AN EVALUATION OF HYDROTHERMAL RESOURCES OF NORTH DAKOTA

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INTRODUCTION

This is the Phase I final technical report of our activities under cooperative agreement DOE-FC07-79ID12030 which was executed March 7, 1979. In the following report I will restate our goal, detail our methods of reaching this goal, and present the results and interpretations of our Phase I study.

GOAL

The object of this study is to evaluate the hydrothermal resources of North Dakota. This evaluation is based on an analysis of existing data on file with the North Dakota Geological Survey (N.D.G.S.) and other state and federal agencies. The principle source of data used during phase I was the oil and gas well files maintained by the N.D.G.S. These files contain the information necessary to conduct an initial evaluation of the hydrothermal resources of the state. Stratigraphic data, bottomhole-temperature data, and chemical data are presented in map form to show the geothermal gradient, temperature, and depth of potential hydrothermal aquifers and the chemical characteristics of potential hydrothermal aquifers.

TASKS

In order to meet our goal, two major tasks were accomplished. First, we created a computer library containing all the necessary oil and gas well data in the North Dakota Geological Survey oil and gas well files. Secondly, we displayed the data in map form and evaluated the results. A detailed discussion of our methods of accomplishing these tasks follows:

Task 1

Task 1 required the coding of all of the necessary data from the North Dakota Geological Survey oil and gas well files and the organization of this data in a computer library program. Figure 1 shows the stepwise procedure that was followed to accomplish this task. The following discussion is keyed to blocks in Figure 1, which are identified by letter.

FIGURE 1 - Stepwise Procedure to Accomplish
Task 1, Build Computer Data Bank

The data necessary to accomplish our goal were identified. Additional data that might be useful for future work or data useful to our oil and gas division were also identified. The sources of the various pieces of data were located and organized to expedite the coding procedure (Figure 1, Block A). Figure 2 shows the data that were coded and the sources of those data. These data were contained in several separate files and in a pre-existing computer well file system developed by Sid Anderson, North Dakota Geological Survey, in 1976.

A coding guide was written to establish and standardize the abbreviations, codes, and procedures necessary to record the data in a compact format (Figure 1, Block B) (Appendix A). Coding forms were designed to expedite the coding procedure and provide a compact reference to the coded data (Appendix A).

Some of the data from wells with sequential N.D.G.S. well numbers less than 5000 had been incorporated in an earlier computer well file system (Figure 2). Consequently, we needed to code only a portion of the total well data for these wells (Figure 1, Block D). These data could then be keypunched, merged with the pre-existing digitized data, and read into our computer library system (Figure 1, Blocks E, F, and I). Wells with sequential N.D.G.S. well numbers greater than 5000 required coding and keypunching for the entire data set (Figure 2) before the data could be read into the computer library system (Figure 1, Blocks G, H, and I).

The data management system we are using is a location oriented computer library system named GEOSTOR. GEOSTOR was developed by Laramie Winczewski, a University of North Dakota geologist, with funds provided by the Surface Environment and Mining research group of the U.S. Forest Service. The data, from each oil and gas well drilled in North Dakota, contained in GEOSTOR consists of owner-operator, location, reference elevation, deepest formation

ITEM *

NDGS WELL NUMBER

	0	2000	4000	6000
NDGS Well No.	X	X		O O O
Permit No.				
API No.		X	X	O O
County	X	X		O O
T.R.S.Q.				
Well Name		X	X	O O
Operator	X	X		O O
Elevation				
Total Depth		X	X	O O
Well Status	X	X		O O
Field				
Completion Date		X	X	O O
I.P.	X	X		O O O
Date Plugged				
Samples		X	X	S S S
Cores	X	X		S S
Logs Run				
FM (Producing)		X	X	L L L
FM (Deepest)	X	X		L
BHT	L	L		L L
Log Tops	T	T	L	L
Perf. Intv.	W	W	W	W
L.O.G.S.F.L.		W	W	P P
Chemical Data	D	D	D D	D D

* See Coding Guide for explanation of abbreviations.

SOURCES

Preexisting Digitized Well Data (NDGS, Open File)-----	X
Circular Five (NDGS, Open File)-----	O
Sample and Core Files (NDGS, Open File)-----	S
Log File (NDGS, Open File)-----	L
Permit Book (NDGS, Open File)-----	P
Well File (NDGS, Legal File)-----	W
Tops File (NDGS, Open File)-----	T
Drill Stem Test File (NDGS, Open File)-----	D

FIGURE 2 - Coded Information and Sources
of That Coded Information

penetrated, total depth, bottom-hole temperature, production information, available samples and cores, available geophysical data, and selected formation tops (Appendix B).

Task 2

Task 2 involved the display and interpretation of the well data compiled during Task 1 and stored in GEOSTOR (Figure 3, Block A). A listing of a few selected wells is included in Appendix C to show the types of data stored in and the output format of the GEOSTOR computer library system.

Displaying the GEOSTOR data required a digitized base map of North Dakota (Figure 3, Block B). We chose a 1:500,000 scale county and township base map for this purpose. Most of our map displays will be physically smaller than the 1:500,000 scale base map (30" x 42") which should enhance the accuracy of our data displays.

The data are contoured on the base map by a SURFACE II, contouring program (Figure 3, Block C). The SURFACE II program, developed by the Kansas Geological Survey, was purchased by the North Dakota Geological Survey.

Required programs were written to interrogate GEOSTOR for the data required to generate the various map presentations (Figure 3, Block D).

Our first priority was to interrogate GEOSTOR (Figure 3, Block D), and verify the data sets required to evaluate the hydrothermal resources of the state. The three principle data sets used are the stratigraphic (Figure 3, Block E), temperature and depth (Figure 3, Block I), and chemical data sets (Figure 3, Block M).

The information contained in each data set was listed, inspected for erroneous values and then test maps were produced and inspected for anomalous areas. The process of locating the erroneous data that produced the anomalous map displays also tested our base map location coordinate

FIGURE 3 - Stepwise procedure to accomplish Task 2, interpret and display data.

system. We are satisfied that the information contained in GEOSTOR is as accurate as the data coded, and that the base map coordinate system and surface II contouring program accurately depict the data in storage.

The map presentation of the stratigraphic (Figure 3, Block E), temperature and depth (Figure 3, Block I), and chemical data sets (Figure 3, Block M) will be discussed individually and then combined to summarize the major aquifer system evaluated. The sources of the data used will be restated in each discussion for the convenience of the reader in interpreting the maps.

The Stratigraphic Data Set (Figure 3, Block E)

Our stratigraphic data set consists of geophysical log tops of selected formations (Figure 4). These tops were incorporated into GEOSTOR from one of two sources. For some wells with N.D.G.S. well numbers less than about 4200 the formation tops had been previously picked and existed in a stratigraphic card file. For wells with N.D.G.S. well numbers greater than about 4200 the formation tops were picked from geophysical logs contained in the N.D.G.S. log files. The tops were "picked" by the principal investigator with stratigraphic counsel from S.B. Anderson (Chief of the Subsurface Section, N.D.G.S.).

Most of the significant formation tops were "picked" on the logs in the N.D.G.S. log file, but only the selected formation tops are incorporated in the current version of GEOSTOR.

The structure maps were constructed by averaging the elevation in feet (sea level datum) of all formation tops within a single township. The township averages for that formation are then contoured to produce a structural map of that formation. All depths displayed on our structure maps are in feet so that they may be easily interpreted by potential users.

SEQUENCE	SYSTEM	GROUP OR FORMATION		DOMINANT LITHOLOGY	
TEJAS	TERTIARY	GLACIAL DEPOSITS		Glacial Drift	
		WHITE RIVER		Clay, Sand and Limestone	
		GOLDEN VALLEY		Clay, Sand and Silt	
		FORT UNION GROUP	TONGUE RIVER	Shale, Sandstone and Lignite	
			CANNONHALL	Marine Sandstone and Shale	
ZUNI	CRETACEOUS	LUDLOW	LUDLOW	Sandstone, Shale and Lignite	
		COLORADO GROUP	HELL CREEK	Sandstone, Shale and Lignite	
			MONTANA LUX HILLS	Marine Sandstone	KP
			PIERRE	Shale	
			FOBIARA	Shale, Calcareous	
			CARLILE	Shale	
			GREENHORN	Shale, Calcareous	
			ELLE FOURCHE	Shale	
		DAKOTA GROUP	MOWRY	Shale	KM
			NEWCASTLE	Sandstone	
			SKULL CREEK	Shale	
			FALL RIVER	Sandstone and Shale	
			LAKOTA	Sandstone and Shale	
	JURASSIC	MORRISON		Shale, Clay	J
		SUNDANCE		Shale, green and brown and Sandstone	
		PIPER		Limestone, Anhydrite, Salt and red Shale	
ABSAROKA	TRIASSIC	SPEARFISH		Siltstone, Salt and Sandstone	TRS
	PERMIAN	MINNEKAHTA		Limestone	PM
		OPECHIE		Shale, Siltstone and Salt	
	PENNSYLVANIAN	MINNELUSA		Sandstone and Dolomite	PNM
		AMSTEIN		Interbedded Dolomite Limestone, Shale and Sandstone	
KASKASKIA	MISSISSIPPIAN	BIG SNOWY GROUP	HEATH	Shale	
			OTTER	Sandstone and Limestone	MKLS
			KIBBLEY	Limestone	MM
		MADISON		Interbedded Limestone and Evaporites	
				Limestone	
	DEVONIAN	BAKKEN		Siltstone and Shale	MB
		THREE FORKS		Shale, Siltstone and Dolomite	
		BIRD BEAR		Limestone	DD
		DUPEROY		Interbedded Dolomite and Limestone	
		SOURIS RIVER		Interbedded Dolomite and Limestone	
		DAWSON BAY		Dolomite and Limestone	
		PRAIRIE		Halite	
		WINNIPEGOSIS		Limestone and Dolomite	
TIPPECANOE	SILURIAN	INTERLAKE		Dolomite	SI
	ORDOVICIAN	STONEWALL		Dolomite and Limestone	
		STONY MOUNTAIN FM.	GUNION MEMBER	Limestone and Dolomite	
			STOUGHTON MEMBER	Crinaceous Limestone	ORR
		RED RIVER		Limestone and Dolomite	
		WINNIPEG GROUP	POUGHLOCK	Calcareous Shale & Siltstone	
			ICLBOX	Shale	
			BLACK ISLAND	Sandstone	
SAUK	CAMBRIAN	DEADWOOD		Limestone, Shale and Sandstone	CD
					PC

FIGURE 4 - Stratigraphic Column of North Dakota and Formation Tops Entered in GEOSTOR (after: Carlson, C.G., and Anderson, S.B., 1966)

Figures 5 through 32 show the structural maps and a posting of control points for the Cretaceous Pierre Formation (KP), Cretaceous Mowry Formation (KM), Jurassic Unconformity (J), Triassic Spearfish Formation (TRS), Permian Minnekahta Formation (PM), Pennsylvanian Minnelusa Formation (PNM), Mississippian Kibbey Limestone (MKLS), Mississippian Madison Formation (MM), base of the Mississippian Madison Formation (MB), Devonian Duperow Formation (DD), Silurian Interlake Formation (SI), Ordovician Red River Formation (ORR), Cambrian Deadwood Formation (CD), and the Precambrian (PC).

The approximate extent of those rock units truncated by erosional unconformities is indicated on these maps by a dashed line (Carlson, C.G., and Anderson, S.B., 1966).

Temperature-Depth Data Set (Figure 3, Block I)

The temperature and depth data set consists of the recorded bottom-hole temperature and the total depth drilled from about 4800 wells. Not all of the approximately 7000 wells drilled for oil and gas recorded both bottom-hole temperature and total depth. These data are presented as a geothermal gradient map of the state and as "slice" maps of the state.

Geothermal Gradient Map

The geothermal gradient was calculated assuming a 40°F mean annual air temperature (Figure 33, Jensen, Ray E., 1972) and the following relationships:

$$\begin{aligned} \text{GRAD } (^{\circ}\text{C/Km}) &= \frac{(\text{BHT } (^{\circ}\text{F}) - 40^{\circ}\text{F})}{\text{Total Depth (Feet)}} \left(\frac{5^{\circ}\text{C}}{9^{\circ}\text{F}} \right) \left(\frac{3280.84 \text{ Feet}}{\text{Km}} \right) \\ &= \frac{(\text{BHT } (^{\circ}\text{F}) - 40^{\circ}\text{F})}{\text{Total Depth (Feet)}} (1822.69) \end{aligned}$$

The average of all the individual geothermal gradients calculated is 30.7°C/Km (.01684°F/Ft). Only those values falling within 2 standard deviations of the mean ($\pm 14.3^{\circ}\text{C/Km}$) (.00784°F/Ft) were utilized in constructing

FIGURE 5 - Structure Map on the top of the Cretaceous
Pierre Formation (KP); CI = 500 Feet

FIGURE 6 - Posting of Control Points for Cretaceous
Pierre Formation Structure Map

FIGURE 7 - Structure Map on the top of the Cretaceous
Mowry Formation (KM); CI = 500 Feet

FIGURE 8 - Posting of Control Points for Cretaceous
Mowry Formation Structure Map

FIGURE 9 - Structure Map on the top of the
Jurassic System (J); CI = 500 Feet

FIGURE 10 - Posting of Control Points for
Jurassic System Structure Map

FIGURE 11 - Structure Map on the top of the
Triassic System (TRS); CI = 500 Feet

FIGURE 12 - Posting of Control Points for
Triassic System Structure Map

FIGURE 13 - Structure Map on the top of the Permian
Minnekahta Formation (PM); CI = 500 Feet

FIGURE 14 - Posting of Control Points for Permian Minnekahta Formation Structure Map

FIGURE 15 - Structure Map on the top of the Pennsylvanian Minnelusa Formation (PNM); CI = 500 Feet

FIGURE 16 - Posting of Control Points for Pennsylvanian
Minnelusa Formation Structure Map

FIGURE 17 - Structure Map on the top of the Mississippian Kibbey Limestone (MKLS); CI = 500 Feet

FIGURE 18 - Posting of Control Points for Mississippian
Kibbey Limestone Structure Map

FIGURE 19 - Structure Map on the top of the Mississippian
Madison Formation (MM); CI = 500 Feet

FIGURE 20 - Posting of Control Points for
Mississippian Madison Structure Map

FIGURE 21 - Structure Map on the Base of Mississippian
Madison Formation (MB); CI = 500 Feet

FIGURE 22 - Posting of Control Points for Base of
Mississippian Madison Formation Structure Map

FIGURE 23 - Structure Map on the top of the Devonian Duperow Formation (DD); CI = 500 Feet

FIGURE 24 - Posting of Control Points for
Devonian Duperow Structure Map

FIGURE 25 - Structure Map on the top of the Silurian Interlake Formation (SI); CI = 500 Feet

FIGURE 26 - Posting of Control Points for Silurian Interlake Formation Structure Map

FIGURE 27 - Structure Map on the top of the Ordovician Red River Formation (ORR); CI = 500 Feet

FIGURE 28 - Posting of Control Points for Ordovician
Red River Formation Structure Map

FIGURE 29 - Structure Map on the top of the Cambrian
Deadwood Formation (CD); CI = 500 Feet

FIGURE 30 - Posting of Control Points for Cambrian
Deadwood Formation Structure Map

FIGURE 31 - Structure Map on the top of the
Precambrian (PC); CI = 500 Feet

FIGURE 32 - Posting of Control Points for
Precambrian Structure Map

FIGURE 33 - Annual Mean Temperatures ($^{\circ}\text{F}$) of
North Dakota (from: Jensen, Ray E., 1972)

the geothermal gradient map. Gradients calculated in any one township were averaged and the township-averages were contoured to produce the map. Figure 34 shows the geothermal gradient map of North Dakota and Figure 35 indicates those townships contributing township averages to the map. The geothermal gradient map is displayed in degrees Celsius per kilometer so that it may be easily compared with geothermal gradient maps produced by other workers in the region.

"Slice" Maps

GEOSTOR was interrogated for the bottom-hole-temperature and total depth data for all wells in storage in order to construct "slice" maps of the temperature data. The "slice" maps (Figure 36) present each bottom-hole-temperature as its deviation from the mean of all bottom-hole-temperatures observed within an arbitrary depth interval. The depth interval chosen was 1000 feet and temperatures are contoured in five degree Fahrenheit intervals above and below the mean for each depth interval. These units were chosen so that these maps may be easily interpreted by potential users. The average change in temperature per 1000 feet at our average calculated gradient of $30.7^{\circ}\text{C}/\text{Km}$ ($.01684^{\circ}\text{F}/\text{Ft}$) is 9.36°C (16.84°F). Figures 37 through 48 present the "slice" maps from 2,000 feet to 14,000 feet. Those townships contributing data to the maps are shown as control points on the maps.

FIGURE 34 - Geothermal gradient map,
North Dakota; CI = 2°C/Km

FIGURE 35 - Posting of Control Points
for Geothermal Gradient Map

A "slice map is a contour map of the deviation from the mean observed temperature for an arbitrary depth interval.

Where:

Depth Interval. All bottom-hole-temperature contained in GEOSTOR between two arbitrary depths. ($Z_2 - Z_1$)

Mean Observed Temperature. ($\bar{T}_O$) The mean of all observed temperatures (bottom-hole-temperatures) within a depth interval.

Observed Temperature. (T_O) A bottom-hole-temperature measured within the depth interval.

Deviation From The Mean. ($T_O - \bar{T}_O$) Observed temperature MINUS the mean observed temperature for a depth interval.

FIGURE 36 - "Slice Maps"

FIGURE 37 - "Slice" Map of Bottom-Hole-Temperature
Data, 2000 - 3000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 93^{\circ}F$

FIGURE 38 - "Slice" Map of Bottom-Hole-Temperature
Data, 3000 - 4000 Feet; CI = 5°F, $\bar{T}$ = 104°F

FIGURE 39 - "Slice" Map of Bottom-Hole-Temperature
Data, 4000 - 5000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 115^{\circ}F$

FIGURE 40 - "Slice" Map of Bottom-Hole-Temperature
 Data, 5000 - 6000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 131^{\circ}F$

FIGURE 41 - "Slice" Map of Bottom-Hole-Temperature
Data, 6000 - 7000 Feet; CI = 5°F, $\bar{T}$ = 144°F

FIGURE 42 - "Slice" Map of Bottom-Hole-Temperature
Data, 7000 - 8000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 158^{\circ}F$

FIGURE 43 - "Slice" Map of Bottom-Hole-Temperature
Data, 8000 - 9000 Feet; CI = 5°F, $\bar{T}$ = 177°F

FIGURE 44 - "Slice" Map of Bottom-Hole-Temperature
Data, 9000 - 10,000 Feet; CI = 5°F, $\bar{T}$ = 197°F

FIGURE 45 - "Slice" Map of Bottom-Hole-Temperature Data,
10.000 - 11.000 Feet; $CI = 5^{\circ}C$, $\bar{T} = 209^{\circ}F$

FIGURE 46 - "Slice" Map of Bottom-Hole-Temperature Data,
11,000 - 12,000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 221^{\circ}F$

FIGURE 47 - "Slice" Map of Bottom-Hole-Temperature Data,
12,000 - 13,000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 228^{\circ}F$

FIGURE 48 - "Slice" Map of Bottom-Hole-Temperature Data,
13,000 - 14,000 Feet; $CI = 5^{\circ}F$, $\bar{T} = 246^{\circ}F$

Chemical Data Set (Figure 3, Block M)

The chemical data set stored in GEOSTOR contains the results of chemical analyses of formation water recovered during drill stem tests. These data were coded from the NDGS drill stem test file and contain the following information on each drill stem test reported, formation tested, tested interval (footage), concentration of major cations (Ca, Mg, Na, Fe), concentration of major anions (CO_3 , HCO_3 , SO_4 , Cl), pH, and resistivity of the formation fluid. These data are concentrated in the principle oil producing formations. Consequently, we didn't have sufficient control to produce map displays of all tested formations. Map summaries of the chemical data were only attempted for the Mississippian Madison Formation. Figures 49 through 56 show variations in the concentration (mg/l) of the chemical species present, TDS and pH for the Madison. The occurrence of measurable concentrations of Fe and CO_3 ions in the Madison water analysis data were extremely rare and were not mapped. The TDS figures used are based on the summation of the concentrations of the major cations and anions indicated. The control for the chemical data maps is shown on the chloride ion map. Appendix D lists the chemical data for other formations not mapped.

FIGURE 49 - Concentration of Chloride (Cl), Mississippian Madison Formation; CI = 25,000 mg/l

FIGURE 50 - Concentration of Sulphate (SO_4), Mississippian Madison Formation; CI = 500 mg/l

FIGURE 51 - Concentration of Bicarbonate (HCO_3),
Mississippian Madison Formation; CI = 50 mg/l

FIGURE 52 - Concentration of Sodium (Na), Mississippian
Madison Formation; CI = 25,000 mg/l

FIGURE 53 - Concentration of Magnesium (Mg), Mississippian
Madison Formation; CI = 500 mg/l

FIGURE 54 - Concentration of Calcium (Ca), Mississippian
Madison Formation; CI = 2,500 mg/l

FIGURE 55 - Concentration of Total Dissolved Solids (TDS),
Mississippian Madison Formation; CI = 25,000 mg/l

FIGURE 56 - pH, Mississippiian Madison Formation; CI = .5

SUMMARY

The basic data presented in the previous section will be summarized to characterize the depth, thickness, temperature, and chemical data for the Mississippian Madison Formation. Our geothermal gradient map will be analyzed to evaluate the areal distribution of the depth of individual gradient values contributing to the map.

Mississippian Madison Formation

The following statement of geologic setting and lithologic character of the Mississippian Madison Formation is summarized from Sedimentary and Tectonic History of North Dakota, Part of the Williston Basin (Carlson, C.G. and Anderson, S.B., 1966).

The Mississippian Madison Formation was deposited during the Kaskaskia Sequence, in the tectonically negative Williston Basin (Figure 57), by a transgressive sea spreading across the area from the north and west. The Williston Basin is part of a larger Devonian seaway whose thickest deposits are in western Canada.

The Madison Formation consists of three gross lithologic subdivisions deposited in environments ranging from normal to restricted marine. The Lodgepole facies consists of thin-bedded, argillaceous or cherty, generally dense, light gray to dark gray limestone. The Mission Canyon facies consists of a massive-bedded pure limestone, composed largely of fragmental and oolitic material, ranging in color from brownish gray to light yellowish gray. The Charles facies consists mainly of halite and anhydrite. Thin shale and minor sandstone tongues are also associated with some anhydrite beds. Some primary dolomite may also be included in this facies.

FIGURE 57 - Cross Section Showing Major Unconformities
in the North Dakota Stratigraphic Column
(After: Carlson, C.G. and Anderson, S.B., 1966)

The Madison is present in the subsurface in the western three fourths of North Dakota but is truncated in the eastern half of the state by a post Kaskaskia erosional unconformity (Figure 57).

The factors used in evaluating a potential hydrothermal aquifer include depth, thickness, water temperature, and water quality. These characteristics are summarized in Figures 58 through 63 for the Mississippian Madison Formation.

The depth of the formation can be determined from the surface elevation in the area of interest and the structural contour map (Figure 58) which shows the elevation in feet (sea level datum) of the top of the formation throughout the state.

The thickness of the Madison is shown on the isopach map in Figure 67. The thickness of the formation is expressed in feet.

The expected temperature of the formation is shown on the isotherm map in Figure 61. The isotherm map is based on bottom-hole-temperatures recorded for wells that bottomed in the Madison. Temperatures are expressed in degrees Fahrenheit.

The variation in the quality of the water contained in the Madison Formation is shown in Figure 63. This map shows the variation in total dissolved solid based on chemical analysis of formation water recovered during drill stem tests.

FIGURE 58 - Structure Map on the top of the Mississippian
Madison Formation (MM); CI = 500 Feet

FIGURE 59 - Isopach Map, Thickness of the Mississippian
Madison Formation in Feet; CI = 100 Feet

FIGURE 60 - Posting of Control Points for
Mississippian Madison Isopach Map

FIGURE 61 - Isotherm Map, Temperature of the Water in the Mississippian Madison Formation; CI = 10°F

FIGURE 62 - Posting of Control Points for
Mississippian Madison Isotherm Map

FIGURE 63 - Concentration of Total Dissolved Solids (TDS),
Mississippian Madison Formation; CI = 25,000 mg/l

Depth Variations in Gradient Data

The "slice" map series shows the average bottom-hole-temperature and the distribution of well control in 1000 foot depth intervals throughout the state. The geothermal gradient map displays the geothermal gradients calculated from all well data, regardless of the depth of the data. Figure 64 shows our geothermal gradient map with bold contours enclosing areas which indicate the maximum depth (in thousands of feet) of most of the gradient data for those areas. From Figure 64 we can see that the distribution of the depth of the gradient control reflects basin geometry, wells are deeper in the western two thirds of the state. We can also see that most of the interesting geothermal gradients ($> 30^{\circ}\text{C}/\text{Km}$ or $.0165^{\circ}\text{F}/\text{Ft}$) are located in the eastern one third of the state and are based on well data less than 4000 feet deep.

FIGURE 64 - Distribution of the Depth of the Gradient Data
(CI = Feet x 1000), with Geothermal Gradient Map (CI = 10°C/Km)

CONCLUSIONS

The Phase I study has created a highly accessible data bank in the form of our GEOSTOR computer library system. The data currently in GEOSTOR consists of information from the NDGS oil and gas well files. These data are concentrated in hydrocarbon producing formations. The stratigraphic distribution of this information allows a hydrothermal evaluation of the Mississippian Madison Formation and the generation of a geothermal gradient map of North Dakota.

Mississippian Madison Formation

The depth of the Madison Formation ranges from about 3000 feet to about 9000 feet and it is up to about 2300 feet thick (Figures 58 and 59). Expected temperatures range from about 250°F in the center of the basin to about 100°F on the eastern flank of the basin, (Figure 61), a medium to low temperature hydrothermal reservoir. The water contained in the Madison is typically very high in NaCl, with the concentration of total dissolved solids as high as 300,000 mg/l (Figure 71). Although the Madison contains water in a useful temperature range, the poor water quality and generally great depth will probably prevent its development as a significant hydrothermal aquifer.

Geothermal Gradient Map

The geothermal gradient map is based on bottom-hole-temperatures measured at various depths. Bottom-hole-temperatures do not reflect equilibrium conditions in the bore hole, but are probably, in all cases, cooler than equilibrium conditions. Therefore, the gradients calculated from the bottom-hole-

temperature and total depth data are conservative, and significant only at the depth measured. The geothermal gradient map is a good generalization of the areas of higher and lower than average geothermal gradients but the variations in the depth of the data being presented should be considered in interpreting the map.

Areas of generally higher geothermal gradients ($>30^{\circ}\text{C/Km}$ or $.0165^{\circ}\text{F/Ft}$) occur in the eastern one third, the north central, and the western edge of the state. In the eastern third and north central areas the depth of the data is generally less than 4000 feet (Figure 64). Lower thermal conductivities in shallower, less well consolidated, sediments can have an insulating effect which would make the gradients higher in these areas. The higher gradients along the western boundary of the state are calculated from data generally deeper than 10,000 feet. These gradients should not be influenced by the insulating effect of shallower, less well consolidated sediments and may indicate areas of somewhat higher heat-flow.

The higher than average gradients ($>30^{\circ}\text{C/Km}$ or $.0165^{\circ}\text{F/Ft}$) in the eastern and northern parts of the state occur in areas where Mississippian Madison Formation and other Paleozoic rocks are truncated by the post Absaroka unconformity (Figure 65). The areas of higher than average geothermal gradient ($>30^{\circ}\text{C/Km}$ or $.0165^{\circ}\text{F/Ft}$) in the eastern and northern parts of the state may be due to warm water from Paleozoic aquifers "leaking" into shallower aquifers. Figure 66 shows that areas of possible hydraulic communication between the truncated Paleozoic rock and the overlying lower Cretaceous clastics correspond to areas of higher gradients. Figure 67 shows that the lower Cretaceous sediments, with a high sand-shale ratio, also generally overlay the areas of higher gradients.

FIGURE 65 - Generalized Geothermal Gradient Map with Pre-Mesozoic Paleogeologic Map (After: Anderson, Sidney B., 1974)
For Formation Names See Appendix A

FIGURE 66 - Generalized Geothermal Gradient Map with Pre-Cretaceous Paleogeologic Map (After: Hansen, Dan E., 1955)
For Formation Names See Appendix A

FIGURE 67 - Generalized Geothermal Gradient Map with Lower Cretaceous Sand-Shale Ratio Map (After: Hanson, Dan E., 1955)

There are probably at least two factors controlling the distribution of higher than average geothermal gradients: first, the depth of the data the gradients are calculated from; secondly, the possibility of water from Paleozoic aquifers "leaking" into shallower aquifers.

FUTURE WORK

Phase II activities will address four tasks. Potential hydrothermal aquifers in the areas of above average geothermal gradients will be mapped by incorporating additional stratigraphic, lithologic, and temperature data into GEOSTOR. Thermal gradients will be measured in holes-of-opportunity to verify the gradient data already collected and to calculate terrestrial heat flow values. Our computer file of water quality data will be expanded by incorporating additional information from state, federal, county, city, and local sources in areas of study.

REFERENCES

1. Anderson, Sidney B., 1974, Pre-Mesozoic Paleogeologic Map of North Dakota: North Dakota Geological Survey Miscellaneous Map Number 17.
2. Carlson, C.G., and Anderson, S.B., 1966, Sedimentary and Tectonic History of North Dakota part of Williston Basin: North Dakota Geological Survey Miscellaneous Series Number 28, pp. 1833-1846.
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4. Jensen, Ray E., 1972, Climate of North Dakota: Fargo, North Dakota, North Dakota State University, 48 p.
5. Leffel, C.S. Jr., and Eisenberg, R.A., 1977, Geothermal Handbook: Laurel, Maryland, Johns Hopkins University, Applied Physics Laboratory, 84 p.

APPENDIX "A"

CODING GUIDE

GHOSTOR
COMPUTER WELL FILE

K.L. Harris

North Dakota Geological Survey

November 30, 1978

1. *Chlorophyll a* (Chl *a*)

TABLE OF CONTENTS

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Coded Data

I NONRECURSIVE DATA

SPACE/FORM

CARD 1

<u>WELL NUMBER:</u> Log file number, may or may not be the same as permit number (see attachment 1).	16
<u>CARD COUNTER:</u> Number all cards for the well sequentially.	12
<u>PERMIT NUMBER:</u> Drilling permit number (16), may or may not be the same as permit number (see attachment 1).	(16)
<u>CHANGE OF RECORD COUNTER:</u> Changes in well records are numbered sequentially.	11
<u>A.P.I. NUMBER:</u> 10 digit number which identifies well as to state, county, and sequential number within county. The third, fourth, and fifth digits give county number (see attachment 2).	(12,13,15)
<u>LOCATION:</u>	
<u>LOGSCL:</u> Township, range, section, and quarter of quarter to four levels (see attachment 3).	213,12,A4
<u>LOGSFL:</u> Feet from a north-south line and an east-west line of the form 1020 N 620 E.	2(14,A1)
<u>ELEVATION:</u> (in feet)	
<u>G.L.:</u> Elevation of ground level.	14
<u>K.B.:</u> Elevation of the Kelly Bushing.	14
<u>D.F.:</u> Elevation of the derrick floor.	14
<u>TOTAL DEPTH:</u> Maximum depth drilled (in feet).	15
<u>DEEPEST FORMATION:</u> Name of Formation at total depth (see attachment 4).	A5
<u>BHT:</u> Bottom hole temperature, measured at total depth (°F).	13
<u>PERMIT CANCELLED:</u> Date the permit was cancelled (Jan. 10, 1971; 01 10 71).	3(12)

78

I. NONRECURSIVE DATA

SPACE/FORM

CARD 2

<u>WELL NUMBER:</u> Log file number.	16
<u>CARD COUNTER:</u> Sequentially numbered cards.	12
<u>OPERATOR:</u> Full name, if possible, of the operator(s) of the well.	A36
<u>WELL NAME:</u> Full name, if possible, of the well.	A36
	80

CARD 3

<u>WELL NUMBER:</u> Log file number.	16
<u>CARD COUNTER:</u> Sequentially numbered cards.	12
<u>WELL STATUS:</u> Initial and final status of the well (see attachment 5).	2A2
<u>DATE:</u>	
<u>COMPLETED:</u> Date of the completion of the well of the form Jan. 10, 1971; 01 10 71.	312
<u>ABANDONED:</u> Enter date the well was plugged or abandoned.	312
<u>FIELD NAME:</u> Name of gas or oil field in which well is located or other interesting information.	A16
<u>INITIAL PRODUCTION:</u> The results of the initial production test are presented as follows:	
<u>GAS PRODUCTION:</u> MCFPD produced in initial production test. Note, if number entered is MMCFPD enter a (1) in space following the gas volume figure.	14,11
<u>OIL PRODUCTION:</u> BOPD produced in initial production test.	14
<u>WATER PRODUCTION:</u> BWPD produced in initial production test. Nondecimal % of oil production (BPD).	14
<u>CONDENSATE PRODUCTION:</u> BCPD produced in initial production test.	14
<u>GAS-OIL RATIO:</u> Enter "N" from gas-oil ratio expressed as (N:1) "N" cubic ft. of gas per barrel of oil.	15
<u>CHOKE:</u> Diameter of choke used in initial production test. Enter numerator of choke size in 64ths of an inch.	12

CARD 3 (cont'd)PRODUCING INTERVAL: Description of producing horizon follows:PRODUCING FORMATION: Name of producing Formation (see attachment 4). A5PERFORATED INTERVAL: Enter depth of top and bottom of overall perforated interval. 2(15)MULTIPLE COMPLETION: Enter (2) for double, (3) for tripple. Information on each additional completion is entered on an additional card 3 (see page 2 of coding form). I1

80CARD 4: Logs run, sample types, Formations, footages, and storage locations. Sample format repeats until all samples are listed.WELL NUMBER: Log file number. I6CARD COUNTER: Sequentially numbered cards. I2LOGS: List logs run left justify, 1 log/4 spaces (- indicate joint logs.) ex.: IES- GR. 9A4SAMPLE TYPE: I1

Core - - - - - Enter (1)

Core chips - - - - - Enter (2)

Cuttings - - - - - Enter (3)

SWC - - - - - Enter (4)

FORMATION: Enter name of Formation sampled for core or core chips only (see attachment 4). A5FOOTAGE: Upper and lower limits of core(s) or samples. 215STORAGE LOCATION: Enter up to three storage locations for sampled interval. Row (I4) and tier (I2). 3(14,12)ADDITIONAL SAMPLES: If additional samples are recorded enter (1). Code additional samples on card 5. I1

79CARD 5: Code samples as on card 4. Additional samples can be coded on cards 5A, 5B, 5C.....

16

12

2(11,A5,2(15),

3(14,12))

11

77

II RECURSIVE DATA

SPACE/FORM

CARDS 6 and 7

WELL NUMBER: log file number.

I6

CARD COUNTER: Sequentially numbered cards.

I2

FM AND DEPTH: Enter the depth of each of the 14 Formations listed.

7(A5,I5)

78

CARD 8: Chemical characteristics of water recovered by drill stem tests.

WELL NUMBER: Log file number.

I6

TESTED INTERVAL

FORMATION: Enter the name of the Formation sampled (See Attachment 4).

A5

FOOTAGE: Upper and lower limits of sampled interval.

2I5

ION CONCENTRATIONS (mg/l or ppm)

CATIONS

Ca, Mg, Na - Enter concentration in mg/l or ppm.

3I6

Fe - Enter concentration in mg/l or ppm x 100

I6

ANIONS

(CO₃, HCO₃, SO₄, Cl) - Enter concentration in mg/l or ppm.

4I6

pH

Enter pH x 100

I4

RESISTIVITY - Resistivity and temperature of water measured.

RESISTIVITY - Enter resistivity of the Formation fluid x 100

I4

TEMPERATURE - Enter the temperature of the Formation fluid at the time of the resistivity measurement

I3

CHANGES IN WELL STATUS OR RECORD

Cards 1 through 7, as needed, are repeated for renewed drilling (OWDD), recompletion, change of ownership, etc. The permit number (on card 1) and change-in-record-counter are coded as follows.

— — 4 0 6 2 —	
└─┬─┘	└─┬─┘
Permit	change-in-record-counter
Number	

Well 4062 is sold

— — 4 0 6 2 1

Well 4062 is recompleted

— — 4 0 6 2 2

Well 4062 is drilled deeper

— — 4 0 6 2 3

ATTACHMENTS

1. Historical relation between well numbers and permit numbers.
2. API standard county numbers.
3. LOGSCL guide.
4. Formation abbreviation list.
5. Well Status Code.
6. Log types and symbols.
7. Alphabetical listing of log types.
8. Sources of coded information.
9. Coding forms.

ATTACHMENT 1. HISTORICAL RELATIONSHIP BETWEEN WELL FILE NUMBERS
AND PERMIT NUMBERS.

WELL FILE NUMBER		PERMIT NUMBER
1 | 507	> +16 =	17 | 523
508		No Permit
509 | 518	> +15 =	524 | 533
519		No Permit
520		No Permit
521 | 567	> +13 =	534 | 580
568 | 695	> +14 =	582 | 709
696		No Permit
697 | 870	> +13 =	710 | 883
871		No Permit
872 | 6187	> +12 =	884 | 6199
6188 | 6199	>	No Wells
6200 | Present	=	6200 | Present

ATTACHMENT 2. API STANDARD COUNTY NUMBERS.

COUNTIES

	State	County		State	County
ADAMS-----	33	001	MOUNTRAIL----	33	061
BARNES-----	33	003	NELSON-----	33	063
BENSON-----	33	005	OLIVER-----	33	065
BILLINGS-----	33	007	PEMBINA-----	33	067
BOTTINEAU-----	33	009	PIERCE-----	33	069
 BOWMAN-----	 33	 011	 RAMSEY-----	 33	 071
BURKE-----	33	013	RANSOM-----	33	073
BURLEIGH-----	33	015	RENVILLE-----	33	075
CASS-----	33	017	RICHLAND-----	33	077
CAVALIER-----	33	019	ROLETTE-----	33	079
 DICKY-----	 33	 021	 SARGENT-----	 33	 081
DIVIDE-----	33	023	SHERIDAN-----	33	083
DUNN-----	33	025	SIOUX-----	33	085
EDDY-----	33	027	SLOPE-----	33	087
EMMONS-----	33	029	STARK-----	33	089
 FOSTER-----	 33	 031	 STEELE-----	 33	 091
GOLDEN VALLEY----	33	033	STUTSMAN-----	33	093
GRAND FORKS-----	33	035	TOWNER-----	33	095
GRANT-----	33	037	TRAILL-----	33	097
GRIGGS-----	33	039	WALSH-----	33	099
 HETTINGER-----	 33	 041	 WARD-----	 33	 101
KIDDER-----	33	043	WELLS-----	33	103
LA MOURE-----	33	045	WILLIAMS-----	33	105
LOGAN-----	33	047			
MC HENRY-----	33	049			
 MC INTOSH-----	 33	 051			
MC KENZIE-----	33	053			
MCLEAN-----	33	055			
MERCER-----	33	057			
MORTON-----	33	059			

ATTACHMENT 3. LOC 3L LOCATION GUIDE.

SYSTEM OF LOCATING WELLS AND TEST HOLES

ATTACHMENT 4. FORMATION ABBREVIATION LIST.

FORMATION ABBREVIATIONS

Tertiary System T

Sentinel Butte Fm.	TSB
Bullion Creek Fm.	TBC
Slope Fm.	TS
Tongue River Fm.	TTR
Cannonball Fm.	TC
Tullock Fm.	TT
Ludlow Fm.	TL

Cretaceous System K

Hell Creek Fm.	KHC
Montana Gr.	KMON
Fox Hill Fm.	KFH
Pierre Fm.	KP
Colorado Gr.	KCOL
Niobrara Fm.	KN
Greenhorn Fm.	KG
Belle Fouche Fm.	KBF
Dakota Gr.	KDAK
Mowry Fm.	KM
Newcastle Fm.	KNWC
Skull Creek Fm.	KSC
Fall River Fm.	KFR
Lakota Fm.	KL

Jurassic System J

Morrison Fm.	JM
Sundance Fm.	JS
Piper Fm.	JP

Triassic System TR

Spearfish Fm.	TRS
---------------	-----

Permian System P

Minnekahta Fm.	PM
Opeche Fm.	PO

Pennsylvanian System PN

Minnelusa Fm.	PNM
Amsden Fm.	PNA
Tyler Fm.	PNT

Mississippian System M

Heath Fm.	MH
Otter Fm.	MO
Kibbey Fm.	MK
Kibbey S.S.	MKSS
Kibbey L.S.	MKLS
Kibbey Silt	MKSH
Madison Fm.	MM

Poplar Interval	MMP
-----------------	-----

Ratcliffe Interval	MMR
--------------------	-----

Midale Subinterval	MMRM
--------------------	------

Frobisher Alida Interval	MMFA
--------------------------	------

Rival Subinterval	MMFAR
-------------------	-------

Tilston Interval	MMT
Bottineau Interval (Lodgepole)	MMB
Bakken Fm.	MB
Devonian System	D
Three Forks Fm.	DTF
Birdbear Fm. (Nisku)	DB
Duperow Fm.	DD
Souris River Fm.	DSR
Dawson Bay	DDB
Prairie Fm.	DP
Winnipegosis Fm.	DW
Ashern Fm.	DA
Silurian System	S
Interlake Fm.	SI
Siluro-Ordovician	SO
Stonewall Fm.	SOS
Ordovician	O
Stony Mtn. Fm.	OSM
Upper Stony Mtn.	OSMU
Lower Stony Mtn.	OSML
Gunton Member	OG
Stoughton Member	OS
Red River Fm.	ORR

Winnipeg Group OW

Roughlock Fm. OWR

Icebox Fm. OWI

Black Island Fm. OWBI

Cambrian System C

Deadwood Fm. CD

Precambrian PC

ATTACHMENT 5

WELL STATUS CODES

<u>MAP SYMBOL</u>	<u>CODE</u>	<u>STATUS</u>
	99	Dry Hole
	88	Location
	10	One oil, no gas completions
	01	No oil, one gas completions
	20	Two oil, no gas completions
	30	(three or more indicated by number near location)
	02	No oil two gas completions
	03	(three or more indicated by number near location)
	11	One oil, one gas completions
	21	(two oil and one gas indicated by "21" near location)
	AP	Abandoned Producer
	OW	Observation Well
	SW	Service Well
	IW	Injection Well
	JW	Junked Well
	TA	Temporarily Abandoned
	IS	Injection and Service
	T	Tight Hole (modify symbol to fit partial information available)
	OP	Other Production
	ST	Stratigraphic Test
	MN	Mineral Exploration
	DA	Dry Abandoned
	PA	Plugged and Abandoned

Electrical Logs:

<u>Log</u>	<u>Symbol</u>
Conductivity Laterolog	CLL
Contact Log	CON
Continuous Dipmeter	CDM
Continuous Dipmeter Digital	CDD
Dip Log	DIP
Dipmeter	DM
Drill Pipe Log	DP
Dual Induction	DI
Dual Laterolog	DLL
Electrical Survey	ES
Focused Resistivity	FOC
Forxo	FRX
Guard	GRD
Induction Electrical	IES
Induction Log	IL
Limestone	LS
Laterolog	LL
Laterolog 3	LL3
Laterolog 7	LL7
Micro Laterolog	MLL
Microlog (Guard)	ML

Electrical Logs (cont'd):

<u>Log</u>	<u>Symbol</u>
Micro Survey	MS
Mini Focused	MIF
Minilog	MIL
Proximity	PRX
Spontaneous Potential	SP

Acoustical Logs:

<u>Log</u>	<u>Symbol</u>
Acoustic, Acoustilog	ACS
Acoustic Amplitude	AMP
Borehole Compensated Acoustic	BCA
Borehole Compensated Sonic	BHC
Cement Bond	BND
Fracture Finder Microseismogram	FFM
Integrated Sonic	ISN
Sonic	SON
Sonic Picture Study	SPS
Seismic Reference Survey	SRS
Velocity	VEL

Radioactivity Logs:

<u>Log</u>	<u>Symbol</u>
Casing Collar Locator	CCL
Chlorine Log (Spectral, Spectrograph)	CHL
Density, densilog, gamma-gamma density	DEN
Formation Density	FD
Formation Density Compensated	FDC
Gamma Ray	GR
Gamma Ray-Neutron	GRN
Isotron	ISO
Neutron	NEU
Neutron-Epithermal Neutron	NEN
Neutron-Gamma	NEG
Neutron Lifetime Log	NLL
Neutron Thermal Neutron	NTN
Radioactive Tracer	TR
Radioactivity (Radiation)	RAD
Sidewall Neutron Porosity	SNP
Thermal Decay Time Log	TDT
Compensated Neutron Formation Density	CNL

Miscellaneous Logs:

<u>Log</u>	<u>Symbol</u>
Caliper	CAL
Completion (Csg. Col. Loc. and Perf. Record)	COM
Deviation Survey	DS
Directional Survey	DIR

Miscellaneous Logs (Cont'd):

<u>Log</u>	<u>Symbol</u>
Experimental Log	EXP
Fluid (Formation Tester)	FT
Formation Analysis Log	FAL
Formation Interval Tester	FIT
Movable Oil Plot	MOP
Multiple Fluid Sampler	MFS
Nuclear Magnetism Log	NML
Permeability	PRM
Synergetic Log	SYG
Temperature	TM
Temperature Differential	TMD
Water Location Survey	WTR

Sample/Drilling Logs:

<u>Log</u>	<u>Symbol</u>
Mud Log, Litholog Log, Drill Log	MDL
Mud Log, Chromatograph	MLC
Paleo Log	BUG
Drilling Time Log	DTL
Geolograph	GLG

ATTACHMENT 7

Alphabetical Listing of

Log Symbols

<u>Symbol</u>	<u>Log</u>
ACS	Acoustic, Acoustilog
AMP	Acoustic Amplitude
BCA	Borehole Compensated Acoustic
BHC	Borehole Compensated Sonic
BND	Cement Bond
BUG	Paleo Log
CAL	Caliper
CCL	Casing Collar Locator
CDD	Continuous Dipmeter Digital
CDM	Continuous Diameter
CHL	Chlorine Log (Spectral, Spectograph)
CLT	Conductivity Laterolog
CNL	Compensated Neutron Formation Density
COM	Completion (Csg. Col. Loc. and Perf. Record)
CON	Contact Log
DEN	Density, Densilog, gamma-gamma density
DI	Dual Injection
DIP	Dip Log
DIR	Directional Survey

DLL	Dual Laterolog
DM	Dipmeter
DP	Drill Pipe Log
DS	Deviation Survey
DTL	Drilling Time Log
ES	Electrical Survey
EXP	Experimental Log
FAL	Formation Analysis Log
FD	Formation Density
FDC	Formation Density Compensated
FFM	Fracture Finder Microseismogram
FIT	Formation Interval Tester
FOC	Focused Resistivity
FRX	Forxo
FT	Fluid (Formation Tester)
GLG	Geolograph
GR	Gamma Ray
GRD	Guard
GRN	Gamma Ray Neutron

IES	Induction Electrical
ISN	Integrated Sonic
IL	Induction Log
ISO	Isotron
LL	Laterolog
LL3	Laterolog 3
LL7	Laterolog 7
LS	Limestone
MDL	Mud Log
MFS	Multiple Fluid Sampler
MIF	Mini Focused
MIL	Minilog
ML	Microlog
MLC	Mud Log, Chromatograph
MML	Microlaterolog
MOP	Movable Oil Plot
MS	Micro Survey

NEG	Neutron-Gamma
NEN	Neutron-Epithermal Neutron
NEU	Neutron
NLL	Neutron Lifetime Log
NML	Nuclear Magnetism Log
NTN	Neutron Thermal Neutron
PRX	Proximity
PRM	Permeability
RAD	Radioactivity (Radiation)
SNP	Sidewall Neutron Porosity
SON	Sonic
SP	Spontaneous Potential
SPS	Sonic Picture Study
SRS	Seismic Reference Survey
SYG	Synergetic Log
TDT	Thermal Decay Time Log
TM	Temperature
TMD	Temperature Differential
TR	Radioactive Tracer

VEL

Velocity

WTR

Water Location Survey

ATTACHMENT 8. SOURCES OF CODED INFORMATION

ITEM *	NDGS WELL NUMBER											
	0			2000			4000			6000		
NDGS Well No.	X			X						O	O	O
Permit No.												
API No.				X				X		O		O
County	X			X						O		O
T.R.S.Q.												
Well Name				X				X		O		O
Operator	X			X						O		O
Elevation												
Total Depth				X				X		O		O
Well Status	X			X						O		O
Field												
Completion Date				X				X		O		O
I.P.	X			X						O		O
Date Plugged												
Samples				X				X		S	S	S
Cores	X			X						S	S	
Logs Run												
FM (Producing)				X				X		L	L	L
FM (Deepest)	X			X							L	
BHT		L		L						L		L
Log Tops		T		T				L		L		
Perf. Intv.		W		W				W		W		
L.O.G.S.F.L.				W				W		P	P	
Chemical Data	D	D			D	D				D	D	

* See Coding Guide for explanation of abbreviations.

SOURCES

Preexisting Digitized Well Data (NDGS, Open File)-----	X
Circular File (NDGS, Open File)-----	O
Sample and Core Files (NDGS, Open File)-----	S
Log File (NDGS, Open File)-----	L
Permit Book (NDGS, Open File)-----	P
Well File (NDGS, Legal File)-----	W
Tops File (NDGS, Open File)-----	T
Drill Stem Test File (NDGS, Open File)-----	D

FIGURE 2 - Coded Information and Sources of That Coded Information

PROGRAM	DATE	CLASS IDENTIFICATION	PUNCHING INSTRUCTIONS	PAGE OF
PROGRAMMER	USER ACCT. NUMBER			CARD STOCK

WELL NUMBER	TESTED INTV.			CONCENTRATION (PPM, Mg/L)								PH x100	Resistivity																
	FM	TOP	BOT.	CA	Mg	Na	Fe(x100)	CO ₃	HCO ₃	SO ₄	Cl		P x1000	OF															
1	6	7	11	12	16	17	21	22	27	28	33	34	39	40	45	46	51	52	57	58	63	64	69	70	75	76	77	78	80

WELL NUMBER	TESTED INTV.			CONCENTRATION (PPM, Mg/L)								PH x100	Resistivity																
	FM	TOP	BOT.	CA	Mg	Na	Fe(x100)	CO ₃	HCO ₃	SO ₄	Cl		P x1000	OF															
1	6	7	11	12	16	17	21	22	27	28	33	34	39	40	45	46	51	52	57	58	63	64	69	70	75	76	77	78	80

WELL NUMBER	TESTED INTV.			CONCENTRATION (PPM, Mg/L)								PH x100	Resistivity																
	FM	TOP	BOT.	CA	Mg	Na	Fe(x100)	CO ₃	HCO ₃	SO ₄	Cl		P x1000	OF															
1	6	7	11	12	16	17	21	22	27	28	33	34	39	40	45	46	51	52	57	58	63	64	69	70	75	76	77	78	80

WELL NUMBER	TESTED INTV.			CONCENTRATION (PPM, Mg/L)								PH x100	Resistivity																
	FM	TOP	BOT.	CA	Mg	Na	Fe(x100)	CO ₃	HCO ₃	SO ₄	Cl		P x1000	OF															
1	6	7	11	12	16	17	21	22	27	28	33	34	39	40	45	46	51	52	57	58	63	64	69	70	75	76	77	78	80

WELL NUMBER	TESTED INTV.			CONCENTRATION (PPM, Mg/L)								PH x100	Resistivity																
	FM	TOP	BOT.	CA	Mg	Na	Fe(x100)	CO ₃	HCO ₃	SO ₄	Cl		P x1000	OF															
1	6	7	11	12	16	17	21	22	27	28	33	34	39	40	45	46	51	52	57	58	63	64	69	70	75	76	77	78	80

PROGRAM	DATE	CLASS IDENTIFICATION	PUNCHING INSTRUCTIONS	PAGE OF
PROGRAMMER	USER AGGT. NUMBER			CARD STOCK

3A

WELL NO.	STATUS	DATE		FIELD NAME WILDCAT OR OWDD ETC.	IP					PERF. INTV.		MULT. COMP.						
CD. CTR.	I F	COMP.	ABAND.		GAS	OIL	WATER	COND.	GOR	CHK	(O.A.)		TOP	BOT.				
		MO	DY	YR	MO	DY	YR	MC	FPD	MM	BOPD	BWPD	BCPD	N:1	N/64	FM		

3B

WELL NO.	STATUS	DATE		FIELD NAME WILDCAT OR OWDD ETC.	IP					PERF. INTV.		MULT. COMP.						
CD. CTR.	I F	COMP.	ABAND.		GAS	OIL	WATER	COND.	GOR	CHK	(O.A.)		TOP	BOT.				
		MO	DY	YR	MO	DY	YR	MC	FPD	MM	BOPD	BWPD	BCPD	N:1	N/64	FM		

5A

WELL NO.	SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			ADD
CD. CTR.			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T	SMPL

5B

WELL NO.	SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			ADD
CD. CTR.			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T	SMPL

5C

WELL NO.	SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			ADD
CD. CTR.			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T	SMPL

5D

WELL NO.	SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			ADD
CD. CTR.			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T	SMPL

5E

WELL NO.	SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			SMPL TYPE	FM	FOOTAGE	STORAGE LOCATION			ADD
CD. CTR.			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T			UPPER LOWER	1 ROW T	2 ROW T	3 ROW T	SMPL

ADDITIONAL CODE SHEET FOR THIS WELL ☐

1	WELL NO.	PERMIT #	API NO.	LOGSCL				LOGSFL				ELEV.			TOTAL DEPTH	DEEPEST FM	BHT	PERMIT CANCELED														
	CD. CTR.	RECORD CHANGE	CO. #	T	R	S	Q	FEET N	FEET E	FEET W	G.L.	K.B.	D.F.				MO	DY	YR													
2	WELL NO.		OPERATOR															WELL NAME														
	CD. CTR.																															
3	WELL NO.	STATUS	DATE						FIELD NAME						IP						PERF. INTV.											
	CD. CTR.	I F	COMP.	ABAND.	MO	DY	YR	MO	DY	YR	WILDCAT OR OWDD ETC.						GAS	OIL	WATER	COND.	GOR	CHK	(O.A.) MULT. COMP.									
4	WELL NO.	LOGS RUN															SMPL TYPE	FM	FOOTAGE		STORAGE LOCATION			ADD.								
	CD. CTR.																		UPPER	LOWER	1	2	3	SMP.								
5	WELL NO.	SMPL TYPE	FM	FOOTAGE		STORAGE LOCATION			SMPL TYPE	FM	FOOTAGE		STORAGE LOCATION			ADD.																
	CD. CTR.			UPPER	LOWER	1	2	3			UPPER	LOWER	1	2	3	SMP.																
6	WELL NO.	1		2		3		4		5		6		7																		
	CD. CTR.	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH																	
7	WELL NO.	8		9		10		11		12		13		14																		
	CD. CTR.	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH	FM	DEPTH																	

APPENDIX "B"

AN INTRODUCTION TO THE
GEOSTOR
MAP-ORIENTED
DATA MANAGEMENT SYSTEM

by

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AN INTRODUCTION TO THE
GEOSTOR
MAP-ORIENTED
DATA MANAGEMENT SYSTEM

Abstract

GEOSTOR is a map-oriented data management system being developed at the University of North Dakota. The system was designed to support a computer-based surface-mine planning system and a model predicting changes in geological characteristics between coal test hole sites. Both projects were funded through the U. S. Forest Service.

GEOSTOR is unique among data management systems in three respects. All data entered into the system derive most of their value from being associated with the map location coordinates of the site from which they were collected. All data are organized into storage and retrieval structures that exploit the natural relationships among the data. The user interacts with the system using a comfortable dialogue.

The most important use of GEOSTOR is the production of maps from files of data managed by the system. The description of the location of a collecting site can be stored in one or more of several coordinate systems, including some unique to GEOSTOR. A few coordinate conversion programs reside within GEOSTOR, but most conversions must be done using programs external to GEOSTOR.

To produce a map, the user identifies the mapping program format, the Z-parameter to be mapped, and the set of collecting site data files from which the Z-parameter and (X,Y) coordinates are to be retrieved. GEOSTOR

searches the files for the requested data and prepares output files for the mapping program. In a similar manner, data can be retrieved for a statistical analysis or other program external to GEOSTOR.

Data structures for the storage and management of associated data are "hand-crafted" in cooperation with those who will be using the system. The result is a set of programs that take advantage of the natural relationships among the associated data for efficient data management and user service.

Some support programs have been developed to meet the needs of the initial users. An example is CROSSEC, a program that displays a geological cross section based on test hole data. Such support programs are expected to increase in number and capability as system use increases.

The design philosophy of GEOSTOR provides for efficient management of map-related data, using an interactive dialogue that is understandable by a person who is not familiar with computer operations. However, to reach that state of operation, considerable programming effort must be expended to prepare the programs for each data structure. Guidelines are provided, the most important of which is user consultation during program development.

GEOSTOR has greatest utility for those researchers and technicians who are very familiar with the kinds of data they are using and whose mapping and analysis operations are usually well defined. Those involved in surface mine planning, operation, and regulation would find GEOSTOR-assisted operations useful.

A version of GEOSTOR is operational at the North Dakota Geological Survey, where it is being used to manage petroleum test hole data and assist in geological and petroleum exploration research.

GHOSTOR needs considerable developmental work to move it past its prototype stage. The guidance of a professional programmer is especially needed to make the existing programs efficient and merge its various parts into an integrated system.

AN INTRODUCTION TO THE
GEOSTOR
MAP-ORIENTED
DATA MANAGEMENT SYSTEM

BACKGROUND

GEOSTOR is a map-oriented data management system being developed at the University of North Dakota. The system was designed to support a computer-based surface-mine planning system developed at Montana State University by the Surface Environment and Mining (SEAM) research group, and a stratigraphic model predicting changes in geological characteristics between coal test hole sites, under development at the University of North Dakota. Both projects were funded through programs of the U. S. Forest Service. An operational version of GEOSTOR, designed for management of coal test hole geologic data, will be delivered to the USFS in January, 1980. A prototype version is being used at the North Dakota Geological Survey.

GEOSTOR IS DIFFERENT

Unlike most commercially available data management systems, GEOSTOR is specifically designed to manage map-associated data. The system has application in all the natural sciences, geography, mineral extraction and its regulation, and some aspects of social science. Any operation for which maps of data are produced on a regular basis, or for which data derive much of their value from association with a map location, can use a version of GEOSTOR.

Many kinds of data can be collected at a site. Data with elements in common are grouped together within a single GEOSTOR data structure, identified by a Type Code. For example, shallow test hole geologic data are

grouped together, separately from overburden chemical or coal core data.

GHOSTOR programs take advantage of the natural relationships among the data of the Type, and the fact that data of the same Type are normally processed together, to promote efficient management of the data. All the data collected from the site, no matter how grouped into separate structures, are keyed to the identification parameters for the collecting site with which they are to be associated.

Finally, GHOSTOR interacts with the user with a dialogue tailored to his requirements. GHOSTOR operations are as simple and explicit as possible so that non-technical personnel will be comfortable with its use.

GHOSTOR AND GEOGRAPHY

The heart of the GHOSTOR system is its ability to associate data with map locations, including three-dimensional aspects. GHOSTOR can store a description of a collecting site location in one or more of several coordinate systems, some unique to GHOSTOR (Table 1). Some programs to convert coordinates among these systems reside within GHOSTOR, but most must be performed by outside programs at this time. Refinement of this capability is subject to availability of development resources.

MAPS FROM GHOSTOR

GHOSTOR is a librarian; no mapping programs reside within it. However, the system is specifically designed to produce the files of data that commercially available mapping programs can use to produce maps.

To produce a map from data managed by GHOSTOR, the user identifies the format required by the mapping program, the parameter to be mapped, and the set of collecting sites from which the parameter value and the (X,Y) coordinate of the site are to be retrieved. GHOSTOR then searches the files,

TABLE 1

LOCATION COORDINATE SYSTEMS USED BY GEOSTOR

LAND OFFICE GRID SYSTEM

Section, township, range, and up to four quarterings of the section; optional reference in feet from section boundaries. A variation references a site to a nearby section corner and calculates an arbitrary grid based on that origin.

LATITUDE AND LONGITUDE

Degrees, minutes, seconds, hundredths of seconds; decimal degrees.

UNIVERSAL TRANSVERSE MERCATOR (UTM)

LAMBERT CONFORMAL

North Dakota State Plane Coordinates.

NDGS Coordinates

An internal coordinate system based on a digitized 1:500,000 township outline map of North Dakota.

REAP Coordinates

A UTM-based coordinate system that eliminates reference to the UTM baseline passing through western North Dakota; developed by the state of North Dakota and valid only in the state.

ARBITRARY GRID

A grid system designed by the user.

retrieves the values, and prepares output files for use by the mapping program. For example, to produce a contour map of the elevation of the top of a coal bed, the user would specify the mapping program to receive the data, such as SURFACE II, a way to identify the coal bed, and the file containing the test hole data for the area to be mapped. The prompting dialogue of GEOSTOR guides the user through the operations.

OTHER USES FOR GEOSTOR

Map file production, although a prime function of GEOSTOR, is not its only use. The user can sift through data on file to retrieve values of parameters with certain characteristics. For example, a list can be prepared to show the ID's of the test sites for which overburden samples were collected. If you have a program that calculates the tonnage of coal in a lease area, GEOSTOR can retrieve the data needed to run the program. Similarly, GEOSTOR can feed data to statistical analysis programs. The system can also be used to maintain records of core samples, their collection sites, present storage locations, and the results of laboratory tests performed on them.

GEOSTOR DATA STRUCTURES

Each kind of data is stored within a data structure that exploits the natural relationships among the data for efficient management. Thus shallow test hole geologic data, coal core data, groundwater data, and overburden chemical data are all stored within their own structures, even though all may be associated with the same collection site, a single test hole. Each of these kinds of data requires custom handling for efficient management. Furthermore, data within a structure are normally processed together. Each

kind of data for which a structure is designed is called a Type. The GEOSTOR Types in operation or recommended at this stage of development are listed in Table 2.

THE PRICE OF GEOSTOR

Described above is the design philosophy for GEOSTOR. At this time, GEOSTOR is operational only with structures for coal test hole geologic data associated with projects at the University of North Dakota, and petroleum well data of the North Dakota Geological Survey. As it now exists, GEOSTOR is not a "canned" program ready for installation anywhere. The programs are public information, but they are presently operational only on an IBM machine with a VSPC timeshare system to support them. The programs are not particularly efficient because they were, for the most part, not written by professional programmers.

Development of the programs for a data structure of GEOSTOR requires close cooperation with the people who will use it. As a result, most programs will be tailored to the needs of a particular operation. This makes them very useful to the originator, but not generally acceptable nor necessarily adaptable to other users. I see this custom program development as both the strongest and weakest aspect of GEOSTOR. Custom program design is expensive; however, the product is superbly suited to the task at hand.

The GEOSTOR programs, as they now exist, provide a firm basis for the management of location description data associated with the collecting site, regardless of the kind of data collected at the site. Management of the specific kind of data collected at the site may require custom programming of storage structures and interactive dialogue to suit the ultimate user.

TABLE 2
GEOSTOR STORAGE AND RETRIEVAL STRUCTURES

Type Code	Description	Status
0	Location and system data	Operational
10	Test hole geological data	Operational
20	Coal quality data	Designed
30	Groundwater data	Recommended
40	Soil test data	Recommended
50	Overburden chemical data	Recommended
60	Overburden engineering data	Recommended
70	Surface biological (botannical) data	Recommended
80	Surface biological (zoological) data	Recommended
90	Mine operation data	Recommended
110	North Dakota Geological Survey petroleum well data	Operational

APPENDIX A

ANNOTATED DATA FILE

APPENDIX A

10 1BN74-198 17 9197402100.00FD 91.00 0.0 13 3 0 0 0
 20 BAUKOL-NOONAN, INC, MINOT, ND
 30 BAUKOL-NOONAN, INC, MINOT, ND; NDGS, GRD FKS, ND
 40 36142N 84WCABB2510S1458W26142N 84W 8050 6738 17639 18114
 41 THE DATA OF THIS HOLE ARE COMPLETE FOR ALL ITEMS EXCEPT
 42 FOR SUPPLEMENTARY DATA ENTRIES ASSOCIATED WITH THE HOLE
 43 SUPPLEMENTARY DATA ENTRIES ARE ILLUSTRATED FOR THE FIRST STRATUM.
 50 1 0 2900 6 1 0 1 1NO ? 0 2100.00 16.00----.. 3 2 1
 60 CLAY, SANDY, BROWN
 61 1 1 2 SUPP. INTEGER NO. 1 123456SUPP. INTEGER NO. 2 222
 62 2 1 1 SUPP. INTEGER NO. 3 333333
 63 1 2 2 SUPP. REAL NO. 1 1.0SUPP. REAL NO. 2 2.0
 64 1 3 1 SUPP. CHAR. NO. 1 CHAR. DATA 1
 70 2 1600 2900 2 1 0 1 1NO ? 0 2084.00 1.00----..
 80 CLAY, SANDY, BLUE
 90 3 1700 1220 2 18510 1 105LOCAL? 0 2083.00 0.33CCCCCLG
 100 LIGNITE (LOCAL? LIGNITE ABOVE KINNEMAN CREEK LIGNITE)
 110 4 1732 2900 2 1 0 1 1NO ? 0 2082.67 12.67----..
 120 CLAY, SANDY, BLUE
 130 5 3000 1220 2 18500 3 101KNCRLG 100 2070.00 1.33CCCCCLG
 140 LIGNITE (KINNEMAN CREEK LIGNITE; UPPER BED)
 150 6 3132 2000 2 18500 3 201KNCRLG 100 2068.67 0.59----UD
 160 CLAY (CLAY PARTING, KINNEMAN CREEK LIGNITE)
 170 7 3191 1220 2 18500 3 301KNCRLG 100 2068.08 3.58CCCCCLG
 180 LIGNITE (KINNEMAN CREEK LIGNITE; LOWER BED)
 190 8 3550 2900 2 1 0 1 1NO ? 0 2064.50 10.50----..
 200 CLAY, SANDY, BLUE
 210 9 4600 1220 2 18410 1 105LOCAL? 100 2054.00 0.17CCCCCLG
 220 LIGNITE (LOCAL? LIGNITE ABOVE HAGEL BED)
 230 10 4616 2900 2 1 0 1 1NO ? 0 2053.83 27.83----..
 240 CLAY, SANDY, BLUE
 250 11 7400 1220 2 1840001 101HAGLLG 100 2026.00 11.50CCCCCLG
 260 LIGNITE (HAGEL LIGNITE)
 270 12 8550 888 2 1 0 1 1NO ? 0 2014.50 5.50??????
 280 NO RECORD
 290 13 9100 999 1 0 0 BOTTOM

Non-Repeating Data

Repeating Data of
the Strata

File ID	Block ID	Literal ID	Date	Surface Elevation	Records and Units	Total Depth	Depth to Bedrock	Keys
10	1BN74-198		17 919740	2100.00	FD	91.00	0.0	13 3 0 0 0

Data Owner

20 BAUKOL-NOONAN, INC, MINOT, ND

Data Storage

30 BAUKOL-NOONAN, INC, MINOT, ND; NDGS, GRD FKS, ND

Location Data

40	36142N 84WCABB2510S1458W	26142N 84W	8050	6738	17639	18114
	Section, township, range, quarterings, feet from boundaries	LOGSFL Origin	LOGSFL Coordinates		NDGS Coordinates	

Comments about
the hole
(no limit)

41 THE DATA OF THIS HOLE ARE COMPLETE FOR ALL ITEMS EXCEPT
42 FOR SUPPLEMENTARY DATA ENTRIES ASSOCIATED WITH THE HOLE
43 SUPPLEMENTARY DATA ENTRIES ARE ILLUSTRATED FOR THE FIRST STRATUM.

First record, first
stratum

Stratum	Depth to top	Datatype Code	Keys	Name Data and Keys	Elev. of Top	Thick- ness	Symb.	Keys
50	1	0	2900 6 1	0 1 1NO ?	2100.00	16.00	----	3 2 1

Comments on stratum
(no limit)

60 CLAY, SANDY, BROWN

First supplementary
integer record
(two items)

Keys	Label 1	Value 1	Label 2	Value 2
61 1 1 2	SUPP. INTEGER NO. 1	123456	SUPP. INTEGER NO. 2	222

Supplementary integer
data, continued

Keys	Label 3	Value 3
62 2 1 1	SUPP. INTEGER NO. 3	333333

Supplementary Real Data
(Two items)

63	| 1 2 2	SUPP. REAL NO. 1	|	1.0	SUPP. REAL NO. 2	|	2.0
	Keys	Label 1		Value 1	Label 2		Value 2

Supplementary Character
Data (One item)

64	| 1 3 1	SUPP. CHAR. NO. 1	|	CHAR. DATA	|
	Keys	Label 1		Value 1	

15

Records of Second
Stratum

70	2	1600	2900	2	1	0	1	1	0	?	0	2084.00	1.00	----	..
80	CLAY, SANDY, BLUE														

Example of three strata,
all of which bear
the same name

130	5	3000	1220	2	18500	3	101	KNCR LG	100	2070.00	1.33	CCCC LG
140	LIGNITE (KINNEMAN CREEK LIGNITE; UPPER BED)											
150	6	3132	2000	2	18500	3	201	KNCR LG	100	2068.67	0.59	---- UD
160	CLAY (CLAY PARTING, KINNEMAN CREEK LIGNITE)											
170	7	3191	1220	2	18500	3	301	KNCR LG	100	2068.08	3.58	CCCC LG
180	LIGNITE (KINNEMAN CREEK LIGNITE; LOWER BED)											

Delimiter identifying
bottom of the hole

290	13	9100	999	1	0	0	BOTTOM
-----	----	------	-----	---	---	---	--------

APPENDIX B
SAMPLE GEOSTOR SESSION

The following is a sample GEOSTOR session printout. Not all capabilities of GEOSTOR are illustrated, particularly the file preparation routines, those used by mapping programs. Operator responses are underlined.

WELCOME TO GEOSTOR, THE MAP-ORIENTED DATA MANAGEMENT SYSTEM.
BEFORE YOU CAN USE GEOSTOR, YOU MUST IDENTIFY YOURSELF USING
THE FOUR-DIGIT IDENTITY CODE YOU HAVE BEEN PROVIDED.
ENTER YOUR IDENTITY CODE, OR ''9999'' FOR A DEMONSTRATION.
?9999

THANK YOU. THE CODE IDENTIFIES YOU AS A USER
AUTHORIZED ACCESS TO THE DATA OF THE PREPARED DATA
SET. SOME OF THE CHANGES YOU MAY MAKE TO THE DATA
SET WILL BE LABELED AS DONE BY YOU.

THIS IS A PROTOTYPE OF GEOSTOR, VERSION 1.UNDG,
NOVEMBER, 1979. THE SYSTEM IS DESIGNED BY
LARAMIE M. WINCZEWSKI OF THE GEOLOGY DEPARTMENT OF
THE UNIVERSITY OF NORTH DAKOTA, WITH MUCH OF THE
PROGRAM CODE WRITTEN BY HOWARD UMPHREY OF THE
NORTH DAKOTA GEOLOGICAL SURVEY. THIS VERSION ALSO
INCLUDES PROGRAMS, NOT SHOWN HERE, TO ENTER DATA
USING CARDS. THOSE PROGRAMS PREPARE THE FILES OF
DATA UPON WHICH THIS INTERACTIVE PROGRAM OPERATES.

THE TIMESHARE FEATURES OF THIS PROGRAM ARE
SUPPORTED BY THE IBM VSPC TIMESHARE SYSTEM AND
THE PROGRAMS ARE EXECUTED ON THE IBM 370/158
COMPUTER AT THE UNIVERSITY OF NORTH DAKOTA.

FUNDING FOR THE DESIGN OF THIS PROTOTYPE
SYSTEM IS BEING PROVIDED BY THE U. S. FOREST
SERVICE UNDER A COOPERATIVE AGREEMENT WITH THE
UNIVERSITY OF NORTH DAKOTA. COOPERATIVE SUPPORT,
IN THE FORM OF COMPUTER SERVICES AND CONSULTATION,
IS BEING PROVIDED BY THE DEPARTMENT OF GEOLOGY AND
THE NORTH DAKOTA GEOLOGICAL SURVEY. THE PROJECT
IS ADMINISTERED BY THE UNIVERSITY OF NORTH DAKOTA
ENGINEERING EXPERIMENT STATION.

THE PROTOTYPE VERSION OF GEOSTOR IS SCHEDULED
TO BE DELIVERED TO THE FOREST SERVICE IN JANUARY,
WITH MINOR MODIFICATIONS DELIVERED IN JULY, 1980.

A DATA SET, PREPARED IN ADVANCE, IS ASSUMED TO BE AN INPUT FILE OF THIS PROGRAM. YOU HAVE A CHOICE OF TWO KINDS OF OPERATIONS YOU MAY PERFORM ON THE DATA SET.

ENTER A '1' IF YOU WISH TO LIST ALL OR PART OF THE DATA SET AND/OR MODIFY VALUES.

ENTER A '2' IF YOU WISH TO RETRIEVE VALUES FOR USE WITH MAPPING, STATISTICAL ANALYSIS OR OTHER EXTERNAL PROGRAMS. (INOPERATIVE, BEING REVISED...)

ENTER A '0' IF YOU WISH TO EXIT THE PROGRAM.

ENTER THE VALUE:

?1

EACH KIND OF DATA PROCESSED BY GEOSTOR HAS A STORAGE AND RETRIEVAL STRUCTURE SPECIFICALLY DESIGNED FOR IT. YOU MUST IDENTIFY THE TYPE OF DATA TO BE PROCESSED. AT THIS TIME, ONLY TYPE 10 DATA, SHALLOW TEST HOLE GEOLOGIC DATA, CAN BE PROCESSED. ENTER A '10' TO PERFORM A PROCESSING DEMONSTRATION.

?10

WELCOME TO GEOSTOR LISTING AND MODIFICATION PROGRAM. IF YOU WISH INSTRUCTIONS, ENTER THE NUMBER '1', OTHERWISE, PRESS THE RETURN KEY

?1

THE DEMONSTRATION FILE OF TEST HOLE DATA IS PART OF A SET PROVIDED BY BAUKOL-NOONAN, INC., FOR THEIR MINE NEAR CENTER, NORTH DAKOTA. THE TEST DATA SET CONTAINS DATA FROM TEN TEST HOLES, NUMBERED FROM ONE TO TEN. A HOLE CAN BE IDENTIFIED BY ONE OF THESE NUMBERS, THE BLOCK ID. ALTERNATIVELY, EACH HOLE HAS A LITERAL ID, UP TO 16 CHARACTERS, WHICH CAN ALSO BE USED FOR IDENTIFICATION.

EACH STRATUM (BED) CAN BE IDENTIFIED BY ITS STRATUM ID NUMBER, WHICH IS ITS NUMBER IN SEQUENCE FROM THE LAND SURFACE. AN INDIVIDUAL BED, OR SEQUENCE OF RELATED BEDS, CAN BE LABELED WITH A BED NAME CODE. THESE CODES, WHICH CAN BE LISTED FOR YOU AFTER THESE INSTRUCTIONS, ALLOW YOU TO IDENTIFY THE SAME BED OR BEDS IN EACH HOLE OF THE SET.

YOU WILL BE PROVIDED WITH 'MENUS' OF PROCESSING OPTIONS. THE PROGRAM WILL GUIDE YOU THROUGH ALL STEPS IN WHAT WE HOPE IS AN EXPLICIT AND UNAMBIGUOUS MANNER.

PLEASE NOTE THE FOLLOWING CONCERNING THE ENTERING OF VALUES ON THE TERMINAL. WHEN YOU ARE ASKED TO ENTER A LITERAL VALUE, ONE WHICH IS NOT A NUMBER VALUE BUT CONSISTS OF LETTERS AND/OR NUMBERS, YOU WILL BE GIVEN A SET OF QUOTE MARKS ENCLOSING THE CHARACTERS YOU WILL BE CHANGING, OR SHOWING YOU THE RESTRICTIONS ON THE SIZE OF YOUR ENTRY.

FOR EXAMPLE, IF YOU ARE ALLOWED TEN PLACES, YOU MIGHT SEE:

'NORTHWEST '

?

TO WHICH YOU WOULD RESPOND, ENTERING THE NEW VALUE AFTER THE QUESTION MARK AND BELOW THE OLD:

'NORTHWEST '

?SOUTH

THE NEW VALUE WOULD THEN BE 'SOUTH

IF YOU ARE ASKED TO ENTER A NUMBER THAT CAN BE MORE THAN ONE PLACE, I.E., OTHER THAN THE DIGITS 0,1,2,3,4,5,6,7,8,9, YOU WILL BE PROVIDED WITH A GUIDE SHOWING THE SPACES YOU HAVE AVAILABLE FOR THE ENTRY. IF YOUR NUMBER DOES NOT HAVE A DECIMAL POINT, YOU MUST BE CERTAIN TO LEAVE NO BLANKS TO THE RIGHT, AS THESE CAUSE THE NUMBER YOU ENTERED TO BE MULTIPLIED BY TEN FOR EACH BLANK.

FOR EXAMPLE, UP TO EIGHT PLACES ARE ALLOWED FOR THE BLOCK ID. YOU WANT THE ONE LABELED 10.

YOU WILL SEE:

87654321

?

YOU WILL ENTER THE NUMBER 10 AS FAR AS POSSIBLE TO THE RIGHT, BELOW THE '21':

87654321

?

10

DECIMAL NUMBERS CAN BE ENTERED ANYWHERE IN THE FIELD, PROVIDED THE DECIMAL POINT IS INCLUDED IN THE ENTRY.

THANK YOU FOR PARTICIPATING IN THIS DEMONSTRATION.

ENTER '1' IF YOUR WANT A LIST OF BED NAME CODES AND DESCRIPTIONS OTHERWISE, PRESS THE RETURN KEY

?1

CODE SYMBOL	DESCRIPTION
8350 BSSTBT	BASE (CONTACT) OF SENTINEL BUTTE FORMATION
8310 SBBSSD	SENTINEL BUTTE FORMATION BASAL SAND
8400 HAGLLG	HAGEL LIGNITE BED
8410 LOCAL?	LOCAL LIGNITE BED ABOVE HAGEL LIGNITE BED
8500 KNCKRLG	KINNEMAN CREEK LIGNITE BED
8510 LOCAL?	LOCAL LIGNITE BED ABOVE KINNEMAN CREEK LIGNITE BED
8520 LOCAL?	LOCAL LIGNITE BED (SECOND) ABOVE KINNEMAN CREEK BED
8600 ANCKRLG	ANTELOPE CREEK LIGNITE BED

ENTER A '1' FOR A PROFILE OF THE DATA SET
OTHERWISE, PRESS THE RETURN KEY

?1

LITERAL ID	BLOCK ID	RECORDS	STRATA	TD (FT)
BN74-198	1	36	13	91.00
BN74-199	2	11	4	31.00
BN74-200	3	19	8	31.00
BN74-201	4	11	4	46.00
BN74-202	5	15	6	46.00
BN74-203	6	17	7	31.00
BN74-204	7	17	7	35.00
BN74-205	8	21	9	91.00
BN74-206	9	15	9	35.00
BN74-207	10	17	7	40.00

DO YOU WISH TO IDENTIFY A TEST HOLE
(1) BY ITS BLOCK ID NUMBER OR
(2) BY ITS LITERAL ID?

?1

ENTER THE BLOCK ID (RIGHT JUSTIFIED) OF THE DATA BLOCK TO BE PROCESSED
ENTER '99999' TO TERMINATE PROCESSING

87654321

? 1

MENU 'A'

BLOCK ID: 1 LITERAL ID: BN74-198

TO VIEW MENU 'B', ENTER '1'
TO VIEW MENU 'C', ENTER '2'
TO TERMINATE PROCESSING THIS BLOCK ENTER '3'
TO TERMINATE ALL PROCESSING, ENTER '4'

FOR A COMPLETE LISTING, ENTER '5'
FOR A PROFILE OF THE HOLE DATA, ENTER '6'

?6

HOLE DATA PROFILE

TOTAL DEPTH: 91.00
COMMENTS: 2
SUPPLEMENTARY RECORDS:
INTEGER: 0 REAL: 0 CHARACTER: 0

STRATA: 13 STRATA RECORDS: 29

PRESS 'RETURN' TO CONTINUE

?_

MENU 'A'

BLOCK ID: 1 LITERAL ID: BN74-198

TO VIEW MENU 'B', ENTER '1'
TO VIEW MENU 'C', ENTER '2'
TO TERMINATE PROCESSING THIS BLOCK ENTER '3'
TO TERMINATE ALL PROCESSING, ENTER '4'

FOR A COMPLETE LISTING, ENTER '5'
FOR A PROFILE OF THE HOLE DATA, ENTER '6'

75

BLOCK ID: 1 LITERAL ID: BN74-198

DATE DRILLED: 17/ 9/1974

SURFACE ELEVATION: 2100.00 F

DATA RECORDS:

DRILLER LOG:	YES
NATURAL GAMMA LOG:	NO
GAMMA DENSITY LOG:	NO
SELF-POTENTIAL LOG:	NO
RESISTIVITY LOG:	NO
SAMPLES SAVED:	NO
OTHER RECORDS:	NO

TOTAL DEPTH: 91.00 F

DEPTH TO BEDROCK: 0. F

DATA OWNER: BAUKOL-NOONAN, INC, MINOT, ND

DATA STORAGE: BAUKOL-NOONAN, INC, MINOT, ND; NDGS, GRD FKS, ND

LOCATION: 36 TWP 142N R1G 84W QTR CODES: CABB

2510 FEET FROM S LINE AND 1458 FEET FROM W LINE

LOGSFL ORIGIN: NW CORNER SECTION 26 142N 84W

LOGSFL Y-COOR: 8050 X-COOR: 6738

NDGS X-COOR: 17639 Y-COOR: 18114

COMMENTS ABOUT THE HOLE:

THE DATA OF THIS HOLE ARE COMPLETE FOR ALL ITEMS EXCEPT
FOR SUPPLEMENTARY DATA ENTRIES ASSOCIATED WITH THE HOLE
SUPPLEMENTARY DATA ENTRIES ARE ILLUSTRATED FOR THE FIRST STRATH.

THERE ARE 13 STRATA RECORDS

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
1	0.	2900	0	1 1	NO	?	2100.00	16.00	----..

CLAY, SANDY, BROWN

SUPPLEMENTARY NON-DECIMAL DATA FOR STRATUM 1

ITEM	LABEL	VALUE
1	SUPP. INTEGER NO. 1	123456
2	SUPP. INTEGER NO. 2	222
3	SUPP. INTEGER NO. 3	333333

SUPPLEMENTARY DECIMAL DATA FOR STRATUM 1

ITEM	LABEL	VALUE
1	SUPP. REAL NO. 1	1.00000
2	SUPP. REAL NO. 2	2.00000

SUPPLEMENTARY CHARACTER DATA FOR STRATUM 1

ITEM	LABEL	VALUE
1	SUPP. CHAR. NO. 1	CHAR. DATA 1

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
2	16.00	2900	0	1 1	NO	?	2084.00	1.00	----..

CLAY, SANDY, BLUE

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
3	17.00	1220	8510	1 1	05	LOCAL?	2083.00	0.33	CCCCLG

LIGNITE (LOCAL? LIGNITE ABOVE KINNEHAN CREEK LIGNITE)

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
4	17.32	2900	0	1 1	NO	?	2082.67	12.67	----..

CLAY, SANDY, BLUE

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
5	30.00	1220	8500	3 1	01	KNCR LG	2070.00	1.33	CCCCLG

LIGNITE (KINNEHAN CREEK LIGNITE; UPPER BED)

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
6	31.32	2000	8500	3 2	01	KNCR LG	2068.67	0.59	----UD

CLAY (CLAY PARTING, KINNEHAN CREEK LIGNITE)

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
7	31.91	1220	8500	3 3	01	KNCR LG	2068.08	3.58	CCCCLG

LIGNITE (KINNEHAN CREEK LIGNITE; LOWER BED)

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
8	35.50	2900	0	1 1	NO	?	2064.50	10.50	----..

CLAY, SANDY, BLUE

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
9	46.00	1220	8410	1 1	05	LOCAL?	2054.00	0.17	CCCCLG

LIGNITE (LOCAL? LIGNITE ABOVE HAGEL BED)

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
10	46.16	2900	0	1 1	NO	?	2053.83	27.83	-----..

CLAY, SANDY, BLUE

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
11	74.00	1220	8400	1 1	01	HAGLLG	2026.00	11.50	CCCCLG

LIGNITE (HAGEL LIGNITE)

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
12	85.50	888	0	1 1	NO	?	2014.50	5.50	??????

NO RECORD

STRATUM	DEPTH	DTCODE	NAME	DATA	CC	ABBRV	ELEVATION	THICKNESS	SYMBOL
13	91.00	999	0	0 0			0.	0.	BOTTOM

MENU 'A'

BLOCK ID: 1 LITERAL ID: BN74-198

TO VIEW MENU 'B', ENTER '1'
 TO VIEW MENU 'C', ENTER '2'
 TO TERMINATE PROCESSING THIS BLOCK ENTER '3'
 TO TERMINATE ALL PROCESSING, ENTER '4'

FOR A COMPLETE LISTING, ENTER '5'
 FOR A PROFILE OF THE HOLE DATA, ENTER '6'

?1

MENU 'B'

BLOCK ID: 1 LITERAL ID: BN74-198

ITEM	VALUE	TO CHANGE ENTER
LITERAL ID	BN74-198	'1'
DATE DRILLED	17/ 9/1974	'2'
SURF. ELEV.	2100.00F	'3'
UNITS	F	'4'
DATA RECORDS		
DRILLER LOG	YES	'4'
NATURAL GAMMA LOG	NO	'4'
GAMMA DENSITY LOG	NO	'4'
SELF-POTENTIAL LOG	NO	'4'
RESISTIVITY LOG	NO	'4'
SAMPLES SAVED	NO	'4'
OTHER RECORDS	NO	'4'
TOTAL DEPTH	91.00F	'5'
DEPTH TO BEDRX	0. F	'6'

TO VIEW MENU 'C', ENTER NUMBER '7'

TO TERMINATE PROCESSING THIS BLOCK, ENTER NUMBER '8'

?1

THE LITERAL ID OF THE SITE IS: 'BN74-198

IF YOU WISH TO MODIFY THE VALUE, ENTER A '1'

OTHERWISE, PRESS THE RETURN KEY

?1

TO MODIFY THE LITERAL ID VALUE, BN74-198

ENTER THE NEW VALUE DIRECTLY BELOW THE OLD

'BN74-198

?BN74-198XX

THE NEW VALUE FOR LITERAL ID IS: 'BN74-198XX

IF YOUR WISH TO TRY AGAIN, ENTER A '1'

OTHERWISE, PRESS THE RETURN KEY

?1

TO MODIFY THE LITERAL ID VALUE, BN74-198XX

ENTER THE NEW VALUE DIRECTLY BELOW THE OLD

'BN74-198XX

?BN74-198A

APPENDIX "C"

Examples of Well Data Stored in
Computer Library Program, GEOSTOR

=====

WELLNO=5103 T-R-S 155 86 36 DA 1980.5 660 E COUNTY:WARD
 OPERATOR: PETROLEUM, INC
 WELLNAME: STATE "H" #1
 PERMIT CANCELED: . . . PERMIT=5115 API#=33 101 143 COUNTY=101
 KB=2236 GL=. DF=. TDEPTH=6732 DEEPEST FM=MMFA BHT=135

FIELDNAME OR WILDCAT
 INITIAL PROD. GAS *10- OIL WATER CONDENSATE GOR CHOKE
 (MCF OR BPD) . . .
 PERFERATED INT. FM= TCP=0 BOTTOM=0
 STATUS=INITIAL:DRY HOLE FINAL:UNDEFINED
 COMPLETION . . . ABANDONED 10 7 71

LOGS RUN: SONL GRL DILL

SAMPLES IN CORE LIBRARY				STORAGE			
TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF
CUTTINGS		460	6730	.	.	.	.
CUTTINGS		6430	6732	.	.	.	.
CORE	MMFA	6606	6649	4	178	.	.

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	0	0	K.B.	MM	6060	-3824	K.B.
KM	3902	-1666	K.B.	MB	0	0	K.B.
J	4520	-2284	K.B.	DD	0	0	K.B.
TRS	5466	-3230	K.B.	SI	0	0	K.B.
PM	0	0	K.B.	ORR	0	0	K.B.
PNM	0	0	K.B.	CD	0	0	K.B.
MKLS	5893	-3657	K.B.	PC	0	0	K.B.

=====

WELLNO=5105 T-R-S 152 86 28 PB 750 N 660 W COUNTY:WARD
 OPERATOR: GENERAL CRUDE OIL CO
 WELLNAME: JEROME JENSEN #1
 PERMIT CANCELED: . . . PERMIT=5117 API#=33 101 144 COUNTY=101
 KB=0 GL=2108 DF=. TDEPTH=9620 DEEPEST FM=DW BHT=158

FIELDNAME OR WILDCAT
 INITIAL PROD. GAS *10- OIL WATER CONDENSATE GOR CHOKE
 (MCF OR BPD) . . .
 PERFERATED INT. FM= TOP=0 BOTTOM=0
 STATUS=INITIAL:DRY HOLE FINAL:UNDEFINED
 COMPLETION . . . ABANDONED 10 22 71

LOGS RUN: SONLGRNLDILL FOCUS LITHO

SAMPLES IN CORE LIBRARY				STORAGE			
TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF
CUTTINGS		0	9590	.	.	.	.
CORE	MMFA	6960	7010	5	178	.	.
CHIPS		6690	9010	.	.	.	.

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	0	0	G.L.	MM	0	0	G.L.
KM	0	0	G.L.	MB	0	0	G.L.
J	0	0	G.L.	DD	0	0	G.L.
TRS	0	0	G.L.	SI	0	0	G.L.
PM	0	0	G.L.	ORR	0	0	G.L.
PNM	0	0	G.L.	CD	0	0	G.L.
MKLS	0	0	G.L.	PC	0	0	G.L.

=====

WELLNO=5108 T-R-S 136 81 19 AD 1850 N 800 E COUNTY:MORTON

OPERATOR: POSEBUD ROYALTY CO

WELLNAME: LARRY MORRELL #42-19

PERMIT CANCELED: . . . PERMIT=5120 API#=33 59 18 COUNTY=59

KB=2017 GL=. DF=. TDEPTH=5180 DEEPEST FM=MMB BHT=110

FIELDNAME OR WILDCAT

INITIAL PROD. GAS #10- OIL WATER CONDENSATE GOR CHOKE

(MCF OR BPD)

PERFERATED INT. FM= TOP=0 BOTTOM=0

STATUS-INITIAL: DRY HOLE FINAL: UNDEFINED

COMPLETION . . . ABANDONED 9 23 71

LOGS RUN: DILLSONL GRL CHECK

SAMPLES IN CORE LIBRARY				STORAGE			
TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF
CUTTINGS		220	5180	.	.	.	.

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	752	1265	K.B.	MM	4454	-2437	K.B.
KM	2843	-826	K.B.	MB	0	0	K.B.
J	3220	-1203	K.B.	DD	0	0	K.B.
TRS	0	0	K.B.	SI	0	0	K.B.
PM	0	0	K.B.	ORR	0	0	K.B.
PNM	3900	-1883	K.B.	CD	0	0	K.B.
MKLS	0	0	K.B.	PC	0	0	K.B.

=====

WELLNO=5109 T-R-S 140 97 31 DD 510 S 660 E COUNTY:STARK

OPERATOR: MONSANTO COMPANY

WELLNAME: ZASTOUPIL #1

PERMIT CANCELED: 0 0 0 PERMIT=5121 API#=33 89 120 COUNTY=89

KB=0 GL=2580 DF=0 TDEPTH=8150 DEEPEST FM=MO BHT=184

FIELDNAME OR WILDCAT WILDCAT

INITIAL PROD. GAS #10- OIL WATER CONDENSATE GOR CHOKE

(MCF OR BPD) 0 0 0 0 0 . 0

PERFERATED INT. FM= TOP=0 BOTTOM=0

STATUS-INITIAL: DRY HOLE FINAL: PLUGGED & ABANDONED

COMPLETION 0 0 0 ABANDONED 9 26 71

LOGS RUN: LL BHC ACS

SAMPLES IN CORE LIBRARY				STORAGE			
TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF
CUTTINGS		600	7260	9	144	0	0
CUTTINGS		7260	8150	9	144	0	0

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	0	0	G.L.	MM	0	0	G.L.
KM	5088	-2508	G.L.	MB	0	0	G.L.
J	5780	-3200	G.L.	DD	0	0	G.L.
TRS	6700	-4120	G.L.	SI	0	0	G.L.
PM	7115	-4535	G.L.	ORP	0	0	G.L.
PNM	7350	-4770	G.L.	CD	0	0	G.L.
MKLS	0	0	G.L.	PC	0	0	G.L.

=====

WELLNO=5996

COUNTY:WARD

T-R-S 160 87 15 AC 1980 N 1980 E

OPERATOR: APEXCO, INC.

WELLNAME: O'CLAIR #1

PERMIT CANCELED:0 0 0 PERMIT=6008 API#=33 101 193 COUNTY=101

KB=1870 GL=0 DF=0 TDEPTH=5830 DEEPEST FM= BHT=100

FIELDNAME OR WILDCAT WILDCAT

INITIAL PROD. GAS *10- OIL WATER CONDENSATE GOR CHOKE
(MCF OR RPD) 0 0 0 0 0 0

PERFERATED INT. FM= TOP=0 BOTTOM=0

STATUS-INITIAL:DRY HOLE FINAL:PLUGGED & ABANDONED

COMPLETION 0 0 0 ABANDONED 10 24 76

LOGS RUN: DLL-GR FDC

SAMPLES IN CORE LIBRARY

TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF	TIER	SHELF
CUTTINGS		5540	5830	9	167	0	0	0	0

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	0	0	K.B.	MM	5246	-3376	K.B.
KM	3456	-1586	K.B.	MB	0	0	K.B.
J	3960	-2090	K.B.	DD	0	0	K.B.
TRS	4938	-3068	K.B.	SI	0	0	K.B.
PM	0	0	K.B.	ORR	0	0	K.B.
PNM	0	0	K.B.	CD	0	0	K.B.
MKLS	0	0	K.B.	PC	0	0	K.B.

=====

WELLNO=5999

COUNTY:BOTTINEAU

T-R-S 162 80 27 AC 1820 N 1820 E

OPERATOR: THE WISER OIL CO.

WELLNAME: WARNER #1

PERMIT CANCELED:3 16 78 PERMIT=6011 API#=33 9 1215 COUNTY=9

KB=0 GL=1488 DF=0 TDEPTH=0 DEEPEST FM= BHT=0

FIELDNAME OR WILDCAT

INITIAL PROD. GAS *10- OIL WATER CONDENSATE GOR CHOKE
(MCF OR RPD) 0 0 0 0 0 0

PERFERATED INT. FM= TOP=0 BOTTOM=0

STATUS-INITIAL:UNDEFINED FINAL:UNDEFINED

COMPLETION 0 0 0 ABANDONED 0 0 0

LOGS RUN:

SAMPLES IN CORE LIBRARY

TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF	TIER	SHELF
------	------	-------	-------	------	-------	------	-------	------	-------

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	0	0	G.L.	MM	0	0	G.L.
KM	0	0	G.L.	MB	0	0	G.L.
J	0	0	G.L.	DD	0	0	G.L.
TRS	0	0	G.L.	SI	0	0	G.L.
PM	0	0	G.L.	ORR	0	0	G.L.
PNM	0	0	G.L.	CD	0	0	G.L.
MKLS	0	0	G.L.	PC	0	0	G.L.

```
=====
WELLNO=6701 T-R-S 141 101 23 CD 680 S 1980 W COUNTY:BILLINGS
OPERATOR: JERRY CHAMBERS
WELLNAME: STATE OF ND #4-23
PERMIT CANCELED:0 0 0 PERMIT=6701 API#=33 7 287 COUNTY=7
KB=0 GL=2335 DF=0 TDEPTH=9400 DEEPEST FM= BHT=212

FIELDNAME OR WILDCAT T.R.
INITIAL PROD. GAS *10- OIL WATER CONDENSATE GOR CHOKE
(MCF OR BPD) 0 0 176 44 0 16
PERFERATED INT. FM=MM TOP=9123 BOTTOM=9182
STATUS-INITIAL:1 OIL & 0 GAS FINAL:UNDEFINED
COMPLETION 11 29 78 ABANDONED 0 0 0
=====
```

LOGS RUN: DLL-MSFLGR FDC-CNL TPG

SAMPLES IN CORE LIBRARY				STORAGE					
TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF	TIER	SHELF
CUTTINGS		9100	9146	10	227	0	0	0	0
CUTTINGS		9146	9199	10	227	0	0	0	0
CUTTINGS		9199	9400	10	227	0	0	0	0

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	0	0	G.L.	MM	8360	-6025	G.L.
KM	4813	-2478	G.L.	MB	0	0	G.L.
J	5645	-3310	G.L.	DD	0	0	G.L.
TRS	6514	-4179	G.L.	SI	0	0	G.L.
PM	6980	-4645	G.L.	ORR	0	0	G.L.
PNM	7318	-4983	G.L.	CD	0	0	G.L.
MKLS	8215	-5880	G.L.	PC	0	0	G.L.

```
=====
WELLNO=6000 T-R-S 140 100 28 BB 660 N 660 W COUNTY:BILLINGS
OPERATOR: SO UNION PRCD CO
WELLNAME: PATRICK REDMOND #1
PERMIT CANCELED:0 0 0 PERMIT=60120 API#=33 7 191 COUNTY=7
KB=0 GL=2786 DF=0 TDEPTH=8460 DEEPEST FM= BHT=196

FIELDNAME OR WILDCAT
INITIAL PROD. GAS *10- OIL WATER CONDENSATE GOR CHOKE
(MCF OR BPD) 0 0 0 0 0 0
PERFERATED INT. FM= TOP=0 BOTTOM=0
STATUS-INITIAL:PLUGGED & ABANDONED FINAL:UNDEFINED
COMPLETION 0 0 0 ABANDONED 11 15 76
=====
```

LOGS RUN: DLL CNL

SAMPLES IN CORE LIBRARY				STORAGE					
TYPE	FORM	UPPER	LOWER	TIER	SHELF	TIER	SHELF	TIER	SHELF
CUTTINGS		2500	7530	10	194	0	0	0	0
CUTTINGS		7530	8350	10	194	0	0	0	0
CUTTINGS		8350	8460	10	194	0	0	0	0

FORMATION TOPS							
FORM	DEPTH	ELEV	BASE	FORM	DEPTH	ELEV	BASE
KP	2092	694	G.L.	MM	0	0	G.L.
KM	5368	-2582	G.L.	MB	0	0	G.L.
J	6177	-3391	G.L.	DD	0	0	G.L.
TRS	7022	-4236	G.L.	SI	0	0	G.L.
PM	7538	-4752	G.L.	ORR	0	0	G.L.
PNM	7830	-5044	G.L.	CD	0	0	G.L.
MKLS	0	0	G.L.	PC	0	0	G.L.

APPENDIX "D"

Chemical Data Set

The following table lists chemical data contained in GEOSTOR which is not presented in map form in the text of this report.

A brief explanation of the table headings is necessary.

OBS - Internal observation number, not significant.

WELLNO - N.D.G.S. Well Number

TOWN, RANGE, SECT - Location of well; township; range and section.
(T162N, R91W, Section 6).

FM - , D, DB, etc. - The abbreviation of the formation tested.
See Appendix "A" for a complete listing of the abbreviations used. (___ = blank, Formation is unknown.)

TOP - Top of tested interval.

BOTTOM - Bottom of tested interval.

CA, MG, NA - The concentration of these cations in mg/l or ppm.

FE - The concentration of this cation in mg/l or ppm x 100.

CO3, HCO3, SO4, CL - The concentration of these anions in mg/l or ppm.

PH - The pH of the tested fluid x 100.

RESIST and F - The resistivity of the Formation fluid ($\rho \times 1000$) at the tested temperature ($^{\circ}\text{F}$).

TDS - Total dissolved solids in tested Formation fluid.

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
1	4130	138	105	9		8640	8701	14726	1744	107393			205	460	185000	670	47	68	309528
2	4359	139	103	5		9240	9310	863	132	7515			305	1256	12400	750	290	77	22471
3	4339	140	103	20		9150	9220	899	118	6458			329	1362	10700	740	335	77	19866
4	4304	146	104	33		11570	11624	16400	6561	108698	11700		644	1360	214420	560	38	77	359783
5	2230	147	96	36		10007	10039	14850	1416	105533			120	860	192480	590	50	68	315259
6	2665	153	94	30		10920	10975	24460	1740	94158			100	176	193400	640	52	68	314034
7	143	155	96	11		8397	8426	16128	1740	96989			176	302	182886	580	46	68	298221
8	42	156	95	16		8512	8537	6839	907	98943			330	1600	166000	620	52	68	274619
9	44	156	95	33		8641	8671	6423	6243	92098			305	613	171000	660	52	68	276682
10	497	156	96	36		8484	8516	10538	1180	79355			120	350	144160	620	50	68	235703
11	1503	157	87	17		6668	6681	17700	3340	94900			600	427	126000	680	46	68	242967
12	184	157	94	6		8272	8312	13056	1740	100511			207	274	182886	600	46	68	298674
13	82	157	95	1		8242	8290	13248	266	102182			188	266	185820	570	46	68	301970
14	256	157	95	2		8275	8320	13248	2204	100671			185	269	184842	610	46	68	301419
15	62	157	95	12		8258	8290	12672	1624	101805			190	288	183864	590	46	68	300443
16	649	157	95	13		8260	8268	12864	1624	96512			205	274	176040	620	46	68	287519
17	77	157	95	36		8323	8372	13056	1508	96516			212	280	176040	600	46	68	287612
18	290	157	95	36		8282	8310	13248	1392	96509			196	280	176040	620	46	68	287665
19	5183	158	81	33		4595	4622	6607	2430	98222			410	1422	169000	590	47	68	278091
20	231	158	94	8		8187	8217	12288	1856	98058			210	328	178040	630	46	68	290780
21	237	158	94	23		8340	8394	1751	482	92467				4256	144000				242956
22	460	158	94	30		8196	8233	12672	1392	98437			151	313	177996	620	46	68	290961
23	482	158	94	30		8214	8236	12672	1740	102854			215	268	185820	600	46	68	303569
24	482	158	94	30		8214	8236	12672	1740	102854			215	268	185820	600	46	68	303569
25	466	158	95	25		8274	8316	12864	1856	99400			149	300	181185	590	46	68	295754
26	298	158	95	26		8278	8335	12864	1508	97994			188	277	177996	630	46	68	290827
27	537	158	95	26		8268	8301	12864	1508	99901			173	299	180930	610	46	68	295675
28	541	158	95	26		8304	8332	12864	1508	100221			206	280	181419	590	46	68	296498
29	2705	161	78	19		3329	3355	2620	360	42668			112	4234	68310	670	77	68	118304
30	6684	161	85	2		6664	6728	25750	3756	79837			134	300	185000	620	65	68	294777
31	2214	161	92	3		10146	10147	7520	1390	110000	80			325	186000	630	1207	60	305315
32	2996	161	96	25		7554	7594	11328	1508	106839			171	579	188708	590	46	68	309133

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HC03	SO4	CL	PH	RESIST	F	TDS
33	1593	162	91	6		6095	6140	774	101	3640			2700	3540	3180	680	595	68	13935
34	3030	162	92	22		4288	4384	15	8	4500			1549	143	5900	820	650	68	12115
35	1492	163	91	23		5903	5916	7300	1450	73200			162	1510	129000	660	49	68	212622
36	1950	163	91	24		5841	5851	9504	1593	99072			170	1000	173440	610	46	68	284779
37	6	163	95	27															
38	254				D	10286	10346	4465	580	111908				272	182004	400	48	68	299229
39	644				D	3199	3216	1406	534	5457			245	3568	9688	640	360	68	20898
40	1495				D	10349	10366	21285	3245	103215				144	206220	460	51	68	334109
41	3448	130	107	12	D	7750	7803	677	103	17773			317	1800	27400	800	155	77	48070
42	3798	131	106	32	D	8042	8102	517	99	6024			586	2650	8200	740	390	77	18076
43	793	149	91	22	D	10045	10100	2160	73	32582			170	6946	49068	620	98	68	90999
44	1202	152	94	6	D			20240	1503	101815			100	162	197064	580	46	68	320884
45	1748	152	94	6	D	10747	10768	6435	2065	33803			135	124	69376	550	86	68	111938
46	1370	152	94	7	D			20614	1466	91523			25	142	181800	520	46	68	295570
47	4240	152	94	7	D	10693	10891	41804	790	59216			143	346	167560	570			269859
48	1567	152	95	12	D	10334	10351	22770	5605	87513				168	191490	500	51	68	307546
49	2148	155	95	7	D	10316	10365	16434	1298	118262			205	215	215000	530	49	68	351414
50	1231	155	96	2	D	10279	10460	49920	11020	24307			220	353	157560	600	50	68	243380
51	1231	155	96	2	D	10279	10460	49920	11020	22692			230	492	154960	600	50	68	239314
52	1982	155	96	12	D	10500	10501	36400	1980	129955	73000		110	120	264000	485			505565
53	2487	155	96	12	D	10266	10484	63000	6000	61187			10	72	223288	440	49	68	353557
54	1729	155	96	13	D	10152	10277	50304	3944	81635			200	166	226260	500	49	68	362509
55	2438	155	96	13	D	10211	10291	43200	3480	79770			137	126	209456	520	49	68	336169
56	2515	155	96	14	D	10322	10352	43607	146	90183			183	192	208119	581			342430
57	2515	155	96	14	D	10129	10305	55000	4500	61752			196	96	205504	510	49	68	327048
58	182	156	95	16	D	10267	10304	49995	5605	67938			475	208	209166	600	51	68	333387
59	1385	156	95	16	D	10090	10150	27048	3304	79949			270	362	180386	600	46	68	291319
60	1385	156	95	16	D	10330	10420	54880	6490	70154			280	122	216550	550	46	68	348476
61	2501	156	95	30	D	10316	10391	20640	2900	106555			30	291	209100	530	48	68	339516
62	2555	156	96	23	D	10461	10508	23040	3190	103983			120	363	210120	650	49	68	340816
63	1534	156	96	26	D			17150	2990	35658			146	338	98000	690	710	68	154282
64	1514	156	96	34	D	10456	10504	47040	4425	76335			295	216	213548	480	48	68	341859

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
65	528	157	89	25	D	8967	9051	48925	6090	64111			186	245	202924	520	47	68	322481
66	1002	157	84	10	D	10271	10328	54321	4060	63186			315	131	205138	640	49	68	327151
67	355	158		18	D	10155	10220	55100	6380	65855				144	217568	400	50	68	345047
68	1517				DB	3393	3400	3430	1593	60325			110	3766	100920	740	66	68	170144
69	1517				DB	3393	3400	3430	1593	60325			110	3766	100920	740	66	68	170144
70	4280				DB	9690	9734	13320	3420	90085			60	259	172300	610	48	68	279444
71	3859	135	83	34	DB	6038	6070	7840	1100	63597			60	2901	113000	680	57	68	188498
72	2584	145	101	16	DB	11020	11100	23925	2004	84951			37	179	179000	580	45	77	290096
73	793	149	91	22	DB	10326	10388	13800	1808	87990			92	547	164952	610	49	68	269189
74	607	149	93	24	DB	10850	11062	18200	4514	83753			355	626	173880	550	47	68	281328
75	607	149	93	24	DB	10850	11062	4600	488	33802			298	1748	60237	610	88	68	101173
76	4095	151	96	34	DB	11060	11088	25816	2071	77542			75	209	171125	600	48	68	276838
77	2373	152	95	1	DB	10380	10450	25650	2850	82098			85	310	180050	600	48	68	291043
78	3086	152	95	1	DB	10487	10565	24700	3400	87191			60	412	187800	520	48	68	303563
79	4618	156	103	17	DB	10494	10560	22306	1731	93911			315	439	189073	610			307775
80	1495				DD	10710	10785	14694	1344	100287			100	555	184140	570	49	68	301120
81	1689				DD	5788	5845	31360	4720	75735			120	344	185744	500	47	68	298023
82	2494				DD	11262	11405	41280	3480	82472			145	264	210120	560	50	68	337761
83	3160				DD	9895	9952	26970	3920	71639			75	429	169290	560	53	68	272323
84	4130	138	105	9	DD	10102	10192	19089	1962	67837			160	901	143375	670	52	68	233324
85	1678	139	101	2	DD	10766	10798	38417	2820	78635				122	197400	500	49	68	317394
86	3927	139	101	21	DD	10631	10686	33200	3250	79662			37	100	191000	610	51	68	307249
87	3044	143	92	27	DD	10033	10126	32300	5700	81330			1575	341	198050	720	50	68	319296
88	2853	143	101	5	DD	11209	11245	48222	3762	75500			85	99	208000	470	42	77	335668
89	5887	144	92	8	DD	10540	10600	1282	1307	135466			195	520	221000	530	58	68	359770
90	3492	146	90	25	DD	10070	10121	36811	4590	68960			769	280	191000	680	50	68	302410
91	4304	146	104	33	DD	11204	11281	35600	19440	70265	11200		161	1100	227200	590	37	77	364966
92	413	147	93	5	DD	10883	10898	25840	2552	32831			34	311	103554	480	60	68	165122
93	1744	148	95	7	DD	11577	11628	47520	4720	77484			670	232	216800	620	50	68	347426
94	2400	148	96	10	DD	11555	11607	50350	3990	75483			170	104	216979	560	51	68	347076
95	793	149	91	22	DD	10712	10724	1805	174	19379			160	5078	29754	630	150	68	56350
96	2750	149	96	36	DD	11281	11320	47232	4872	76353			108	139	215384	500	50	68	344088

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HC03	SO4	CL	PH	RESIST	F	TDS
97	2373	152	95	1	DD	10562	10640	35150	3420	82764			135	385	199465	590	49	68	321319
98	3086	152	95	1	DD	10658	10744	19950	3420	99276			37	444	198050	510	49	68	321177
99	2967	152	96	3	DD	10748	10950	35900	2725	45683			170	316	141600	640	53	68	226394
100	2967	152	96	3	DD	10748	10950	35900	2725	45683			170	316	141600	640	53	68	226394
101	2226	153	94	18	DD	11150	11278	56050	3400	70831			425	132	218000	600	50	68	348838
102	2841	153	94	29	DD	10858	10933	43500	4200	78084			278	53	209456	560	47	68	335571
103	2839	153	94	30	DD	10921	10979	57500	3600	69575			224	122	219336	530	48	68	350357
104	2602	153	95	6	DD	10266	10332	28000	6804	89884	12600		81	1150	207320	450	38	77	345839
105	1679	153	96	10	DD	10615	10668	44055	3540	79225			185	97	210296	560	47	68	337398
106	2375	155	96	10	DD	10151	10236	56050	5700	67053			230	120	219000	770	51	68	348153
107	1729	155	96	13	DD	10424	10490	62370	5900	63618			245	102	225472	540	50	68	357707
108	2147	155	96	23	DD	10376	10465	58900	2850	69659			205	78	219800	540	51	68	351492
109	2409	155	96	23	DD	10131	10208	57000	8550	62627			635	230	221844	570	50	68	350886
110	2092	156	95	17	DD	10464	10465	36135	3540	87023			185	268	208184	530	52	68	335335
111	2149	156	95	18	DD	10299	10350	57915	5900	64444				110	219000	580	52	68	347369
112	2344	156	95	19	DD	10314	10440	28215	2950	95964			75	300	206280	560	48	68	333784
113	2583	156	95	20	DD	10349	10423	15744	2088	100602			39	537	188700	520	46	68	307710
114	1820	156	96	35	DD	10160	10449	6500	660	39629			200	923	73755	690	75	68	121667
115	392	157	85	21	DD	7607	7645	17100	2840	31248			295	1076	85770	570	73	68	138329
116	1745	157	95	21	DD	10082	10205	58410	5900	66134			355	174	222220	550	50	68	353193
117	4665	158	95	6	DD	10178	10188	59000	4600	60700				50	211400	480	50	68	335750
118	3983	158	95	16	DD	10284	10329	19280	1960	90560			25	405	179200	600	47	68	291430
119	3983	158	95	16	DD	9980	10274	56800	8100	62844				71	221000	550	48	68	348815
120	2182	158	95	21	DD	10195	10274	64350	5300	64057			365	120	227820	550	50	68	362012
121	4514	158	95	24	DD	10105	10140	55000	14400	444963				69	208600	550	54	68	723032
122	4390	158	95	27	DD	10027	10065	44180	10692	69000			18	247	215840	480			339977
123	3899	158	95	28	DD	10076	10129	42250	3545	74648			120	225	200000	560	50	68	320788
124	265	158	95	35	DD	10046	10084	39250	5596	69605			145	185	192906	550	46	68	307687
125	2010	163	102	7	DD	8006	8049	15048	1888	112919			160	340	205960	610	49	68	336315
126	1679	153	96	10	DDB	11038	11069	79200	5900	45088			355	172	226556	570	50	68	357271
127	1679	153	96	10	DSR	10980	11015	81180	5900	49105			295	141	236312	560	51	68	372933
128	3827	162	78	20	DSR	4952	5005	11063	1558	87931			75	913	159029	740	49	68	260569

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
129	5279	157	76	34	DW	5079	5129	8016	1556	90788	16900		61	1003	158120	550	44	73	276444
130	5498	157	82	1	DW	6765	6821	31872	4228	79525			183	460	199000	610	52	68	315268
131	5281	158	75	16	DW	4784	4814	1964	511	28862	28700		610	5548	45380	650	105	73	111575
132	5283	158	77	34	DW	5240	5289	7415	462	88732	13200		134	1417	150321	650	50	74	261681
133	5277	162	77	11	DW			5691	1143	82403	7600		293	1903	138976	583	49	72	238009
134	4655	162	78	31	DW	5333	5365	7068	425	90712			185	1400	152650	720	42	68	252440
135	1835	133	72	20	JGS	2720	2738	51	27	1097		37	305	1950	201	830	2540	68	3668
136	3571				KDAK			170	18	3565			812	2485	3550	790	828	68	10600
137	4485				KDAK	5384	5424	351		5246			875	252	8023	740			14747
138	3339	139	101	12	KDAK			598	78		9700		671	1180	26636	700	190	74	38863
139	1764	162	95	29	KDAK	4615	4625	21	2	3296			2125	306	3666	770	840	68	9416
140	924	164	78	32	KDAK			18	4	1760		58	918	343	1900				5001
141	2923	137	100	15	KL			10	3	3185			122	230	4060	770	800	68	7610
142	1541				M	8485	8532	16600	2420	89400			131	543	174000	610	43	68	283094
143	3729				M	3010	3056	4890	2091	72467	5900		244	2196	124795				212583
144	4224				M	8985	9041	18546	2040	99639			195	460	192000	620	43	68	312880
145	3146	139	101	1	M	8008	8034	4650	1232	63930				760	109890	420	58	68	180462
146	893	161	79	21	M	3476	3509	4845	1276	48166			100	2663	84564	610	68	68	141614
147	2187	161	80	1	M	3438	3456	5346	1121	42620			110	2450	76596	720	75	68	128243
148	793	149	91	22	MB	9974	10054	2160	73	35716			145	7152	53766	620	91	68	99012
149	607	149	93	24	MB	10530	10712	1840	61	26137			305	7884	37756	620	110	68	73983
150	2996	161	96	25	MB	7906	7940	12288	1972	109742			60	158	196612	620	46	68	320832
151	613				MH	8249	8254	8700	976	91801			100	1091	158976	620	49	68	261644
152	2909				MH	8203	8221	13000	840	73544			44	739	138320	540	51	68	226487
153	1522	137	100	15	MH	8086	8103	7500	660	56121			166	532	101270	570	60	68	166249
154	2923	137	100	15	MH			4020	972	45669				527	80000	540	70	68	131188
155	3733	138	101	24	MH			3760	520	32961			220	788	58300	650	90	68	96549
156	5028	139	98	3	MH	8070	8112	16400	1215	95799	29900		112	1300	179630	410	41	77	324356
157	2395	139	100	6	MH	8124	8136	12144	1339	59290	2		100	307	116560	590	56	68	189742
158	2486	139	100	8	MH			12352	1280	63210	8900		92	300	122854	580	90	74	208988
159	518	139	100	9	MH	8245	8287	12100	1580	64200			110	674	124500	450	1134	71	203164
160	518	139	100	9	MH			10668	6699	52353			55	1260	118200	530	61	68	189235

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CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
161	3146	139	101	1	MH	8008	8034	4650	1232	63930				760	109890	420	58	68	180462
162	2928	139	101	3	MH	8237	8266	11200	1320	54791			264	452	107692	590	58	68	175719
163	3643	139	101	12	MH	8024	8052	9911	928	59176			245	459	111038	690	58	68	181757
164	1789	139	101	14	MH	7947	7960	1280	143	10600			438	1410	17800	550	232	68	31671
165	1789	139	101	14	MH			11590	644	66898				315	106182	840			185629
166	4009	139	101	20	MH			1836	256				321	820	53352	720	79	75	56585
167	3761	139	102	2	MH	7668	7710	13080	1300	99129			49	824	179200	680	48	68	293582
168	3761	139	102	2	MH	7768	7710	15240	1280	96415			85	766	178800	640	49	68	292586
169	3790	139	102	10	MH	7618	7655	12000	1280	94177			100	1045	169400	650	49	68	278002
170	3790	139	102	10	MH	7692	7750	9530	75		5		185	551	99800	650	62	68	110146
171	3829	139	102	23	MH			351		1881			297	889	2698	730			6116
172	4027	139	102	25	MH			14506	1366	64377			21	295	128865	520			209430
173	4027	139	102	25	MH			9023	759	37249			79	558	75260	610			122928
174	4077	139	102	27	MH	7800	7830	16544	1744	60641			60	284	127650	640	1136	60	206923
175	919	153	95	33	MH	7430	7483	14400	1464	108865			78	414	197316	450	46	68	322537
176	1536				MK	8172	8192	3600	120	104500			120	3860	165000	740	44	68	277200
177	1267	152	96	17	MK	7933	8019	4950	1560	83187			60	743	141036	640	51	68	231536
178	796	159	94	29	MK	6987	7027	4300	793	66498			98	1728	111159	620	57	68	184576
179	613				MKSS	8513	8553	8300	915	90412			44	397	156492	480	49	68	256560
180	2805				MKSS	7890	7909	369	30	9616			490	6057	10820	710	300	68	27382
181	3160				MKSS	7750	7808	7254	896	81324			60	367	140580	600	51	68	230481
182	4280				MKSS	8011	8030	190	57	4598			490	6592	2420	840	630	68	14347
183	1508	139	101	10	MKSS	8178	8222	451	100	21503			365	4387	30809		150	68	57615
184	4642	140	102	30	MKSS	8172	8220	380	480	35889			120	2250	55700	720	95	68	94819
185	1469	149	96	25	MKSS	8345	8464	7742	1160	110193			85	454	186664	590	46	68	306298
186	882	151	95	8	MKSS	8062	8152	4465	522	103258			102	2161	167040	530	47	68	277548
187	1111	152	95	1	MKSS	7697	7766	6534	1020	804			54	804	166260	500	48	68	175476
188					MM	6322	6412	9785	1798	107593			440	652	187776	600	46	68	308044
189	60				MM	8473	8488	13900	2060	99977			245	363	184400	680	47	68	300945
190	183				MM	8564	8610	12376	914	79			195	352	147300	700	49	68	161216
191	442				MM	8500	8560	12948	1598	82401			195	267	154360	730	49	68	251769
192	613				MM	9488	9499	860	49	18591			415	3761	27324	660	160	68	51000

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
193	629				MM	8197	8217	11920	1500	102041			185	205	182600	710	46	68	298451
194	850				MM	9080	9170	969	52	5053			475	2814	7308	660	460	68	16671
195	1018				MM	8279	8287	11805	1370	96133			135	334	172838	730			282615
196	1450				MM	4590	4610	3504	783	38846			365	3671	65480	730	81	68	112649
197	1464				MM	8684	8694	1270	109	29200			180	2870	45500	570	110	68	79129
198	1487				MM	5555	5577	10780	2006	104280			380	583	185120	620	46	68	303149
199	1539				MM	4399	4415	2450	3009	46495			110	2320	83048	710	72	68	137432
200	1574				MM	9045	9085	266	42	1478			295	950	2000	740	1400	68	5031
201	1689				MM	4512	4539	6076	1770	91889			270	1644	156275	550	47	68	257924
202	1794				MM	4526	4558	7700	1460	104600			210	2900	177000	670	43	68	293870
203	2117				MM	9018	9046	10890	354	117138			120	1060	200128	630	49	68	329690
204	2412				MM	6303	6356	3610	684	48642			245	3400	80759	720	70	68	137340
205	2554				MM	4514	4525	6528	1392	105315			132	1051	177200	630	47	68	291618
206	2614				MM	4554	4574	6200	1260	108393			330	112	181560	620	46	68	297855
207	2617				MM	4559	4572	6200	1440	103338			365	1287	173400	640	47	68	286030
208	2633				MM	4558	4573	5500	1140	87822			224	2043	146880	650	50	68	243609
209	2663				MM	4519	4529	6700	1458	106789			305	889	180000	730	50	68	296141
210	2696				MM			5962	1568	92566			317	959	162000	640	52	68	263372
211	2729				MM	4730	4761	7600	1440	103440			285	1100	176220	640	47	68	290085
212	2826				MM	8112	8173	3100	1080	121284			98	2716	193648	560	46	68	321926
213	2835				MM	4564	4581	6700	1620	101323			400	974	171912	590	47	68	282929
214	2926				MM	4560	4580	7600	840	104307			366	962	175864	610	47	68	289939
215	3116				MM	4600	4620	6460	1824	101698			278	1129	172617	540	47	68	284006
216	3145				MM	4583	4603	6080	1720	97142			340	1507	164300	550	48	68	271089
217	3160				MM	8310	8357	16740	2352	94296			195	869	181170	610	49	68	295622
218	3194				MM	4499	4512	5194	1298	74472			390	2311	125913	620	53	68	209578
219	3571				MM			9020	1820	105960			279	583	184250	630	41	68	301912
220	3749				MM	3998	4015	3620	700	45303			170	3288	75800	760	72	68	128881
221	3838				MM	5294	5909	8000	1361	107019			429	530	182470	490	41	77	299809
222	3914				MM	4240	4265	5640	1420	98770			85	1129	165600	680	48	68	272644
223	4127				MM	4576	4583	6500	1260	104939			270	895	176220	610	47	68	290084
224	4150				MM			17000	1955	83929			159	207	165000	640	43	77	268250

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
225	4250				MM	8788	8848	24400	10935	94829	14600		166	1700	213710	530	38	77	360340
226	4280				MM	8686	8734	209	80	813			230	984	997	800	2300	68	3313
227	6966				MM			600	80	4733	400		29	9	5461	810	41	77	11312
228	7087				MM	6300	6424	7615	1094	100100			372	2110	174400	670	42	77	285691
229	7127				MM	8838	8901	16232	122	99500	260		1227	1130	184000	822	43	77	302471
230	1575	129	106	9	MM	6855	6869	568	89	1800			355	1778	2523	680	1000	68	7113
231	6322	130	91	7	MM	6310	6220	20942	3586	88000	2400		116	345	188000	559	43	77	303389
232	1446	130	103	34	MM	7319	7395	2097	248	20455			280	4152	32760	720	140	68	59992
233	43	132	78	8	MM	3569	3599	1682	608	27919	400		166	6226	43126	725	99	79	80127
234	511	134	96	24	MM	8023	8110	2660	580	18841			730	700	34518	680	140	68	58029
235	3859	135	83	34	MM	5112	5148	6000	1640	72384			220	2329	125200	730	54	68	207773
236	1926	136	93	35	MM	7819	7884	6138	1475	118672			185	1100	197288	650	47	68	324858
237	6243	137	92	26	MM	7710	7752	11623	2431	96000	3700		320	293	180480	612	40	77	294847
238	1396	137	100	14	MM			15250	2850	63919			170	251	133600	710	52	68	216040
239	849	138	100	34	MM	9168	9192	874	58	9530			415	1544	15034	660	260	68	27455
240	4091	138	102	10	MM	9016	9042	1200	109	8288			500	1749	13644	690	280	68	25490
241	4525	138	104	16	MM	9182	9198	500	60	2302			290	950	3740	700	910	68	7842
242	3695	138	703	11	MM	8739	8796	16678	1450	98654			60	672	185377	630	49	68	302891
243	375	139	100	4	MM			130	17	2163			486	1950	1904	760			6650
244	375	139	100	4	MM	9434	9451	50	20	2849			185	864	3796	700	860	68	7764
245	522	139	100	4	MM	9415	9422	1700	366	18478			720	5382	28188	640	160	68	54834
246	2577	139	100	4	MM	9415	9422	608	342	17063			190	1114	27460	610	170	68	46777
247	291	139	100	9	MM	9404	9430	132	17	3111			535	1646	3557	750	830	68	8998
248	625	139	100	9	MM			130	12	2544			389	2625	2013	765			7713
249	794	139	100	9	MM	9425	9435	8400	2697	1470	16800		610	1010	24140	550	430	68	55127
250	448	139	100	10	MM	9390	9403	6745	2204	1336			380	868	19560	540	230	68	31093
251	598	139	100	10	MM	9444	9476	1748	139	25386			440	5283	38502	660	130	68	71498
252	598	139	100	10	MM	9240	9291	1748	139	25386			440	5283	38502	660	130	68	71498
253	738	139	100	15	MM			104	11	2596			445	2625	2027	800			7808
254	739	139	100	16	MM			139	17	2677			542	3000	1904	770			8279
255	795	139	100	16	MM			1330	112	1370	180		418	955	6580	620			10945
256	1855	139	101	2	MM			77	1	943			940	220	884	670	2550	68	3065

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
257	4325	139	101	3	MM			11928	2538	99280			170	1275	180600	640	46	68	295791
258	1508	139	101	10	MM			298	45	1636			281	825	2405	780	1460	74	5490
259	2725	139	101	10	MM	9349	9402	1862	209	8358			305	786	16038	670	270	68	27558
260	3268	139	101	10	MM	9110	9132	260	35	1406			245	778	2014	770	1520	68	4738
261	1789	139	101	14	MM			277	17	1642			261	1138	1763	730			5098
262	3761	139	102	2	MM	8929	8935	295	41	1647			245	930	2353	760	1320	68	5511
263	3928	139	102	3	MM			351	30	4727			267	1017	7100	710			13492
264	4268	139	102	8	MM	9040	9059	400	80	3465			355	1022	5325	740	650	68	10647
265	3573	139	102	11	MM	8844	8869	21160	2890	96444			205	254	194320	600	46	68	315273
266	3573	139	102	11	MM	9260	9280	280	42	1445			255	720	2167	700	1350	68	4909
267	3939	139	102	15	MM	8974	8979	1210	154	5869			214	860	10880				19187
268	4012	139	102	22	MM	8861	8877	725	80	5838			120	1765	9150	760	400	68	17678
269	3829	139	102	23	MM			501		3731			278	803	5893	720			11206
270	3829	139	102	23	MM			351		1587			303	844	2272	730			5357
271	4019	139	102	26	MM			220	110	1115			185	831	1709	780	1670	68	4170
272	4627	139	103	5	MM	9146	9194	4200	420	25887			130	3200	46150	720	110	68	79987
273	2768	140	100	4	MM	9816	9856	499	70	4868			330	678	7904	730	490	68	14349
274	4642	140	102	30	MM			401	61	2921			464	1174	4260	730	690	68	9281
275	824	141	91	8	MM	7794	7869	1560	268	19573			342	5124	29754	640	160	68	56621
276	3044	143	92	27	MM	8470	8508	15744	2320	104698			234	512	195600	550	46	68	319108
277	552	143	100	17	MM	8257	8266	11995	1827	95052			145	328	172838	700	47	68	282185
278	552	143	100	17	MM	8257	8266	14046	1154	90481			185	235	167500	700	47	68	273601
279	2853	143	101	5	MM	9773	9818	5076	1026	54290			415	639	95000	640	54	77	156446
280	2853	143	101	5	MM	9543	9588	4512	855	57818			354	3325	97000	670	52	77	163864
281	3199	144	92	16	MM	8689	8763	16554	2352	841644			185	718	165330	600	50	68	1026783
282	2798	144	99	9	MM	9968	10058	9328	928	110802			305	332	189696	610	46	68	311391
283	2689	144	99	21	MM	9910	9952	12800	1080	113071			224	271	199875	610	47	68	327321
284	2788	144	99	33	MM	10126	10149	11712	1044	107883			315	397	189696	630	46	68	311047
285	4419	144	102	14	MM	9315	9360	4607	825	88984			244	2263	146000	670	51	77	242923
286	734	145	91	17	MM	8709	8721	19392	2668	98954			246	233	192660	550	48	68	314153
287	2821	145	99	3	MM	9981	10049	17088	1508	104619			222	338	195624	560	46	68	319399
288	2678	145	101	23	MM	9462	9517	15400	167	112022			171	477	200000	700	42	77	328237

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
289	1516	146	82	32	MM	6139	6165	9408	2596	101184			220	900	179494	710	46	68	293802
290	826	146	91	11	MM	8568	8610	34200	5220	84475			180	350	205668	600	46	68	330093
291	6894	146	103	5	MM	9290	9405	10421	1459	105800			146	1450	193600	592	44	77	312876
292	413	147	93	5	MM	8930	8950	22800	1160	90204			380	862	182004	540	49	68	297410
293	2848	147	93	8	MM	9192	9245	20000	4200	96924			205	546	196612	570	46	68	318487
294	6663	147	104	3	MM	9270	9370	9740	584	113900			85	864	184400	570	46	68	309573
295	2352	148	95	18	MM	9894	10005	17622	1770	99159			315	470	188760	640	47	68	308096
296	2400	148	96	10	MM	9614	9700	20900	2052	101967			255	860	199460	650	51	68	325494
297	793	149	91	22	MM	8553	8583	2520	439	126994			406	465	201042	620	46	68	331866
298	1469	149	96	25	MM	9400	9463	32830	3835	86098			120	253	201818	570	46	68	324954
299	3089	150	79	14	MM	5128	5115	7790	2280	101474			396	920	176040	540	47	68	288900
300	1309	150	94	20	MM	9205	9350	15444	2040	87552			440	845	167440	640	48	68	273761
301	2383	150	94	30	MM	9291	9329	13300	1600	104737			355	1060	188762	650	47	68	309814
302	1798	150	95	2	MM	9384	9447	17028	2006	92477			500	750	177776	670	48	68	290537
303	1542	150	95	6	MM			14000	1520	83893			475	173	158200	720	50	68	258261
304	1716	150	95	9	MM	9080	9142	35770	4130	77869			60	392	195120	450	47	68	313341
305	1792	150	95	15	MM	9304	9363	14652	1888	96794			660	545	179944	630	47	68	294483
306	2032	150	95	15	MM	9300	9366	14454	1888	94177			245	570	175780	690	48	68	287114
307	1938	150	95	16	MM	9319	9354	15642	1888	92755			245	680	175608	620	47	68	286818
308	1459	150	95	18	MM	9270	9327	14504	2006	96721			575	605	179920	670	46	68	294331
309	1854	150	96	17	MM	9518	9564	16038	2006	92633			305	324	176692	640	47	68	287998
310	1849	150	96	29	MM	9526	9550	15642	1770	96366			405	292	181028	680	46	68	295503
311	1606	150	97	35	MM	9560	9627	18620	2242	85982			414	555	171456	560	47	68	279269
312	1746	151	96	8	MM	9380	9435	18612	2242	106231			415	510	202708	620	48	68	330718
313	1305	151	96	34	MM	9312	9423	17325	2700	101294			195	663	194166	650	46	68	316343
314	920	151	97	11	MM	9440	9500	16150	2900	105643			170	500	199512	600	46	68	324875
315	1202	152	94	6	MM			20000	1450	97997			110	148	190600	650	46	68	310305
316	1202	152	94	6	MM			17600	3604	152627			102		333000	590			506933
317	1262	152	94	6	MM			14300	1450	76517			140	370	147200	730	50	68	239977
318	1265	152	94	6	MM			21900	1700	92225			110	131	185800	690	46	68	301866
319	1432	152	94	6	MM	8877	8991	19600	2832	100553			85	523	197600	600	46	68	321193
320	1279	152	94	7	MM			13350	1450	66842			185	329	130600	680	53	68	212756

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
321	1342	152	94	7	MM			10472	1142	53927			160	551	104540	700	60	68	170792
322	1370	152	94	7	MM			14750	1450	82133			85	222	156800	660	48	68	255440
323	1417	152	94	7	MM			8188	686	99296			25	317	169400	690	47	68	277912
324	1512	152	94	8	MM			30464	2626	85792			135	288	193600	630	50	68	312905
325	1254	152	94	17	MM	8944	8975	17622	2800	100102			176	603	193200	640	47	68	314503
326	1398	152	94	17	MM			19992	800	93740			195	276	181980	640	47	68	296983
327	1499	152	94	17	MM			16946	1028	91193			185	358	173272	670	48	68	282982
328	1440	152	94	18	MM			19040	1028	106974			270	262	201340	640	46	68	328914
329	1468	152	94	18	MM			18100	4000	86581			195	165	177000	720	47	68	286041
330	1111	152	95	1	MM			18100	2300	78009			170	214	158800	690	49	68	257593
331	1144	152	95	1	MM			20560	2056	85657			230	166	174240	690	48	68	282909
332	1250	152	95	1	MM			12850	3700	68180			135	284	138400	660	52	68	223549
333	1255	152	95	1	MM			20182	2398	87696			205	185	177714	690	47	68	288380
334	1323	152	95	1	MM			14280	2280	71182			185	372	141328	720	53	68	229627
335	1350	152	95	1	MM			13800	2550	72346			170	194	143200	730	50	68	232260
336	1352	152	95	1	MM			14661	1142	73485			205	276	142296	710	52	68	232065
337	1372	152	95	1	MM			12380	1256	67783			185	407	129712	740	53	68	211723
338	1571	152	95	2	MM			19230	1256	88701			205	198	174240	690	48	68	283830
339	1711	152	95	2	MM			20182	1941	87567			205	194	176176	690	48	68	286265
340	2035	152	95	2	MM			16755	2170	84222			230	298	165528	690	48	68	269203
341	2480	152	95	2	MM			19992	2284	65078			170	25	142296	680	51	68	229845
342	1114	152	95	5	MM			15488	1256	93109			245	407	174240	700	470	68	284745
343	1474	152	95	5	MM			12186	1485	68793			160	354	131648	720	53	68	214626
344	1862	152	95	5	MM			17618	1941	90602			270	337	176176	690	46	68	286944
345	1088	152	95	6	MM	9053	9063	14208	812	83503			205	255	156000	700	48	68	254983
346	1162	152	95	6	MM			16184	1598	92238			185	354	175200	670	47	68	285759
347	2030	152	95	6	MM			18973	1599	89662			270	272	176176	670	46	68	286952
348	1218	152	95	7	MM			18005	2284	91306			245	177	179080	660	46	68	291097
349	1360	152	95	7	MM			11616	1485	61554			465	539	118096	730	56	68	193755
350	1504	152	95	7	MM			16946	342	86196			280	235	163600	670	49	68	267599
351	1601	152	95	7	MM			14280	1598	77622			183	635	149080	640	50	68	243398
352	4013	152	95	7	MM			17326	1028	95181			280	358	180040	670	46	68	294213

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
353	1310	152	95	8	MM			18850	2056	92676			270	210	181984	700	46	68	296046
354	1312	152	95	8	MM			18392	1941	87175			195	337	172304	670	47	68	280344
355	1419	152	95	8	MM			17517	2398	87258			205	210	172304	690	47	68	279892
356	1555	152	95	8	MM			16843	2056	85015			255	386	166496	710	48	68	271051
357	1557	152	95	8	MM			18198	1713	92141			185	177	179080	680	46	68	291494
358	1558	152	95	8	MM			18779	1941	102992			185	227	197472	680	46	68	321596
359	1596	152	95	8	MM			17618	2056	83401			245	190	165528	680	48	68	269038
360	1846	152	95	11	MM	8555	9060	23760	2950	95412			255	508	197288	620	47	68	320173
361	1344	152	95	12	MM			20950	2300	90402			185	148	183000	650	46	68	296985
362	1351	152	95	12	MM			20950	2850	87728			230	131	177200	660	47	68	289089
363	1567	152	95	12	MM			20940	3420	91381			160	135	187800	650	46	68	303836
364	2034	152	95	12	MM			25320	2280	74149			120	303	165528	670	50	68	267700
365	1277	152	95	16	MM			20563	2284	89650			245	226	181016	690	46	68	293984
366	1181	152	95	17	MM			21490	1713	85931			295	251	175208	690	47	68	284888
367	1200	152	95	17	MM			20909	1941	94448			270	527	187792	690	46	68	305887
368	1241	152	95	17	MM			15101	1941	67062			195	251	135520	720	51	68	220070
369	1284	152	95	17	MM			16456	2170	81364			205	186	160688	690	49	68	261069
370	1331	152	95	17	MM			17424	1941	55676			295	309	121968	720	55	68	197613
371	1361	152	95	17	MM			19554	1827	94256			245	382	184888	690	46	68	301152
372	1488	152	95	17	MM			18005	1827	92878			270	325	180048	710	46	68	293353
373	1256	152	95	18	MM			24006	3426	93577			255	206	196504	630	46	68	317974
374	1295	152	95	18	MM			17618	2741	94064			245	259	183920	640	46	68	298847
375	1423	152	95	18	MM	9210	9234	26880	2784	88236			315	319	191360	580	46	68	309894
376	1562	152	95	18	MM			19040	1598	91497			255	341	179080	660	46	68	291811
377	948	152	95	19	MM	9229	9269	28512	3120	87775			264	217	194622	520	46	68	314510
378	1156	152	95	19	MM			25362	1941	76566			230	94	168432	640	48	68	272625
379	1327	152	95	19	MM			25132	1142	85333			255	263	179080	650	48	68	291205
380	1065	152	95	20	MM			25749		1941			245	123	176176	650	46	68	204234
381	1143	152	95	20	MM			21706	1126	88344			205	198	177693	680	47	68	289272
382	1242	152	95	20	MM			27685	1941	92226			255	337	196504	670	46	68	318948
383	1285	152	95	20	MM			26717	2741	93682			145	370	199408	640	46	68	323063
384	1289	152	95	20	MM			22845	1599	85165			205	210	176176	640	47	68	286200

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
385	1316	152	95	20	MM			24974	2284	82701			160	280	178112	670	46	68	288511
386	1433	152	95	20	MM			16456	1599	54873			295	205	118096	710	56	68	191524
387	1193	152	95	29	MM			27878	2512	83293			230	144	184888	640	48	68	298945
388	1246	152	95	29	MM			28846	2170	89255			205	478	194568	650	46	68	315522
389	1317	152	95	29	MM			25168	2284	94439			220	309	196504	660	46	68	318924
390	1330	152	95	29	MM			23813	2170	94224			295	37	193600	660	46	68	314139
391	1066	152	95	30	MM	9276	9295	26740	3000	90396			200	331	195132	570	46	68	315799
392	2661	152	95	32	MM			24974	2056	90642			205	202	189728	670	46	68	307807
393	147	152	96	15	MM	9066	9110	200		131032			241	13364	192096	1030	46	68	336933
394	1267	152	96	17	MM	9001	9060	18216	2520	100533			185	506	194166	650	46	68	316126
395	1085	152	96	24	MM	9264	9356	20988	1920	97483			280	365	192666	550	46	68	313702
396	41	152	96	26	MM	9083	9116	29300	2840	88348			176	412	196000	580	53	68	317076
397	2645	153	94	21	MM	9454	9548	13600	1920	102186			220	665	186660	640	46	68	305251
398	1282	153	94	32	MM			13709	1827	75160			195	272	145200	710	51	68	236363
399	1319	153	94	32	MM			16755	2056	85050			270	235	166496	700	49	68	270862
400	1335	153	94	32	MM	8912	9000	21120	2900	88487			245	230	182000	660	46	68	294982
401	1335	153	94	32	MM	8912	9000	3120	435	16531			49	273	31875	840	145	68	52283
402	2316	153	94	32	MM			10662	1713	60107			220	384	116160	710			189246
403	1269	153	94	33	MM			20754	1828	68270			75	238	147136	690	51	68	238301
404	1563	153	94	33	MM			13800	2850	89424			170	218	170400	720	47	68	276862
405	1886	153	94	33	MM	9289	9360	19404	1770	94868			280	404	185364	670	47	68	302090
406	786	153	95	6	MM	8356	8394	29450	2320	24958			34	352	97092	500	65	68	154206
407	542	153	95	7	MM	8718	8776	16400	1830	35446			15	378	88740	620	66	68	142809
408	78	153	95	16	MM	8914	8963	20200	1220	91833			308	212	180612	610	46	68	294385
409	283	153	95	16	MM	8867	8907	12508	2784	98623			248	221	182004	530	48	68	296388
410	283	153	95	16	MM	8868	8904	18816	2714	96790			255	193	190210	660	46	68	308978
411	1084	153	95	20	MM	9166	9201	16236	1680	90792			170	630	173106	520	47	68	282614
412	397	153	95	25	MM	9105	9171	16720	2320	89309			318	382	173636	570	50	68	282685
413	3167	153	95	31	MM	8728	8935	14550	1910	86617			270	216	164600	670	50	68	268163
414	3167	153	95	31	MM	8728	8935	14550	1910	86617			270	216	164600	670	50	68	268163
415	919	153	95	33	MM	8960	9020	13490	1856	106871			160	524	193644	600	46	68	316545
416	1131	153	95	35	MM	9036	9139	15642	1920	93575			292	573	177018	550	46	68	289020

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
417	1679	153	96	10	MM	8890	8943	15680	2124	94112			185	532	178600	530	46	68	291233
418	1101	153	98	28	MM	8872	8926	12276	1800	103519			305	874	185820	600	46	68	304594
419	1152	153	98	30	MM	8823	8909	12078	1440	106910			405	686	189732	450	46	68	311251
420	4891	154	82	31	MM	5522	5540	9784	340	102950			458	1103	176150	660	42	68	290785
421	2930	154	83	8	MM	5748	5778	8300	1980	105041			239	744	181792	580	46	68	298096
422	2816	154	92	12	MM	8821	8998	19200	2552	97613			162	285	191672	530	46	68	311484
423	1135	154	95	7	MM	9036	9139	15048	2040	97211			234	642	181908	550	46	68	297083
424	128	154	95	16	MM	8570	8604	12940	1380	97660			230	302	177200	720	46	68	289712
425	6068	154	95	18	MM	8240	8320	13270	1240	91500	50		186	625	178700	661	41	77	285571
426	305	154	95	33	MM			25840	3248	80344			156	220	178866	540	48	68	288674
427	674	154	95	34	MM	8377	8416	15580	1740	61584			54	315	127368	530	57	68	206641
428	1333	154	96	36	MM	8502	8515	22572	3360	87976			230	244	185120	610	46	68	299502
429	474	155	90	24	MM	7887	7920	5700	1856	17053			280	1852	40271	570	130	68	67012
430	3227	155	94	16	MM	8743	8852	16491	1692	94098			330	397	178770	650	47	68	291778
431	603	155	95	5	MM			13138	1598	81054			255	263	152586	700	48	68	248894
432	719	155	95	5	MM	8413	8419	10472	1370	73713			305	294	135828	730	50	68	221982
433	87	155	95	6	MM			9114	1405	71762			256	420	135000	710	60	68	217957
434	87	155	95	6	MM	8410	8446	8378	2170	56908			195	453	108480	780	58	68	176584
435	216	155	95	6	MM	8406	8454	4760	456	33121			450	809	59980	780	87	68	99576
436	223	155	95	6	MM	8532	8566	8758	1142	55086			415	477	103200	790	60	68	169078
437	347	155	95	6	MM	8417	8462	9520	1720	59329			390	453	112800	750	56	68	184212
438	376	155	95	6	MM	8325	8362	13140	2060	81873			220	290	155200	710	49	68	252783
439	709	155	95	6	MM	8440	8466	6912	870	57385			535	294	102752	630	59	68	168748
440	709	155	95	6	MM	8520	8543	10282	1370	65986			340	392	123480	730	54	68	201850
441	710	155	95	6	MM	8502	8530	5332	1256	37695			195	766	70560	780	75	68	115804
442	66	155	95	7	MM	8503	8516	12120	1500	89060			110	441	162800	650	48	68	266031
443	86	155	95	7	MM	8512	8545	13518	1599	93375			185	272	172300	730	47	68	281249
444	439	155	95	7	MM	8466	8476	10280	1480	70383			390	412	130536	710	52	68	213481
445	439	155	95	7	MM	8502	8524	13520	2520	80562			205	289	155200	710	48	68	252296
446	475	155	95	7	MM	8498	8505	13320	2160	81535			365	294	155200	700	48	68	252874
447	721	155	95	7	MM	8428	8435	12760	2060	78943			245	281	150000	700	48	68	244289
448	490	155	95	8	MM	8490	8497	12756	1942	83125			205	284	156120	700	50	68	254432

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
449	937	155	95	8	MM	8474	8629	9520	1942	64563			255	303	121720	730	54	68	198303
450	970	155	95	17	MM	8444	8458	13700	1720	87539			170	246	164000	710	49	68	267375
451	1031	155	95	17	MM	8397	8410	15552	1972	99524			245	646	186160	640	46	68	304099
452	138	155	95	18	MM	8464	8476	12940	1940	89732			270	275	166600	690	48	68	271757
453	281	155	95	18	MM	8454	8472	18468	2056	86526			205	292	171800	660	48	68	279347
454	593	155	95	18	MM	8468	8474	13900	1720	94588			245	247	175600	670	47	68	286300
455	1494	155	95	28	MM	8378	8388	14112	1888	95825			230	594	177708	690	46	68	290357
456	75	155	96	1	MM	8487	8520	13490	1740	89975			258	291	167360	540	47	68	273114
457	165	155	96	1	MM	8370	8408	12756	1598	95514			185	282	174242	710	47	68	284577
458	352	155	96	1	MM	8444	8484	12376	2170	948			185	4272	174240	700	47	68	194191
459	399	155	96	1	MM	8399	8435	11620	2280	89891			185	208	165600	650	48	68	269784
460	496	155	96	1	MM	8395	8430	8568	1714	64384			160	426	119060	760	55	68	194312
461	575	155	96	1	MM	8320	8328	10280	1480	81741			230	343	148200	660	50	68	242274
462	3844	155	96	1	MM	8452	8492	22320	1840	85895			185	326	177000	690	49	68	287566
463	161	155	96	2	MM	8350	8390	13708	1941	93759			205	254	174240	730	47	68	284107
464	261	155	96	2	MM	8402	8424	11044	1714	85471			305	482	155840	730	49	68	254856
465	570	155	96	2	MM	8278	8398	10852	2170	79094			230	342	147140	740	50	68	239828
466	640	155	96	2	MM	8284	8348	13518	1713	96940			230	252	178120	730	47	68	290773
467	789	155	96	2	MM	8350	8376	12186	1828	78867			220	314	148180	690	49	68	241595
468	300	155	96	10	MM	8325	8362	6660	920	45354			245	652	83800	720	67	68	137631
469	310	155	96	10	MM	8351	8405	9900	1828	54766			380	514	106720	700	58	68	174108
470	202	155	96	11	MM	8392	8426	536	214	118804			295	10600	176820	650	46	68	307269
471	202	155	96	11	MM	8392	8428	10660	1560	72609			230	369	135000	730	52	68	220428
472	267	155	96	11	MM	8300	8338	4560	1142	37154			295	725	68000	750	77	68	111876
473	445	155	96	11	MM	8419	8448	12940	1942	81843			351	289	154400	680	48	68	251765
474	648	155	96	11	MM	8262	8441	14860	1820	83839			230	250	160600	680	48	68	261599
475	386	155	96	12	MM	8420	8052	12000	1820	75178			280	455	142000	730	50	68	231733
476	412	155	96	12	MM	8428	8466	12948	1942	84635			220	312	158760	720	49	68	258817
477	562	155	96	13	MM	8400	8420	2574	720	51057			160	2298	83619	550	73	68	140428
478	562	155	96	13	MM	8507	8676	6280	1020	46411			1015	5555	84672	750	67	68	144953
479	50	155	96	14	MM	8348	8429	10000	3400	90000	2000			180	170000	630			275580
480	653	155	96	14	MM	8422	8629	8568	1256	60232			295	482	111200	730	56	68	182033

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
481	5623	155	96	14	MM	8294	8375	12560	2970	84868			280	304	161400	700	48	68	262382
482	954	155	96	15	MM	8290	8316	12380	1714	84691			550	290	157000	700	48	68	256625
483	1895	155	96	22	MM	8248	8298	14058	2242	98845			315	665	183200	620	45	68	299325
484	1051	155	96	36	MM			3998	571	37180			940	655	65058	760	81	68	108402
485	106	156	95	3	MM	8414	8428	208	165	120379			450	14450	175608	760	49	68	311260
486	136	156	95	3	MM	8417	8427	13490	1624	95570			162	263	175728	500	46	68	286837
487	146	156	95	4	MM	8374	8390	13680	2204	93291			740	294	173880	550	46	68	284089
488	146	156	95	4	MM	8374	8390	12757	1370	97623			170	440	176722	700	46	68	289082
489	198	156	95	8	MM	8456	8699	4760	456	33839			1135	578	60860	770	86	68	101628
490	210	156	95	9	MM	8397	8424	14820	1972	77887			680	261	151524	570	49	68	247144
491	210	156	95	9	MM	8397	8424	12186	800	98335			245	311	175200	740	47	68	287077
492	243	156	95	9	MM	8406	8440	17480	1972	95794			185	317	184096	500	46	68	299844
493	379	156	95	9	MM	8410	8440	12760	1480	95720			245	264	174200	690	47	68	284669
494	514	156	95	9	MM	8395	8476	1190	314	10852			1270	680	18520	770	220	68	32826
495	595	156	95	9	MM	8422	8445	10092	1714	74688			270	406	137600	720	51	68	224770
496	294	156	95	10	MM	8427	8453	17100	2552	74865			454	262	152716	550	51	68	247949
497	294	156	95	10	MM	8430	8575	1285	286	15655			1305	644	26020	780	160	68	45195
498	67	156	95	14	MM	8512	8540	13680	1740	95831			195	280	176774	500	47	68	288500
499	67	156	95	14	MM	8510	8707	5140	1370	36336			1185	714	67920	760	82	68	112665
500	249	156	95	14	MM	8556	8576	6290	1260	89751			140	2112	151600	540	51	68	251153
501	51	156	95	15	MM	8317	8473	12756	2170	93818			270	230	173280	750	47	68	282524
502	53	156	95	15	MM	8448	8468	12376	2512	94860			220	285	175200	730	47	68	285453
503	54	156	95	15	MM	8410	8450	14470	800	85606			245	268	159640	710	49	68	261029
504	56	156	95	15	MM	8450	8485	13300	1508	93301			185	259	171544	540	47	68	280097
505	1045	156	95	15	MM	8469	8475	11804	2284	79609			305	298	149940	700	50	68	244240
506	42	156	95	16	MM	8490	8512	13680	1856	94991			342	282	175728	530	48	68	286879
507	42	156	95	16	MM	8490	8512	12380	2060	91902			120	266	169400	630	47	68	276128
508	163	156	95	16	MM	8438	8478	12560	1480	94146			245	287	171400	700	47	68	280118
509	181	156	95	16	MM	8522	8542	11044	2170	83311			255	302	154000	670	49	68	251082
510	182	156	95	16	MM	8389	8390	15200	1624	82936			660	265	158976	580	48	68	259661
511	182	156	95	16	MM	8415	8484	10860	1600	83994			170	458	153000	670	49	68	250082
512	443	156	95	16	MM	8444	8480	10472	1484	79579			220	372	145200	750	50	68	237327

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
513	790	156	95	16	MM	8432	8474	12360	1600	93521				255	322	170400	700	47	68 278458
514	1014	156	95	16	MM	8425	8455	12940	1380	50017				205	474	103600	690	60	68 168616
515	152	156	95	17	MM	8470	8516	13518	1828	84152				160	266	158760	690	49	68 258684
516	204	156	95	17	MM	8420	8452	8940	1720	72091				160	457	131600	660	53	68 214968
517	296	156	95	17	MM	8448	8506	11804	1714	78977				270	332	147300	700	50	68 240397
518	325	156	95	17	MM	8443	8475	13824	1740	94431				245	441	174720	640	47	68 285401
519	388	156	95	17	MM	8449	8496	12566	2284	85633				245	428	160520	700	47	68 261676
520	4382	156	95	17	MM	8548	8570	16968	2144	77619				120	340	155680	610	49	68 252871
521	269	156	95	18	MM	8420	8456	11044	2056	83474				205	345	153920	750	49	68 251044
522	479	156	95	18	MM	8470	8496	10472	1598	75598				305	350	139360	730	50	68 227683
523	500	156	95	18	MM	8454	8465	13518	1941	91551				230	403	170360	740	47	68 278003
524	647	156	95	18	MM	8472	8507	12186	2170	85083				245	301	158760	700	49	68 258745
525	1035	156	95	18	MM	8430	8742	61	9	3372				1905	679	3727	820	760	68 9753
526	1075	156	95	18	MM	8482	8488	12756	1714	88721				245	289	164060	700	47	68 267785
527	153	156	95	19	MM	8484	8530	11614	2284	91791				205	315	168444	710	47	68 274653
528	268	156	95	19	MM	8461	8500	9900	1484	79661				305	407	144240	730	50	68 235997
529	404	156	95	19	MM	8500	8526	10480	1820	85160				280	329	154800	710	49	68 252869
530	405	156	95	19	MM	8532	8550	6474	800	49248				465	543	89080	760	66	68 146610
531	405	156	95	19	MM	8427	8459	11420	1380	91894				205	344	165600	710	48	68 270843
532	1039	156	95	19	MM	8457	8487	10852	1484	78804				280	374	144640	720	49	68 236434
533	102	156	95	20	MM	8510	8526	11804	1713	93991				490	287	170360	750	47	68 278645
534	131	156	95	20	MM	8520	8600	10092	1142	76273				195	408	138420	780	51	68 226530
535	289	156	95	20	MM	8548	8595	12566	1942	83336				195	277	156120	690	49	68 254436
536	311	156	95	20	MM	8538	8580	8760	1380	68046				280	431	124000	740	54	68 202897
537	324	156	95	20	MM	8562	8600	7044	1828	50664				390	614	95260			155800
538	80	156	95	21	MM			10092	1828	66961				1600	406	125240	720	53	68 206127
539	424	156	95	21	MM	8507	8488	8000	1140	65572				405	523	118000	750	55	68 193640
540	429	156	95	21	MM	8476	8503	13138	1256	95103				230	254	173280	740	47	68 283261
541	444	156	95	21	MM	8507	8514	13140	1280	98783				270	262	179000	700	46	68 292735
542	219	156	95	22	MM	8474	8510	6854	1276	89432				205	290	153460	700	49	68 251517
543	428	156	95	22	MM	8545	8566	14820	1740	92924				315	277	173636	540	47	68 283712
544	428	156	95	22	MM	8545	8566	14440	1740	94820				540	272	176364	550	47	68 288176

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
545	168	156	95	28	MM	8627	8663	11800	1380	85758			280	294	156800	720	49	68	256312
546	190	156	95	28	MM	8620	8675	11040	1600	73814			340	346	137600	700	50	68	224740
547	191	156	95	28	MM	8610	8670	8568	1714	60372			295	281	112900	730	57	68	184130
548	417	156	95	28	MM	8600	8626	11800	2056	86941			270	297	160600	670	48	68	261964
549	788	156	95	28	MM	8602	8615	12560	1600	95071			245	256	173200	720	47	68	282932
550	192	156	95	29	MM	8628	8670	9520	1260	72288			245	376	131600	730	52	68	215289
551	218	156	95	29	MM	8504	8532	11800	1484	89950			245	280	163600	650	48	68	267359
552	351	156	95	29	MM	8500	8545	12756	1484	84022			270	299	156120	730	49	68	254951
553	391	156	95	29	MM	8570	8604	12000	1820	95305			220	290	173200	720	47	68	282835
554	480	156	95	29	MM	8532	8570	9900	2284	71527			280	379	134060	730	51	68	218430
555	69	156	95	30	MM	8463	8490	12756	1828	103932			195	403	187800	640	46	68	306914
556	101	156	95	30	MM	8468	8516	10472	1942	74415			280	446	138480	730	51	68	226035
557	137	156	95	30	MM	8460	8500	12186	1828	84566			205	286	157000	710	49	68	256071
558	414	156	95	30	MM			11234	1714	76740			205	331	142880	700	50	68	233104
559	418	156	95	30	MM	8486	8526	12376	1828	99939			230	306	181020	700	46	68	295699
560	812	156	95	30	MM	8456	8476	13320	1714	104720			170	253	189800	640	46	68	309977
561	55	156	95	31	MM	8460	8490	12756	2056	86325			145	316	161400	720	48	68	262998
562	119	156	95	31	MM	8450	8480	10282	1256	68437			170	430	127000	760	53	68	207575
563	189	156	95	31	MM	8426	8469	7616	1713	55650			245	799	103576	770	60	68	169599
564	189	156	95	31	MM	8426	8436	7236	1028	56397			340	1292	101640	730	60	68	167933
565	272	156	95	31	MM	8393	8438	11234	1828	71613			230	351	133180	750	51	68	218436
566	331	156	95	31	MM	8442	8487	12566	1714	79763			195	282	149940	730	50	68	244460
567	159	156	95	32	MM	8434	8472	7616	1142	49656			425	719	92620	790	64	68	152178
568	169	156	95	32	MM	8423	8456	10660	1720	75686			295	334	140200	690	51	68	228895
569	169	156	95	32	MM	8423	8456	11234	1828	70254			245	337	133180	760	52	68	217078
570	187	156	95	32	MM	8450	8481	10092	1598	65172			255	399	122600	720	54	68	200116
571	214	156	95	32	MM	8508	8550	9710	2170	76565			330	397	141120	770	50	68	230292
572	433	156	95	32	MM	8554	8566	11996	1828	86692			245	321	157800	750	48	68	258882
573	679	156	95	32	MM	8537	8542	12948	1370	82851			220	286	154360	730	49	68	252035
574	741	156	95	32	MM	8501	8506	12376	1598	81412			245	393	151700	700	48	68	247724
575	841	156	95	33	MM	8594	8601	12760	1380	94743			255	257	172400	700	47	68	281795
576	309	156	95	35	MM	8416	8445	12376	2626	93401			205	301	173280	730	47	68	282189

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
577	309	156	95	35	MM	8415	8449	18810	1624	88219			258	415	173636	540	47	68	282962
578	59	156	96	25	MM	8520	8540	12756	1828	100079			195	236	181980	700	46	68	297074
579	225	156	96	25	MM	8486	8521	10852	2170	89789			280	353	163600	720	48	68	267044
580	688	156	96	25	MM	8485	8726	27	5	3926			1710	515	4744	790	690	68	10927
581	185	156	96	35	MM	8300	8328	12160	1826	100460			340	359	181332	550	46	68	296477
582	185	156	96	35	MM	8380	8409	9900	1942	74400			245	454	137460	730	51	68	224401
583	870	156	96	35	MM	8372	8379	11234	2284	84709			255	313	156820	720	49	68	255615
584	982	156	96	35	MM	8372	8605	2476	914	22822			425	515	41620	740	120	68	68772
585	45	156	96	36	MM	8472	8500	13138	2056	87035			185	286	163170	720	48	68	265870
586	113	156	96	36	MM	8366	8404	13680	1740	91079			186	314	169452	540	47	68	276451
587	113	156	96	36	MM	8366	8404	13328	3198	79568			195	383	155240	730	49	68	251912
588	323	156	96	36	MM	8416	8457	11044	1598	90395			245	349	161400	730	48	68	265031
589	420	156	96	36	MM	8448	8469	12566	2398	97353			170	284	179080	700	46	68	291851
590	497	156	96	36	MM	8395	8415	12756	1598	82649			185	331	154360	49	730	68	251879
591	2567	157	75	1	MM	3036	3057	2650	1230	53281			68	4350	87210	710	65	68	148789
592	2610	157	75	10	MM	3122	3138	2832	1044	56470			132	4451	91800	680	63	68	156729
593	2956	157	79	33	MM	4008	4020	4450	1260	80232			365	2317	133380	630	51	68	222004
594	883	157	80	21	MM	4362	4382	1064		16935	168		37	8016	21872	1080	180	68	48092
595	392	157	85	21	MM	6016	6116	8075	1798	99199			195	1195	171544	550	49	68	282006
596	175	157	94	5	MM	8227	8244	12000	1940	100570			195	407	181600	680	46	68	296712
597	307	157	94	5	MM	8239	8290	11920	2300	102282			170	357	185200	740	46	68	302229
598	129	157	94	6	MM	8264	8304	11800	1940	102551			170	293	184400	690	46	68	301154
599	184	157	94	6	MM	8272	8312	6840	1280	64094			675	389	114600	750	56	68	187878
600	367	157	94	6	MM	8213	8263	10660	1480	83992			145	334	152400	690	49	68	249011
601	415	157	94	6	MM	8268	8308	4760	1260	43592			145	810	78652	760	71	68	129219
602	493	157	94	6	MM	8224	8253	10860	1720	90337			195	349	163200	690	48	68	266661
603	554	157	94	6	MM	8268	8289	10380	1040	86875			135	165	155200	720	49	68	253795
604	245	157	94	7	MM	8270	8297	11540	2180	102462			160	441	184400	730	46	68	301183
605	502	157	94	7	MM	8281	8289	10960	2200	100007			160	227	179800	680	46	68	293354
606	513	157	94	7	MM	8229	8240	11424	1941	99334			170	444	178664	670	46	68	291977
607	978	157	94	7	MM	8278	8286	11740	2180	99715			120	359	180600	710	46	68	294714
608	1030	157	94	8	MM	8298	8538	9320	1380	73681			355	484	133600	820	50	68	218820

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
609	1116	157	94	8	MM	8238	8245	12120	2420	98268				230	190	179800	680	46	68 293028
610	1092	157	94	18	MM	8257	8277	11040	1260	96853				195	387	172200	780	47	68 281935
611	1093	157	94	18	MM	8255	8264	12120	1270	98575				160	275	176900	670	46	68 289300
612	1191	157	94	18	MM	8210	8231	11420	2280	98575				185	262	178600	690	46	68 291322
613	1253	157	94	18	MM			10780	1962	83602				185	350	153380	700	49	68 250259
614	724	157	94	30	MM	8264	8272	13464	2160	96149				195	430	177996	550	46	68 290394
615	612	157	94	31	MM	8284	8318	13068	3120	96688				240	386	180930	550	46	68 294432
616	612	157	94	31	MM	8284	8318	12186	1599	92760				160	346	168954	670	47	68 276005
617	822	157	94	31	MM	8336	8537	3175	692	26177				475	930	47050	750	110	68 78499
618	1032	157	94	31	MM	8321	8327	11805	1599	93291				245	476	168954	710	48	68 276370
619	1032	157	94	31	MM	8321	8327	12375	1593	98016				195	240	177080	610	47	68 289499
620	82	157	95	1	MM	8242	8290	12900	3116	96652				185	275	180680	680	46	68 293808
621	114	157	95	1	MM	8292	8331	9901	2284	82884				355	461	151476	730	49	68 247361
622	299	157	95	1	MM	8226	8254	6660	1380	61326				195	660	109800	670	57	68 180021
623	350	157	95	1	MM	8260	8276	11800	1820	98357				110	314	177600	650	46	68 290001
624	398	157	95	1	MM	8265	8300	3998	679	36131				170	811	64086	750	83	68 105875
625	398	157	95	1	MM	8265	8300	3944	808	32606				185	325	59280	730	89	68 97148
626	419	157	95	1	MM	8254	8499	3560	580	29844				1295	474	52920	760	98	68 88673
627	855	157	95	1	MM	8282	8302	11920	1740	99140				145	270	178800	690	46	68 292015
628	256	157	95	2	MM	8275	8320	12186	1599	105334				195	283	188374	700	46	68 307971
629	1062	157	95	2	MM	8267	8290	9720	1380	67659				145	227	169920	610	49	68 249051
630	1477	157	95	9	MM	8332	8361	12544	1888	96224				120	395	175760	650	49	68 286931
631	1165	157	95	10	MM	8285	8292	12186	1485	100540				160	367	180606	690	46	68 295344
632	93	157	95	11	MM	8258	8294	7800	1260	72019				490	128200	400	53	68 209769	
633	366	157	95	11	MM	8208	8274	4960	1020	42588				195	821	76720	730	72	68 126304
634	811	157	95	11	MM			2980	405	28490				755	433	49640	730	100	68 82703
635	913	157	95	11	MM	8171	8242	100	30	5732				905	535	8100	860	470	68 15402
636	971	157	95	11	MM			9330	1256	79154				185	527	141766	710	51	68 232218
637	1027	157	95	11	MM			11805	1713	105614				185	415	188374	700	46	68 308106
638	1027	157	95	11	MM	8202	8268	144	127	594				135	280	1256	680	2620	68 2536
639	32	157	95	12	MM	8312	8350	35590	6920	40321				185	425	144920	650	50	68 228361
640	32	157	95	12	MM	8312	8350	14652	2160	103075				240	490	190710	550	46	68 311327

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
641	681	157	95	12	MM	8289	8297	11420	2060	99681			135	341	179600	670	670	68	293237
642	606	157	95	13	MM	8265	8271	10960	1260	88372			305	270	159000	570	48	68	260167
643	606	157	95	13	MM	8265	8271	7045	799	62985			60	334	111666	740	57	68	182889
644	649	157	95	13	MM	8260	8268	11995	1713	97215			205	402	175752	690	46	68	287282
645	876	157	95	13	MM	8291	8298	13660	1384	90480			160	235	167500	690	47	68	273419
646	301	157	95	14	MM	8240	8272	171	80	692			390	272	1175	820	2520	68	2780
647	365	157	95	14	MM	8238	8271	11220	1700	97349			160	321	174600	750	47	68	285350
648	473	157	95	14	MM	8238	8244	11805	1713	96741			145	319	174780	680	46	68	285503
649	1043	157	95	14	MM	8162	8227	11360	1962	92083			135	379	167500	690	47	68	273419
650	315	157	95	23	MM	8270	8310	329	45	1623			525	1070	2120	740	1280	68	5712
651	315	157	95	23	MM	8276	8290	12314	1732	101753			145	275	183500	690	46	68	299719
652	928	157	95	23	MM	8251	8261	3040	680	28041			465	1118	49520	720	99	68	82864
653	1077	157	95	23	MM			2500	580	19427			1365	5658	34800	760	130	68	64330
654	751	157	95	24	MM	8251	8257	12314	1732	93770			135	183	171260	660	47	68	279394
655	946	157	95	24	MM	8260	8268	12120	1380	102087			170	318	182600	710			298675
656	989	157	95	24	MM	8269	8276	11736	1732	97531			185	251	175960	680	47	68	287395
657	990	157	95	24	MM	8263	8271	12672	2640	98729			270	457	181908	550	46	68	296676
658	626	157	95	25	MM	8228	8239	9720	1020	43875			7	601	87400	560	66	68	142623
659	666	157	95	25	MM	8220	8230	11995	1370	95430			220	568	171868	700	46	68	281451
660	935	157	95	25	MM	8247	8253	11995	1713	95273			37	425	172838	660	47	68	282281
661	1047	157	95	25	MM	8191	8196	11424	1599	93626			185	310	168954	700	47	68	276098
662	744	157	95	26	MM	8238	8418	3660	580	28645			425	412	51800	700	100	68	85522
663	1029	157	95	26	MM	8230	8236	11210	1596	91628			234	546	165282	570	48	68	270496
664	1078	157	95	26	MM	8214	8221	11805	1485	95971			170	423	172838	710	47	68	282692
665	257	157	95	35	MM	8300	8328	12566	1370	94658			205	334	171868	680	47	68	281001
666	257	157	95	35	MM	8300	8328	11928	2192	90913			170	170	167500	700	47	68	272873
667	507	157	95	36	MM	8300	8309	12376	1256	94409			195	234	170896	680	47	68	279366
668	507	157	95	36	MM	8300	8309	13056	1624	96302			210	293	176040	590	46	68	287525
669	770	157	95	36	MM	8269	8281	12000	1720	90899			170	425	166042	660	47	68	271256
670	909	157	95	36	MM	8284	8291	11920	1740	95913			175	5	174000	690	47	68	283753
671	5281	158	75	16	MM	3010	3056	4890	2091	72467			244	2196	124795	630	48	73	206683
672	1973	158	77	13	MM	3325	3348	2574	1268	36937			100	1640	63956	730	83	68	106475

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HC03	SO4	CL	PH	RESIST	F	TDS
673	2652	158	78	13	MM	3343	3363	2160	552	45288			63	5910	70890	690	76	68	124863
674	2708	158	80	5	MM	4242	4272	5200	1200	88434			168	2030	147510	590	51	68	244542
675	3396	158	80	5	MM	6742	6755	8360	1482	114444			205	445	195190	670	49	68	320126
676	2670	158	80	6	MM	4201	4212	5184	1334	96117			118	1178	160380	620	48	68	264311
677	2803	158	80	6	MM	4278	4333	5376	1450	97780			335	1825	163020	590	48	68	269786
678	3151	158	80	8	MM	4246	4264	4940	1480	98489			295	1354	163800	620	48	68	270358
679	416	158	93	15	MM	8312	8364	6745	1160	106709			270	1203	178866	520	48	68	294953
680	441	158	94	5	MM	8238	8263	12120	1500	98156			160	185	177000	690	46	68	289121
681	484	158	94	5	MM	8240	8260	9720	1260	84346			245	444	150506	690	49	68	246521
682	804	158	94	5	MM	8240	8249	11614	1713	101396			170	360	181578	680	46	68	296831
683	340	158	94	6	MM	8185	8240	11360	3116	99657			170	328	182560	680	46	68	297191
684	393	158	94	6	MM	8204	8245	12376	1827	94650			205	354	172838	690	47	68	282250
685	510	158	94	6	MM	8183	8234	12186	1142	101825			185	362	181578	710	46	68	297278
686	628	158	94	6	MM	8218	8236	11800	1820	102176			110	275	183520	670	46	68	299701
687	662	158	94	6	MM	8200	8253	12320	1740	104224			160	461	187200	730	46	68	306105
688	728	158	94	6	MM	8106	8205	11540	1620	102324			160	380	182600	720	46	68	298624
689	238	158	94	7	MM	8116	8158	9240	2420	77769			220	315	143000	710	50	68	232964
690	312	158	94	7	MM	8158	8194	11740	1620	102003			175	175	182600	650	46	68	298313
691	339	158	94	7	MM	8200	8240	11740	1740	95712			185	230	173200	570	47	68	282807
692	346	158	94	7	MM	8170	8210	8568	1256	75642			170	579	134970	700	52	68	221185
693	452	158	94	8	MM	8226	8246	13276	1154	100530			195	250	181620	710	46	68	297025
694	506	158	94	8	MM	8205	8217	12314	1846	96647			170	251	175960	690	47	68	287188
695	209	158	94	17	MM	8141	8180	10780	2080	98040			160	364	176000	730	47	68	287424
696	285	158	94	17	MM	8158	8211	12314	1846	89315			160	220	164680	700	47	68	268535
697	753	158	94	17	MM	8195	8400	6160	1260	49607			830	552	90200	760	65	68	148609
698	99	158	94	18	MM	8122	8260	6283	1256	55795			685	581	100014	720	61	68	164614
699	99	158	94	18	MM	8121	8176	11904	1972	97610			244	286	177018	580	47	68	289034
700	99	158	94	18	MM	8160	8218	13300	1740	96089			366	330	176364	550	46	68	288189
701	132	158	94	18	MM	8098	8228	4240	1040	38649			245	550	69600	720	78	68	114324
702	176	158	94	18	MM	8111	8150	8860	1960	81480			135	260	146800	730	50	68	239495
703	282	158	94	18	MM	8086	8127	5570	776	57380			145	731	100000	740	60	68	164602
704	326	158	94	18	MM	8117	8169	11043	1599	97225			220	311	173810	700	46	68	284208

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
705	326	158	94	18	MM			14360	1300	99995			185	244	183150	660	47	68	299234
706	345	158	94	18	MM	8084	8140	10960	700	92963			160	180	164600	720	48	68	269563
707	355	158	94	18	MM	8049	8120	10100	1280	90361			170	359	161200	700	48	68	263470
708	148	158	94	19	MM	8150	8186	10960	1500	90296			170	195	162800	710	48	68	265921
709	148	158	94	19	MM	8142	8216	10860	1720	97696			195	316	174784	680	47	68	285571
710	195	158	94	19	MM	8182	8240	10780	1620	97587			220	260	174000	670	47	68	284467
711	250	158	94	19	MM	8162	8225	11920	1384	97361			185	235	175020	700	47	68	286105
712	314	158	94	19	MM	8193	8246	11360	1740	97273			195	135	175000	570	47	68	285703
713	581	158	94	19	MM	8186	8198	11740	2078	97896			255	275	177840	700	46	68	290084
714	523	158	94	20	MM	8208	8216	558	162	13328			465	1150	20900	790	210	68	36563
715	650	158	94	20	MM	8225	8233	11920	1840	98307			220	220	177800	680	46	68	290307
716	703	158	94	20	MM	8208	8217	12120	1840	100981			195	617	182000	700	46	68	297753
717	894	158	94	20	MM	8262	8503	54	16	3718			1645	550	4515	710	720	68	10498
718	906	158	94	29	MM	8291	8297	12000	1940	99365			185	336	179800	790	46	68	293626
719	964	158	94	29	MM	8263	8269	12180	1720	101363			185	280	182600	690	46	68	298328
720	199	158	94	30	MM	8226	8236	11920	1620	101804			175	190	182600	660	46	68	298309
721	454	158	94	30	MM	8250	8295	8940	1140	109340			255	321	187400	690	46	68	307396
722	667	158	94	30	MM	8218	8228	12180	2160	96959			135	440	177000	780	47	68	288874
723	809	158	94	30	MM	8256	8263	12180	2060	101901			205	292	184400	690	46	68	301038
724	135	158	94	31	MM	8287	8336	12380	2160	101531			185	286	178800	780	46	68	295342
725	186	158	94	31	MM	8271	8300	8860	220	25972			100	165	56200	750	94	68	91517
726	368	158	94	31	MM	8260	8274	12320	2080	99796			175	125	181600	680	46	68	296096
727	400	158	94	31	MM	8306	8346	1540	700	108987			170	235	172600	720	47	68	284232
728	487	158	94	31	MM	8235	8247	12000	1820	100078			170	280	180600	690	46	68	294948
729	498	158	94	31	MM	8228	8274	11100	1140	102345			205	145	180600	710	46	68	295535
730	729	158	94	31	MM	8228	8243	12890	2078	94344			205	255	174080	710	47	68	283852
731	749	158	94	31	MM	8206	8225	4425	1185	40243			85	215	73150	720	75	68	119303
732	488	158	94	32	MM	8255	8273	11420	1820	98903			185	359	177694	670	46	68	290381
733	908	158	94	32	MM	8222	8478	760	920	97154			280	433	153400	700	49	68	252947
734	495	158	95	1	MM	8160	8195	12320	1620	99499			145	150	179800	700	46	68	293534
735	495	158	95	1	MM	8148	8255	8930	1276	87015			135	1279	152716	500	48	68	251351
736	726	158	95	1	MM	8150	8184	12186	1370	102056			85	509	182548	680	46	68	298754

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
737	726	158	95	1	MM	8160	8195	12672	2400	99142			170	453	181908	550	46	68	296745
738	783	158	95	1	MM			960					1695	453	4980	750	680	68	8088
739	1016	158	95	11	MM	8078	8154	12186	1941	101555			185	321	183520	710	46	68	299708
740	228	158	95	12	MM			10853	1142	105804			170	231	185462	680	46	68	303662
741	576	158	95	12	MM			11995	1485				195	11513	189346	700	46	68	214534
742	627	158	95	12	MM	8185	8193	11234	1713	100608			160	443	179636	680	46	68	293794
743	905	158	95	12	MM	8178	8192	11995	1713	100956			205	326	181578	680	46	68	296773
744	108	158	95	13	MM	8188	8218	11740	1500	101542			120	135	181600	700	46	68	296637
745	156	158	95	13	MM	8136	8225	377	90	3155			280	236	5460	750	710	68	9598
746	157	158	95	13	MM	8152	8178	11424	1485	102071			220	375	181578	710	46	68	297153
747	158	158	95	13	MM	8102	8246	7620	1380	73359			160	497	130200	710	52	68	213216
748	158	158	95	13	MM			11160	1840	103567			170	487	184400	610	46	68	301624
749	276	158	95	13	MM	8139	8250	10960	1740	103239			230	235	183400	720	46	68	299804
750	509	158	95	13	MM	8182	8220	10960	1620	97352			185	230	175000	690	47	68	285347
751	717	158	95	14	MM	8634	8650	6283	1142	57969			245	1074	102926	750	60	68	169639
752	800	158	95	14	MM	8265	8283	12566	1370	109729			170	288	195170	700	46	68	319293
753	800	158	95	14	MM			4570	1256	39675			1015	679	71854	770	76	68	119049
754	130	158	95	23	MM	8246	8295	11995	1256	104973			195	347	186432	720	46	68	305198
755	212	158	95	23	MM	8246	8295	11805	1256	109578			170	326	193230	700	46	68	316365
756	574	158	95	23	MM	8309	8319	9139	1713	90429			160	459	160216	730	49	68	262116
757	641	158	95	23	MM	8326	8336	12120	1740	99540			160	218	179800	720	46	68	293578
758	241	158	95	24	MM	8234	8276	11920	1960	96636			135	251	175600	700	47	68	286502
759	252	158	95	24	MM	8194	8280	7426	1370	68682			205	823	122346	730	54	68	200852
760	253	158	95	24	MM	8261	8307	10860	1380	88371			160	345	159200	790	48	68	260316
761	319	158	95	24	MM	8136	8204	7616	1256	63528			185	598	114578	690	56	68	187761
762	332	158	95	24	MM	8180	8230	10100	1480	87825			160	456	157220	690	49	68	257241
763	154	158	95	25	MM	8372	8400	11740	1840	96051			185	250	174000	700	47	68	284066
764	233	158	95	25	MM	8200	8242	14440	1500	94269			185	275	175020	680	47	68	285689
765	259	158	95	25	MM	8266	8336	11540	1500	96864			175	135	174000	710	47	68	284214
766	266	158	95	25	MM	8260	8300	11420	1940	100516			165	282	180600	670	46	68	294923
767	266	158	95	25	MM			12000	1940	76190			405	506	143800	660	50	68	234841
768	423	158	95	25	MM	8304	8335	11220	1140	95403			205	288	170000	790	47	68	278256

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
769	423	158	95	25	MM	8365	8395	16720	2088	93717			135	319	179912	530	46	68	292891
770	466	158	95	25	MM	8274	8316	12320	1160	100936			205	206	180600	740	46	68	295427
771	298	158	95	26	MM	8278	8335	9901	1028	87699			160	454	155360	700	49	68	254602
772	356	158	95	26	MM	8300	8350	6100	920	57758			160	640	102000	810	60	68	167578
773	541	158	95	26	MM	8304	8332	1720	800	20625			1330	563	36000	710	130	68	61038
774	556	158	95	26	MM	8277	8448	5140	1140	44191			840	668	79600	810	70	68	131579
775	677	158	95	27	MM	8276	8511	4189	1142	40979			1025	716	72826	800	75	68	120877
776	118	158	95	35	MM			2475	571	220281			1365	690	36024	760	120	68	261406
777	453	158	95	35	MM	8276	8308	8940	800	78505			170	464	138800	770	51	68	227679
778	471	158	95	35	MM	8328	8356	9040	2078	73230			185	460	134560	700	52	68	219553
779	127	158	95	36	MM	8306	8344	12000	1820	105789			170	292	189400	660	46	68	309471
780	213	158	95	36	MM	8293	8332	12180	1820	104785			160	258	188200	700	46	68	307403
781	353	158	95	36	MM	8346	8390	12500	1740	100913			170	198	182600	690	46	68	298121
782	421	158	95	36	MM	8249	8274	10662	1485	94085			145	334	167984	710	47	68	274695
783	447	158	95	36	MM	8271	8290	7620	1380	72075			170	514	128200	750	53	68	209959
784	781	158	95	36	MM	8330	8360	10662	1370	91883			220	484	164100	690	48	68	268719
785	847	158	95	36	MM	8312	8340	5520	800	47985			270	756	85400	820	68	68	140731
786	2960	159	80	31	MM	4229	4248	5568	1508	95783			356	2340	160056	600	48	68	265611
787	3009	159	81	30	MM	4547	4562	5952	1276	94748			288	1574	159068	590	48	68	262906
788	2976	159	81	31	MM	4510	4523	5472	1276	74561			318	2304	126524	620	53	68	210455
789	2471	159	81	33	MM	4492	4521	6528	1620	102518			270	1425	173194	720	47	68	285555
790	5986	159	82	35	MM	4547	4557	6600	1680	102196			410	1450	172900	560	47	68	285236
791	2792	159	82	36	MM	4500	4543	6400	4131	98946			312	520	175370	450	41	77	285679
792	796	159	94	29	MM	8080	8100	12100	1281	109654			152	597	193752	630	46	68	317536
793	823	159	94	29	MM	7905	7965	2185	427	120358			88	3778	187920	500	46	68	314756
794	828	159	94	32	MM	8044	8295	6920	1160	57578			415	808	103600	750	59	68	170481
795	966	159	94	32	MM	8079	8088	7524	1080	110461			145	1272	185820	610	46	68	306302
796	1449	159	94	32	MM			11360	2080	102750			185	200	184400	690	46	68	300975
797	1910	160	79	4	MM	3448	3470	2772	885	40393			170	4100	66666	690	86	68	114986
798	962	160	80	5	MM	3912	3924	3800	1508	47733			205	3354	82152	610	71	68	138752
799	2899	160	83	22	MM	4518	4540	6200	1800	94849			336	1733	161044	610	48	68	265962
800	4534	160	83	27	MM	4520	4550	6500	2400	90655			270	775	157600	640	50	68	258200

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
801	2995	160	83	30	MM	4662	4696	7680	2320	105031			366	1028	177840	550	46	68	294265
802	1660	160	92	1	MM	7222	7253	8232	1534	95983			145	1228	166098	530	48	68	273220
803	2071	160	94	3	MM	7600	7647	11088	1770	114990			145	1020	201310	620	47	68	330323
804	2194	160	94	29	MM	7937	7955	9405	1357	113963			205	1140	195420	670	47	68	321490
805	2646	160	94	29	MM	7933	7933	11000	1440	108468			149	315	190650	660	46	68	312022
806	5716	160	96	13	MM	7787	7806	2198	83	100498			111	500	162000	640	57	68	265390
807	1656	161	79	16	MM	3443	3498	9504	1652	44852			415	1550	89430	620	66	68	147403
808	1996	161	79	23	MM	3368	3390	5049	1239	50478			75	2000	88888	650	70	68	147729
809	1526	161	79	27	MM	3361	3380	3185	1121	52247			120	3798	86621	730	64	68	147092
810	524	161	81	19	MM	4072	4125	5510	1972	92435			295	1360	156900	530	49	68	258472
811	2271	161	81	30	MM	4092	4129	5148	1357	75584			440	2350	127660	640	57	68	212539
812	2300	161	81	30	MM	4080	4112	5148	1298	80460			425	2050	135240	580	55	68	224621
813	2782	161	82	14	MM	4104	4122	4800	2187	109434			254	390	183180	570	41	77	300245
814	1058	161	82	15	MM	4159	4167	5473	1530	92986			115	1761	156215	650	50	68	258080
815	2813	161	82	23	MM	4124	4145	5376	1566	100992			274	1021	168940	570	47	68	278169
816	2320	161	82	25	MM	4182	4202	5890	2052	100341			270	1120	170200	630	48	68	279873
817	2343	161	82	25	MM	4098	4111	5760	1740	104893			170	1001	176220	670	47	68	289784
818	5518	161	85	10	MM			8702	1112	103109			61	570	181000	580	50	68	294554
819	5518	161	85	10	MM			8702	1112	103109			61	570	181000	580	50	68	294554
820	1083	161	90	11	MM	6155	6215	4356	840	34537			380	3486	60636	660	88	68	104235
821	945	161	90	28	MM	6689	6741	1292	209	111541			254	959	174084	610	46	68	288339
822	1082	161	90	30	MM	6882	6910	11088	2400	106835			205	780	190710	600	46	68	312018
823	836	161	92	6	MM	6960	6978	9800	1769	107038			210	815	186876	610	46	68	306508
824	2722	161	98	13	MM	7288	7390	6528	986	95492			108	1718	160380	590	48	68	265212
825	1435	162	79	4	MM	3295	3302	3456	116	44166			120	3725	71760	750	82	68	123343
826	1670	162	80	6	MM	3522	3547	3332	1239	40191			195	3560	68761	640	82	68	117278
827	1629	162	81	23	MM	3607	3620	4508	2065	45911			440	2647	82603	570	68	68	138174
828	916	162	81	26	MM	3692	3704	3040	928	49687			108	4378	81432	530	69	68	139573
829	1637	162	82	34	MM	4032	4042	5390	1652	99160			270	1420	166098	620	47	68	273990
830	1761	162	82	36	MM	4027	4035	5148	1711	99821			280	1312	166936	610	47	68	275208
831	985	162	90	16	MM	5830	5870	2099	360	20403			145	3930	33252	610	140	68	60189
832	1554	162	91	4	MM	6110	6128	4165	826	94521			295	1235	154489	630	49	68	255531

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HC03	SO4	CL	PH	RESIST	F	TDS
833	1461	162	91	5	MM	6155	6188	3293	661	33020			220	3247	56160	690	92	68	96601
834	1485	162	91	5	MM	6094	6108	1803	307	17774			234	4736	27872	790	170	68	52726
835	1500	162	91	8	MM	6116	6161	3920	649	70267			390	3633	114304	690	60	68	193163
836	2562	162	92	3	MM	6236	6263	7872	1392	107894			255	894	183600	640	46	68	301907
837	2474	162	92	12	MM	6237	6260	4876	880	123539			550	660	200940	720	47	68	331445
838	1429	162	95	20	MM	7026	7032	11200	1840	114200			150	378	201000	660	43	68	328768
839	2970	162	101	20	MM	7022	7039	9024	1580	141527			98	756	196612	580	46	68	349597
840	1669	163	78	11	MM			1630	394	19700			120	4530	31200	770	146	68	57574
841	1237	163	79	20	MM	3269	3292	4158	1080	45105			245	3198	80661	740	70	68	134447
842	1281	163	80	5	MM	3314	3340	1820	552	14665			145	3572	24730	760	180	68	45484
843	2119	163	80	19	MM	4519	4529	5634	2006	121674			340	900	204260	590	46	68	334814
844	438	163	80	21	MM	3417	3421	3040	928	49088			122	4321	80542	540	71	68	138041
845	993	163	81	12	MM	3396	3406	2653	672	23477			135	3646	40098	640	130	68	70681
846	1510	163	81	24	MM	3465	3475	3675	915	40393			110	3592	68761	680	84	68	117446
847	1353	163	82	4	MM	3692	3702	5346	2040	73385			245	2137	126880	660	54	68	210033
848	911	163	82	31	MM	3730	3750	3040	638	31218			82	4095	52323	640	98	68	91396
849	2283	163	83	23	MM	3968	3988	3168	649	36292			280	3300	60880	600	88	68	104569
850	1436	163	83	25	MM	3995	4014	4800	1392	80811			355	2430	135200	650	51	68	224988
851	5557	163	86	13	MM			9618	2780	99804			256	560	183000	600	50	68	296018
852	5557	163	86	13	MM			9618	2780	99804			256	560	183000	600	50	68	296018
853	5708	163	86	13	MM			9160	1946	90946			268	584	166000	620	50	68	268904
854	5708	163	86	13	MM			9160	1946	90946			268	584	166000	620	50	68	268904
855	5587	163	87	1	MM			9618	3058	100568			171	540	185000	620	50	68	298955
856	5587	163	87	1	MM			9618	3058	100568			171	540	185000	620	50	68	298955
857	5634	163	87	1	MM			10076	834	107430			171	516	190000	630	50	68	309027
858	5634	163	87	1	MM			10076	834	107430			171	516	190000	630	50	68	309027
859	5565	163	87	2	MM			10076	1112	105683			220	516	188000	610	46	68	305607
860	5565	163	87	2	MM			10076	1112	105683			220	516	188000	610	50	68	305607
861	5485	163	87	12	MM			9618	1390	93534			220	510	169000	610	50	68	274272
862	5485	163	87	12	MM			9618	1390	93534			220	510	169000	610	50	68	274272
863	5603	163	87	12	MM			10076	1390	100579			244	530	181000	630	47	68	293819
864	5603	163	87	12	MM			10076	1390	100579			244	530	181000	630	50	68	293819

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
865	5834	163	87	12	MM			8702	1946	105291			329	584	187000	600	50	68	303852
866	5834	163	87	12	MM			8702	1946	105291			329	584	187000	600	50	68	303852
867	1080	163	88	11	MM	5030	5055	2376	432	112574			230	2646	177018	550	46	68	295276
868	1490	163	88	31	MM	5819	5840	10584	1416	104937			380	563	184080	610	46	68	301960
869	2800	163	89	13	MM	5243	5302	9216	1972	107295			610	633	186732	550	46	68	306458
870	974	163	89	22	MM	5307	5357	3990	928	98237			365	2257	159414	620	49	68	265191
871	1076	163	90	22	MM	5506	5530	2257	360	24143			270	4074	39120	600	120	68	70224
872	1837	163	90	28	MM	5755	5766	7425	1534	77959			205	1570	136580	580	55	68	225273
873	1501	163	91	17	MM			2900	492	47600			216	4040	77000	740	75	68	132248
874	1501	163	91	17	MM	5878	5912	8820	1298	108436			185	1080	185744	630	46	68	305563
875	2548	163	92	2	MM	6160	6178	8428	1534	107081			295	573	183958	520	46	68	301869
876	1540	163	92	17	MM	6095	6111	7056	1770	107088			195		182172	670	46	68	298281
877	1640	163	92	17	MM	6065	6096	2979	424	14282			390	4893	33488	690	140	68	56456
878	1700	163	92	20	MM	6160	6178	8526	1652	108499			270	627	186638	520	46	68	306212
879	1700	163	92	20	MM	6160	6178	8526	1652	108499			270	627	186638	520	46	68	306212
880	1799	163	92	20	MM	5737	5744	47520	5900	75218			450	330	216800	590	49	68	346218
881	1530	163	92	24	MM			3400	789	87100			234	2240	141000	700	49	68	234763
882	1742	163	92	34	MM			8700	789	110900			186	476	186000	620	43	68	307051
883	3617	163	95	3	MM	6250	6287	7574	1283	101045			220	912	172198	680	47	68	283232
884	2688	163	98	10	MM	6453	6499	8600	1200	105390			81	1122	180400	610	46	68	296793
885	2010	163	102	7	MM	6967	6991	12276	1770	105139			85	520	188620	590	49	68	308410
886	884	164	77	33	MM	2980	2987	3323	1238	54698			258	2945	91540	640	62	68	154002
887	994	164	81	33	MM	3525	3537	3990	1334	35614			112	3046	63570	600	90	68	107666
888	317	156	95	20	MM	J 8479	8517	3998	799	38421			205	851	67920	810	80	68	112194
889	215	158	94	18	MM	4 8284	8318	12186	1599	92760			185	311	178000	5690	7046	468	285041
890	2877	161	82	9	MM	M 4218	4236	6400	1800	102216			270	1596	172900	610	47	68	285182
891	528	157	89	25	MMB	7580	7675	7410	1856	70348			415	1721	125520	540	54	68	207270
892	524	161	81	19	MMB	4531	4557	2755	870	80569			280	2369	129704	530	52	68	216547
893	3827	162	78	20	MMB	3865	3900	5002	1269	71737			120	2362	121389	740	54	68	201879
894	1186	153	94	32	MMFAR			13708	1484	62051			185	382	123904	740	55	68	201714
895	223	155	95	6	MMFAR	8458	8488	10100	2160	65774			195	418	125200	750	54	68	203847
896	4716	155	96	11	MMFAR			29925	2309	68034			79	581	164370	540			265298

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
897	4716	155	96	11	MMFAR	8332	8365	16090	1490	1114			233	1114	122690	640			142731
898	979	157	95	14	MMFAR	8246	8255	11614	1713	98192			135	272	176722	670	46	68	288648
899	1067	157	95	23	MMFAR	8271	8276	12180	1380	96333			170	332	173820	650	47	68	284215
900	77	157	95	36	MMFAR	8323	8372	13860	1920	96135			220	383	177996	550	46	68	290514
901	65	158	95	13	MMFAR	8150	8194	14155	1624	53386			145	354	111780	550	59	68	181444
902	1764	162	95	29	MMFAR	7064	7065	9520	1156	105354			185	342	182360	630	46	68	298917
903	4268	139	102	8	MMR	8808	8844	18468	4796	104890			110	357	208120	570	46	68	336741
904	6861	139	106	10	MMR	8687	8891	4896	2943	103955			634	1105	178000	760	56	68	291533
905	4467	140	105	21	MMR	8946	8986	14800	2080	106954			170	168	197000	610	48	68	321172
906	6894	146	103	5	MMR	9170	9230	13627	1459	107600	7600		146	700	196800	544	42	77	327932
907	6625	147	104	11	MMR	9038	9045	12400	1050	108500			134	184400	593	620	46	68	307077
908	499	158	95	35	MMR	8168	8186	2280	1020	21890			305	1078	39800	830	120	68	66373
909	4759	161	92	35	MMR	7261	7309	8480	1871	126767			425	5500	211580	500	38	77	354623
910	4759	161	92	35	MMR	7261	7309	8480	1871	126767			425	5500	211580	500	38	77	354623
911	4429	162	103	35	MMR	6968	6989	10400	4131	99636	19000		351	1240	183180	650	41	77	317938
912	657				MMRM	7672	7717	10494	2006	115392			135	950	201624	610	49	68	330601
913	2805				MMRM	8465	8487	15552	1566	105030			95	384	193648	560	46	68	316275
914	2894	142	103	24	MMRM	9289	9360	18400	2040	104178			30	538	198780	550	47	68	323966
915	2584	145	101	16	MMRM	9423	9428	28600	3006	86135				232	192000	440	45	77	309973
916	1876	158	87	22	MMRM	6161	6202	4455	826	117643			145	1194	190784	650	46	68	315047
917	1844	158	91	10	MMRM	7680	7724	4356	1003	121641			145	1200	197288	640	47	68	325633
918	1843	159	88	32	MMRM	6534	6584	5346	1239	111680			120	1332	184280	620	47	68	303997
919	2054	160	78	17	MMRM	3429	3446	2970	767	40819			170	5000	66666	710	820	68	116392
920	2777	161	78	17	MMRM	3341	3358	2832	783	41478			110	4337	68023	700	77	68	117563
921	2424	161	78	20	MMRM	3322	3336	2746	499	52407			98	3988	84150	740	67	68	143888
922	2457	161	78	20	MMRM	3313	3348	2880	986	57708			120	4750	93408	720	64	68	159852
923	1592	161	79	15	MMRM	3465	3490	3332	1475	50394			160	4000	83388	800	68	68	142749
924	2289	161	79	25	MMRM	3308	3324	6336	1357	52159			255	1480	94380	650	66	68	155967
925	2090	161	79	28	MMRM	3396	3462	2277	501	28921			65	3300	47627	670	115	68	82691
926	3004	162	79	8	MMRM	3292	3309	3168	957	46884			120	4181	77558	670	70	68	132868
927	3309	162	79	18	MMRM	3402	3412	3561	1354	52274			120	3983	87870	720	67	68	149162
928	2842	162	79	20	MMRM	3356	3388	3034	673	44321			168	4037	72618	730	74	68	124851

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
929	2740	162	79	30	MMRM	3393	3441	3200	1008	52313			44	3580	86625	650	66	68	146770
930	1588	162	80	17	MMRM	3538	3556	2499	620	25884			145	3741	43311	700	110	68	76200
931	2484	162	90	9	MMRM	5802	5835	4032	928	65887			110	3292	108976	700	59	68	183225
932	2922	162	90	17	MMRM	5852	5884	6720	1624	113828			198	558	191672	670	46	68	314600
933	1535	162	91	5	MMRM	6078	6104	5586	1298	57514			195	630	101802	690	62	68	167025
934	1535	162	91	5	MMRM	6078	6104	5586	1298	57514			195	630	101802	690	62	68	167025
935	1687	162	91	6	MMRM	6081	6110	5292	1121	113123			230	728	186448	630	46	68	306942
936	1639	162	91	7	MMRM	6142	6174	5292	1062	109712			205	731	181028	640	46	68	298030
937	1639	162	91	7	MMRM	6142	6174	5292	1062	109712			205	731	181028	640	46	68	298030
938	1878	162	91	8	MMRM	6108	6140	3564	885	57447			295	4100	94300	770	63	68	160591
939	3545	162	91	8	MMRM	6142	6179	2565	513	30300			220	5400	48660	600	100	68	87658
940	3431	162	91	35	MMRM			5600	1191	114306			195	860	188860	480	40	77	311012
941	1847	162	92	22	MMRM	6348	6372	5148	112	111122			110	1130	179940	630	47	68	297562
942	1549	162	92	24	MMRM			5200	910	107700			180	1160	177000	660	45	68	292150
943	1532	162	95	9	MMRM	6695	6725	5600	728	73200			342	2300	123000	700	52	68	205170
944	3162	163	83	5	MMRM	3789	3821	3540	900	39605			37	3457	67320	860	77	68	114859
945	3770	163	83	16	MMRM	3828	3855	4290	1220	45560			100	2526	79500	730	70	68	133196
946	1552	163	90	18	MMRM	5713	5735	1470	208	11200			1140	3480	17400	770	231	77	34898
947	1872	163	91	22	MMRM	5920	5921	10890	1888	98073			255	404	175600	660	46	68	287110
948	1648	163	91	28	MMRM	5940	5950	6664	870	112738			425	598	187532	740	46	68	308827
949	1648	163	91	28	MMRM	5940	5950	6664	870	112738			425	598	187532	740	46	68	308827
950	1703	163	94	12	MMRM	6191	6221	6076	1298	108102			195	1085	180364	500	47	68	297120
951	4691	163	95	29	MMRM	6462	6485	6830	1210	99293			145	656	168200	600	48	68	276334
952	2702	163	96	8	MMRM	6346	6373	7500	1380	113045			186	654	191070	550	46	68	313835
953	151	140	80	18	O			2859	489	51666			135	2798	84000	740	70	68	141947
954	3261	129	106	15	ORR	8289	8308	2061	451	101341			75	3609	158570	620	48	68	266107
955	6322	130	91	7	ORR	8355	8414	21844	2796	89500			43	170	190000	543	44	77	304353
956	2677	130	107	3	ORR	8346	8348	893	203	13227			403	2304	20640	820	191	77	37670
957	6920	141	104	25	ORR	12000	12250	940	80	4128			6	23	5100	705	45	77	10277
958	2853	143	101	5	ORR	12785	12920	1692	342	64897			781	2220	102000	680	52	77	171932
959	2584	145	101	16	ORR	13205	13280	15125	1336	33384			610	1050	81000	700	69	77	132505
960	4990	156	84	22	ORR	9055	9115	49000	5880	62690			60	145	200400	590	49	68	318175

CHEMICAL DATA

OBS	WELLNO	TOWN	RANGE	SECT	FM	TOP	BOTTOM	CA	MG	NA	FE	CO3	HCO3	SO4	CL	PH	RESIST	F	TDS
961	6223	156	86	15	ORR	10216	10243	65731	6321	46300	10400		198	32	218880	515	45	77	347862
962	613				PNM	8019	8066	7400	1525	106386				410	181332	380	47	68	297053
963	4280				PNM	7365	7400	400	91	8769			330	2666	12340	810	31	68	24596
964	511	134	96	24	PNM	7610	7660	16530	2668	104173			710	878	196648	580	47	68	321607
965	4989	135	82	11	PNM	3902	3918	824	210	6086			49	3225	9050	640	640	68	19444
966	3859	135	83	34	PNM	4615	4634	2360	1200	66493			60	2714	108200	630	58	68	181027
967	1508	139	101	10	PNM	7452	7500	2471	708	119679			49	1081	190210	660	46	68	314198
968	4642	140	102	30	PNM	7410	7445	2100	580	117392			185	775	185800	730	46	68	306832
969	1469	149	96	25	PNM	7770	7843	706	742	122537			512	3852	189280	640	46	68	317629
970	1716	150	95	9	PNM	7315	7374	568	566	125866			315	7473	191102	500	46	68	325890
971	4224				PNT	8045	8058	5002	476	58320			378	2000	98500	780	55	77	164676
972	1665	137	100	15	PNT	8123	8128	6800	1140	46686			174	600	89908	620	65	68	145308
973	2395	139	100	6	PNT	8124	8136	9600	1320	45989	2		174	380	91390	570	65	68	148855
974	2309	139	100	7	PNT	8155	8170	12400	1560	60243			152	365	119054	570	55	68	193774
975	2486	139	100	8	PNT	8281	8292	13200	2160	63329			204	350	126598	580	53	68	205841
976	518	139	100	9	PNT	8271	8278	14000	1320	63312			112	328	125970	570	54	68	205042
977	2426	139	100	17	PNT	8244	8261	13600	1560	67200			200	341	131898	570	52	68	214799
978	4325	139	101	3	PNT	8152	8165	10390	1485	58222			255	770	114802	630	56	68	185924
979	4357	140	103	13	PNT	7818	7912	9235	4111	66029			170	290	129858	610	53	68	209693
980	6839	150	104	11	S	11720	11840	25016	2860	92140			561	129	202000	680	68	68	322706
981	6243	137	92	26	TRS	5868	5750	8317	790	20200	150		146	1700	51600	745	88	77	82903
982	4052	163	79	7	TRS	3190	3191	4329	866	48631			49	2125	83600	570	69	68	139600