 03 CA	8-Feb-70	PETWELL	217MLTN	3482					7.6							
37N 04W 03 CBA 01	3-Feb-69	WELL	217MLTN	3867	5440				7.6	171	2543	5.16	1.22	51.78		
37N 04W 03 CDCABC01	17-Jul-95	WELL	211TMDC	787	1010	1303	1192		7.46	401	360	6.46	.5	2.21		8.5
37N 04W 03 CDCD 01	4-Jan-94		211TMDC	513	684											
37N 04W 03 DC	16-May-60	PETWELL	217MLTN	2691					8.8							
37N 04W 03 DC	16-May-60	PETWELL	217MLTN	2706					8.7							
37N 04W 03 DC 01		PETWELL	217CBNK	5645	8245				7.2	497	4203	4.32	1.44	42.79		
37N 04W 03 DC 01		PETWELL	217CBNK	4876	6667				8.6	155	2897	4.	2.3	67.49		
37N 04W 03 DC 01		PETWELL	217CBNK	4152	5436				9.1	174	2082	3.61	2.75	54.46		
37N 04W 03 DC 01		PETWELL	217CBNK	3382	4483				8.8	174	1783	4.18	2.31	42.46		
37N 04W 03 DC 01		PETWELL	217CBNK	3172	4101				8.9	124	1505	4.61	2.15	46.88		
37N 04W 03 DCD 01		PETWELL	217CBNK	5583	6425				9.8	0	1388			0.0		
37N 04W 04 ABD	7-Sep-95	STREAM		1662	1836	2280		8.2		736	281	13.71	-6.85	4.17	20.	19.
37N 04W 04 ABD	26-Jul-95	STREAM		1708	1884	2350		8.4		868	285	13.64	-6.82	3.54	22.	20.5
37N 04W 04 ABDCDC		RIVER	SURFACE H20	1684	1860		2350		8.4	870				3.	22.	20.5
37N 04W 04 ABDCDC		RIVER	SURFACE H20	1696	1870		2280		8.2	750				4.	20.	19.
37N 04W 04 ABDCDC	16-Jul-97	RIVER	SURFACE H20	1515	1540	1970	1957	8.8	8.22	587	41	7.73	.24	5.06	28.	26.
37N 04W 04 DAA	10-Jun-65	PETWELL	217MLTN	4411					7.8							
37N 04W 05 BDBDDC	24-Aug-95	WELL	112TILL	983	1163	1325	1319	6.82	7.93	650	291	5.67	1.13	1.23	18.	9.
37N 04W 09	18-Sep-59	PETWELL	330MDSN	2799					8.6							
37N 04W 09 ADB	10-Apr-70	PETWELL	217MLTN	7823					9.							
37N 04W 10 AC 01		PETWELL	217CBNK	4234	5997				7.1	526	2850	4.58	1.26	29.71		
37N 04W 10 AC 01		PETWELL	217CBNK	5280	7604				7.3	466	3756	4.3	1.5	41.15		
37N 04W 10 BBC		PETWELL	217MLTN	4872					8.7							
37N 04W 10 CA 01		PETWELL	217CBNK	4487	6402				7.8	232	3096	5.08	1.36	51.39		
37N 04W 11 AB		PETWELL		4278	6317	16020	6320	7.82	7.8	149	3296	5.5	1.15	13.04		4.8
37N 04W 12 DB 01	21-Oct-65	WELL	211VRGL	1119	1079					364	304	14.03	-7.01	0.0		8.9
37N 04W 03 BACCDA01	13-Jul-90	KIT TAP	211TMDC	1190	1462		1819		7.64	282	440	6.51	.56	8.35		
37N 04W 03 BACCDA01	13-Jul-90	RESERVOIR	211TMDC	1169	1441		1820		7.76	264	440	6.48	.64	8.63		
37N 04W 12 DBCDAB	16-Jul-95	WELL	211TMDC	4123	4573	6360	4780	8.08	8.09	150	727	6.12	.98	46.46		13.
37N 04W 03 BACCDA01	23-Feb-85	WELL	211TMDC	1397	1690				7.7	352	474	6.7	.4			
37N 04W 03 BACCDA01	2-Jun-88	WELL	211TMDC	1566	1875				7.5	402	500	6.7	.3			
37N 04W 12 DBCDAB-2	16-Jul-97	WELL	211TMDC	4432	4871	5410	5130	8.22	8.44	78	710	6.46	.99	71.97	19.	10.
37N 04W 15 BA	31-May-66	PETWELL	330MDSN	2748					7.2							
37N 04W 15 BA 01		PETWELL	217CBNK	4383	6402				7.2	457	3264	4.45	1.38	33.98		
37N 04W 15 BB 01		WELL	211EGLE	968	1229		1430		8.32	269	422	6.28	1.02	6.58		
37N 04W 15 BCCBBB01	17-Jul-95	WELL	211TMDC	977	1261	1700	1527		7.8	329	459	6.3	.75	5.44		9.
37N 04W 16 ACB	5-May-73	PETWELL	217MLTN	4443					7.6							
37N 04W 16 BCD 01		PETWELL	217CBNK	4402	6317				6.9	364	3096	4.91	.99	38.96		
37N 04W 16 BDDD	19-Jul-59	PETWELL	217MLTN	7190					7.2							
37N 04W 16 BDDD	19-Jul-59	PETWELL	217MLTN	6684					8.9							
37N 04W 17		PETWELL	217MLTN	5988					8.2							
37N 04W 18 BBB	15-Sep-59	PETWELL	217MLTN	5632					8.4							
37N 04W 19 AD 01		PETWELL	217CBNK	5797	8283					45	4019	13.18	-6.59	157.67		
37N 04W 27 CBDA 01	22-Oct-65	WELL	211VRGL	1115	1025					10	554	16.07	-8.04	0.0		
37N 04W 27 CBDABB01	18-Jul-95	WELL		1062	1395	1795	1683	7.76	8.85	5	450	8.47	.19	74.37		9.
37N 04W 28 C 01		WELL	211EGLE	1687	2162		2560		8.55	114	768	6.35	1.1	24.46		
37N 04W 29 DBCCBB	8-Aug-95	WELL		2614	2789	3120	2210	7.43	7.96	1949	282	4.63	1.65	.74		8.
37N 04W 31 C	17-Apr-70	PETWELL	217MLTN	18084					5.3							
37N 05W 01 CD		PETWELL	217CBNK	4016					7.8							
37N 05W 02 01	12-Mar-59	PETWELL	330MDSN	4117	5259				8.9	137	1850	4.16	2.37	61.7		
37N 05W 02 02	12-Mar-59	PETWELL	217CBNK	4594	5862				7.4	1010	2050	4.17	1.61	20.19		

Ground-water parameters

LOCATION	SAMPLE DATE	SAMPLE SOURCE	GEOLOGIC SOURCE	TDS CALC'D (mg/l)	TDS SUM OF DIS CONST (mg/l)	FLD SC (umho/cm)	LAB SC (umho/cm)	FIELD pH	LAB pH	HRDNS AS CaCO3 (mg/l)	ALK AS CaCO3 (mg/l)	RYZNAR STAB IND	LANGLIER SAT IND	SAR	AIR TEMP (deg C)	WATER TEMP (deg C)
37N 05W 03 ACC 01		PETWELL	217CBNK	4612	6505				6.6	243	3059	5.91	.34	51.58		
37N 05W 03 CBA		PETWELL	217CBNK	7834					8.							
37N 05W 03 CBA 01		PETWELL	217CBNK	4321	6160				7.9	261	2973	4.6	1.65	46.23		
37N 05W 03 DB 01		PETWELL	217CBNK	4080	5780				8.2	182	2748	4.47	1.86	53.1		
37N 05W 04 DDDDBD 01	11-Aug-95	SPRING	112TILL	2905	3300	3790	3330		8.17	1956	638	4.03	2.07	2.42	21.	11.
37N 05W 06		PETWELL	217SBRS	3757					8.7							
37N 05W 06 CBDDCA01	14-Jul-95	WELL	211TMDC	761	1051	1283	1266	8.79	8.74	9	469	8.08	.33	41.88		8.
37N 05W 06 DA 01		PETWELL	217SBRS	5169	6803				8.3	197	2645	4.07	2.12	64.03		
37N 05W 07 ADB 01	19-Oct-65	WELL	211TMDC	1190	1050		1800			23	501	15.77	-7.89	0.0		
37N 05W 09 CCCACA01	10-Aug-95	WELL	211TMDC	1433	1948	2010	1804	7.39	7.69	294	832	5.85	.92	9.23	16.	9.
37N 05W 10 AC 01		PETWELL	217CBNK	6005	8593				7.4	516	4183	4.16	1.62	44.58		
37N 05W 10 AC 01		PETWELL	217CBNK	6157	7895				8.7	510	2814	3.77	2.47	45.12		
37N 05W 10 AD		PETWELL	217CBNK	4539					8.3							
37N 05W 10 DCDADA	3-Aug-95	WELL	211TMDC	959	1312	1560	2330	7.49	8.39	140	572	6.18	1.1	11.28		9.
37N 05W 10 DDD		PETWELL	330MDSN	3772					7.2							
37N 05W 10 DDD 01		PETWELL	217CBNK	5296	7199				7.5	689	3076	3.88	1.81	36.34		
37N 05W 11 ABC		PETWELL	330MDSN	4462					8.5							
37N 05W 11 BC 01		PETWELL	217CBNK	6079	8648				7.9	520	4153	3.58	2.16	43.24		
37N 05W 11 DC 01		PETWELL	217SBRS	6130	8743					304	4224	11.68	-5.84	61.45		
37N 05W 12	8-Jul-63	PETWELL	217BILD	4339					8.6							
37N 05W 12 ACADDA01	17-Jul-95	WELL	211TMDC	1387	1702	2380	2080	7.67	7.71	279	511	6.31	.7	10.16		8.5
37N 05W 12 BB 01		PETWELL	217CBNK	4439	6329				7.2	375	3055	4.68	1.26	38.52		
37N 05W 12 BB 01		PETWELL	217CBNK	4042	5427				7.3	299	2239	4.96	1.17	39.07		
37N 05W 12 BB 01		PETWELL	217CBNK	4481	6396				7.4	361	3096	4.5	1.45	39.79		
37N 05W 12 BC	11-Dec-58	PETWELL	330MDSN	1823					8.7							
37N 05W 15 DAA 01	18-Oct-65	WELL	211VRGL	1612	1252		2700			467	220	14.53	-7.26	0.0		
37N 05W 16 AAACCD	31-Jul-96	SPRING	112TILL	4838	5211	5520	4920	7.26	7.3	1883	602	5.05	1.13	8.45	28.5	19.
37N 05W 19 DAC 01	19-Oct-65	WELL	211TMDC	3515	3116		3500			756	851	12.65	-6.33	0.0		6.7
37N 05W 19 DADBDB01	3-Aug-95	WELL		2424	2917	3610	3200	7.24	8.42	298	797	4.95	1.73	19.18	17.	8.
37N 05W 20 DCCCDC	13-Jun-96	WELL	211TMDC	5005	5311	5260	5140	7.17	7.	2246	495	5.23	.88	8.17	29.	10.
37N 05W 21 ABBACB	11-Jul-96	WELL	211TMDC	2553	2966	3120	3140	7.26	7.6	746	668	5.37	1.11	9.38	20.	10.
37N 05W 21 ABBDBA	29-Jun-95	WELL	211TMDC	3360	3662	3850	3400	7.04	8.12	2192	488	4.13	1.99	2.31		10.
37N 05W 22 CCACAC	16-Jul-95	RESEVOIR	SURFACE H20	646	741	984	949	9.06	8.68	355	154	5.92	1.38	1.54		18.5
37N 05W 23 BB	16-Apr-33	PETWELL	210CLRD/217KOTN	11715												
37N 05W 23 BB	27-Jun-33	PETWELL	217DRLG	6080												
37N 05W 23 BB 01	23-Mar-33	PETWELL	211EGLE	1223	1560					0	552			0.0		
37N 05W 23 BB 01		PETWELL	217CBNK	6083	8595					278	4060	12.5	-6.25	64.02		
37N 05W 23 CDD 01		PETWELL	217CBNK	6079	8591				7.	398	4060	4.76	1.12	52.3		
37N 05W 23 CDD 01		PETWELL	217CBNK	6103	8640				6.9	569	4101	4.62	1.14	42.73		
37N 05W 23 CDD 01		PETWELL	217CBNK	7279	9689				7.5	474	3896	3.9	1.8	55.44		
37N 05W 23 CDD 01		PETWELL	217CBNK	6982	9265				7.6	358	3691	4.13	1.74	62.19		
37N 05W 23 DA 01		PETWELL	217SBRS	7699	9642				8.4	108	3151	4.69	1.86	130.42		
37N 05W 23 DA 01		PETWELL	217SBRS	8377	10843				8.4	108	3996	4.53	1.94	144.38		
37N 05W 24 AA 01		PETWELL	217CBNK	5368	6865					212	2420	13.12	-6.56	62.73		
37N 05W 24 BA 01		PETWELL	217CBNK	5980	8233				7.4	443	3642	4.09	1.65	47.9		
37N 05W 24 BB	19-May-41	PETWELL	217CBNK ?	6802												
37N 05W 24 BB 01		PETWELL	217CBNK/SBRS	6366	8954					670	4183	11.29	-5.64	40.46		
37N 05W 24 CB 01		PETWELL	217SBRS	6551	8707					635	3486	11.48	-5.74	41.17		
37N 05W 24B	5-Jul-39	PETWELL		2599												
37N 05W 25 01		PETWELL	217SBRS	5905	7960				7.7	189	3322	4.76	1.47	75.36		
37N 05W 25 BC 01		PETWELL	217CBNK	5162	6557					411	2255	12.4	-6.2	42.06		
37N 05W 25 BC 01		PETWELL	217SBRS	5356	6713					331	2194	12.97	-6.49	49.47		
37N 05W 26 CCBCAC01	3-Aug-95	WELL	211VRGL	723	1004	1309	1360	8.81	8.77	11	455	8.2	.28	39.83	21.	8.
37N 05W 29 DD 01	19-Oct-65	WELL	211TMDC	2615	2428					546	869	13.11	-6.56	0.0		
37N 05W 30 BAAABB	14-Aug-97	MON WELL	112TILL	2962	3269	4240	4170	7.08	7.1	2904	496	4.84	1.13	2.93	27.	8.5
37N 05W 30 BDDA	25-Feb-98	MON WELL	112TILL	1912	2138	1370	2360	7.56	8.01	1325	364	5.24	1.39	1.63	1.6	4.
37N 05W 30 BDDA	25-Feb-98	MON WELL	112TILL	2319	2517	2	2640	7.51	7.97	1510	320	5.03	1.47	1.76	1.6	6.

Ground-water parameters

LOCATION	SAMPLE DATE	SAMPLE SOURCE	GEOLOGIC SOURCE	TDS CALC'D (mg/l)	TDS SUM OF DIS CONST (mg/l)	FLD SC (umho/cm)	LAB SC (umho/cm)	FIELD pH	LAB pH	HRDNS AS CaCO3 (mg/l)	ALK AS CaCO3 (mg/l)	RYZNAR STAB IND	LANGLIER SAT IND	SAR	AIR TEMP (deg C)	WATER TEMP (deg C)
37N 05W 30 CCAA	25-Feb-98	MON WELL	112TILL	4647	5126	2750	4650	6.4	7.56	3263	774	4.03	1.76	2.71	-1.8	6.
37N 05W 30 CCCC	25-Feb-98	MON WELL	112TILL	3735	4007	2210	3570	7.26	7.92	2030	439	4.63	1.65	3.18	-5.5	6.
37N 05W 30 CDACDD	14-Aug-97	MON WELL	112TILL	2247	2510	4030	3800	6.9	7.17	2892	425	4.89	1.14	2.18	28.	10.
37N 05W 35 AB		PETWELL	330MDSN	5604					8.2							
37N 05W 35 BAB 01		PETWELL	217SBRS/CBNK	8969	11755				7.9	607	4503	3.29	2.31	60.98		
37N 05W 35 BAB 01		PETWELL	217SBRS/CBNK	8969	11755				7.9	607	4503	3.29	2.31	60.98		
37N 05W 35 BAB 01		PETWELL	217SBRS/CBNK	8802	11476				7.9	387	4322	3.54	2.18	76.78		
37N 05W 35 CDABBB01	4-Aug-95	WELL	211VRGL	987	1276	1560	1478	7.1	8.24	268	467	5.83	1.2	6.78	17.	9.
37N 05W 35 CDABBB01	1939	WELL	211VRGL	647	715					443	220	14.63	-7.32	0.0		
37N 05W 35 DC		PETWELL	330MDSN	9659					7.9							
37N 05W 35 DC	12-Sep-59	PETWELL	330MDSN	9816					7.4							
37N 06W 01 ADDDDA01	14-Jul-95	WELL	211TMDC	678	937	1283	1204	9.06	8.88	5	419	8.49	.2	50.85		8.5
37N 06W 02 CAC 01		PETWELL	217CBNK	8115	9871				8.6	158	2842	4.25	2.18	113.4		
37N 06W 03 DC 01		PETWELL	217CBNK	6448	8538				7.9	289	3379	4.12	1.89	60.31		
37N 06W 11 ABDABB01	8-Aug-95	WELL	211TMDC	518	730	851	858	7.67	7.68	340	342	6.59	.55	1.54		8.
37N 06W 11 BA		PETWELL	330MDSN	4508					8.							
37N 06W 11 BA		PETWELL	330MDSN	4023					8.							
37N 06W 11 BA		PETWELL	330MDSN	3264					8.7							
37N 06W 11 BA 01		PETWELL	217CBNK	3315	4035				9.2	124	1171	5.29	1.96	49.87		
37N 06W 11 BA 01		PETWELL	217CBNK	7851	9957				8.2	205	3404	4.19	2.	95.36		
37N 06W 11 BA 01		PETWELL	217CBNK	9008	11291				7.6	172	3691	4.72	1.44	120.28		
37N 06W 11 BCADDC01	8-Aug-95	WELL	330MDSN	5374	7041	9840	9550	6.87	7.34	322	2695	5.02	1.16	50.4		14.
37N 06W 23 AD	11-Nov-57	PETWELL	330MDSN	3995					7.6							
37N 06W 24 ABAAAB01	29-Jun-95	WELL		923	1315	1531	1490	8.76	8.44	9	634	8.07	.19	52.9		8.
37N 06W 24 CDADBC01	29-Jun-95	WELL	211TMDC	741	1084	1155	1219	7.98	8.23	48	554	7.12	.56	17.14		8.
37N 06W 24 CDDADB01	29-Jun-95	WELL		1071	1510	1679	1667	8.61	8.43	43	710	6.74	.85	26.22		8.
37N 06W 25 01		PETWELL	217SBRS	6158	8025				8.4	111	3018	4.75	1.83	102.94		
37N 06W 29 DACBBC	15-Jul-95	SPRING	112TILL	1716	2017	2440	2270	7.38	7.97	951	486	5.3	1.33	3.25		10.
37N 06W 34 CCDADB	15-Jul-95	SPRING	112TILL	1537	1821	2480	2280	7.65	7.81	579	458	5.87	.97	5.97		10.
37N 06W 36 DC 01		PETWELL	217CBNK	5446	6009				8.4	400	913	6.33	1.03	43.52		

Ground-water quality data - major elements

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Cl (mg/l)	SO4 (mg/l)	NO3 (mg/l)	F (mg/l)	PO4 (mg/l)
35N 04W 01 ABDDBA01	12-Jul-96	WELL	97Q0038	180	115	160	5.1	0.024	0.014	10	375.8		250	570	8.4	<1	
36N 04W 08 ADCC	25-Feb-98	MON WELL	98Q0815	544.6	245.4	607	17.8	<.005	0.118	17	475.8		163.9	2689.4	107.9	3.8	<1
36N 04W 08 BAAD	24-Feb-98	MON WELL	98Q0820	488.2	478.9	811.2	17.5	<.005	0.062	12	603.9		139	4100.7	54.9	4.8	<1
36N 04W 08 DDBB	24-Feb-98	MON WELL	98Q0819	247.9	199.9	82.6	10.8	<.005	0.002	14	383.1		29.2	1084	13.3	<.5	<1
36N 04W 11 BBADCD	2-Aug-95	WELL	96Q0179	54.4	40.1	294.1	2.8	0.007	<.002	6.7	605.1		11	450	0.9	0.2	<.1
36N 04W 11 CAAACA01	2-Aug-95		96Q0178	76.9	42.8	139.7	3.2	<.003	0.116	9.6	510.8		6.5	250	0.15	0.2	<.1
36N 04W 14 AACCCC	14-Jul-95	WELL	96Q0100	114.4	59.1	71.8	3.3	0.112	0.01	9.4	362		10	350	0.7	0.1	<.1
36N 04W 14 AACCCC	10-Feb-54	WELL	54Q0001	70.1	46.7			0.4			462.5	0	10	231.2			
36N 04W 14 AADDDC	8-Sep-54	WELL	54Q0002	56	41			1			488		11	247			
36N 04W 14 ADCBDC	30-Jun-65	WELL	65Q0007	28	41			0.24			412	0	9	430	<.023	0.2	
36N 04W 17 ABAC	24-Feb-98	MON WELL	98Q0817	546.1	304.4	385.8	20	<.005	0.1	16	444.1		209	2768.6	9.76	3.5	<1
36N 04W 17 AC 01		PETWELL	77Q0025	34	92	3712					2440	270	4214	138			
36N 04W 22 ADCCCB01	2-Aug-95	WELL	96Q0175	53.7	33.7	238.8	2.3	0.007	<.002	6.9	545.3	14.4	8	300	1	0.3	<.1
36N 04W 22 DCA	20-Oct-65	WELL	65Q0023	68	62			1.36			342	0	16	392	2.395	0.4	
36N 04W 28 B 01		WELL	30Q0002	40	40	1095					1990		700	28			
36N 04W 28 DBB	10-Jul-30	PETWELL				421					500	48	16	392			
36N 04W 28 DBB	27-Jul-30	PETWELL				1239					1220	242	850	89			
36N 04W 28 DBB	22-Jul-30	PETWELL		40	40	1095					1990		700	28			
36N 04W 28 DBB 01		PETWELL	30Q0009			420					605	24	11	348			
36N 04W 30 BBBDB 01	30-Jun-95	WELL	96Q0008	24.6	11.4	289.1	2.2	0.083	0.051	7.8	466.9		12	350	0.05	0.5	<.1
36N 04W 35 AB 01	24-Sep-65	WELL	65Q0004	32	37			5.72			427	0	8	190		0	
36N 04W 35 ADAADA	12-Jul-95	WELL	97Q0037	10.8	6.9	188.5	1	0.03	0.013	6.9	460.7		4.1	81	<.05	<1	
36N 05W 01 ABB		PETWELL		6	2	147					15	0	78	212			
36N 05W 01 ABB	14-Apr-70	PETWELL		6	2	415					135	264	205	83			
36N 05W 01 DCCCDB	13-Jul-95	WELL	96Q0108	2.1	1.2	325.8	0.75	<.05	<.002	6	563.6	38.4	19	300	0.15	1.4	<.1
36N 05W 01 DCCCDB	18-Mar-54	WELL	54Q0005	3	5			0.3			506	65	23	257			
36N 05W 02	7-Sep-33	PETWELL		28	tr	4663					5000		3976	487			
36N 05W 04 ABABDD01	15-Oct-65	WELL	65Q0022	14	44			0			630	45	33	1950	0.52	1.3	
36N 05W 04 ABABDD01	1-Jul-95	WELL	96Q0014	104.2	58.3	1200	5.5	0.758	0.113	6.9	855.5		40	2250	27.5	0.8	<.5
36N 05W 04 DB 01		PETWELL	39Q0006	73	30	2866					5750		1296				
36N 05W 04 DBA 01	14-Feb-40	WELL	40Q0001	73	30						5750		1296				
36N 05W 05 ACBDBB01	13-Jul-95	WELL	96Q0103	90.2	67.9	727.9	4.8	2.6	0.334	11	576.7		40	1500	<.05	0.2	<.1
36N 05W 07 CC		PETWELL		63	26	1632					2050	291	1041	172			
36N 05W 09 BC 01	2-Dec-76	WELL	76Q1455	130	62.8	1100	5.2	0.88	0.18	7.7	903		32	2200	<.023	0.7	
36N 05W 11 CBC	17-Apr-70	PETWELL		114	14	1227					1990	0	968	13			
36N 05W 12 DCCCAD01	21-Jun-54	WELL	54Q0004	2	4			0.12			488	42	12	215			
36N 05W 13 AAAAAD	21-Jun-54	WELL	54Q0003	1	2			0.22			614	54	38.5	38.5			
36N 05W 14 ACDDDD	4-Aug-95	WELL	96Q0182	16	8.7	278.6	2.1	0.101	0.024	7.2	399.4	0	13	325	0.05	0.4	<.1
36N 05W 14 ACDDDD	24-Sep-65	WELL		2	0			3.3			370	57	15	43	3.773	0.6	
36N 05W 14 DBBBCB01	17-Jul-95	WELL	96Q0106	0.946	0.399	276.2	0.66	<.05	<.002	5.8	435.9	51.2	16	250	<.05	1.2	<.1
36N 05W 14 DBBBCB01	24-Oct-64	WELL	64Q0063	8	<.1			0.24			540	21	15	216	<.023	1.1	
36N 05W 15 D 01		PETWELL	37Q0006			4612					5500	240	3536	132			
36N 05W 18 B	2-Jul-70	PETWELL		137	41	1595					2925	tr	1021	135			
36N 05W 18 BB		PETWELL		158	39	1443					1540	601	922	124			
36N 05W 18 DAABAA01	12-Jun-95	WELL	96Q0091	173	130	376	5.5	0.194	0.013	7.7	512	0	17.5	1300	4.25	0.1	<.1
36N 05W 19 AC	8-Sep-59	PETWELL		29	8	2484					4275	0	1420	0			
36N 05W 19 AC	1-Oct-59	PETWELL		173	182	1964					2550	0	2214	230			
36N 05W 19 BC	2-Jul-70	PETWELL		137	39	1592					3000	0	993	100			
36N 05W 23 01		PETWELL	35Q0007	53	5	5035					4100		5454	51			
36N 05W 23 AABDB 01	30-Jun-95	WELL	96Q0017	25.8	14.7	504	2.4	0.141	0.039	7	423.7	13.6	21	750	<.05	0.7	<.1
36N 05W 23 ACCBDA	30-Jun-95	WELL	96Q0005	58.1	32.5	953.4	4	0.057	0.077	7.5	1107		9	1390	<.05	0.6	<.2
36N 05W 23 CABBB	21-Oct-35	PETWELL				5015					2890	301	5670	39			
36N 05W 24	7-Jul-36	PETWELL				254					440	tr	22	152			
36N 05W 24 DBCDAA	30-Jun-95	WELL	96Q0010	54.6	32.5	413.4	4	0.113	0.149	7.6	664.5		9	600	<.05	0.4	<.1
36N 05W 25 CD 01		PETWELL	54Q0031	15	5	679					1255	24	288	58			
36N 05W 26 BD 01		PETWELL	43Q0011			3003					1710		2744	1211			
36N 05W 27 BD		PETWELL		41	tr	3114					685		3856	841			

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Cl (mg/l)	SO4 (mg/l)	NO3 (mg/l)	F (mg/l)	PO4 (mg/l)
36N 05W 28 AB	28-Jul-33	PETWELL				1462					720		27	2451			
36N 05W 28 DD	9-Mar-33	PETWELL		1944		1101		tr			975		4572				
36N 05W 29 ACBBAC	17-Aug-97	SPRING	98Q0173	457	517.6	407.5	12.7	<.005	0.021	13	488	0	165.1	3125	73.5	0	<.05
36N 05W 29 ACBBAC	28-Apr-82	SPRING	82Q0195	444	381	337	12	0.014	0.008	8.3	470	0	121	2620	69.6	0.4	
36N 05W 32 ADADCB01	1-Jul-95	WELL	96Q0019	63.5	23.6	13.8	8.2	<.003	<.002	13	335.5		3.5	27.5	0.75	0.1	<.1
36N 05W 32 BCDACC	24-Aug-95	WELL	96Q0286	90	76	767.2	5.8	<.03	0.056	6.4	802.8		80	1400	12.5	<1	<.1
36N 05W 32 DA	25-Oct-32	PETWELL				4820					5800	505	3439	38			
36N 05W 33 A	9-Mar-33	PETWELL				781					1780		171				
36N 05W 33 CA	9-Mar-33	PETWELL		155	35	702		tr			1610		524				
36N 05W 33 CBBBDB01	1-Jul-95	WELL	96Q0006	316.6	147.9	195.2	7	0.112	0.673	9.9	358.7		42.5	1425	0.25	0.7	<.1
36N 05W 33 CBBC 01	2-Dec-76	WELL	76Q1454	220	107	162	6.3	1.19	0.43	9.2	362	0	52	952	<.023	0.3	
36N 05W 33 CBBCAA01	1-Jul-95	WELL	96Q0007	16.3	7.9	369.1	1.5	0.059	0.017	6.5	519.7	11.2	17	400	<.05	1.2	<.1
36N 05W 34		PETWELL		48	29	1792					2800	120	1142	30			
36N 05W 34 AA	2-Jul-70	PETWELL		34	25	1605					3050	0	808	37			
36N 05W 35 ACDDCC01	30-Jun-95	WELL	96Q0011	7.7	4.5	508.3	1.4	0.053	0.007	6.5	616.5	25.6	13	600	0.05	2.1	<.1
36N 06W 01 ABADCA01	12-Jul-95	WELL	96Q0097	295.6	153.8	766.7	9.8	<.02	0.488	9.7	724.7	94.8	20	2150	17.5	0.1	<1
36N 06W 02 DA 01	23-Feb-33	WELL	33Q0004								575	37	129	454			
36N 06W 04 DC	24-Aug-55	PETWELL		15	15	1516					1320	552	616	506			
36N 06W 11 AC	28-Jul-46	PETWELL		110	tr	1523							1000	1377			
36N 06W 12 AC	18-Mar-47	PETWELL		43	62	2735					2825	298	1782	951			
36N 06W 12 AC 01	18-Mar-47	WELL	47Q0012	43	62						2825	298	1782	951			
36N 06W 12 BC	11-Dec-47	PETWELL		91	38	1659					3020		1071	5			
36N 06W 12 BCABDA01	12-Jul-95	WELL	96Q0094	666.6	921.4	455.7	19.6	0.029	0.082	8	852.8		40	3500	600	0.1	<10
36N 06W 12 BCACAC01	3-Jul-95	WELL	96Q0016	531.7	556.4	608.8	13.3	0.009	0.048	8.4	1154		27.5	3250	187.5	0.7	<.5
36N 06W 12 CA		PETWELL		61	35	1638					3050	0	962	tr			
36N 06W 12 CB		PETWELL		26	12	699					980	118	446	tr			
36N 06W 12 DA 01		WELL	84Q0847								573	0					0
36N 06W 12 DA 01	10-Jul-80	POND	80Q1617	6.4	72.8	8516	119	0.17	0.019	6.9	4429	2573	4840	2012	10	7.2	
36N 06W 12 DA 01	10-Jul-80	POND	80Q1615	11.3	68.5	2243	1.7	0.15	0.001	12	2121	228	1560	860	3.4	3.2	
36N 06W 12 DA 01	10-Jul-80	OIL_BRINE	80Q1616	4.2	30.1	1855	47.8	0.035	<.001	12	1968	124	1080	356	3	3.4	
36N 06W 12 DA 01	10-Jul-80	WELL	80Q1613	109	106	316	13.7	0.66	2.36	11	556	0	417	297	<.1	1.2	
36N 06W 12 DA 01	10-Aug-80	WELL	80Q1614	137	142	1475	12.6	0.014	0.004	4.3	717	0	1973	1072	9.6	4	
36N 06W 13 DD	19-Sep-56	PETWELL		20	12	1025					830	74	536	739			
36N 06W 13 DD	17-Sep-56	PETWELL		55	17	1194					1710	tr	633	490			
36N 06W 14 DC	23-Aug-36	PETWELL				2823						1793	1609	203			
36N 06W 16 DD	8-Nov-61	PETWELL		169	27	1629					3170	0	1046	0			
36N 06W 23 CA		PETWELL		48	55	1114					1440	335	454	375			
36N 06W 23 CA 01		PETWELL	55Q0071	21	19	2281					3370	458	1075	47			
36N 06W 25 CBA	16-Jan-74	PETWELL		34	44	4337					7100	0	2400	473			
36N 06W 25 DDADCA	25-Aug-95	WELL	96Q0285	188.7	112.8	527	5.7	<.03	0.005	7.3	561.2		160	1250	25	<.1	<.1
36N 06W 26 DC 01		PETWELL	39Q0007			2828					4600		1689				
36N 06W 28 DA 01		PETWELL	60Q0028	28	12	2951					5000	182	1446	91			
36N 06W 28 DA 01		PETWELL	61Q0030	32		3007					5730		1363				
36N 06W 33 AC 01		PETWELL	61Q0031	34	21	3289					3230		2934	519			
36N 06W 33 AC 01		PETWELL	61Q0032	31	16	3222					2830	99	2737	775			
36N 06W 33 AC 01		PETWELL	61Q0033	73		3121					2550	118	2470	1154			
36N 06W 34 01		PETWELL	36Q0010	35		2835					4900		1566	28			
36N 06W 35 AB	31-Aug-39	PETWELL		24		2994					4500	240	1737	32			
36N 06W 35 CA 01		PETWELL	39Q0008	12		3582					7550		1158				
36N 07W 03 CB	16-Jul-54	PETWELL		84	37	1242					2710	0	509	121			
36N 07W 03 CB	16-Jul-54	PETWELL		11	12	835					760	72	186	66			
36N 07W 03 CB	15-Jul-54	PETWELL		10	6	891					510	72	770	350			
36N 07W 03 CB	15-Jul-54	PETWELL		10	6	866					760	tr	633	402			
36N 07W 12 DD	12-Nov-55	PETWELL		119	50	1616					3320	0	831	119			
36N 07W 36 CB		PETWELL		253	26	2727					4050	0	862	2050			
37N 03W 19 BCBADB	13-Jul-95	WELL	96Q0098	44.2	31.8	1036.	3.2	<.02	.003	7.2	547	0.	17.5	1920.	7.5	.7	<.1
37N 04W 02 DDDBCC	30-Jun-95	WELL	96Q0012	58.9	30	892.3	4.1	0.021	7.66	6.6	567.7		22	1700	1.75	0.4	<.5

Ground-water quality data - major elements

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Cl (mg/l)	SO4 (mg/l)	NO3 (mg/l)	F (mg/l)	PO4 (mg/l)
37N 04W 02 DDDBCC	2-Dec-76	WELL	76Q1456	62.5	32.8	935	4.2	0.09	0.02	7.1	633	0	29	1701	4.6	0.4	
37N 04W 03	3-Feb-69	PETWELL		52	10	1556					3100	0	706	16			
37N 04W 03 01		PETWELL	63Q5024	64	17	2199					4825		727	30			
37N 04W 03 BACCDA 01	8-Dec-81	WELL		196		230					411				33.5	0.1	
37N 04W 03 BACCDA01	15-Jul-95	WELL	96Q0107	57.5	30.9	259.9	3.2	<.05	0.011	7	950.4		19	500	2.75	0.3	<.1
37N 04W 03 BACCDA01	13-Jul-90	WELL	90Q0232	61.9	33	259	3.61	0.241	0.01	8.2	500		16	403	2.66	0.4	<.1
37N 04W 03 BCDDBB17D	11-Jul-96	WELL	97Q0040	120	42	300	6.3	0.031	1.021	8.5	544.9		28	623	<.05	<1	
37N 04W 03 BCDDBB17D	11-Jul-96	WELL	97Q0041	120	40	290	6.3	0.036	1	8.9	545.3		25	600	<.05	<1	
37N 04W 03 BCDDBB17S	11-Jul-96	WELL	97Q0039	156.1	89.5	337.3	12.5	2.4	4.2	16	322.1	0	48.6	1140	0.64	<1	
37N 04W 03 BDC 01	13-Jul-90	STREAM	90Q0230	6.39	45.3	2700	64	0.112	0.018	2.8	4490	530	1280	7	0.09	0.8	<.1
37N 04W 03 CA	8-Feb-70	PETWELL		27	12	1294					2800	0	750	20			
37N 04W 03 CBA 01	3-Feb-69	WELL	65Q0059	52	10	1556					3100	0	706	16			
37N 04W 03 CDCABC01	17-Jul-95	WELL	96Q0105	96	39.2	101.9	4.1	<.05	0.006	9.2	438.4		17	300	3.75	0.1	<.1
37N 04W 03 CDCD 01	4-Jan-94		95Q0590	72.3	30.4	66.4	3.6	0.01		10	338		12	150	1.25		
37N 04W 03 DC	16-May-60	PETWELL		120	36	841					1200	143	153	807			
37N 04W 03 DC	16-May-60	PETWELL		50	12	969					1240	192	102	770			
37N 04W 03 DC 01		PETWELL	60Q0029	130	42	2193					5125		755				
37N 04W 03 DC 01		PETWELL	60Q0030	52	6	1928					3530	99	525	527			
37N 04W 03 DC 01		PETWELL	60Q0031	50	12	1652					2530	434	490	268			
37N 04W 03 DC 01		PETWELL	60Q0032	50	12	1288					2170	167	245	551			
37N 04W 03 DC 01		PETWELL	60Q0072	30	12	1201					1830	217	82	729			
37N 04W 03 DCD 01		PETWELL	61Q0034			2364					1660	1586	790	25			
37N 04W 04 ABD	7-Sep-95	STREAM	96Q5001	140	94	260	9	0.019	0.028		343	0	40	950	<.05	0.3	<.2
37N 04W 04 ABD	26-Jul-95	STREAM	96Q5000	150	120	240	15	0.063	0.07	1.5	347	0	60	950	<.05	0.2	<.2
37N 04W 04 ABDCDC		RIVER		150	120	240	15	0.063	0.07	1.5	347	0	60	950		0.2	<.05
37N 04W 04 ABDCDC		RIVER		140	94	260	9	0.019	0.028	2.7	343	0	40	950		0.3	<.01
37N 04W 04 ABDCDC	16-Jul-97	RIVER	98Q0048	81.6	93	281.4	8.9	0.041	0.007	0.3	49.8	0	51.1	974	0.3	0	<.05
37N 04W 04 DAA	10-Jun-65	PETWELL		81	7	1753					3370	0	903	7			
37N 04W 05 BDBDDC	24-Aug-95	WELL	96Q0284	172.1	53.5	71.8	7.6	<.003	<.002	12	355.4		40	450	0.55	<.1	<.1
37N 04W 09	18-Sep-59	PETWELL		15	9	1135					1775	120	584	62			
37N 04W 09 ADB	10-Apr-70	PETWELL		tr	tr	3163					2025	418	3105	140			
37N 04W 10 AC 01		PETWELL	59Q0034	161	30	1565					3475		766				
37N 04W 10 AC 01		PETWELL	60Q0073	134	32	2042					4580		816				
37N 04W 10 BBC		PETWELL		67	21	1930					3196	120	1148	12			
37N 04W 10 CA 01		PETWELL	62Q0031	37	34	1800					3775		717	39			
37N 04W 11 AB		PETWELL	97Q0165	21.5	23.1	365.4	67.6	0.067	0.134	13	4019		1060	747	<.05	<1	
37N 04W 12 DB 01	21-Oct-65	WELL	65Q0008	75	43			0			370	36	45	505	4.292	0.6	
37N 04W 03 BACCDA01	13-Jul-90	KIT TAP	90Q0231	60.38	31.81	322	3.53	<0.004	<0.002	8	536	0	17	480	2.63	0.6	
37N 04W 03 BACCDA01	13-Jul-90	RESERVOIR	90Q0233	54.5	31	322	3.72	0.03	0.016	7.7	536	0	20.5	462	2.6	0.5	
37N 04W 12 DBCDAB	16-Jul-95	WELL	96Q0101	34	15.9	1321	3.2	<.02	0.004	6.8	886.9		32.5	2270	1.5	0.8	<1
37N 04W 03 BACCDA01	23-Feb-85	WELL		75	39	371		0.02	0.008		578			625	1.7	0.3	
37N 04W 03 BACCDA01	2-Jun-88	WELL		86	45	426		<.01	<.005		610			706	1.9	0.3	
37N 04W 12 DBCDAB-2	16-Jul-97	WELL	98Q0049	14.98	9.9	1462	3.5	<.003	0.003	7.1	865	25.2	25.9	2457	<.05	0	<.05
37N 04W 15 BA	31-May-66	PETWELL		73	23	1052					2460	0	389	0			
37N 04W 15 BA 01		PETWELL	66Q0045	145	23	1669					3980		578	7			
37N 04W 15 BB 01		WELL	73Q0151	37	43	248	3.3	<.01	<.01	6.6	515	4	6.1	366	<.023	0.2	
37N 04W 15 BCCBBB01	17-Jul-95	WELL	96Q0093	61.3	42.7	226.6	3.2	0.147	0.048	8.5	560		8	350	<.05	0.2	<1
37N 04W 16 ACB	5-May-73	PETWELL		32	26	1740					2757	0	1004	283			
37N 04W 16 BCD 01		PETWELL	74Q5022	113	20	1709					3775		700				
37N 04W 16 BDDD	19-Jul-59	PETWELL		81	28	2805					3100	0	2749	tr			
37N 04W 16 BDDD	19-Jul-59	PETWELL		47	11	2664					2200	360	2519	tr			
37N 04W 17		PETWELL		48	17	2447					5368	0	653	179			
37N 04W 18 BBB	15-Sep-59	PETWELL		19	33	2283					3600	185	1339	tr			
37N 04W 19 AD 01		PETWELL	39Q0009	18		2429					4900		915	21			
37N 04W 27 CBDA 01	22-Oct-65	WELL	65Q0002	4	0			0.22			674	57	8	280	0.158	1.3	
37N 04W 27 CBDABB01	18-Jul-95	WELL	96Q0109	1.1	0.458	367.8	0.82	<.05	<.002	5.7	657.6	54	7	300	0.1	0.7	<1
37N 04W 28 C 01		WELL	73Q0152	14	19.2	600	2	<.01	<.01	4.5	936	19	87	477	<.023	3	

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Cl (mg/l)	SO4 (mg/l)	NO3 (mg/l)	F (mg/l)	PO4 (mg/l)
37N 04W 29 DBCCBB	8-Aug-95	WELL	96Q0241	568	129	74.8	5.7	0.096	0.006	23	344	0	160	1450	32.5	0.1	<.1
37N 04W 31 C	17-Apr-70	PETWELL		5330	170	1048					270	0	11340	63			
37N 05W 01 CD		PETWELL		52	19	1605					3170	0	779	tr			
37N 05W 02 02	12-Mar-59	PETWELL	59Q0028	40	9	1659					2250	295	982	24			
37N 05W 02 02	12-Mar-59	PETWELL	59Q0029	253	92	1475					2500		1522	20			
37N 05W 03 ACC 01		PETWELL	73Q5015	51	28	1846					3730		850				
37N 05W 03 CBA		PETWELL		50	60	2968					2200	0	3250	423			
37N 05W 03 CBA 01		PETWELL	73Q5014	60	27	1716					3625		696	36			
37N 05W 03 DB 01		PETWELL	74Q5023	53	12	1645					3350		710	10			
37N 05W 04 DDDDBD 01	11-Aug-95	SPRING	96Q0243	392.7	236.9	246.4	13.1	0.08	1.8	16	778.4		60	1500	55	<.1	<1
37N 05W 06		PETWELL		255	15	1257					2875	120	414	280			
37N 05W 06 CBDDCA01	14-Jul-95	WELL	96Q0096	2.4	0.681	285.4	0.68	<.02	<.002	6.2	570.9	27.6	5	150	<.05	2.2	<.1
37N 05W 06 DA 01		PETWELL	56Q0043	69	6	2065					3220	217	1111	115			
37N 05W 07 ADB 01	19-Oct-65	WELL	65Q0029	6	2	450		0			610	66	26	338	0.407	1.1	
37N 05W 09 CCCACA01	10-Aug-95	WELL	96Q0242	64.3	32.3	363.3	3.4	0.04	0.305	9.2	1014		10.5	450	0.2	0.1	<.1
37N 05W 10 AC 01		PETWELL	62Q0032	126	49	2328					5100		990				
37N 05W 10 AC 01		PETWELL	62Q0033	56	90	2342					3425	295	1485	202			
37N 05W 10 AD		PETWELL		41	65	1696					2150	0	1485	193			
37N 05W 10 DCDADA	3-Aug-95	WELL	96Q0177	25.9	18.4	307.2	2	0.037	<.002	3.8	696.6	37.2	20	200	0.1	0.7	<.1
37N 05W 10 DDD		PETWELL		67	32	1451					2640	0	894	28			
37N 05W 10 DDD 01		PETWELL	58Q0025	210	40	2192					3750		1007				
37N 05W 11 ABC		PETWELL		90	30	1664					2660	300	980	7			
37N 05W 11 BC 01		PETWELL	74Q5024	139	42	2266	114				5063		1020	4			
37N 05W 11 DC 01		PETWELL	39Q0010	97	15	2462					5150		1019				
37N 05W 12	8-Jul-63	PETWELL		36	23	1695					2625	0	1010	282			
37N 05W 12 ACADDA01	17-Jul-95	WELL	96Q0104	55.8	34	390	3.1	0.639	0.165	7.4	622.2	26.4	37	525	<.05	0.5	<.1
37N 05W 12 BB 01		PETWELL	58Q0026	119	19	1715					3725		726	25			
37N 05W 12 BB 01		PETWELL	58Q0028	105	9	1553					2730		1030				
37N 05W 12 BB 01		PETWELL	58Q0027	115	18	1738					3775		715	35			
37N 05W 12 BC	11-Dec-58	PETWELL		99	30	610					975	185	369	50			
37N 05W 14 CC	4-Oct-33	PETWELL		87	64	2357					5025		1048	10			
37N 05W 15 AAA 01		PETWELL	59Q0035	108	23	2258					4750		979				
37N 05W 15 AD 01		PETWELL	66Q0071	45	16	2406					5175		804	30			
37N 05W 15 ADA 01		PETWELL	61Q0035	81	13	1085					2510		395				
37N 05W 15 DAA 01	18-Oct-65	WELL	65Q0016	70	71			0			268	0	33	795	14.684	0.8	
37N 05W 19 DAC 01	19-Oct-65	WELL	65Q0028	156	89	925		18.4			1037		34	1780	0.361	1.2	
37N 05W 19 DADBDB01	3-Aug-95	WELL	96Q0180	73.5	27.9	761.5	4.1	0.291	0.146	7.2	971.1	55.2	15	1000	0.25	0.6	<.1
37N 05W 20 DCCCDC	13-Jun-96	WELL	96Q0786	434.8	281.9	889.6	8.8	0.016	0.318	11	603.2		154	2745	182	<1	
37N 05W 21 ABBACB	11-Jul-96	WELL	97Q0042	154	87.9	589	6	0.37	0.185	11	815		19.6	1280	3.5	<1	
37N 05W 22 CCACAC	16-Jul-95	RESEVOIR	96Q0092	87.1	33.5	66.6	13.4	0.026	0.049	15	187.4	17.3	20	300	0.05	0.1	<.1
37N 05W 23 BB	16-Apr-33	PETWELL		68	7	4537					450		6857	25			
37N 05W 23 BB 01	23-Mar-33	PETWELL	33Q0020			379					665	372	27	117			
37N 05W 23 CDD 01		PETWELL	56Q0044	92	41	2399					4950		1092	17			
37N 05W 23 CDD 01		PETWELL	56Q0045	119	66	2342					5000		1092	21			
37N 05W 23 CDD 01		PETWELL	56Q0071	162	17	2775					4750		1488	497			
37N 05W 23 CDD 01		PETWELL	56Q0072	117	16	2704					4500		1468	460			
37N 05W 23 DA 01		PETWELL	65Q0066	22	13	3455					4860	576	1851	66			
37N 05W 24 AA 01		PETWELL	40Q0009	32	32	2097					2950		1434	320			
37N 05W 24 BA 01		PETWELL	74Q5025	156	13	2317					4440		1300	7			
37N 05W 24 BB	19-May-41	PETWELL		158	76	2571					5250		1415				
37N 05W 24 BB 01		PETWELL	41Q0005	153	70	2407					5100		1224				
37N 05W 24 CB 01		PETWELL	39Q0011	147	65	2383					4250		1074	788			
37N 05W 24B	5-Jul-39	PETWELL		93	tr	828					913		15	1214			
37N 05W 25 01		PETWELL	61Q0036	56	12	2382					4050		1433	27			
37N 05W 25 BC 01		PETWELL	39Q0012	79	52	1960					2750		1716				
37N 05W 25 BC 01		PETWELL	39Q0013	42	55	2069					2675		1872				
37N 05W 26 CCBCAC01	3-Aug-95	WELL	96Q0181	2.1	1.5	309.3	1.1	<.003	<.002	5.7	553.9	22.4	7	100	<.05	0.8	<.1

Ground-water quality data - major elements

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	K (mg/l)	Fe (mg/l)	Mn (mg/l)	SiO2 (mg/l)	HCO3 (mg/l)	CO3 (mg/l)	Cl (mg/l)	SO4 (mg/l)	NO3 (mg/l)	F (mg/l)	PO4 (mg/l)
37N 05W 29 DD 01	19-Oct-65	WELL	65Q0027	90	78	725		13.6			1060	0	20	1165	0.113	0.8	
37N 05W 30 BAAABB	14-Aug-97	MON WELL	98Q0174	684.3	290.5	362.9	13	0.027	0.021	15	605.1	0	79	1147	71.8	0	<.05
37N 05W 30 BDDA	25-Feb-98	MON WELL	98Q0813	205.9	197	136.3	4.5	0.018	0.117	15	444.1		66.9	1062.4	4.03	1.8	<1
37N 05W 30 BDDA	25-Feb-98	MON WELL	98Q0812	312.1	177.5	157	11.3	0.102	<.001	12	390.4		68.3	1372.9	14.3	1.8	<1
37N 05W 30 CCAA	25-Feb-98	MON WELL	98Q0818	652.5	397	355.4	17.8	<.005	1.016	19	943.1		114.9	2491.5	129.7	3.8	<1
37N 05W 30 CCCC	25-Feb-98	MON WELL	98Q0814	383.8	260.4	328.8	12.4	<.005	0.072	15	535.6		29.7	2425.5	12.78	2.9	<1
37N 05W 30 CDACDD	14-Aug-97	MON WELL	98Q0175	690.9	283.5	269.8	11.8	0.008	0.578	17	518.5	0	49.9	668	<.05	0	<.05
37N 05W 35 AB		PETWELL		44	207	1893					2050	tr	2297	153			
37N 05W 35 BAB 01		PETWELL	54Q0032	179	39	3454					5490		2484	109			
37N 05W 35 BAB 01		PETWELL	54Q0033	179	39	3454					5490		2484	109			
37N 05W 35 BAB 01		PETWELL	54Q0034	140	9	3469					5270		2484	104			
37N 05W 35 CDABBB01	4-Aug-95	WELL	96Q0176	62.2	27.3	254.8	3.2	0.007	0.003	7.8	569.7		50	300	0.45	0.6	<.1
37N 05W 35 CDABBB01	1939	WELL	65Q0018	62	70			0			268	0	114	200	0.61	0.2	
37N 05W 35 DC		PETWELL		352	165	3298					4400	0	3503	174			
37N 05W 35 DC	12-Sep-59	PETWELL		114	48	3857					5500	0	2968	168			
37N 06W 01 ADDDDA01	14-Jul-95	WELL	96Q0102	1.4	0.334	257.9	0.62	<.02	<.002	6.1	509.9	29.6	5	125	<.05	0.8	<.1
37N 06W 02 CAC 01		PETWELL	62Q0034	37	16	3278					3460	229	2851				
37N 06W 03 DC 01		PETWELL	55Q0072	91	15	2356					4120		1956				
37N 06W 11 ABDABB01	8-Aug-95	WELL	96Q0244	68.1	41.2	65.2	5.5	<.003	<.002	9.2	416.8		18	100	5.5	0.1	<.1
37N 06W 11 BA		PETWELL		137	14	1713					3300	0	968	51			
37N 06W 11 BA		PETWELL		93	5	1552					3050	0	636	235			
37N 06W 11 BA		PETWELL		10	15	1283					1760	310	293	486			
37N 06W 11 BA 01		PETWELL	56Q0073	10	24	1275					1420	384	362	560			
37N 06W 11 BA 01		PETWELL	56Q0074	59	14	3137					4150		2494	103			
37N 06W 11 BA 01		PETWELL	56Q0075	59	6	3625					4500		3081	20			
37N 06W 11 BCADDC01	8-Aug-95	WELL	96Q0240	77.3	31.4	2079	54.6	<.2	0.023	13	3286		1500	<2.5	<.05		<1
37N 06W 23 AD	11-Nov-57	PETWELL		82	9	1562					2680	0	1022	tr			
37N 06W 24 ABAAAB01	29-Jun-95	WELL	96Q0009	2.7	0.48	358.9	1.2	0.06	0.011	7	772.7	10.4	8	150	<.05	3.3	<.1
37N 06W 24 CDADBC01	29-Jun-95	WELL	96Q0013	12.1	4.3	272.6	1.7	0.235	0.093	7.3	675.9		8.5	100	<.05	0.9	<.1
37N 06W 24 CDDADB01	29-Jun-95	WELL	96Q0018	11.2	3.6	394.1	1.9	0.138	0.03	6.6	865	16.8	9.5	200	<.05	0.8	<.1
37N 06W 25 01		PETWELL	61Q0037	28	10	2493					3680		1699	115			
37N 06W 29 DACBBC	15-Jul-95	SPRING	96Q0090	150	140	230	3	<.02	0.009	8.4	593		80	800	12.5	0.4	<.1
37N 06W 34 CCDADB	15-Jul-95	SPRING	96Q0095	100	80	330	3.1	0.007	<.002	9.6	559		46	660	32.5	0.3	<.1
37N 06W 36 DC 01		PETWELL	74Q5026	12	90	2001					1110	133	2350	313			

Ground-water quality data - trace elements

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Al (ug/l)	Sb (ug/l)	As (ug/l)	Ba (ug/l)	Be (ug/l)	B (ug/l)	Br (ug/l)	Cd (ug/l)	Cr (ug/l)	Co (ug/l)	Cu (ug/l)	Pb (ug/l)	Li (ug/l)	Mo (ug/l)	Ni (ug/l)	NO2 as N (mg/l)	P tot dis (mg/l)	Se (ug/l)	Ag (ug/l)	Sr (ug/l)	Ti (ug/l)	Va (ug/l)	Zn (ug/l)	Zr (ug/l)
35N 04W 01 ABDDBA01	12-Jul-96	WELL	97Q0038	133	<2	3.7	33	<2	218	123	<2	7.9	<2	11	<2	27	<10	21			123	<1	3887	<10	<5	539	<20
36N 04W 08 ADCC	25-Feb-98	MON WELL	98Q0815	<30	<2	19	11.5	<2	<80	<500	<2	32	<2	12	<2	<50	<10	<7	1.18	<.1	1026	<1	3381	<10	8.1	29.2	<5
36N 04W 08 BAAD	24-Feb-98	MON WELL	98Q0820	<30	<2	16	20.6	<2	337	<500	<2	38	<2	15	<2	<50	<10	<7	<.25	<.1	851	<1	7020	<10	9.9	6.5	<5
36N 04W 08 DDBB	24-Feb-98	MON WELL	98Q0819	<30	<2	1.3	18.3	<2	<80	<500	<2	27	<2	<2	<2	<50	<10	<7	<.25	<.1	26.7	<1	2344	<10	6.8	2.1	<5
36N 04W 11 BBADCD	2-Aug-95	WELL	96Q0179	<30	<2	<1	9.9	<2	422	<50	<2	<2	<2	7.9	<2	17	<10	3.4	<.05	<.2	6.5	<1	1837	<10	<5	26.4	<20
36N 04W 11 CAAACA01	2-Aug-95		96Q0178	<30	<2	<1	15.8	<2	319	<50	<2	<2	<2	5.7	3.9	25	<10	2.9	<.05	<.2	<1	<1	2575	<10	<5	14.7	<20
36N 04W 14 AACCCC	14-Jul-95	WELL	96Q0100	<30	<2	<1	24.8	<2	163	<50	<2	<2	<2	2.1	<2	14	<10	3.9	<.05	<.2	8.5	<1	1903	<10	<5	87.3	<20
36N 04W 17 ABAC	24-Feb-98	MON WELL	98Q0817	<30	<2	4.2	31.3	<2	<80	<500	<2	28	<2	5.6	<2	<50	<10	<7	<.25	<.1	245	<1	3483	<10	7.4	8.6	<5
36N 04W 22 ADCCCB01	2-Aug-95	WELL	96Q0175	<30	<2	<1	12.9	<2	406	<50	<2	<2	<2	6.3	<2	7	<10	2.1	<.05	<.2	6.8	<1	1614	<10	<5	54.9	<20
36N 04W 30 BBBDB 01	30-Jun-95	WELL	96Q0008	<30	<2	<1	18.3	<2	431	50	<2	2.6	<2	4.5	<2	25	<10	<2	<.05	<.2	<1	<1	1104	<10	<5	15.1	<20
36N 04W 35 ADAADA	12-Jul-95	WELL	97Q0037	76.9	<2	<1	80	<2	445	<100	<2	14	<2	61	2.2	27	<10	2.3			<1	<1	380	<10	<5	195	<20
36N 05W 01 DCCCDB	13-Jul-95	WELL	96Q0108	<30	<2	1.6	14.2	<2	631	350	<2	<2	<2	5	<2	27	<10	<2	<.05	<.2	2.9	<1	139	<10	<5	<2	<20
36N 05W 04 ABABDD01	1-Jul-95	WELL	96Q0014	<30	<2	2.2	5.4	<2	838	500	<2	<2	<2	13	<2	54	<10	3.7	<.05	<.2	71.2	<1	3608	<10	<5	97.2	<20
36N 05W 05 ACBDBB01	13-Jul-95	WELL	96Q0103	<30	<2	1	6	<2	737	<50	<2	<2	<2	9.7	<2	41	<10	7.7	<.05	<.2	2.4	<1	2524	<10	<5	17	<20
36N 05W 09 BC 01	2-Dec-76	WELL	76Q1455	80	<200	<2			980			<10		<10	20	40		30			<2		4000			700	
36N 05W 14 ACDDDD	4-Aug-95	WELL	96Q0182	<30	<2	<1	16.3	<2	322	200	<2	<2	<2	3.2	<2	27	<10	<2	<.05	<.2	<1	<1	1007	<10	<5	8.8	<20
36N 05W 14 DBBBCB01	17-Jul-95	WELL	96Q0106	<30	<2	<1	15.9	<2	490	<50	<2	<2	<2	3.8	<2	21	<10	<2	<.05	<2	2.5	<1	86	<10	<5	3.6	<20
36N 05W 18 DAABAA01	12-Jun-95	WELL	96Q0091	<30	<2	<1	19.5		543	50	<2	<2	<2	9.8	2.8	32	<10	5.1	<.05	<.2	6.3	<1	6464	<10	<5	90.9	<20
36N 05W 23 AABDB 01	30-Jun-95	WELL	96Q0017	<30	<2	1.2	13.3	<2	548	350	<2	<2	<2	5.8	<2	43	<10	<2	<.05	<.2	2.7	<1	1099	<10	<5	6.1	<20
36N 05W 23 ACCBDA	30-Jun-95	WELL	96Q0005	85.9	<2	1.4	6.5	<2	842	100	<2	5.4	<2	14	<2	36	<10	<2	<.05	<.2	<1	<1	2040	<10	<5	16.1	<20
36N 05W 24 DBCDAA	30-Jun-95	WELL	96Q0010	<30	<2	<1	9.4	<2	518	50	<2	4.6	<2	4.6	<2	21	<10	<2	<.05	<.2	<1	<1	1830	<10	<5	4.3	<20
36N 05W 29 ACBBAC	17-Aug-97	SPRING	98Q0173	<30	<2	8.4	23.9	<2	471	<25	<2	11	<2	5.1	<2	38	<10	45	<.05	<.2	294	<1	7022	<10	<5	5.9	<20
36N 05W 29 ACBBAC	28-Apr-82	SPRING	82Q0195	30					320		<2	3		38	<40	20	<20	10				<2	5950	36	10	21	<3
36N 05W 32 ADADCB01	1-Jul-95	WELL	96Q0019	<30	<2	<1	360.9	<2	<30	<50	<2	<2	<2	35	<2	12	<10	<2	<.05	<.2	1.2	<1	204	<10	<5	75.5	<20
36N 05W 32 BCDACC	24-Aug-95	WELL	96Q0286	<30	<2	2.2	8.4	<2	769	250	<2	7.5	<2	20	2.9	39	<10	3.3	<.25	<.2	14.2	<1	3550	<10	<5	260	<20
36N 05W 33 CBBBDB01	1-Jul-95	WELL	96Q0006	<30	<2	<1	7.5	<2	235	<50	<2	3.1	<2	2.9	<2	61	<10	6.4	<.05	<.2	<1	<1	9556	<10	<5	385	<20
36N 05W 33 CBBC 01	2-Dec-76	WELL	76Q1454	70	<200	<2			270			<10		<10	80	60		30			<2		6800			170	
36N 05W 33 CBBCAA01	1-Jul-95	WELL	96Q0007	<30	<2	10	8.8	<2	555	100	<2	<2	<2	3.6	<2	31	<10	<2	<.05	<.2	<1	<1	609	<10	<5	4.3	<20
36N 05W 35 ACDDCC01	30-Jun-95	WELL	96Q0011	<30	<2	2	9	<2	674	50	<2	2.7	<2	6.1	<2	34	<10	<2	<.05	<.2	<1	<1	496	<10	<5	6.5	<20
36N 06W 01 ABADCA01	12-Jul-95	WELL	96Q0097	<30	<2	1	15.1	<2	425	<250	<2	<2	<2	13	<2	38	<10	13	<.05	<.2	39.2	<1	4453	<10	<5	63.1	<20
36N 06W 12 BCABDA01	12-Jul-95	WELL	96Q0094	<30	<2	8.2	22.4	<2	419	<2000	<2	2.1	<2	13	<2	32	<10	28	<.25	<.2	505	<1	13000	<10	<5	16	<20
36N 06W 12 BCACAC01	3-Jul-95	WELL	96Q0016	<30	<2	3.6	13.8	<2	574	<250	<2	7.7	<2	18	<2	29	<10	16	<.05	<.2	213	<1	11	<10	<5	164	<20
36N 06W 25 DDADCA	25-Aug-95	WELL	96Q0285	<30	<2	1.3	14.3	<2	675	100	<2	3.7	<2	38	<2	38	<10	5.4	<.25	<.2	78.2	<1	4149	<10	<5	131	<20
37N 03W 19 BCBADB	13-Jul-95	WELL	96Q0098	<30	<2	2	9	<2	1042	150	<2	<2	<2	29	<2	125	<10	3			18	<1	2072	<10	<5	65	<20
37N 04W 02 DDDBCC	30-Jun-95	WELL	96Q0012	<30	<2	<1	4.7	<2	756	<50	<2	4.6	<2	10	<2	113	<10	<1	<.05	<.2	12.3	<1	3687	<10	<5	28.8	<20
37N 04W 02 DDDBCC	2-Dec-76	WELL	76Q1456	70		<2			1000			<10		<10	<50	120		20			6.5		3			540	
37N 04W 03 BACCDA 01	8-Dec-81	WELL				<1	<100				<1	<5			<5						17	<10					
37N 04W 03 BACCDA01	15-Jul-95	WELL	96Q0107	<30	<2	<1	10.2	<2	330	<50	<2	<2	<2	4.8	<2	23	<10	2.1	<.05	<.2	1.9	<1	1148	<10	<5	2.6	<20
37N 04W 03 BACCDA01	13-Jul-90	WELL	90Q0232	<40			15		280	<100	<1	<5		<4	<5	27	<40	<20				<4	1120	4	<4	48	<6
37N 04W 03 BCDDBB17D	11-Jul-96	WELL	97Q0040	<30	<2	1.2	30.8	<2	316	263	<2	9.2	2.6	6.2	<2	23	<10	15			2.2	<1	1036	<10	<5	4.4	<20
37N 04W 03 BCDDBB17D	11-Jul-96	WELL	97Q0041	<30	2.1	1.5	31.2	<2	327	293	<2	13	2.5	5.8	<2	25	<10	16			3.8	<1	1070	<10	<5	4.9	<20
37N 04W 03 BCDDBB17S	11-Jul-96	WELL	97Q0039	33	<2	11	67.5	<2	292	359	<2	9.9	4.9	7.1	<2	32	<10	25			4.4	<1	1064	<10	<5	7.1	<20
37N 04W 03 BDC 01	13-Jul-90	STREAM	90Q0230	<40			595		1700	4400	<5	<5		<4		2560	<40	<20				<4	929	<4	<4	125	<6
37N 04W 03 CDCABC01	17-Jul-95	WELL	96Q0105	<30	<2	<1	41.7	<2	169	50	<2	<2	<2	3.6	<2	21	<10	3.2	<.05	<.2	6	<1	1096	<10	<5	20.7	<20
37N 04W 04 ABD	7-Sep-95	STREAM	96Q5001	<30		2	62		280		<2	3	<2	3	<2	42	<10	5			3	<1	1600		<5	<8	
37N 04W 04 ABD	26-Jul-95	STREAM	96Q5000	<30		6	100		310		<2	2	<2	4	<2	42	<10	7			3	<1	1000		<5	2	
37N 04W 04 ABDCDC		RIVER		<30		6	100		310	150	<2	2	<2	4	<2	42	<10	7	<.05	<.2	3	<1	1000		<5	2	
37N 04W 04 ABDCDC		RIVER		<30		2	62		280	200	<2	3	<2	3	<2	42	<10	5	<.05	<.2	3	<1	1600		<5	<8	
37N 04W 04 ABDCDC	16-Jul-97	RIVER	98Q0048	<30	<2	3.2	23.1	<2	187	255	<2	<2	<2	4.8	<2	52	<10	10	<.05	<.2	4	<1	1071	<10	<5	<2	<20
37N 04W 05 BDBDDC	24-Aug-95	WELL	96Q0284	<30	<2	<1	97.3	<2	121	150	<2	<2	<2	2.6	<2	22	<10	4.6	<.05	<.2	1.4	<1	688	<10	<5	130	<20
37N 04W 11 AB		PETWELL	97Q0165	<30	<2	868	629.6	<2	1877	<250	<2	67	<2	39	<2	3017	<10	4.2	<.05		42.2	<1	455	<10	20	5.9	21
37N 04W 03 BACCDA01	13-Jul-90	KIT TAP	90Q0231	<40			13		355	100	<5	<5		<4.		23	<40	<20				<4	1190	5	<4	63	<6
37N 04W 03 BACCDA01	13-Jul-90	RESERVOIR	90Q0233	<40			41		328	100	<5	<5		8		31	<40	<20				<4	1180	5	<4	76	<6
37N 04W 12 DBCDAB	16-Jul-95	WELL	96Q0101	74.9	<10	1	5.8	<10	1114	250	<10	<10	<10	25	<10	144	<50	2.6	<.05	<.2	6.9	<5	2307	<10	<25	21.5	<20
37N 04W 03 BACCDA01	23-Feb-85	WELL				<1	0				<1	<5			<5						<2	<10					
37N 04W 03 BACCDA01	2-Jun-88	WELL				<1	0				<1	<5			<5						0	<10					
37N 04W 12 DBCDAB-2	16-Jul-97	WELL	98Q0049	<30	<2	1.4	4.8	<2	1261	394	<2	16	<2	16	<2	218	<10	<2	<.05	<.2	4.7	<1	2488	<10	<5	2.4	<20
37N 04W 15 BCCBBB01	17-Jul-95	WELL	96Q0093	<30	<2	<1	8.4		395	<50	<2	<2	<2	2.9	<2	23	<10	<2	<.05	<.2	<1	<1	1809	<10	<5	13.9	<20
37N 04W 27 CBDABB01	18-Jul-95	WELL	96Q0109	<30	<2	<1	12.4	<2	679	50	<2	<2	<2	6.4	<2	38	<10	<2	0.1	<.2	<1	<1	116	<10	<5	2.8	<20
37N 04W 29 DBCCBB	8-Aug-95	WELL	96Q0241	<80	<2	4.7	74.2	0	<80	N/A	10	<2	<2	3.2	<2	40	<10	16	<.05	<.2	192	<1	1279	<10	<5	2134	<20
37N 05W 04 DDDDBD 01	11-Aug-95	SPRING	96Q0243	<80	<2	4.8	124.2		316	<200	<2	<2	<2	3.5	<2	33	<10	13	0.05	<.2	70.1	<1	4076	<10	<5	10.6	<20
37N 05W 06 CBDDCA01	14-Jul-95	WELL	96Q0096	<30	<2	<1	11.8	<2	395	<50	<2	<2	<2	3.7	<2	27	<10	<2	<.05	<.2	<1	<1	90	<10	<5	4.4	<20
37N 05W 09 CCCACA01	10-Aug-95	WELL	96Q0242	<80	<2	<1	8.7		621	100	<2	<2	<2	5.7	2.4	19	<10	<2	<.05	<.2	1.8	<1	1678	<10	<5	116	<20
37N 05W 10 DCDADA	3-Aug-95	WELL	96Q0177	<30	<2	1.6	4.7	<2	483	900	<2	<2	<2	5.2	<2	10	<10	<2	<.05	<.2	7.7	<1	822	<10	<5	10.1	<20
37N 05W 12 ACADDA01	17-Jul-95	WELL	96Q0104	<30	<2	2.2	12.9	<2	564	800	<2	<2	<2	5	<2	15	<10	<2	<.05	<.2	5.1	<.1	1087	<10	<5	5.5	<20
37N 05W 15 AD 01		PETWELL	66Q0071										<2														

LOCATION	SAMPLE DATE	SAMPLE SOURCE	MBMG QW #	Al (ug/l)	Sb (ug/l)	As (ug/l)	Ba (ug/l)	Be (ug/l)	B (ug/l)	Br (ug/l)	Cd (ug/l)	Cr (ug/l)	Co (ug/l)	Cu (ug/l)	Pb (ug/l)	Li (ug/l)	Mo (ug/l)	Ni (ug/l)	NO2 as N (mg/l)	P tot dis (mg/l)	Se (ug/l)	Ag (ug/l)	Sr (ug/l)	Ti (ug/l)	Va (ug/l)	Zn (ug/l)	Zr (ug/l)
37N 05W 16 AAACCD	31-Jul-96	SPRING	97Q0166	<30	<2	8.8	12.4	<2	739	<250	<2	25	2	15	<2	59	<10	38	<.05		170	<1	13000	<10	7.4	8.8	<20
37N 05W 19 DADBDB01	3-Aug-95	WELL	96Q0180	<30	<2	2.7	5.7	<2	733	150	<2	<2	<2	10	3.3	80	<10	2.7	<.05	<.2	1.5	<1	2369	<10	<5	152	<20
37N 05W 20 DCCCDC	13-Jun-96	WELL	96Q0786	<30	<2	12	13	<2	861	<250	<2	<2	<2	31	2.1	92	<10	20	<.05		534	<1	14000	<10	<5	193	<20
37N 05W 21 ABBACB	11-Jul-96	WELL	97Q0042	<30	<2	<1	12.9	<2	702	134	<2	16	<2	11	2.5	49	<10	17			5.4	<1	6520	<10	<5	11.5	<20
37N 05W 21 ABBDBA	29-Jun-95	WELL	96Q0015	<30	<2	1.8	24.6	<2	225	250	<2	3.8	<2	7.2	<2	86	<10	9.7	<.05	<.2	129	<1	4366	<10	<5	190	<20
37N 05W 22 CCACAC	16-Jul-95	RESEVOIR	96Q0092	<30	<2	6.9	150.9		80	<50	<2	<2	<2	2.5	<2	10	<10	5.1	<.05	0.3	2.3	<1	397	<10	<5	<2	<20
37N 05W 26 CCBCAC01	3-Aug-95	WELL	96Q0181	<30	<2	2.6	9.6	<2	522	100	<2	<2	<2	9	<2	19	<10	<2	<.05	<.2	<1	<1	199	<10	<5	14.7	<20
37N 05W 30 BAAABB	14-Aug-97	MON WELL	98Q0174	<30	<2	5.6	32.1	<2	128	<25	<2	13	<2	8.7	<2	380	<10	61	<.05	<.2	203	<1	4957	<10	<5	12.7	<20
37N 05W 30 BDDA	25-Feb-98	MON WELL	98Q0813	<30	<2	1.4	29.6	<2	<80	<500	<2	25	<2	3.6	<2	<50	<10	<7	<.25	<.1	3.7	<1	2268	<10	6.7	13.2	<5
37N 05W 30 BDDA	25-Feb-98	MON WELL	98Q0812	<30	<2	1.9	69.2	<2	<80	<500	<2	22	<2	8	<2	<50	11	<7	<.25	<.1	22.4	<1	3377	<10	5.8	22.1	<5
37N 05W 30 CCAA	25-Feb-98	MON WELL	98Q0818	<30	<2	6.5	37.1	<2	<80	<500	<2	68	2.1	7.8	<2	<50	<10	9.3	<.25	<.1	276	<1	8040	<10	18	48.1	<5
37N 05W 30 CCCC	25-Feb-98	MON WELL	98Q0814	<30	<2	3.7	26.59	<2	<80	<500	<2	<10	<2	15	<2	<50	<10	<7	<.25	<.1	209	<1	3606	<10	8.9	20.3	<5
37N 05W 30 CDACDD	14-Aug-97	MON WELL	98Q0175	<30	<2	7.4	148.2	<2	141	234	3.2	10	2.1	6.9	<2	403	<10	63	<.05	<.2	252	<1	4457	<10	<5	10.9	<20
37N 05W 35 CDABBB01	4-Aug-95	WELL	96Q0176	<30	<2	<1	12.1	<2	439	250	<2	3	<2	4.8	<2	50	<10	3.1	<.05	<.2	3.4	<1	627	<10	<5	18.6	<20
37N 06W 01 ADDDDA01	14-Jul-95	WELL	96Q0102	<30	<2	<1	12.4	<2	268	<50	<2	<2	<2	3.5	<2	32	<10	<2	<.05	<.2	<1	<1	56	<10	<5	<2	<20
37N 06W 11 ABDABB01	8-Aug-95	WELL	96Q0244	<80	<2	<1	60.2		<80	50	<2	<2	<2	4.8	<2	33	<10	2.7	<.05	<.2	6	<1	1347	<10	<10	170	<20
37N 06W 11 BCADDC01	8-Aug-95	WELL	96Q0240	<100	<10	37	10000	<2	2460		<10	<10	<2	49	<40	2685	<10	2.4	<.25	<.5	46.9	<5	25000	<20	<5		<20
37N 06W 24 ABAAAB01	29-Jun-95	WELL	96Q0009	<30	<2	<1	57	<2	514	100	<2	4.9	<2	4.4	<2	36	<10	<2	<.05	<.2	4.6	<1	110	<10	<5	285	<20
37N 06W 24 CDADBC01	29-Jun-95	WELL	96Q0013	<30	<2	<1	25.5	<2	420	100	<2	<2	<2	4.7	<2	30	<10	<2	<.05	<2	<1	<1	260	<10	<5	7.2	<20
37N 06W 24 CDDADB01	29-Jun-95	WELL	96Q0018	<30	<2	1.3	12.3	<2	472	100	<2	2.6	<2	4.9	<2	41	<10	<2	<.05	<.2	1.4	<1	359	<10	<5	19.4	<20
37N 06W 29 DACBBC	15-Jul-95	SPRING	96Q0090	<30	<2	3.1	36.4		157	650	<2	<.2	<2	8.7	<2	58	<10	7	<.05	<.2	24.4	<1	3039	<10	<5	8.3	<20
37N 06W 34 CCDADB	15-Jul-95	SPRING	96Q0095	<30	<2	3.1	23.2	<2	166		<2	<2	<2	11	<2	26	<10	3.7	<.05	<.2	34.6	<1	1752	<10	<5	13.8	<20

APPENDIX E

WATER QUALITY EXPLANATION AND MAXIMUM CONTAMINANT LEVELS

APPENDIX F

INJECTION WELL REVIEW

RED RIVER WATERSHED

GLACIER AND TOOLE COUNTIES, MONTANA

APPENDIX G

MSCA DRILL LOGS

APPENDIX H

PLATES