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EFFECTS OF BRINE ON THE CHEMICAL QUALITY OF WATER IN PARTS OF CREEK, LINCOLN, OKFUSKEE, PAYNE, POTTAWATOMIE, AND SEMINOLE COUNTIES, OKLAHOMA

U.S. GEOLOGICAL SURVEY

Open-File Report 84-445

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By Robert B. Morton

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By

Robert B. Morton

ABSTRACT

A study of water-quality degradation due to brine contamination was made in an area of about 1,700 square miles in east-central Oklahoma. The study area coincides, in part, with the outcrop of the Vamoosa-Ada aquifer of Pennsylvanian age.

Water samples collected from 180 wells completed in the Vamoosa-Ada aquifer, and at 168 sites from streams draining the Vamoosa-Ada aquifer show scattered occurrences of water-quality degradation by brine. Degradation of water quality by brine is indicated where: (1) Chloride concentration is equal to or greater than 400 milligrams per liter (2) bromide concentration is equal to or greater than 2 milligrams per liter (3) the ratio of lithium to sodium is equal to or less than 0.01, and the chloride concentration is equal to or greater than 400 milligrams per liter, or (4) the ratio of sodium plus chloride to dissolved solids is equal to or greater than 0.64. Other ratios of secondary importance that also indicate water-quality degradation by brine in the area are (1) a sodium/chloride ratio of about 0.46; (2) a sodium/bromide ratio of about 92; and (3) a bromide/chloride ratio of about 0.0048.

Differences in concentrations of bromide, lithium, strontium, dissolved solids, calcium, magnesium, sodium, chloride, and sulfate were subjected to analysis of variance based on use of the index values in partition data sets. The result of the analysis of variance showed the significance of the indices for all constituents except sulfate.

The two most reliable brine indicators are chloride and bromide. Chloride is a slightly more reliable index statistically than bromide. The indices developed can be used to indicate water-quality degradation by brine. The accuracy is improved if the indices are used conjunctively.

Of the 133 pairs of oil and gas well geophysical logs analyzed, data from 5 pairs indicate a possible rise in the interface between freshwater and saltwater in the Vamoosa-Ada aquifer. Therefore, any rise of the interface is not regional, but is restricted to local areas.

The criteria developed in this study indicate that brine has degraded water quality at 63 sites on streams draining the Vamoosa-Ada aquifer, and at 15 water wells completed in the Vamoosa-Ada aquifer, and at 5 oil and gas wells penetrating the Vamoosa-Ada aquifer.

INTRODUCTION

Background

An earlier study by D'Lugosz and McClaflin (1981) indicated that the water resources in the area of the Vamoosa-Ada aquifer may be affected by brines. Onsite observations and analysis of water samples collected by D'Lugosz and McClaflin indicate that activities related to oil and gas operations are potential sources of such brines. Therefore, their work is the basis for the present study.

Purpose and Scope

This study was made in cooperation with the Oklahoma Geological Survey to determine areas where water quality has been degraded and the potential sources of the degradation. The study included the use of chemical-graphical and geophysical methods for identifying the areas and sources of the degraded water.

Parts of Creek, Lincoln, Okfuskee, Payne, Pottawatomie and Seminole, Counties are included in the study area as shown by the index map (figure 1). The study area generally coincides with the areal extent of the Vamoosa-Ada aquifer (plate 1, maps A, B, and C).

Figure 1.--Location of study area.

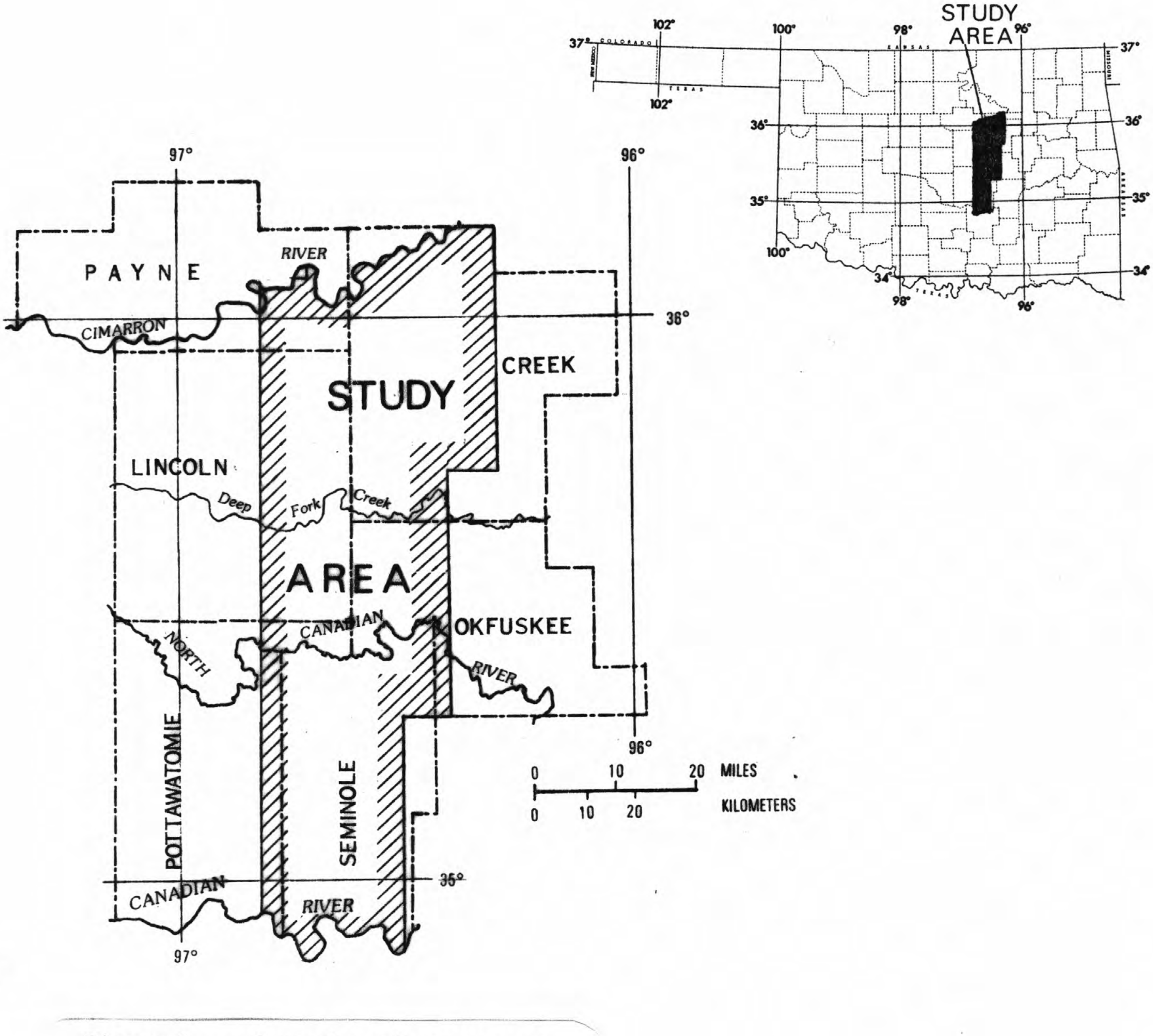


Figure 1. -- Location of study area

Location and General Description of the Study Area

The study area includes slightly less than 1700 mi^2, and extends about 90 mi from the Cimarron River on the north to the Canadian River on the south, and about 30 mi from east to west. The area described extends from township 5 north to 19 north, and range 5 east to 9 east.

The study area is part of the Osage Plains section of the Central Lowlands physiographic province (Fenneman and Johnson, 1946). The mean annual temperature is about 61°F (16°C) and the mean annual precipitation is about 37 in. The land surface slopes generally eastward and is gently rolling and well drained by numerous tributaries to the Cimarron, North Canadian, and Canadian Rivers, and Deep Fork Creek, the four principal streams in the area. Most of the major streams are perennial, whereas the smaller streams are dry during extended periods of little or no precipitation. Altitude of the land surface ranges from slightly less than 800 ft in the larger stream valleys to more than 1,100 ft in the uplands, but generally the higher altitudes range from 950 to 1,000 ft.

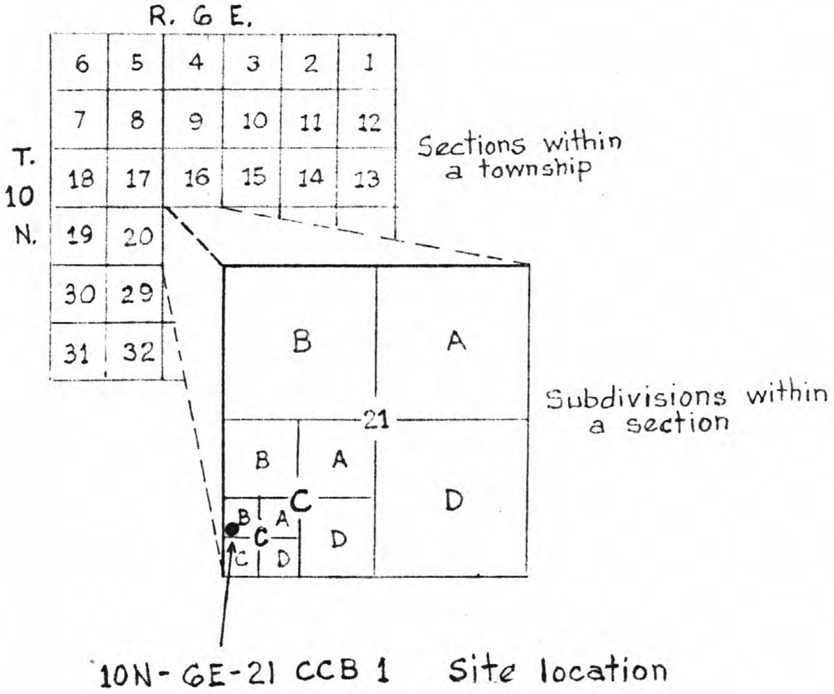
The petroleum industry, including many supportive enterprises, is the dominant industry in the study area. Oil and gas fields range in size from one or two wells to such huge fields as Cushing, Seminole, and Bowlegs, which had 1605, 255, and 175 active wells, respectively, in 1976 (McCaslin, 1977). Few sizeable areas are without some evidence of oil and gas operations. The cattle and farm industry are second in importance.

Previous Studies

Many studies have been made of the chemistry of oil-field brines and related-degradation effects on the water resources of other areas. Except for the preliminary work done by D'Lugosz and McClaflin (1981), a review of the literature indicates that this investigation is the initial study of the effects of brine degradation on the water resources of the project area.

Site Numbering System

Land descriptions given in this report use the U.S. Bureau of Land Management system of land subdivisions, as follows: the number of the township, range, section, and position within the quarter-quarter-quarter section. The number following the quarter-quarter-quarter section is the sequence number. This method of site location is shown below:



Acknowledgments

Many farmers and ranchers interrupted their work to supply requested information on their water wells and in many instances to aid in the collection of a water sample. Without their cooperation, this study would not have been possible.

GEOLOGY OF THE VAMOOSA-ADA AQUIFER

Most of the geologic descriptions and the following section on hydrology are condensed from D'Lugosz and McClaflin (1981). The outcrop area of the Vamoosa-Ada aquifer is shown on plate 1, maps A, B, and C. The bedrock in the study area is Pennsylvanian in age and is overlain locally by alluvial and terrace deposits of Quaternary age. The Vamoosa-Ada aquifer is part of the bedrock sequence and includes the Vamoosa Group[1] and underlying and overlying Pennsylvanian formations that are lithologically similar and hydrologically connected. In the study area the Vamoosa-Ada aquifer, in ascending order, consists of the uppermost part of the Barnsdall Formation, The Tallant Formation, the Vamoosa Group, The Ada Group, and the lower part of the Vanoss Group.

Lithologically, the Vamoosa-Ada aquifer consists of a complex sequence of fine-to very fine-grained sandstone, siltstone, shale, and conglomerate, with interbedded very thin limestone. Individual sandstone units are 1 to 5 ft thick and are limited in areal extent.

Structurally, the Vamoosa-Ada aquifer is part of a monocline which dips westward at 30 to 90 ft/mi. Thus, the Vamoosa-Ada aquifer is a source of ground water west of its outcrop area. A series of normal faults trending mostly northwest occur en echelon from southern Seminole County, across Okfuskee County, into Creek County and continue northward. Few faults exceed 3 mi in length and most average about 1 mi. Displacement rarely is more than 100 ft, usually is about 50 ft and probably does not extend below rocks of Pennsylvanian age.

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[1] The stratigraphic nomenclature and age determinations used herein are those accepted by the Oklahoma Geological Survey and do not necessarily agree with those of the U.S. Geological Survey.

HYDROLOGY OF THE VAMOOSA-ADA AQUIFER

In the outcrop area, water in the Vamoosa-Ada aquifer is under water-table conditions, whereas west of the western edge of the outcrop belt confined conditions prevail. The gradient of the water table in the outcrop area generally is to the east, but locally is toward gaining streams (pl.1, map A.). In the confined part of the aquifer the potentiometric surface presumably follows the monoclinal dip to the west. Water-level measurements made in a few wells that penetrate the confined part of the aquifer show that water levels in the confined part of the aquifer range from 70 to 150 ft below water levels in the unconfined part of the aquifer. The movement and occurrence of water in the Vamoosa-Ada aquifer depends significantly on the difference in the thickness of the sandstone units. The base of the freshwater is lower in altitude where the sandstone sequence is thick and is higher where sandstones grade into less permeable shale and siltstone. The effect of the en echelon faults on the movement of ground water is not known but they are of limited extent and, therefore, not likely to have any regional effect on the hydrology of the aquifer. Movement of ground water across the fault zones depends on the relative degree of fracturing, brecciation, or cementation associated with the faulting.

Plate 1.--Geohydrologic maps of the area generally underlain by the Vamoosa-Ada aquifer in parts of Creek, Lincoln, Okfuskee, Paynee, Pottawotomie, and Seminole Counties, Oklahoma

Based on recovery tests made in seven wells in 1978, transmissivity values for the aquifer ranged from 70 to 490 ft^2/d and averaged 200 ft^2/d. Hydraulic conductivity ranged from 2 to 4 ft/d and averaged slightly less than 3 ft/d. Storage coefficients determined from four unpublished tests made in the confined part of the aquifer in 1944 by the U.S. Geological Survey ranged from 0.0001 to 0.0003, whereas storage, or specific yield, in the unconfined part was estimated at 0.12. Comparison of water-level measurements in wells with base-flow measurements in the Hilliby and Polecat Creek basins which are geologically and topographically typical of the aquifer outcrop area, shows that a rise in water level is accompanied by an increase in base flow, whereas a water-level decline results in a decrease in base flow. Thus, recharge and discharge are in approximate equilibrium. The volume of water in storage is near capacity most of the time.

BRINE DETECTION METHODS

Chemical-Graphical

Water samples were collected for chemical analysis from 348 sites; 168 were surface-water sites and 180 were ground-water sites (pl. 1), map B). Most of the samples were collected in 1979 and 1980; however, 15 samples were collected for less complete chemical analysis in 1978. Sampling-site selection was based on a 2- to 3-mi grid throughout the study area. In this way, sample sites generally were evenly distributed throughout the entire area. Time and budget constraints precluded a smaller grid spacing. As a consequence of the large grid spacing, many sites where water possibly is degraded by brine were not sampled; therefore, this study does not represent a complete inventory of all sites with degraded water in the area.

Plate 1, map B.--Water-sample sites, geophysical log sites, oil and gas fields in the area of the Vamoosa-Ada aquifer, east-central Oklahoma.

Three hundred forty-two samples were analyzed for the common ions plus bromide and lithium. One hundred eighteen surface-water samples and 127 ground-water samples were analyzed for dissolved organic carbon (DOC). As noted later in this report, chloride is the best indicator of brine. When DOC concentration was plotted against chloride concentration, no relation was observed for either the surface-water or ground-water samples; therefore, DOC analysis was terminated.

A few of the data points in figures 2 through 9 plot some distance away from the general trend of the data points. Such points may represent valid data, but many probably are the result of errors. Included in the possible sources of error are analytical errors in the laboratory, round-off error of the laboratory values, tabulation error in the laboratory, key-punch errors, contamination of sample container, or contamination of the sample during the collection procedure. Most of the fresh water in the study area is either a sodium bicarbonate type or a sodium calcium bicarbonate type, and most brines are a sodium chloride type. The presence of other water types in the area may explain some of the variability seen in figures 2 through 9. Data points with question marks may be the result of one or more of the sources of error. These outlying points were used neither in determining the position of the median lines nor in the delineation of the ranges of each ratio.

The laboratory analyses for the water samples collected at the 348 sites are listed, alphabetically by county, in table 1; the table presents the data used in the chemical-graphical method for determining the presence of brine in the study area. In table 1, surface-water analyses are indicated by a value for "Streamflow, instantaneous"; whereas ground-water analyses are indicated by a value for "Depth of well, total".

Table 1.--Chemical analyses of water from selected streams and wells

Basis for use of brine-effect indices

The occurrence of brine in the subsurface may originate in 2 ways. One origin may be the re-solution of halite whose chemical composition is sodium chloride. In such cases the halite commonly occurs as bedded salt in the rock column. However, the section on geology indicates that studies by many investigators have failed to indentify salt or other evaporites in the Pennsylvanian-age rocks of Oklahoma. Carpenter (1978) indicates that the ratio of sodium to chloride in the re-solution of halite is 1. The average sodium concentration of all water samples collected in the study area is 679.4 milligrams per liter and the average chloride concentration of all water samples collected in the study area is 1383.5 milligrams per liter. The ratio of average sodium concentrations to average chloride concentration in the study area is 0.49. The data presented indicates, therefore, that the origin of brine in the study area is not by re-solution of halite.

The second, and most acceptable origin of brine in the study area is seawater. As indicated by Carpenter (1978), the chemical evolution of subsurfaces brines derived from seawater includes an evaporative process in which the least soluble chemical elements progressively precipitate out of solution, whereas the more soluble chemical elements remain in solution in increasing concentrations. Carpenter (1978) explains further that the sodium/chloride ratio should be between 0.55 and 0.58 for any concentration of seawater up to halite saturation, but any modification of seawater by evaporative concentration beyond halite saturation, or by diagenetic reactions, should lower the sodium content relative to chloride so that the sodium/chloride ratio should be less than 0.5. Since the sodium/chloride ratio in the subsurface brines of the study area is 0.49, the conclusion is reached that such brines originated from seawater.

On all the graphs the value for the respective elemental ratios for seawater is shown. The position of the seawater value relative to the more briny, or right side of the graphs, further indicates a seawater origin for the brines. Where available date permitted, plots from brine analyses are shown on some of the graphs. The analyses were made by different oil companies and later complied by the The University of Oklahoma, Energy Resources Institute, Office of Information Systems Programs from whom the analyses were purchased for this study.

Sodium, chloride, bromide, and lithium, 4 of the more soluble chemical elements in the brines of the study area were used in determining the brine-effect indices as log-log plots, in some cases, of a ratio versus a component of the ratio. Because there is a significant disparity in the concentrations of sodium, chloride, bromide and lithium, the logarithmic approach is considered useful. Other workers such as Whittemore and Pollack (1979) use a log-log plot of a ratio versus a component of the ratio. The particular combinations of elements used in the plots were determined empirically.

Brine-effect indices and their limitations

The solubility of the alkali metals and halides and their usefulness in brine indexing is discussed by Chebotarev (1955), White, Hem, and Waring (1963), and by Whittemore and Pollock (1979). The importance of chloride as an indicator of oil-field brine pollution is discussed by Revelle (1941), and by Collins (1974). Bromide as an indicator of oil-field waters is discussed by Rittenhouse (1967); and Collins (1976) reports on lithium and bromide in oil-field brine.

Sodium, chloride, bromide, and lithium occur in much greater concentrations in oil-field brines than in fresh ground water and surface water. For example, a representative analysis of freshwater in the study area shows the following constituent concentrations: 22 mg/L (milligrams per liter) of sodium, 23 mg/L of chloride, 0.2 mg/L of bromide, and 20 µg/L (micrograms per liter) of lithium (Table 1, analysis 326). By contrast, a representive analysis of oil-field brine in the area shows concentrations of 42,000 mg/L of sodium, 91,000 mg/L of chloride, 280 mg/L of bromide, and 1900 µg/L of lithium (Table 1, analysis 290). As shown in table 2, the concentrations of these four constituents are greater after the indicated 5 stages of sea water evaportion than the concentrations of the same consitutents in the original sea water sample. Consequently, greater solubility helps to make sodium, chloride, bromide, and lithium useful indices for tracing brine contamination. Because of the solubility of sodium, chloride, bromide, and lithium plus their recognized use as brine indicators by earlier researchers cited above, these four constituents were used in a series of graphs (figs. 2-9) to determine the indices described in this study.

Table 2.--Five relative concentration changes of some dissolved ions during evaporation of sea water and brine.

Table 2.--Five relative concentration changes of some dissolved ions during evaporation of sea water and brine

From Collins (1975) and used with the permission of the author and the publisher

Constituents	(Approximate Concentrations in milligrams per liter)					
	Sea water[1]	$CaSO^4$	NaCl	$MgSO^4$	KCl	$MgCl_2$
Lithium	0.2	2	11	12	27	34
Sodium	11,000	98,000	140,000	70,000	13,000	12,000
Potassium	350	3,600	23,000	37,000	26,000	1,200
Rubidium	0.1	1	6	8	14	10
Magnesium	1,300	13,000	74,000	80,000	130,000	153,000
Calcium	400	1,700	100	10	0	0
Strontium	7	60	10	1	0	0
Boron	5	40	300	310	750	850
Chloride	19,000	178,000	275,000	277,000	360,000	425,000
Bromide	65	600	4,000	4,300	8,600	10,000
Iodide	0.05	2	5	7	8	8

1/ Columns headed sea water, $CaSO_4$ and so forth, represent stages in sea water evaporation. For example, sea water contains 0.2 mg/L (milligrams per liter) of lithium; after calcium sulfate ($CaSO_4$) has been precipitated the residual brine contains about 2 mg/L of lithium; after sodium chloride (NaCl) has been precipitated the residual brine contains about 11 mg/L of lithium; after magnesium sulfate ($MgSO_4$) has been precipitated the residual brine contains about 12 mg/L of lithium; after potassium chloride (KCl) has been precipitated the residual brine contains about 27 mg/L of lithium; after magnesium chloride ($MgCl_2$) has been precipitated the residual brine contains about 34 mg/L of lithium.

Before the proposed indices are discussed, some general observations are in order. Numerous plots, or graphs, were made using different combinations of some of the data presented in table 1. The purpose for the graphs was to determine constituent relations, expressed numerically, which would help distinguish freshwater from different mixtures of freshwater and brine. The plotted data showing the most consistent relations, and,from which numerical relations could be derived, are shown in figures 2 through 9. There may be objection to the repetition in deriving some of the indices, but if the same conclusion can be reached by more than one approach, the more acceptable is that conclusion. The results of the analysis of all water samples collected show a range grading from virtually freshwater through different, but increasingly briny, mixtures of freshwater and brine, and ending with samples that are mostly brine.

The use of numerical expressions for the indices in this study may be assumed to imply mathematical exactness of the indices. No assertion is made for such mathematical precision. The change from freshwater to brine, as indicated by plots of the analysis of the many water samples collected, is gradational. The indices method used for identifying brine contamination requires that a decision indicating brine contamination must be made at some point in the progressive change from freshwater to brine. The indices are considered the best estimate for that point.

Except for iodide, not used in this study, all values reported in table 1 are rounded to one decimal place. The rounding helps explain the linear arrangement of some of the data points in the figures. The rounding also may affect the position of the plotted points in the graphs, and the scatter of points at the left, or freshwater end, of the graphs. In the case of bromide, a reported value of 0.1 mg/L may include values ranging from 0.05 to 0.15 mg/L. Restated, the actual value may be 50 per cent more, or 50 percent less, than the reported value. In figure 2, the maximum sodium/bromide ratio is 3500 and the minimum is 29 for a bromide concentration of 0.1 mg/L. Applying the maximum "correction" of 50 percent to the plotted-ratio values results in new ratio values ranging from 1750 to 43. Thus, the scatter is slightly exaggerated by rounding of the reported data. However, the diffusion of points observed on the left of most of the graphs is real and is explained by the large range in constituent concentrations in mixtures of freshwater and brine. Less scatter, such as that observed on the right of the graphs, would indicate more widespread polution so that most water in the study area would not be potable. Such is not the case; most of the water in the study area is potable, hence the proliferation of points and their scatter on the left of the graphs.

The relation of the sodium/bromide ratios to bromide concentrations is shown in figure 2. Most of the sodium/bromide ratio values are widely scattered for given bromide concentrations until a critical bromide concentration of about 2 mg/L is reached. At bromide concentration equal to or greater than about 2 mg/L, the range of the sodium/bromide ratios narrows and begins to reach a median value of about 92. The median value range is 35 to 155. For the purpose of this report, a bromide concentration equal to or greater than about 2 mg/L, is proposed as one of the indicators of water-quality degradation by brine, because it represents a subtle break in the background bromide concentration in most waters of the study area.

The relation of sodium/chloride ratios to bromide concentrations is shown in figure 3. The explanation given for figure 2 applies equally here except for the substitution of chloride for bromide in the ratio along the vertical axis. Again a bromide concentration equal to or greater than approximately 2 mg/L, apparently is a critical value for indexing possible water-quality degradation by brine; also, a median sodium/chloride ratio of about 0.46 is indicative of possible brine presence if the bromide concentration is equal to or greater than 2mg/L. The median value range is 0.28 to 0.72. The median sodium/chloride ratio of 0.46 generally agrees with a mean ratio of 0.52 derived from 45 random samples of oil-field brine in the Walnut River basin of south-central Kansas (Leonard, 1972). The conclusions based on data used in this report also agree with Leonard's conclusions that the sodium/chloride ratio in freshwater usually exceeds 0.60; whereas the ratio in water containing brine usually is less than 0.60.

Figures 2-5.--Relation of:

2. Sodium/bromide ratios to bromide concentrations.
3. Sodium/chloride ratios to bromide concentrations.
4. Bromide/chloride ratios to chloride concentrations.
5. Sodium/chloride ratios to chloride concentrations.

Figure 6.--Relation of sodium/chloride ratios to chloride concentrations resulting from the hypothetical mixing of two solutions with different volumes and concentrations. Concentrations range from 12 to 42,000 milligrams per liter of sodium, and 4.2 to 91,000 milligrams per liter of chloride.

Figure 7.--Relation of lithium/bromide ratios to chloride concentrations.

Figure 8.--Relation of lithium/bromide ratios to chloride concentrations resulting from the hypothetical mixing of two solutions with different volumes and concentrations. Concentrations range from 0.02 to 0.5 milligrams per liter of lithium, 0.1 to 100 milligrams per liter of bromide, and 4.3 to 22,000 milligrams per liter of chloride.

Figure 9.--Relation of sodium plus chloride/dissolved solids (residue at 180°Celsius) ratios to chloride concentrations.

The relation of bromide/chloride ratios to chloride concentrations is shown in figure 4. As chloride concentrations increase, the range of the bromide/chloride ratio decreases until an approximately constant ratio is reached. This ratio is about 0.0048 beginning at a bromide concentration equal to or greater than 2 mg/L and a chloride concentration equal to or greater than 400 mg/L. The median value range is 0.0025 to 0.0090. The lines marking 400 mg/L of chloride, 2 mg/L of bromide, and the median bromide/chloride ratio of 0.0048 have a common intersection point. A bromide concentration equal to or greater than 2 mg/L again is indicated as a possible brine index and a chloride concentration equal to or greater than 400 mg/L, also appears to be signigicant as a brine index.

The relation of sodium/chloride ratios to chloride concentrations is shown in figure 5. The scatter of points is apparent at the smaller chloride concentrations; however, the range of sodium/chloride ratios converges and reaches a general linear relationship at larger chloride concentrations. This situation is shown by the median line whose rate of change continually decreases until it becomes a constant value of about 0.46 beginning at a chloride concentration of about 400 mg/L. Therefore, a chloride concentration equal to or greater than 400 mg/L and a median sodium/chloride ratio of about 0.46 are further supported as brine indicators.

The curve shown in figure 6 was constructed to test the hypothesis that the water samples analyzed are different mixtures of freshwater and brine. From the analyzed data, a sample analysis with the smallest constituent concentration (freshwater) and a sample analysis with the greatest constituent concentration (brine) were selected. The extremes in values for sodium and chloride are shown in table 3. Different volumes of the two solutions then were mixed, hypothetically, according to the equation shown below:

$$\frac{V_1C_1 + V_2C_2}{V_1 + V_2} = \text{Constituent concentration in milligrams per liter in mixture} \quad (1)$$

where

V_1 = volume of solution 1,

V_2 = volume of solution 2,

C_1 = concentration of chloride in solution 1, and

C_2 = concentration of chloride in solution 2.

Table 3.--Sample-analysis data used in constructing figures 6 and 8.

Table 3.--Water-sample analyses used in constructing figures 6 and 8.

Figure	Solution number	Extreme values of constituent concentrations (milligrams per liter)		
		Sodium		Chloride
6	1	12		4.2
	2	42,000		91,000
		Lithium	Bromide	Chloride
8	1	0.02	0.1	4.3
	2	0.5	110	22,000

Because the hypothetical curve in figure 6 approximates the shape of the curve in figure 5, one concludes that the waters sampled are different mixtures of freshwater and brine. On both curves the sodium/chloride ratio stablizes at the median value of about 0.46 at a chloride concentration equal to or greater than 400 mgL.

The relation between lithium/bromide ratios and chloride concentrations is shown in figure 7. The median line for the plotted values shows an inflection in the direction of greater chloride concentration beginning at a chloride concentration of about 400 mg/L. The 400 mg/L chloride line and the 0.01 lithium/bromide ratio line divide figure 7 into four quadrants. Approximately 98 percent of the points plot in the upper left and lower right quadrants. The few values that plot in the upper right and lower left quadrants may result from one or more of the errors discussed earlier in this report. Because a chloride concentration equal to or greater than 400 mg/L of chloride previously has been shown to be a brine index, figure 7 indicates the values which plot both to the right of the 400 mg/L chloride line and also are on or below the lithium/bromide ratio line of 0.01 are brine contaminated. Therefore, a lithium/bromide ratio equal to or less than 0.01 is considered a brine index when used in conjunction with the chloride index described above.

Figure 8 is a hypothetical-mixing curve constructed in the same way as figure 6 except that concentrations of lithium, bromide, and chloride were used in equation 1. The values for the three constituents used are shown in table 3. As before, a comparison of the two curves indicates a similarity in shape and the analyzed data appear to be various combinations of freshwater and brine.

Table 3.--Sample analysis data used in constructing figures 6 and 8.

The relation between the ratio of sodium plus chloride/dissolved solids (residue at 180 degrees Celsius), and chloride concentrations is shown in figure 9. The median line through the plotted points shows a break in the direction of greater chloride concentration at about 400 mg/L of chloride. At this concentration of chloride, the ratio of sodium plus chloride/dissolved solids has a value of about 0.64. Therefore, when the above ratio is about equal to or greater than 0.64 brine effect is indicated. Furthermore, 400 mg/L of chloride apparently is a consistent brine index in the study area.

Limitations of indices

Although the indices developed in this study are useful in defining and identifying water-quality degradation by brine, failure of the indices usually is traceable to one or more of the different sources of error, or lack of conformity to water type, as described earlier in this report. The water-type problem is illustrated by the degradation of water from three wells located in sec. 6, T. 8 N., R. 5 E., and secs. 4 and 27, T. 9 N., R. 5 E., near the Seminole-Pottawatomie County line, (pl. 1, map B and table 1, analysis nos. 213, 216, and 294, respectively). According to the land owners, the three wells yielded potable water and were used as a domestic water suppy, but water from them is now unfit to drink. In 1979 analyses of water samples show dissolved solids for the three wells contained 3,840 mg/L, 2,530 mg/L, and 3,910 mg/L of dissolved solids, respectively.

The indices used in this report are based on typical sodium chloride (brine) type water. The water from the three wells, and probably in the local area, is a sodium sulfate type rather than a typical sodium chloride oil-field brine type; the largest bromide concentration was 1.0 mg/L, and the largest chloride concentration was 220 mg/L. Therefore, the indices do not apply in the unusual circumstances of the three wells. The failure of the indices in the case of sodium sulfate type water is predictable from the statistical analysis (see section on statistical analysis) which shows no significant difference in sulfate concentration between Group 1 (freshwater) and Group 2 (degraded water).

The cause of the anomalous water type just describe in the three wells is not known but may be attributed to a difference in the local geology or hydrology. Other possible explanations are as follows: (1) Atypical brine at the time of origin; (2) geochemical alteration of typical brine--because gypsum is unknown in the rock column of the area, the sulfate-type water may be caused by oxidation of hydrogen sulfide commonly associated with some crude oil. (3) a combination of items 1 and 2; or (4) the addition of chemicals to the brine by the oil operator, after it leaves the rock, or reservoir, which originally contained it.

Statistical analysis

A summary of the indices that have been described is presented in table 4. Some of the indices are more important than others; consequently, the three which are most important are called primary indices; whereas the other four, called secondary indices, have supporting value and need to be used with a primary index.

Visual examination of the water-sample analyses indicated that for an index concentration not significantly greater than the minimum, for example bromide 2 mg/L, concentrations of lithium, strontium, magnesium, and sulfate did not necessarily correlate with changes in the concentrations of the index. A water-sample analysis with 3.0 mg/L of bromide may have a smaller concentration of strontium, for example, than another water-sample analysis with a bromide concentration of 2.5 mg/L. The primary indices, therefore, were statistically evaluated using analysis of variance and Duncan's multiple-range test. Concentration values for the following constituents were used in the test: bromide, lithium, strontium, dissolved solids, calcium, magnesium, sodium, chloride, and sulfate.

Water samples whose constituent concentrations are too small to be included with the indexed-water samples represent freshwater and are called Group 1. Except for sulfate, each constituent showed a significant statistical difference (at the 95-percent confidence level) from Group 2 data when classed according to the indices. Samples with constituent concentrations compatible with the index values represent degraded-water samples and are called Group 2. The concentration of sulfate in the water resources of the study area is not significantly different (at the 95-percent confidence level) between the two groups. The mean sulfate concentration for water samples analyzed for the 348 is sites is about 63 mg/L.

Table 4.--Summary of indices of brine effects from figures 2 through 9.

Table 4.--Summary of indices of brine effects

Type	Index (approximate)
Primary	Chloride concentration equal to or greater than 400 milligram per liter.
Primary	Bromide concentration equal to or greater than 2 milligrams per liter.
Primary	Sodium plus chloride/dissolved solids (residue at 180° Celsius) ratio equal to or greater than 0.64.
Secondary	Lithium/bromide ratio equal to or less than 0.01 when chloride concentration is equal to or greater than 400 milligrams per liter.
Secondary	Median sodium/chloride ratio equal to 0.46 (range 0.28 to 0.72) when bromide concentration is equal to or greater than 2 milligrams per liter, or chloride concentration is equal to or greater than 400 milligrams per liter.
Secondary	Median sodium/bromide ratio equal to 92 (range 35 to 155) when bromide concentration is equal to or greater than 2 milligrams per liter.
Secondary	Median bromide/chloride ratio equal to 0.0048 (range 0.0025 to 0.0090) when bromide concentration is equal to or greater than 2 milligrams per liter, or chloride concentration is equal to or greater than 400 milligrams per liter.

The two most reliable brine indicators are chloride and bromide. A procedure using a digital computer to compare the difference in standard deviation between waters in Groups 1 and 2, segregated according to concentrations of chloride and bromide, shows that chloride is a slightly more reliable index than bromide. Chloride at a concentration equal to or greater than about 400 mg/L, was determined to be the best single indicator of water degradation by brine. Reliability in the use of the indices developed in this study usually is increased by using a combination of indices, particularly when one of the indicators is chloride.

A further test of the bromide and chloride indices is by use of the R^2 statistic which measures how much variation in the dependent variable can be accounted for by a linear regression model according to the following general equation for simple regression:

$$\mu = \alpha + \beta\,(X - \overline{X}) \qquad (2)$$

where

μ = mean of dependent variable (for example, magnesium),
α and β = regression coefficients
X = sample value for independent variable (for example, chloride), and
$\overline{X}$ = sample mean for independent variable (for example, chloride).

Restated, the R^2 statistic when multiplied by 100 is a measure, in percentage, of how well the dependent variables, in Groups 1 and 2, correlate with the independent variables, bromide and chloride. The correlation can range from 0 to 100 percent; the greater the percentage, the better the correlation. The correlation of the dependent variables in waters from Groups 1 and 2 with bromide and chloride are shown in table 5.

Table 5.--R^2 statistics values (X 100)

Variable	Bromide		Chloride	
	Group 1	Group 2	Group 1	Group 2
Bromide	--	--	81.58	95.98
Lithium	1.39	89.36	2.45	87.53
Strontium	.68	93.76	2.05	96.61
Dissolved Solids	12.38	96.29	22.82	99.07
Calcium	6.90	97.45	10.40	96.86
Magnesium	7.94	94.66	7.22	93.32
Sodium	7.56	96.10	16.24	98.96
Chloride	53.76	96.03	--	--

Thus, when bromide is the independent variable, the correlation with the other constituents in Group 1 (freshwater) is weak in most cases, and is in contrast to a strong correlation between bromide and the other constituents in Group 2 (degraded water). Similarly, where chloride is the independent variable, the correlation with most constituents in Group 1 is considerably less than the correlation with members of Group 2. Sulfate was ignored in the R^2 calculations because, as stated earlier, the sulfate concentration is not significantly different between the two groups.

Geophysical

The change with depth from fresh to saltwater in different places is observable on geophysical logs. The ideal means of detecting a rise in the interface by geophysical logs is by comparing a log made during well construction with a log from the same hole many years later. Such ideal conditions do not exist for this study, therefore, logs from any two wells drilled 0.5 mi apart, or less, and generally with a time separation of 20 years, or more, were compared. Relative structural position of the wells and the stratigrahic correlation of the sandstone units were considered. A rise of 10 ft was considered significant. About 266 geophysical logs of oil or gas tests, or 133 pairs, as shown on plate 1, map C, met the foregoing constraints of distance, time, structural position, and stratigraphic correlation. Significant rises in the interface may have occurred in 5 of the 133 pairs, as indicated below: Apparently a widespread rise in the interface has not taken place.

Well location	Possible rise in interface (feet)
Sec.19, T.5 N., R.7 E.	230
Sec.13, T.9 N., R.5 E.	120
Sec.35, T.11 N., R.6 E.	250
Sec.33, T.15 N., R.7 E.	90
Sec.28, T.16 N., R.5 E.	100

Plate 1, map C.--Locations of oil or gas wells with geophysical logs used to determine a possible rise in the fresh water, salt water interface, Vamoosa-Ada aquifer area, east-central Oklahoma.

Because porosity logs were not available for most of the older logs used, and for some of the more recent ones, dissolved-solids concentrations of the formation waters were not obtainable from standard log analysis within an acceptable degree of accuracy; therefore, a qualitative inspection was made of the suite of curves on each log to determine a possible rise in the interface. The assumption was made that the change across the interface occurs in the range of 1,000 to 1,500 mg/L of dissolved solids. In some wells the change from fresh to saltwater is abrupt, whereas in other wells a transition zone of 200 ft or more may occur. In the latter situations, the depth selected for the interface was the one showing the greatest degree of contrast on the suite of curves.

A rise in the interface may result from the disposal of large quanities of unwanted brine by the use of disposal wells. The disposal well either is one drilled specifically for that purpose or is a non-commercial well converted to a disposal well. Brine is introduced, commonly from a holding tank, into the disposal well. The brine enters the disposal zone usually because of the hydrostatic head of the water column in the well, but in some areas the brine must be forced into the disposal zone by pumping.

The terms, disposal well and injection well, commonly are used interchangeably. An injection well is an opening or hole used to transfer material, usually a fluid, from the surface into the subsurface. A disposal well is used to discard unwanted material, usually a fluid, from the surface to the subsurface. Thus, a disposal well is a special case of an injection well distinguished by its use.

Injection wells, if properly constructed and maintained, usually present no contamination problems unless mechanical failures in the well, inadequate cementing procedure, pipe corrosion, or otherwise inadequate construction or use allow the injected brines to travel upward outside the casing and invade shallower, permeable formations which may be sources of freshwater. If this situation persists, especially in a pressurized system, a rise in the interface between fresh and saltwater occurs and degradation of the freshwater aquifer results.

POSSIBLE SOURCES OF BRINES

Listed below are possible sources of brines identified in the streams and ground water of the study area. The chances for the occurrence of each possible source then are evaluated sequentially.

1. Solution of salt beds within the Vamoosa-Ada aquifer and underlying formations.

As stated in the section on geology, the bedrock in the study area is Pennsylvanian in age and consists mostly of sandstone, shale, siltstone, and limestone. Studies by many investigators have failed to disclose salt or other evaporites in the Pennsylvanian-age rocks of Oklahoma.

2. Addition of minerals from agriculture practice.

Chloride, if it occurs in commercial fertilizer at all, is present only in trace quantities. Consequently, fertilizers are not a source of brines.

3. Solution of salt from formations of Permian age west of the study area.

Formations of Permian age contain salt deposits about 80 mi west of the study area. Because the Cimarron River extends about 175 mi west of the study area (fig. 8), the Cimarron retains some effects from solution of these deposits. The average chloride concentration in the Cimarron for the 1976-79 water years, inclusive, was about 3,000 mg/L at Perkins.

During this time the mean of the mean daily discharges was about 670 ft^3/s at Perkins. The average chloride concentration for the same period near Guthrie (fig. 8), was about 3,300 mg/L. No discharge data is available for the Cimarron River near Guthrie but flow should be less than at Perkins because Guthrie is a considerable distance upstream from Perkins. Thus, the average chloride concentration in the Cimarron River decreased about 300 mg/L from Guthrie to Perkins. Geologic and hydrologic data indicate a continued decrease in chloride concentration to less than 3,000 mg/L, because of increased discharge, for the remaining distance downstream to the study area. For example, plate 1, map A shows almost 200 ft of hydraulic head toward the Cimarron River along its entire stretch in the study area. Thus, the Cimarron is dominantly a gaining stream, a fact supported by an average flow of 1,244 ft^3/s at Oilton from 1934 to 1945, when streamflow was being measured at Oilton. Such a rate is almost double the flow of 670 ft^3/s at Perkins. Lesser streams, originating in, or a short distance west, of the study area are not affected by natural brine contamination because of a lack of a connection to salt-bearing formations.

4. Natural surface discharge of connate brines.

The freshwater-saltwater interface in the ground-water regimen in most places is several hundred feet below land surface and no known hydraulic head relation exists that, under natural conditions, would cause a significant rise in the interface.

5. Pumpage in quantities sufficient to cause a rise in the freshwater-saltwater interface.

There is very little use of ground water for irrigation in the study area. Most large-capacity wells are municipal wells, and degradation of ground-water supplies is not associated with towns and outlying areas. Most wells in the area are less than 200 ft deep and yield less than 10 gal/min. The total annual pumpage of ground water is less than 5,000 acre-ft (D'Lugosz and McClaflin, 1981), which is insufficient to induce significant upward movement of the interface.

6. Natural fluctuations in the freshwater-saltwater interface caused by changes in recharge from precipitation.

Natural fluctuations in the freshwater-saltwater interface may result from changes in hydraulic head caused by changes in recharge lasting more than an estimated 20 years. Available precipitation data indicates no significant changes in precipitation during the last 20 years; therefore, changes in recharge during this time probably have not occurred.

7. Atmospheric source.

The lack of importance of airborne chloride in inland areas is clearly indicated by the following references. Junge and Gustafson (1957), obtained average concentrations of chloride in precipitation at many sampling points in the United States during 1955 and 1956. Their data show that only a small area near the coasts has as much as 0.5 mg/L of chloride in precipitation and that over most of the country the average is less than 0.3 mg/L of chloride. Riffenburg (1925), reports that the average chloride concentration in rainwater for several parts of the world is 3.0 mg/L.

8. Industry source.

No industries have been observed, other than oil or gas, whose operations produce a brine effluent, and especially no industry, except oil and gas, whose brine-effluent distribution would explain the brine occurrences observed in the water resources of the project area. Moreover, most industry tends to locate in, or near, towns; however, brine effects described in this report are not restricted to centers of population.

Plate 1, map B, shows water-sample sites, active and abandoned oil and gas fields, and the location of oil and gas test sites wherein a significant rise in the freshwater-saltwater interface has occurred as described in the geophysical section of this report. Analysis of 63 surface-water samples and 15 ground-water samples show brine effects by indices developed in this study. The location of these 78 sampling sites plus the 5 locations showing a rise of the interface are in, or near, oil or gas fields.

Because of the dendritic-type drainage pattern in the study area, a single source of brine in a drainage basin may account for more than one degraded surface-water sample in downstream order of occurrence. Thus, the 63 surface-water samples showing brine effects do not necessarily represent 63 separate brine sources.

D'Lugosz and McClaflin (1981) determined that the specific conductance of water in Wewoka Creek and its tributaries ranged from 255 to 44,000 µmho. In order to determine the entrance points of such mineralized water into the creek, a series of measurements were made during a baseflow period in August 1975. The measurements show that specific conductance increased from 5,800 µmho near the mouth of the creek to 19,000 µmho about 8 mi upstream. From the upstream point, specific conductance increased to 44,000 µmho near the headwaters of the creek; the discharge of the creek did not change significantly in the upstream reaches. These measurements show that mineralized water was entering the upstream reach of Wewoka Creek during August 1975.

Whereas the identification of degraded water with oil-and gas-industry operations by visual observations may not be possible at some locatities, at others the relation is more apparent. Most of the items in the following list are not isolated occurrences but can be observed at several locations. All occur in, or near, oil or gas fields.

A. Salt encrustation on the alluvium surface and along the banks of small tributary streams.

B. Water in a small tributary is briny, and dark-brown oil-sludge floats on the water and covers the stream banks. Flow in the tributary originates near an oil well on the stream bank.

C. Sizeable areas of dead vegetation, including large trees, in proximity to producing wells and associated installations such as storage tanks for oil and for salt water.

D. Pipe from a salt-water storage tank near a producing well leads to a stream bank. Brine is flowing from the pipe and water downstream from the pipe is degraded.

E. Unlined pits containing brine or brine and crude oil.

F. Degradation of water may occur where no current oil or gas operation is apparent. For example, a water sample was collected and analyzed from an unused water well (analysis 175, table 1) in sec.9, T.13 N., R.7 E., Okfuskee County, plate 1, map B. Analysis showed chloride, 4,800 mg/L; sodium, 1,700 mg/L; dissolved solids (residue at 180° Celsius), 9,530 mg/L; and bromide, 33 mg/L. Initially the water from the well reportedly was potable but as the hydraulic head in the Vamoosa-Ada aquifer was lowered by continued use, the chemical quality deteriorated. Analysis of the water from a nearby stream (analysis 176, table 1) shows chloride, 22,000 mg/L; sodium, 11,000 mg/L; dissolved solids (residue at 180° Celsius), 38,000 mg/L; and bromide, 110 mg/L. This area had at one time been the site of an oil well as evidenced by a concrete base which once supported an oil-well pumping unit. The concrete base is obscured in vegetation several hundred yards east of the unused water well.

G. The following situation is included because the relation can be observed at a number of places in the study area and, therefore, may be significant: A domestic well that reportedly once was a source of potable water is now unusable because of the degradation of the chemical quality of the water. A saltwater-injection well is located several hundred feet from the unusable domestic well.

H. Onsite examination of a small tributary discloses that the water in the tributary is briny and streamflow originates at a point opposite a salt-water injection well located on the stream bank several hundred feet away from the stream.

Collins (1971) gives a detailed discussion of oil and gas operations that may be potential sources of contamination. Included are the possible overflow of brine, or emulsions of petroleum and brine, from disposal ponds; also the leakage of such liquids from faulty or inadequately constructed ponds. The leaking brines may pass through the soil, reappear at the surface, and produce scar areas. Some of the brine may remain in the soil, and subsequent leaching will pollute surface streams or shallow subsurface aquifers. Other potential sources of pollution Collins discusses are crude oil (or brine) escaping from leaky pipe connections, unplugged or improperly plugged wells, improperly cased and cemented wells, holes in pipe lines or storage tanks, and accidents.

Collins cites casing leaks in disposal wells as a means by which brine may enter freshwater aquifers. He states that injected brines must be chemically compatible with the brine in the disposal zone, otherwise precipitates may form on the face of the injection zone, thus decreasing fluid conductivity. Frequently the injected brines are chemically treated to inhibit precipitation reactions. However, if pressure is used to force brines into a disposal zone for any reason, bottomhole pressure must not exceed 1 $(lb/ft^2)/ft$ of overburden or the hydraulic pressure may induce fracturing, and in time the brine may migrate upward to a freshwater zone. Collins states that most accidental fractures will be horizontal if the disposal zone beneath the overlying impermeable rocks is no deeper than 1,000 ft. However, if the disposal operation is at depths greater than 1,500 ft, the fracture orientation may be vertical resulting in an increased potential for contamination of upper freshwater zones.

CONCLUSION

The presence of brine is most apparent in small streams where dilution is at a minimum and salt crusts and brown oil sludge are fairly common. Degradation of water quality by brine is indicated at 63 of the 168 surface-water sites, and 20 of the 180 ground-water sites.

Two methods, chemical-graphical and geophysical, were used for detecting the presence of brine in the water resources of the area. The two more reliable chemical-graphical indices are: chloride equal to or greater than 400 mg/L, and bromide equal to or greater than 2 mg/L. The chloride index probably is the most reliable of the proposed indices. All the indices are based on concentrations of chloride, bromide, sodium, lithium, and dissolved solids, or ratios of the concentrations of these constituents and dissolved-solids concentrations. The use of geophysical logs for detecting brine contamination by rise of the freshwater-saltwater interface is reliable in most instances.

The indices are supported in many places by visual evidence of brine degradion in the streams from which the samples were collected. The same indices also are applicable to ground waters; however, the presence of brine in ground water is not obvious because visual evidence is absent. Results of this study indicate that the effect of brine on the water quality of the study area is local rather than extensive in occurrence.

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GLOSSARY OF TECHNICAL TERMS

The following definitions are from Dixon and Massey (1969), Hawley (1971), Lohman (1972), Lohman and others (1972), Gary and others (1972), Hem (1970), Skougstad and others (1979), and Wolf (1979).

Acre-foot.--The volume of water required to cover 1 acre to a depth of 1 foot and is equivalent to 43,560 cubic feet or 325,851 U.S. gallons.

Alkali metal.--A metal in group 1A of the periodic system: lithium, sodium, potassium, rubidium, cesium, and francium.

Aquifer.--A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Base flow.--Sustained or fair weather streamflow usually composed mostly of groundwater effluent.

Breccia.--A coarse-grained clastic rock composed of large (greater than 2 millimeters in diameter), angular, and broken rock fragments that are cemented together in a fine-grained matrix.

Brine.--Any solution of sodium chloride and water, usually containing other salts also. Concentrations range from 3 percent to 20 percent or more.

Cation.--An ion with a positive charge. An ion is an atom or radical that has lost or gained one or more electrons and thus has acquired an electric charge.

Confidence level.--A percentage indicating how sure one is of the inference being made. In statistics the value for the confidence level is $1-\alpha$, where α is the area in the critical region at either end of a normal distribution curve.

Confined ground water.--Confined ground water is under pressure significantly greater than atmospheric, and its upper limit is the bottom of a bed of distinctly lesser hydraulic conductivity than that of the material in which the confined water occurs.

Conglomerate.--A coarse grained, clastic sedimentary rock composed of rounded (to subangular) fragments larger than 2 millimeters in diameter set in a fine grained matrix of sand, silt, or any of the common natural cementing materials.

Connate water.--Connate water generally is similar in age or somewhat younger, since last direct contact with the atmosphere, than the age of its associated rocks.

Diagenesis (mineral).--Recombination or rearrangement of a mineral resulting in a new mineral.

Evaporites.--A nonclastic sedimentary rock composed primarily of minerals produced from a saline solution that became concentrated by evaporation of the solvent.

Fault.--A surface or zone of rock fracture along which there has been displacement, from a few inches to a few miles.

Geophysical log.--A log obtained by lowering an instrument into a borehole or well and recording continuously on a meter at the surface some physical property of the rock material being logged.

Gypsum.--A widely distributed mineral consisting of hydrous calcium sulfate: $CaSO_4.2H_2O$

Halides.--Binary compounds of the halogens: fluorine, chlorine, bromine, iodine, and astatine.

Head, static.--The static head is the height above a standard datum of the surface of a column of water (or other liquid) that can be supported by the static pressure at a given point.

Hydraulic conductivity.--If a porous medium is isotropic and the fluid is homogenous, the hydraulic conductivity of the medium is the volume of water at the existing kinematic viscosity that will move in unit time under a unit hydraulic gradient through a unit area measured at right angles to the direction of flow.

Ion.--An atom or radical that has lost or gained one or more electrons, and has thus acquired an electric charge.

Mean.--A central value, or average, of a distribution and is defined as the sum of all observations divided by the number of observations.

Median.--A central value defined as the middle observation if there is an odd number of observations and, by convention, is the mean of the two central observations if there is an even number of observations.

Monocline.--A unit of strata that dips or flexes from the horizontal in one direction only, and is not part of an anticline or syncline.

National geodetic vertical datum of 1929 (NGVD of 1929):--A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Mean Sea Level.

Normal fault.--A fault in which the hanging wall (above) appears to have moved downward relative to the footwall (below).

Pennsylvanian.--A period of the Paleozoic era, and its corresponding system of rocks, thought to have been the span of time between 320 and 280 million years ago.

Permian.--The last period of the Paleozoic era, and its corresponding system of rocks, thought to have been the span of time between 280 and 225 million years ago.

Potentiometric surface.--The potentiometric surface is a surface which represents the static head. As related to an aquifer, it is defined by the levels to which water will rise in tightly cased wells. The water table is a particular potentiometric surface.

Recharge.--The process involved in the absorption and addition of water to the zone of saturation. Also, the volume of water added.

Residue at 180°Celsius--The weight of material remaining from an aliquot of a water sample that will yield less than 200 milligrams residue after being dried at 180°Celsius for 2 hours and immediately weighed.

Specific conductance.--The reciprocal of the resistance, in ohms, measured between opposite faces of a centimeter cube of an aqueous solution at a specific temperature.

Specific yield.--The specific yield of a rock or soil is the ratio of: (1) The volume of water which the rock or soil, after being saturated will yield by gravity to (2) the volume of the rock or soil. The definition implies that gravity drainage is complete.

Standard deviation.--The standard deviation of a distribution is the positive square root of the variance. See definition of variance.

Storage coefficient.--The storage coefficient is the volume of water an aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in head.

Stratigraphy.--The branch of geology that deals with the definiton and description of major and minor natural divisions of rocks available for study in outcrop or from subsurface, and with the interpretation of their significance.

Transmissivity.--Transmissivity is the rate at which water of the prevailing kinematic viscosity is transmitted through a unit width of the aquifer under a unit hydraulic gradient.

Unconfined water.--Ground water in an aquifer that has a water table.

Variance.--The variance is the sum of squares of the deviations of the observations from the arithmetic mean of the observations, divided by one less than the total number of observations, and is a measure of the spread of a distribution about the mean.

Viscosity.--The property of a substance to offer internal resistance to flow; its internal friction.

Water table.--The water table is that surface in an unconfined water body at which the pressure is atmospheric. It is defined by the levels at which water stands in wells that penetrate the water body just far enough to hold standing water. In wells which penetrate to greater depths, the water level will stand above or below the the water table if an upward or downward component of ground-water flow exists.

FACTORS FOR CONVERTING INCH-POUND UNITS
TO INTERNATIONAL SYSTEM (SI) UNITS

The following factors may be used to convert the inch-pound units given herein to the International System of Units (SI):

Multiply inch-pound unit	By	To obtain SI unit
inch (in.)	25.40	millimeter
foot (ft)	.3048	meter
cubic foot (ft^3)	.02832	cubic meter
cubic foot per second (ft^3/s)	.02832	cubic meter per second
mile (mi)	1.609	kilometer
square mile (mi^2)	2.590	square kilometer
gallon per minute (gal/min)	.06309	liter per second
acre	4,047.856	square meter
acre-foot (acre-ft)	1,233	cubic meter
foot per day (ft/d)	.3048	meter per day
foot squared per day (ft^2/d)	.0929	meter squared per day
gallon (gal)	3.785	liter
foot per mile (ft/mi)	.1894	meter per kilometer
pound per square inch per foot [($lb/in.^2$)/ft)]	.23	kilogram per square centimeter per meter
Micromhos per centimeter at 25° Celsius (µmho)	1.000	microsiemens per centimeter at 25° Celsius

Table 1.--Chemical analyses of water from selected streams and wells.

(CFS, cubic feet per second; MG/L, milligrams per liter; UG/L, micrograms per liter; C, celsius)

CREEK

SITE NO.	LOCAL IDENTIFIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAMFLOW, INSTANTANEOUS (CFS)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH FIELD (UNITS)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)
1	14N-06E-12 AAA	80-02-27	1500	260	--	690	7.5	230	0	47	28
2	14N-07E-09 BCB	80-03-03	1630	236	--	720	7.6	200	0	39	24
3	14N-07E-12 CCB	80-03-04	1145	--	<.10	159	7.3	67	13	15	7.1
4	14N-07E-14 BBB	80-03-04	1045	117	--	284	6.9	120	18	27	12
5	14N-07E-18 ACA	80-03-04	0830	--	.20	3710	7.9	900	690	200	96
6	14N-07E-20 DCD	80-03-05	1330	--	<.10	136	7.1	40	16	8.5	4.6
7	14N-07E-23 DDA	80-03-05	1100	63	--	226	6.6	98	9	21	11
8	14N-07E-27 AAA	80-03-05	1200	--	.10	194	6.7	45	13	11	4.3
9	14N-07E-29 DAD	80-03-05	1530	38	--	194	5.8	38	4	9.4	3.4
10	14N-08E-06 BBA	80-03-04	1530	--	E.10	4820	3.7	740	740	160	81
11	14N-08E-06 BCC	80-03-04	1430	35	--	4310	6.5	930	860	230	85
12	14N-08E-09 BAB	80-03-06	1400	--	3.5	2440	7.7	500	370	130	42
13	14N-08E-12 BBB	80-03-06	1730	--	<.10	281	9.1	59	35	14	5.8
14	14N-08E-15 BDA	80-03-06	1230	114	--	138	5.5	32	30	8.5	2.7
15	14N-08E-21 CBB	80-03-06	1000	--	<.10	134	6.7	36	18	7.0	4.6
16	14N-08E-30 CCB	80-03-05	0930	--	<.10	4180	6.8	640	610	150	64
17	15N-07E-02 BCC	80-04-03	0915	118	--	1000	7.3	390	60	80	45
18	15N-07E-15 CBB	80-04-08	1500	--	<.10	670	8.2	270	9	63	27
19	15N-07E-15 CCD	80-08-03	1630	147	--	390	7.6	170	0	40	17
20	15N-07E-19 DDD	80-04-03	1800	140	--	615	7.3	260	50	46	35
21	15N-07E-24 AAA	80-04-03	1500	111	--	422	7.6	190	0	43	21
22	15N-07E-26 CCB	80-03-04	1800	59	--	520	7.1	240	1	57	24
23	15N-07E-26 CDC	80-03-04	1630	--	.25	232	7.8	91	5	21	9.3
24	15N-07E-29 CDD	80-02-28	1630	--	<.10	3213	8.2	1400	1000	260	170
25	15N-08E-04 DCD	80-03-13	0830	41	--	150	7.6	45	0	13	3.1
26	15N-08E-07 BBB	80-04-03	1245	159	--	2110	6.7	490	410	110	52
27	15N-08E-08 BAA	80-03-12	1745	--	<.10	2580	7.5	390	330	91	40
28	15N-08E-10 AAA	80-03-12	1500	--	<.10	649	7.4	290	44	68	30
29	15N-08E-11 AAA	80-03-12	1630	119	--	561	7.4	230	0	48	26
30	15N-08E-15 CDC	80-03-12	1200	134	--	471	6.8	130	30	28	14
31	15N-08E-16 CCC	80-03-11	1800	--	<.10	7300	8.1	1000	920	250	91
32	15N-08E-17 CDD	80-03-12	0930	85	--	700	7.2	350	16	71	41
33	15N-08E-26 BBA	80-03-12	1300	--	<.10	1530	7.5	290	180	71	28

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	BROMIDE DIS- SOLVED (MG/L AS BR)	IODIDE, DIS- SOLVED (MG/L AS I)
					CREEK						
1	14N-06E-12 AAA	80-02-27	45	1.3	2.7	280	13	36	.2	.2	--
2	14N-07E-09 BCB	80-03-03	71	2.2	6.9	310	27	19	.4	.1	--
3	14N-07E-12 CCB	80-03-04	7.3	.4	1.2	54	17	10	.2	.2	--
4	14N-07E-14 BBB	80-03-04	9.1	.4	.8	99	14	9.7	.2	.2	.01
5	14N-07E-18 ACA	80-03-04	390	5.7	5.2	210	50	1000	.2	4.0	.04
6	14N-07E-20 DCD	80-03-05	7.8	.5	1.6	24	18	10	.1	.1	--
7	14N-07E-23 DDA	80-03-05	5.1	.2	1.3	89	11	5.1	.2	.1	--
8	14N-07E-27 AAA	80-03-05	13	.8	1.6	32	19	20	.1	.5	--
9	14N-07E-29 DAD	80-03-05	21	1.5	.6	34	19	15	.1	.3	.00
10	14N-08E-06 BBA	80-03-04	630	10	9.2	0	7.6	1500	.2	11	.01
11	14N-08E-06 BCC	80-03-04	480	6.9	5.2	63	11	1400	.1	6.4	.00
12	14N-08E-09 BAB	80-03-06	280	5.5	4.0	130	9.9	660	.3	22	--
13	14N-08E-12 BBB	80-03-06	23	1.3	2.3	24	27	42	.1	.3	--
14	14N-08E-15 BDA	80-03-06	9.3	.7	1.0	2	12	20	.0	.2	--
15	14N-08E-21 CBB	80-03-06	16	1.2	1.7	18	15	26	.1	.3	.00
16	14N-08E-30 CCB	80-03-05	510	8.8	7.3	28	20	1200	.1	19	.01
17	15N-07E-02 BCC	80-04-03	52	1.2	7.1	330	47	98	.2	.3	.00
18	15N-07E-15 CBB	80-04-08	30	.8	5.4	260	25	35	.3	.4	--
19	15N-07E-15 CCD	80-08-03	13	.4	1.5	180	5.0	6.9	.2	.1	--
20	15N-07E-19 DDD	80-04-03	29	.8	2.0	210	54	30	.1	.3	--
21	15N-07E-24 AAA	80-04-03	9.3	.3	1.5	210	1.3	4.3	.1	.1	--
22	15N-07E-26 CCB	80-03-04	12	.3	1.4	240	3.5	13	.2	.2	--
23	15N-07E-26 CDC	80-03-04	8.1	.4	2.1	86	12	12	.2	.1	--
24	15N-07E-29 CDD	80-02-28	160	1.9	3.4	310	25	910	.3	4.5	.02
25	15N-08E-04 DCD	80-03-13	6.1	.4	3.3	45	11	5.9	.1	.1	--
26	15N-08E-07 BBB	80-04-03	220	4.3	4.8	80	30	570	.1	3.2	.03
27	15N-08E-08 BAA	80-03-12	350	7.7	5.0	67	30	730	.2	3.8	.02
28	15N-08E-10 AAA	80-03-12	23	.6	1.9	250	41	29	.3	.3	--
29	15N-08E-11 AAA	80-03-12	32	.9	2.5	280	4.3	7.2	.3	.1	--
30	15N-08E-15 CDC	80-03-12	46	1.8	1.6	98	30	68	.1	.5	--
31	15N-08E-16 CCC	80-03-11	1100	15	10	85	21	2300	.1	10	.04
32	15N-08E-17 CDD	80-03-12	13	.3	1.2	330	13	16	.2	.4	.01
33	15N-08E-26 BBA	80-03-12	200	5.1	5.8	110	14	430	.2	2.2	--

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
			CREEK				
1	14N-06E-12 AAA	80-02-27	17	356	20	410	8.5
2	14N-07E-09 BCB	80-03-03	18	398	40	850	--
3	14N-07E-12 CCB	80-03-04	14	112	6	50	4.7
4	14N-07E-14 BBB	80-03-04	16	169	9	60	1.5
5	14N-07E-18 ACA	80-03-04	12	2060	20	1900	4.3
6	14N-07E-20 DCD	80-03-05	9.7	100	<4	40	3.8
7	14N-07E-23 DDA	80-03-05	18	140	5	70	2.3
8	14N-07E-27 AAA	80-03-05	15	121	<4	60	3.3
9	14N-07E-29 DAD	80-03-05	26	136	10	60	3.1
10	14N-08E-06 BBA	80-03-04	20	2740	10	4200	2.4
11	14N-08E-06 BCC	80-03-04	24	2540	20	1300	6.4
12	14N-08E-09 BAB	80-03-06	11	1350	10	1800	--
13	14N-08E-12 BBB	80-03-06	5.9	160	<4	90	5.9
14	14N-08E-15 BDA	80-03-06	13	91	6	50	1.0
15	14N-08E-21 CBB	80-03-06	17	126	7	60	--
16	14N-08E-30 CCB	80-03-05	12	2190	20	2000	2.9
17	15N-07E-02 BCC	80-04-03	18	550	40	4700	--
18	15N-07E-15 CBB	80-04-08	8.4	366	8	380	--
19	15N-07E-15 CCD	80-08-03	16	204	10	200	--
20	15N-07E-19 DDD	80-04-03	18	343	10	920	--
21	15N-07E-24 AAA	80-04-03	15	220	20	180	--
22	15N-07E-26 CCB	80-03-04	18	277	20	170	4.9
23	15N-07E-26 CDC	80-03-04	13	138	6	80	3.9
24	15N-07E-29 CDD	80-02-28	19	1760	10	2500	3.8
25	15N-08E-04 DCD	80-03-13	17	87	5	60	17
26	15N-08E-07 BBB	80-04-03	18	1160	10	470	--
27	15N-08E-08 BAA	80-03-12	7.2	1440	20	1600	9.0
28	15N-08E-10 AAA	80-03-12	13	365	6	340	6.1
29	15N-08E-11 AAA	80-03-12	15	304	30	250	8.0
30	15N-08E-15 CDC	80-03-12	12	253	10	130	3.4
31	15N-08E-16 CCC	80-03-11	4.6	4160	40	5600	6.9
32	15N-08E-17 CDD	80-03-12	19	385	20	130	--
33	15N-08E-26 BBA	80-03-12	3.3	897	9	1100	12

CREEK

SITE NO.	LOCAL IDENTIFIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAMFLOW, INSTANTANEOUS (CFS)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH FIELD (UNITS)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)
34	15N-08E-28 DCC	80-03-11	1415	--	<.10	1290	7.6	260	110	63	24
35	15N-08E-33 CBB	80-03-11	1645	51	--	154	6.0	60	12	15	5.5
36	15N-08E-34 DDD	80-03-06	1630	114	--	760	7.2	300	140	69	30
37	15N-09E-31 CCC	80-03-11	1200	99	--	3500	12.7	800	51	320	.3
38	15N-09E-32 BCC	80-03-11	0945	--	.30	1120	7.7	200	120	49	18
39	16N-07E-10 DDC	80-04-02	1400	59	--	285	6.4	93	24	26	6.7
40	16N-07E-16 BBB	80-04-01	1600	--	<.10	1700	8.6	250	180	62	23
41	16N-07E-17 DCD	80-04-01	1800	178	--	459	7.5	190	13	47	18
42	16N-07E-23 ABA	80-04-02	1200	--	7.0	1400	7.9	270	160	66	26
43	16N-07E-26 BCA	80-04-02	1100	109	--	560	7.4	240	0	57	24
44	16N-07E-28 ADD	80-04-02	0900	--	.75	568	8.0	170	48	39	17
45	16N-08E-02 CAD	80-03-18	1715	--	<.10	158	7.4	54	17	12	5.8
46	16N-08E-04 BAC	80-03-19	1015	34	--	320	7.0	110	2	31	8.4
47	16N-08E-07 CAD	80-05-07	1445	210	--	202	6.4	82	13	19	8.4
48	16N-08E-13 DCD	80-03-18	1615	158	--	545	7.4	240	0	52	26
49	16N-08E-16 ABB	80-03-18	1145	--	<.10	2630	8.3	490	310	110	52
50	16N-08E-16 DDA	80-03-18	0945	99	--	261	6.3	89	30	21	8.8
51	16N-08E-19 BDC	80-04-02	1730	101	--	141	6.0	51	16	12	5.2
52	16N-08E-26 BAB	80-03-13	1330	--	.30	1340	8.0	240	150	61	22
53	16N-08E-27 DDA	80-03-13	1230	140	--	440	8.4	180	15	41	20
54	16N-08E-31 BBB	80-04-02	1515	--	<.10	219	7.5	80	13	19	8.0
55	16N-09E-06 DDD	80-03-20	1015	120	--	136	5.6	38	22	9.0	3.8
56	16N-09E-08 CCC	80-03-18	1400	--	<.10	9100	8.0	1200	1100	350	72
57	17N-07E-02 BAB	80-07-09	1400	121	--	860	7.0	300	0	50	42
58	17N-07E-03 BBC	78-03-29	1000	--	E.10	15000	5.7	33000	33000	10000	1900
59	17N-07E-03 CCD	80-05-09	0830	--	.04	8500	7.2	1300	1200	320	110
60	17N-07E-08 BAA	80-05-08	1230	--	<.10	22360	8.0	3800	3700	1000	320
61	17N-07E-12 CCB	80-05-08	1330	256	--	460	8.0	200	0	40	25
62	17N-07E-16 CBB	80-05-08	1830	110	--	2750	6.7	1100	970	220	130
63	17N-07E-18 BAA	80-07-11	0900	58	--	340	--	130	51	31	12
64	17N-07E-19 DCD	80-07-10	1800	190	--	460	--	260	59	49	33
65	17N-07E-23 CAC	80-05-08	1530	--	<.10	850	8.4	100	49	26	9.3
66	17N-07E-25 ADD	80-05-08	1000	153	--	218	5.8	54	26	12	5.8
67	17N-07E-28 AAA	80-05-09	1045	108	--	610	6.2	190	130	43	19
68	17N-07E-31 DAD	80-05-07	1100	--	.10	845	7.9	400	55	86	46
69	17N-07E-33 DDC	80-05-07	1015	--	.75	2800	8.0	380	310	98	33

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	BROMIDE DIS-SOLVED (MG/L AS BR)	IODIDE, DIS-SOLVED (MG/L AS I)
					CREEK						
34	15N-08E-28 DCC	80-03-11	140	3.8	3.0	150	12	300	.2	1.4	--
35	15N-08E-33 CBB	80-03-11	6.4	.4	1.0	48	8.1	12	.1	.1	--
36	15N-08E-34 DDD	80-03-06	18	.5	3.7	160	68	86	.1	.5	--
37	15N-09E-31 CCC	80-03-11	26	.4	21	--	55	17	.3	.2	.00
38	15N-09E-32 BCC	80-03-11	130	4.0	2.3	78	16	280	.1	2.0	--
39	16N-07E-10 DDC	80-04-02	14	.6	.8	69	18	23	.1	.1	--
40	16N-07E-16 BBB	80-04-01	240	6.6	3.9	71	49	450	.1	2.8	.01
41	16N-07E-17 DCD	80-04-01	14	.4	1.8	180	29	7.6	.1	.1	--
42	16N-07E-23 ABA	80-04-02	150	4.0	4.2	110	12	330	.2	2.0	--
43	16N-07E-26 BCA	80-04-02	22	.6	2.6	250	4.7	19	.2	.2	--
44	16N-07E-28 ADD	80-04-02	43	1.4	3.4	120	20	77	.2	.6	--
45	16N-08E-02 CAD	80-03-18	9.4	.6	1.7	37	12	15	.2	.1	--
46	16N-08E-04 BAC	80-03-19	2.9	.1	20	110	11	2.4	.2	.1	--
47	16N-08E-07 CAD	80-05-07	5.4	.3	1.2	69	9.8	6.3	.2	.1	--
48	16N-08E-13 DCD	80-03-18	15	.4	3.4	240	10	16	.2	.1	--
49	16N-08E-16 ABB	80-03-18	330	6.5	1.3	180	9.8	790	.4	2.9	--
50	16N-08E-16 DDA	80-03-18	8.8	.4	5.6	59	24	12	.1	.1	--
51	16N-08E-19 BDC	80-04-02	4.7	.3	1.4	35	21	4.0	.1	.1	.03
52	16N-08E-26 BAB	80-03-13	150	4.2	3.3	90	11	340	.2	1.7	--
53	16N-08E-27 DDA	80-03-13	14	.4	1.5	170	21	12	.1	.1	.01
54	16N-08E-31 BBB	80-04-02	8.6	.4	2.1	67	17	10	.1	.1	--
55	16N-09E-06 DDD	80-03-20	7.2	.5	1.0	16	14	13	.2	.1	.01
56	16N-09E-08 CCC	80-03-18	1400	18	11	63	18	3000	.2	14	.09
57	17N-07E-02 BAB	80-07-09	25	.6	1.7	320	28	7.7	.4	.0	.00
58	17N-07E-03 BBC	78-03-29	64000	154	820	66	--	95000	--	240	9.8
59	17N-07E-03 CCD	80-05-09	1300	16	15	61	23	2900	.2	15	.15
60	17N-07E-08 BAA	80-05-08	3900	27	38	120	16	17000	.1	--	--
61	17N-07E-12 CCB	80-05-08	24	.7	2.8	220	17	5.7	.2	.1	--
62	17N-07E-16 CBB	80-05-08	82	1.1	4.4	120	.5	830	.2	4.6	.01
63	17N-07E-18 BAA	80-07-11	22	.9	.8	76	13	74	.2	.4	.01
64	17N-07E-19 DCD	80-07-10	17	.5	1.4	200	68	22	.3	.1	.01
65	17N-07E-23 CAC	80-05-08	120	5.1	4.8	55	25	200	.3	1.1	--
66	17N-07E-25 ADD	80-05-08	17	1.0	1.1	28	21	26	.2	.4	--
67	17N-07E-28 AAA	80-05-09	39	1.2	3.4	58	59	110	.1	.8	--
68	17N-07E-31 DAD	80-05-07	32	.7	5.1	350	52	39	.3	.4	--
69	17N-07E-33 DDC	80-05-07	390	8.7	7.4	70	10	770	.2	4.1	.05

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
			CREEK				
34	15N-08E-28 DCC	80-03-11	12	692	9	820	7.0
35	15N-08E-33 CBB	80-03-11	21	81	5	80	2.6
36	15N-08E-34 DDD	80-03-06	11	409	30	350	--
37	15N-09E-31 CCC	80-03-11	3.8	847	20	1700	14
38	15N-09E-32 BCC	80-03-11	6.3	593	6	680	2.8
39	16N-07E-10 DDC	80-04-02	17	157	6	70	--
40	16N-07E-16 BBB	80-04-01	5.5	915	10	1100	--
41	16N-07E-17 DCD	80-04-01	17	219	10	930	--
42	16N-07E-23 ABA	80-04-02	3.7	745	10	880	--
43	16N-07E-26 BCA	80-04-02	19	302	30	290	--
44	16N-07E-28 ADD	80-04-02	3.4	307	<4	370	--
45	16N-08E-02 CAD	80-03-18	12	102	<4	60	3.4
46	16N-08E-04 BAC	80-03-19	14	218	<4	180	8.7
47	16N-08E-07 CAD	80-05-07	17	112	<4	40	--
48	16N-08E-13 DCD	80-03-18	16	278	30	410	2.8
49	16N-08E-16 ABB	80-03-18	5.5	1430	10	1600	6.7
50	16N-08E-16 DDA	80-03-18	13	141	<4	90	27
51	16N-08E-19 BDC	80-04-02	13	83	<4	70	--
52	16N-08E-26 BAB	80-03-13	7.2	731	10	1100	8.8
53	16N-08E-27 DDA	80-03-13	14	237	10	100	1.7
54	16N-08E-31 BBB	80-04-02	14	126	<4	70	--
55	16N-09E-06 DDD	80-03-20	14	83	<4	40	4.1
56	16N-09E-08 CCC	80-03-18	6.0	5020	510	15000	5.6
57	17N-07E-02 BAB	80-07-09	14	437	10	520	--
58	17N-07E-03 BBC	78-03-29	--	168000	--	--	--
59	17N-07E-03 CCD	80-05-09	9.3	5040	90	6900	--
60	17N-07E-08 BAA	80-05-08	9.3	15600	210	--	--
61	17N-07E-12 CCB	80-05-08	18	253	6	1100	--
62	17N-07E-16 CBB	80-05-08	20	1820	50	560	--
63	17N-07E-18 BAA	80-07-11	15	263	7	150	--
64	17N-07E-19 DCD	80-07-10	13	335	20	520	--
65	17N-07E-23 CAC	80-05-08	6.7	473	10	670	--
66	17N-07E-25 ADD	80-05-08	15	115	6	60	--
67	17N-07E-28 AAA	80-05-09	20	349	10	120	--
68	17N-07E-31 DAD	80-05-07	9.8	503	<4	620	--
69	17N-07E-33 DDC	80-05-07	3.1	1530	20	2000	--

CREEK

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH FIELD (UNITS)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
70	17N-07E-35 CAA	80-05-07	1800	146	--	419	6.7	180	32	40	20
71	17N-08E-07 ABB	80-05-08	1115	--	<.10	2225	7.9	410	260	93	43
72	17N-08E-09 BBB	80-07-09	1530	67	--	184	5.5	50	16	12	4.9
73	17N-08E-10 AAA	80-07-10	1230	43	--	700	--	170	15	65	2.9
74	17N-08E-12 CDD	80-04-08	1700	--	<.10	1120	7.2	240	170	51	27
75	17N-08E-14 CDD	80-07-10	1030	--	<.10	1462	--	340	240	74	37
76	17N-08E-15 CCD	80-03-19	1630	--	<.10	4700	7.1	890	860	190	100
77	17N-08E-17 DCC	80-03-19	1530	--	<.10	800	8.3	220	110	45	25
78	17N-08E-21 BCB	80-03-19	1430	79	--	232	6.6	79	0	17	8.8
79	17N-08E-26 CBD	80-03-19	1800	144	--	350	7.6	150	0	37	14
80	17N-08E-32 CCA	80-03-19	1200	--	<.10	522	7.9	100	43	25	9.1
81	17N-08E-36 DDC	80-03-20	1300	117	--	244	6.3	60	14	13	6.6
82	17N-09E-30 BDC	80-03-20	1100	--	1.0	940	8.0	190	97	47	18
83	18N-07E-01 DCD	80-04-23	1645	115	--	1300	7.2	460	81	97	52
84	18N-07E-05 ABA	80-04-23	1030	160	--	710	6.7	230	34	54	24
85	18N-07E-08 DAA	80-04-18	1400	--	.01	36000	7.5	6400	6300	1800	450
86	18N-07E-10 AAD	80-05-06	1430	181	--	740	7.3	270	0	63	25
87	18N-07E-16 ACD	80-04-18	1200	95	--	1581	7.1	670	420	180	53
88	18N-07E-19 CAA	80-04-18	0900	--	2.3	6510	8.0	1000	790	260	93
89	18N-07E-23 ABA	80-05-06	1600	--	.01	1004	8.3	470	150	74	70
90	18N-07E-29 CBB	80-04-17	1745	45	--	998	7.3	380	130	87	40
91	18N-08E-01 CAC	80-07-17	1700	138	--	375	6.0	150	110	34	16
92	18N-08E-04 DDA	80-07-18	1000	168	--	349	7.3	260	90	64	24
93	18N-08E-18 ABA	80-04-23	1800	--	.35	376	8.2	150	17	34	15
94	18N-08E-21 CBC	80-07-11	1045	51	--	138	--	48	15	12	4.4
95	18N-08E-22 BAB	80-07-11	1200	--	.01	370	--	170	37	37	18
96	18N-08E-24 ABB	80-07-16	1430	120	--	192	6.6	88	6	21	8.4
97	18N-08E-31 BAA	80-05-06	1800	28	--	920	7.1	310	35	63	38
98	18N-08E-32 ADA	80-07-09	1600	--	<.10	460	7.9	190	25	41	20
99	18N-08E-34 AAB	80-07-10	1430	171	--	330	--	170	0	35	20
100	18N-09E-08 BCB	80-07-16	1600	--	<.10	900	7.7	260	24	66	24
101	18N-09E-30 AAA	80-07-16	1200	300	--	440	7.2	300	34	77	27
102	18N-09E-31 CCC	80-07-10	1600	103	--	371	--	190	0	34	26
103	19N-07E-26 CDD	80-04-23	1230	--	2.0	1880	8.0	540	340	130	52
104	19N-07E-36 AAA	80-04-23	1330	--	1.1	440	7.9	150	28	36	14
105	19N-08E-15 ABA	80-07-24	1500	126	--	3290	7.4	840	670	240	56

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	BROMIDE DIS- SOLVED (MG/L AS BR)	IODIDE, DIS- SOLVED (MG/L AS I)
CREEK											
70	17N-07E-35 CAA	80-05-07	11	.4	1.5	150	16	22	.2	.2	.00
71	17N-08E-07 ABB	80-05-08	280	6.0	5.5	150	27	600	.2	4.0	.01
72	17N-08E-09 BBB	80-07-09	11	.7	.8	34	7.6	29	.2	.2	.00
73	17N-08E-10 AAA	80-07-10	13	.4	7.2	160	5.4	8.2	.1	.1	.01
74	17N-08E-12 CDD	80-04-08	110	3.1	2.5	69	19	290	.1	1.6	.00
75	17N-08E-14 CDD	80-07-10	190	4.5	2.3	94	7.5	480	.3	1.8	.05
76	17N-08E-15 CCD	80-03-19	540	7.9	5.9	30	26	1500	.2	7.6	.01
77	17N-08E-17 DCC	80-03-19	61	1.8	2.3	110	7.1	170	.3	.4	--
78	17N-08E-21 BCB	80-03-19	12	.6	1.3	96	.2	4.2	.4	.0	--
79	17N-08E-26 CBD	80-03-19	13	.5	1.3	150	2.8	11	.3	.1	--
80	17N-08E-32 CCA	80-03-19	59	2.6	1.9	57	18	110	.2	.6	--
81	17N-08E-36 DDC	80-03-20	22	1.2	2.1	46	21	19	.2	.2	--
82	17N-09E-30 BDC	80-03-20	86	2.7	2.2	95	13	180	.2	1.1	--
83	18N-07E-01 DCD	80-04-23	66	1.3	4.3	380	170	31	.3	.1	.01
84	18N-07E-05 ABA	80-04-23	51	1.5	1.5	200	46	66	.2	.4	--
85	18N-07E-08 DAA	80-04-18	7200	39	96	140	43	16000	.3	84	.69
86	18N-07E-10 AAD	80-05-06	50	1.3	3.9	290	70	11	.3	.1	--
87	18N-07E-16 ACD	80-04-18	47	.8	1.9	250	13	380	.4	2.6	--
88	18N-07E-19 CAA	80-04-18	950	13	12	250	14	2100	.3	8.4	.09
89	18N-07E-23 ABA	80-05-06	45	.9	3.5	320	170	50	.4	.4	--
90	18N-07E-29 CBB	80-04-17	62	1.4	2.4	250	67	140	.2	.9	--
91	18N-08E-01 CAC	80-07-17	18	.6	2.0	39	40	40	.3	.1	.01
92	18N-08E-04 DDA	80-07-18	40	1.1	2.4	170	57	36	.3	.1	.00
93	18N-08E-18 ABA	80-04-23	19	.7	2.3	130	21	20	.2	.3	.01
94	18N-08E-21 CBC	80-07-11	7.6	.5	.6	33	16	7.8	.2	.1	.00
95	18N-08E-22 BAB	80-07-11	26	.9	5.5	130	26	69	.3	.2	.01
96	18N-08E-24 ABB	80-07-16	6.2	.3	.7	82	7.7	6.3	.2	.1	.00
97	18N-08E-31 BAA	80-05-06	28	.7	1.8	280	16	46	.2	.9	--
98	18N-08E-32 ADA	80-07-09	28	.9	3.5	160	22	52	.3	.2	.01
99	18N-08E-34 AAB	80-07-10	16	.5	1.6	180	7.6	7.0	.3	.0	.01
100	18N-09E-08 BCB	80-07-16	140	3.8	3.3	240	7.8	240	.3	.6	.06
101	18N-09E-30 AAA	80-07-16	14	.4	1.2	270	9.2	36	.3	.2	.00
102	18N-09E-31 CCC	80-07-10	21	.7	1.7	210	15	14	.3	.1	.01
103	19N-07E-26 CDD	80-04-23	160	3.0	3.5	200	13	480	.2	3.2	.02
104	19N-07E-36 AAA	80-04-23	30	1.1	2.6	120	19	45	.2	.5	--
105	19N-08E-15 ABA	80-07-24	380	5.7	6.4	170	200	940	.3	3.3	.10

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	LITHIUM DIS-SOLVED (UG/L AS LI)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)
			CREEK				
70	17N-07E-35 CAA	80-05-07	19	221	10	70	--
71	17N-08E-07 ABB	80-05-08	13	1260	10	2100	--
72	17N-08E-09 BBB	80-07-09	13	115	<4	90	--
73	17N-08E-10 AAA	80-07-10	12	246	8	410	--
74	17N-08E-12 CDD	80-04-08	9.5	627	8	630	--
75	17N-08E-14 CDD	80-07-10	16	993	10	1300	--
76	17N-08E-15 CCD	80-03-19	3.2	2630	10	2900	4.4
77	17N-08E-17 DCC	80-03-19	10	410	4	450	11
78	17N-08E-21 BCB	80-03-19	22	130	10	90	7.3
79	17N-08E-26 CBD	80-03-19	14	182	10	140	3.9
80	17N-08E-32 CCA	80-03-19	14	280	4	270	3.4
81	17N-08E-36 DDC	80-03-20	18	143	<4	60	10
82	17N-09E-30 BDC	80-03-20	5.3	479	10	570	3.3
83	18N-07E-01 DCD	80-04-23	15	665	20	3900	--
84	18N-07E-05 ABA	80-04-23	18	390	20	470	--
85	18N-07E-08 DAA	80-04-18	9.5	28200	930	62000	--
86	18N-07E-10 AAD	80-05-06	17	417	10	9200	--
87	18N-07E-16 ACD	80-04-18	15	1040	20	800	--
88	18N-07E-19 CAA	80-04-18	14	3960	70	6700	--
89	18N-07E-23 ABA	80-05-06	3.5	646	10	310	--
90	18N-07E-29 CBB	80-04-17	19	648	10	2200	--
91	18N-08E-01 CAC	80-07-17	16	295	10	240	--
92	18N-08E-04 DDA	80-07-18	17	399	20	1000	--
93	18N-08E-18 ABA	80-04-23	2.1	203	<4	170	--
94	18N-08E-21 CBC	80-07-11	14	94	<4	70	--
95	18N-08E-22 BAB	80-07-11	14	306	5	230	--
96	18N-08E-24 ABB	80-07-16	16	121	10	730	--
97	18N-08E-31 BAA	80-05-06	17	375	20	680	--
98	18N-08E-32 ADA	80-07-09	8.0	279	9	300	--
99	18N-08E-34 AAB	80-07-10	14	196	9	320	--
100	18N-09E-08 BCB	80-07-16	14	671	8	530	--
101	18N-09E-30 AAA	80-07-16	11	349	10	140	--
102	18N-09E-31 CCC	80-07-10	16	246	10	270	--
103	19N-07E-26 CDD	80-04-23	6.6	1080	20	1400	--
104	19N-07E-36 AAA	80-04-23	3.6	230	<4	230	--
105	19N-08E-15 ABA	80-07-24	8.2	2230	20	5800	--

SITE NO.	LOCAL IDENTIFIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAMFLOW, INSTANTANEOUS (CFS)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH FIELD (UNITS)	HARDNESS (MG/L AS CACO3)	HARDNESS, NONCARBONATE (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)
CREEK											
106	19N-08E-20 DAA	80-07-24	1715	218	--	470	6.2	130	92	32	11
107	19N-08E-24 BBB	80-07-17	1230	163	--	610	7.4	490	200	160	22
108	19N-08E-26 DCD	80-07-17	1430	63	--	380	7.6	220	0	53	21
109	19N-08E-28 DCC	80-07-18	1130	112	--	114	5.7	31	7	7.7	2.7
110	19N-09E-06 DCC	80-07-24	1215	--	.02	3080	8.4	420	210	110	34
111	19N-09E-18 DDD	80-07-17	1000	106	--	390	7.6	210	0	44	25
112	19N-09E-31 AAA	80-07-16	1730	81	--	441	7.6	290	0	63	32
LINCOLN											
113	12N-05E-36 DDA	79-07-17	1000	96	--	670	7.5	200	0	41	23
114	12N-06E-10 ADD	79-07-24	1530	189	--	688	8.2	100	0	20	12
115	12N-06E-15 BAA	79-07-24	0830	--	<.10	719	--	330	0	52	49
116	12N-06E-17 DAA	79-07-23	1700	230	--	385	6.8	140	0	31	16
117	12N-06E-19 BBB	79-07-23	1500	--	<.10	8427	7.9	1300	1000	290	130
118	12N-06E-28 DAD	79-07-11	1200	412	--	675	6.8	180	21	56	9.7
119	13N-05E-36 DDD	80-02-28	0930	--	<.10	1102	8.3	500	0	81	73
120	13N-06E-06 AAD	79-07-25	1200	--	.10	774	8.4	230	62	43	30
121	13N-06E-07 BAA	79-07-25	1430	161	--	1321	7.6	52	0	11	5.9
122	13N-06E-15 BCC	79-07-25	1000	170	--	773	7.1	140	0	30	16
123	13N-06E-19 CDC	79-07-26	0845	127	--	721	7.8	35	0	7.3	4.1
124	13N-06E-21 ABA	79-07-25	0830	--	<.10	880	7.5	370	0	69	49
125	13N-06E-26 CBC	79-07-24	1700	109	--	1060	7.1	170	0	33	20
126	13N-06E-32 DDC	79-09-14	0900	109	--	460	7.1	280	16	56	33
127	13N-06E-34 CCD	80-02-28	1100	--	<.10	550	8.0	210	0	48	23
128	14N-06E-11 BAA	80-02-28	1230	68	--	982	7.2	350	55	67	43
129	14N-06E-15 CBB	79-09-14	1100	--	E500	900	8.1	230	51	51	25
130	14N-06E-27 CCB	79-07-26	1030	125	--	520	6.9	190	0	41	20
131	14N-06E-27 DCD	80-02-27	1700	--	<.10	6200	7.5	1600	1300	330	180
132	14N-06E-35 DDC	79-07-26	1200	118	--	644	7.5	240	0	51	27
133	15N-05E-01 DAD	80-03-20	1800	92	--	562	7.7	210	25	43	26
134	15N-06E-02 AAA	80-03-10	1800	153	--	625	7.5	260	1	56	29
135	15N-06E-10 CCD	80-03-07	0930	79	--	920	8.0	100	0	23	11
136	15N-06E-12 ADC	80-04-04	0930	24	--	411	7.3	170	0	40	17
137	15N-06E-18 DCC	80-03-21	0830	42	--	565	8.3	66	0	15	6.8
138	15N-06E-22 BBB	80-03-07	0800	--	<.01	750	7.6	260	12	62	26

SITE NO.	LOCAL IDENTIFIER	DATE OF SAMPLE	SODIUM, DISSOLVED (MG/L AS NA)	SODIUM ADSORPTION RATIO	POTASSIUM, DISSOLVED (MG/L AS K)	ALKALINITY (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)	CHLORIDE, DISSOLVED (MG/L AS CL)	FLUORIDE, DISSOLVED (MG/L AS F)	BROMIDE DISSOLVED (MG/L AS BR)	IODIDE, DISSOLVED (MG/L AS I)
CREEK											
106	19N-08E-20 DAA	80-07-24	40	1.6	1.2	33	34	94	.2	.5	.01
107	19N-08E-24 BBB	80-07-17	29	.6	2.1	290	240	29	.4	.2	.00
108	19N-08E-26 DCD	80-07-17	21	.6	2.0	230	25	13	.2	.1	.00
109	19N-08E-28 DCC	80-07-18	11	.9	.4	24	13	13	.2	.1	.00
110	19N-09E-06 DCC	80-07-24	480	10	11	210	160	800	.4	.2	.10
111	19N-09E-18 DDD	80-07-17	27	.8	1.8	240	12	15	1.0	.1	.00
112	19N-09E-31 AAA	80-07-16	25	.6	1.8	290	31	22	.2	.2	.00
LINCOLN											
113	12N-05E-36 DDA	79-07-17	83	2.6	2.1	280	16	49	.4	.3	--
114	12N-06E-10 ADD	79-07-24	150	6.6	3.1	380	17	20	1.1	.2	--
115	12N-06E-15 BAA	79-07-24	52	1.2	3.7	380	30	21	.5	.3	--
116	12N-06E-17 DAA	79-07-23	22	.8	1.2	150	14	21	.2	.2	--
117	12N-06E-19 BBB	79-07-23	1500	18	4.3	250	28	3000	.4	13	.03
118	12N-06E-28 DAD	79-07-11	93	3.0	2.8	160	210	5.0	.7	.0	.01
119	13N-05E-36 DDD	80-02-28	74	1.4	4.3	560	56	22	.3	.2	.01
120	13N-06E-06 AAD	79-07-25	65	1.9	6.6	170	61	150	.4	1.1	--
121	13N-06E-07 BAA	79-07-25	350	21	3.0	420	360	26	4.6	.2	.01
122	13N-06E-15 BCC	79-07-25	140	5.1	2.9	240	45	100	1.6	.6	--
123	13N-06E-19 CDC	79-07-26	190	14	3.4	330	20	58	.5	.3	--
124	13N-06E-21 ABA	79-07-25	60	1.4	4.2	390	28	58	.4	.5	--
125	13N-06E-26 CBC	79-07-24	200	6.8	6.0	300	110	130	1.1	.6	--
126	13N-06E-32 DDC	79-09-14	23	.6	.9	260	42	25	.4	.2	--
127	13N-06E-34 CCD	80-02-28	19	.6	3.7	220	22	16	.2	.1	--
128	14N-06E-11 BAA	80-02-28	63	1.5	3.3	290	110	69	.4	.2	.00
129	14N-06E-15 CBB	79-09-14	100	2.9	7.4	180	69	160	.5	.9	.07
130	14N-06E-27 CCB	79-07-26	39	1.2	1.3	190	26	35	.4	.4	--
131	14N-06E-27 DCD	80-02-27	750	8.3	5.3	300	18	2100	.2	19	.03
132	14N-06E-35 DDC	79-07-26	54	1.5	3.1	280	24	48	.5	.8	--
133	15N-05E-01 DAD	80-03-20	31	.9	.7	190	47	19	.4	.2	--
134	15N-06E-02 AAA	80-03-10	28	.8	2.6	260	28	11	.2	.1	--
135	15N-06E-10 CCD	80-03-07	150	6.4	3.9	340	69	26	.6	.2	--
136	15N-06E-12 ADC	80-04-04	18	.6	1.0	170	23	10	.2	.1	--
137	15N-06E-18 DCC	80-03-21	110	5.9	3.2	190	74	15	.5	.1	--
138	15N-06E-22 BBB	80-03-07	47	1.3	3.5	250	29	59	.3	.4	--

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
CREEK							
106	19N-08E-20 DAA	80-07-24	8.8	333	10	240	--
107	19N-08E-24 BBB	80-07-17	14	711	20	2000	--
108	19N-08E-26 DCD	80-07-17	16	280	8	740	--
109	19N-08E-28 DCC	80-07-18	16	80	6	130	--
110	19N-09E-06 DCC	80-07-24	7.9	1770	10	1800	--
111	19N-09E-18 DDD	80-07-17	16	262	20	380	--
112	19N-09E-31 AAA	80-07-16	15	353	10	300	--
LINCOLN							
113	12N-05E-36 DDA	79-07-17	20	412	30	310	3.4
114	12N-06E-10 ADD	79-07-24	12	459	20	660	1.2
115	12N-06E-15 BAA	79-07-24	11	478	9	300	4.0
116	12N-06E-17 DAA	79-07-23	25	231	8	140	.9
117	12N-06E-19 BBB	79-07-23	11	5610	20	3400	3.8
118	12N-06E-28 DAD	79-07-11	13	475	10	1100	--
119	13N-05E-36 DDD	80-02-28	10	647	8	430	6.2
120	13N-06E-06 AAD	79-07-25	2.7	517	5	520	10
121	13N-06E-07 BAA	79-07-25	7.6	1040	20	450	.8
122	13N-06E-15 BCC	79-07-25	12	510	10	640	.5
123	13N-06E-19 CDC	79-07-26	10	497	20	190	.8
124	13N-06E-21 ABA	79-07-25	13	568	7	440	6.0
125	13N-06E-26 CBC	79-07-24	9.2	718	10	280	5.5
126	13N-06E-32 DDC	79-09-14	19	357	10	140	1.3
127	13N-06E-34 CCD	80-02-28	5.8	275	9	210	10
128	14N-06E-11 BAA	80-02-28	12	561	40	490	.6
129	14N-06E-15 CBB	79-09-14	5.3	549	20	850	7.0
130	14N-06E-27 CCB	79-07-26	15	326	8	170	2.6
131	14N-06E-27 DCD	80-02-27	13	3750	10	3400	11
132	14N-06E-35 DDC	79-07-26	17	400	20	520	1.2
133	15N-05E-01 DAD	80-03-20	14	310	20	100	5.6
134	15N-06E-02 AAA	80-03-10	16	327	10	1400	11
135	15N-06E-10 CCD	80-03-07	9.8	540	20	310	6.7
136	15N-06E-12 ADC	80-04-04	9.3	229	10	150	--
137	15N-06E-18 DCC	80-03-21	11	342	10	750	3.4
138	15N-06E-22 BBB	80-03-07	4.5	405	8	500	8.9

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH FIELD (UNITS)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
LINCULN											
139	15N-06E-26 DDC	80-02-27	1330	55	--	442	7.3	170	0	39	18
140	15N-06E-33 BBA	80-02-28	1430	231	--	710	7.6	230	0	49	27
141	15N-06E-34 CCD	80-02-27	1130	--	<.10	760	8.1	250	50	57	26
142	16N-05E-04 AAA	80-04-15	1700	--	<.10	1170	8.3	330	78	70	37
143	16N-05E-11 BCB	80-04-22	1830	15	--	413	7.5	160	19	39	15
144	16N-05E-12 DCD	80-03-21	1200	--	<.10	680	8.2	270	4	55	33
145	16N-05E-24 CBB	80-03-17	1700	30	--	1590	7.3	620	200	130	72
146	16N-06E-01 BCB	80-04-09	1030	80	--	134	6.2	44	15	10	4.5
147	16N-06E-03 CCD	80-08-09	0845	--	<.10	680	8.0	290	43	61	34
148	16N-06E-18 AAA	80-03-21	1345	31	--	1093	7.6	410	96	75	53
149	16N-06E-23 BBA	80-04-01	1430	87	--	5210	7.2	1300	1200	370	100
150	16N-06E-29 ADA	80-03-21	1030	120	--	441	7.7	190	18	39	22
151	16N-06E-33 DAD	80-03-20	1700	134	--	690	7.5	270	0	45	38
152	16N-06E-35 BCB	80-03-10	1630	--	<.10	444	8.5	200	6	37	25
153	17N-05E-26 DAA	80-04-09	1640	--	.50	560	8.3	190	33	41	22
154	17N-05E-28 ABA	80-04-15	1830	104	--	850	7.5	370	0	46	61
155	17N-05E-35 AAD	80-04-09	1500	105	--	1220	7.9	98	0	28	6.6
156	17N-06E-27 DCD	80-04-09	1130	--	<.10	495	7.8	250	9	60	24
157	17N-06E-31 CDC	80-04-09	1400	--	<.10	330	7.9	140	9	34	13
158	17N-06E-32 DDD	80-04-09	1245	177	--	604	7.5	250	0	51	30
UKFUSKEE											
159	11N-07E-08 DDD	79-07-31	1600	--	1.0	425	8.0	180	33	42	19
160	11N-07E-19 CCC	79-08-01	0800	--	1.5	1112	7.7	340	260	86	31
161	11N-07E-20 BBB	79-08-01	1000	105	--	1280	6.2	440	5	100	45
162	12N-07E-02 CDC	79-08-07	1430	83	--	340	6.5	160	5	34	17
163	12N-07E-03 DAA	79-08-06	1630	--	<.10	1545	8.2	410	200	80	50
164	12N-07E-17 DCC	79-07-27	0900	E150	--	516	6.4	270	0	60	29
165	12N-07E-24 ADA	79-11-02	0930	39	--	129	4.6	26	14	6.4	2.5
166	12N-07E-26 CDC	80-02-22	1000	--	<.10	261	--	89	16	20	9.4
167	12N-07E-27 DDA	79-08-01	1330	130	--	420	5.6	210	0	45	23
168	12N-07E-32 BAA	79-07-31	1200	--	<.10	351	7.3	160	1	41	19
169	12N-07E-32 BCB	79-07-31	1430	87	--	610	6.8	310	35	66	34
170	12N-08E-08 AAC	79-08-07	1630	109	--	116	6.0	25	1	6.4	2.1
171	12N-08E-31 DAA	79-08-01	1600	57	--	200	5.2	110	23	32	8.3

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	BROMIDE DIS-SOLVED (MG/L AS BR)	IODIDE, DIS-SOLVED (MG/L AS I)
					LINCOLN						
139	15N-06E-26 DDC	80-02-27	22	.7	1.0	190	15	14	.3	.1	--
140	15N-06E-33 BBA	80-02-28	45	1.3	2.7	270	37	21	.7	1.0	--
141	15N-06E-34 CCD	80-02-27	41	1.1	4.6	200	62	61	.2	.4	--
142	16N-05E-04 AAA	80-04-15	46	1.1	3.7	250	62	88	.4	.6	.00
143	16N-05E-11 BCB	80-04-22	22	.8	6.6	140	31	16	.2	.3	--
144	16N-05E-12 DCD	80-03-21	33	.9	2.1	270	32	25	.5	.3	--
145	16N-05E-24 CBB	80-03-17	98	1.7	1.6	420	110	180	1.0	1.0	.01
146	16N-06E-01 BCB	80-04-09	4.4	.3	.5	29	14	4.6	.1	.1	.01
147	16N-06E-03 CCD	80-08-09	24	.6	3.2	250	72	17	.3	.2	--
148	16N-06E-18 AAA	80-03-21	89	1.9	1.4	310	190	46	.9	.4	.01
149	16N-06E-23 BBA	80-04-01	460	5.5	2.7	110	15	1500	.0	10	.01
150	16N-06E-29 ADA	80-03-21	15	.5	1.0	170	33	6.4	.8	.1	--
151	16N-06E-33 DAD	80-03-20	46	1.2	3.4	320	10	17	.5	.1	--
152	16N-06E-35 BCB	80-03-10	15	.5	3.4	190	24	11	.2	.2	--
153	17N-05E-26 DAA	80-04-09	40	1.3	4.2	160	35	52	.3	.4	--
154	17N-05E-28 ABA	80-04-15	25	.6	1.2	390	18	16	1.1	.1	.00
155	17N-05E-35 AAD	80-04-09	240	11	3.1	280	290	20	.6	.1	.01
156	17N-06E-27 DCD	80-04-09	7.2	.2	1.4	240	9.7	7.2	.4	.2	--
157	17N-06E-31 CDC	80-04-09	10	.4	3.6	130	16	8.7	.3	.1	--
158	17N-06E-32 DDD	80-04-09	30	.8	2.5	270	24	14	.3	.1	2.4
					OKFUSKEE						
159	11N-07E-08 DDD	79-07-31	24	.8	2.4	150	20	45	.3	.4	--
160	11N-07E-19 CCC	79-08-01	110	2.6	3.5	84	15	360	.1	1.7	.02
161	11N-07E-20 BBB	79-08-01	100	2.1	1.8	430	56	110	.2	.9	.03
162	12N-07E-02 CDC	79-08-07	13	.5	1.1	150	14	12	.2	.1	--
163	12N-07E-03 DAA	79-08-06	190	4.1	4.6	210	16	410	.4	2.2	.03
164	12N-07E-17 DCC	79-07-27	15	.4	1.6	310	4.1	8.2	.3	.0	--
165	12N-07E-24 ADA	79-11-02	11	.9	.7	12	13	12	.1	.1	.01
166	12N-07E-26 CDC	80-02-22	12	.6	2.2	73	25	13	.2	.3	--
167	12N-07E-27 DDA	79-08-01	16	.5	.9	220	14	10	.2	.2	--
168	12N-07E-32 BAA	79-07-31	10	.3	2.0	180	14	9.8	.3	.2	--
169	12N-07E-32 BCB	79-07-31	23	.6	.8	270	29	44	.2	--	--
170	12N-08E-08 AAC	79-08-07	11	1.0	.9	24	16	4.9	.1	.1	--
171	12N-08E-31 DAA	79-08-01	5.7	.2	1.2	91	14	10	.2	.1	--

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	LITHIUM DIS-SOLVED (UG/L AS LI)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)
			LINCOLN				
139	15N-06E-26 DDC	80-02-27	13	236	20	180	.2
140	15N-06E-33 BBA	80-02-28	13	356	30	490	3.0
141	15N-06E-34 CCD	80-02-27	3.0	398	10	410	12
142	16N-05E-04 AAA	80-04-15	8.1	486	5	350	--
143	16N-05E-11 BCB	80-04-22	12	265	<4	230	--
144	16N-05E-12 DCD	80-03-21	5.9	348	<4	240	12
145	16N-05E-24 CBB	80-03-17	11	928	20	750	20
146	16N-06E-01 BCB	80-04-09	11	79	6	130	--
147	16N-06E-03 CCD	80-08-09	9.0	400	8	190	--
148	16N-06E-18 AAA	80-03-21	11	692	20	580	4.1
149	16N-06E-23 BBA	80-04-01	17	2970	20	1100	--
150	16N-06E-29 ADA	80-03-21	8.4	238	10	180	4.5
151	16N-06E-33 DAD	80-03-20	15	363	20	1300	8.6
152	16N-06E-35 BCB	80-03-10	1.2	223	5	280	8.5
153	17N-05E-26 DAA	80-04-09	7.3	335	6	340	--
154	17N-05E-28 ABA	80-04-15	13	430	20	430	--
155	17N-05E-35 AAD	80-04-09	13	807	20	690	--
156	17N-06E-27 DCD	80-04-09	11	275	8	140	--
157	17N-06E-31 CDC	80-04-09	6.9	192	4	170	--
158	17N-06E-32 DDD	80-04-09	14	334	10	1200	--
			OKFUSKEE				
159	11N-07E-08 DDD	79-07-31	14	281	4	190	6.3
160	11N-07E-19 CCC	79-08-01	28	925	20	600	19
161	11N-07E-20 BBB	79-08-01	23	758	30	280	14
162	12N-07E-02 CDC	79-08-07	21	187	9	120	2.9
163	12N-07E-03 DAA	79-08-06	11	978	10	280	3.7
164	12N-07E-17 DCC	79-07-27	15	319	10	190	.5
165	12N-07E-24 ADA	79-11-02	14	73	8	40	.6
166	12N-07E-26 CDC	80-02-22	18	154	<4	110	3.6
167	12N-07E-27 DDA	79-08-01	19	257	10	200	6.5
168	12N-07E-32 BAA	79-07-31	15	210	<4	130	2.7
169	12N-07E-32 BCB	79-07-31	21	402	10	190	1.1
170	12N-08E-08 AAC	79-08-07	15	73	<4	40	.2
171	12N-08E-31 DAA	79-08-01	14	148	6	50	2.9

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH FIELD (UNITS)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
					OKFUSKEE						
172	12N-08E-32 CCB	79-08-01	1430	--	<.10	343	7.3	160	3	39	16
173	12N-08E-34 BBB	79-08-02	0830	--	<.10	705	7.2	230	83	60	20
174	13N-07E-09 DAA	79-08-16	1115	105	--	356	6.6	140	17	30	15
175	13N-07E-09 DAA	79-08-16	1300	149	--	12760	6.2	3400	3200	840	320
176	13N-07E-10 CBC	79-08-16	1000	--	<.10	42140	7.0	6000	5900	1600	450
177	13N-07E-11 CCC	79-07-26	1630	--	<.10	470	7.6	220	3	53	22
178	13N-07E-12 AAA	79-08-07	1300	120	--	470	6.9	230	0	48	26
179	13N-07E-17 ABB	79-07-26	1500	--	<.10	400	8.0	180	0	43	18
180	13N-07E-18 BAA	79-07-26	1400	89	--	548	7.2	290	0	63	33
181	13N-07E-22 DCC	79-08-07	0930	149	--	387	6.5	200	0	43	22
182	13N-07E-24 DDD	79-08-07	1100	--	<.10	501	7.9	270	0	53	33
183	13N-07E-27 CCB	79-08-06	1500	--	<.10	500	7.1	260	14	56	30
184	13N-07E-30 BAB	79-08-06	1300	--	<.10	297	7.5	140	0	31	15
185	13N-07E-33 CCC	79-08-07	0830	133	--	813	7.0	280	0	57	34
186	13N-08E-27 BBC	79-11-02	1400	115	--	380	6.5	160	3	37	17
187	13N-08E-30 DDC	79-11-02	1230	40	--	320	5.9	67	0	14	7.7
188	13N-08E-33 DCD	79-11-02	1100	--	<.10	136	5.8	33	17	7.7	3.3
					PAYNE						
189	17N-05E-11 DDC	80-04-10	1420	--	.40	900	8.7	260	73	62	26
190	17N-06E-02 AAD	80-04-17	1400	--	.07	291	7.4	96	16	23	9.3
191	17N-06E-05 AAA	80-04-11	0845	--	10	507	7.8	150	27	34	15
192	17N-06E-05 BBA	80-04-10	1700	--	<.10	700	8.7	360	0	63	49
193	17N-06E-07 DDC	80-04-10	1800	203	--	539	8.3	24	0	7.4	1.4
194	17N-06E-10 BAA	80-04-11	1045	145	--	391	7.2	160	9	42	13
195	17N-06E-14 CCC	80-04-10	0930	120	--	405	6.3	130	91	31	13
196	17N-06E-16 CBB	80-04-10	1100	--	.04	400	7.9	150	18	36	14
197	17N-06E-20 CDC	80-04-10	1200	83	--	880	7.4	320	0	60	40
198	18N-05E-11 AAB	80-04-16	1500	140	--	12932	6.9	2500	2300	690	190
199	18N-05E-12 BCB	80-04-16	1330	81	--	2100	7.0	780	590	220	56
200	18N-05E-22 BBA	80-04-22	1530	88	--	1080	7.4	370	37	61	52
201	18N-05E-24 DDA	80-04-16	1700	--	<.10	850	8.0	550	17	90	78
202	18N-05E-34 BBB	80-04-16	1100	--	1.0	2420	8.6	330	180	79	33
203	18N-05E-35 AAD	80-04-10	1600	179	--	990	7.3	270	0	63	26
204	18N-06E-07 CBB	80-04-16	1600	--	.05	1165	8.2	360	92	110	21

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	BROMIDE DIS- SOLVED (MG/L AS BR)	IODIDE, DIS- SOLVED (MG/L AS I)
					OKFUSKEE						
172	12N-08E-32 CCB	79-08-01	12	.4	1.2	160	12	15	.3	.2	--
173	12N-08E-34 BBB	79-08-02	68	1.9	3.6	150	24	160	.3	.7	--
174	13N-07E-09 DAA	79-08-16	18	.7	1.1	120	20	17	.1	.2	.02
175	13N-07E-09 DAA	79-08-16	1700	13	7.2	200	47	4800	.1	33	.02
176	13N-07E-10 CBC	79-08-16	11000	63	31	89	130	22000	.3	110	.80
177	13N-07E-11 CCC	79-07-26	16	.5	4.2	220	11	26	.4	.3	--
178	13N-07E-12 AAA	79-08-07	18	.5	2.3	230	6.7	28	.2	.4	--
179	13N-07E-17 ABB	79-07-26	8.1	.3	4.2	200	10	7.8	.3	.1	--
180	13N-07E-18 BAA	79-07-26	9.8	.3	2.2	300	8.9	12	.2	.1	--
181	13N-07E-22 DCC	79-08-07	5.6	.2	1.1	200	8.5	7.2	.0	.1	.00
182	13N-07E-24 DDD	79-08-07	19	.5	2.9	280	12	15	.7	.2	--
183	13N-07E-27 CCB	79-08-06	11	.3	2.2	250	15	17	.5	.2	--
184	13N-07E-30 BAB	79-08-06	8.9	.3	4.0	150	7.2	5.4	.3	.1	--
185	13N-07E-33 CCC	79-08-07	98	2.5	2.0	310	53	81	.7	.5	--
186	13N-08E-27 BBC	79-11-02	14	.5	2.0	160	8.8	18	.2	.3	--
187	13N-08E-30 DDC	79-11-02	28	1.5	.7	84	12	22	.7	.3	--
188	13N-08E-33 DCD	79-11-02	8.7	.7	2.1	16	12	19	.1	.2	--
					PAYNE						
189	17N-05E-11 DDC	80-04-10	68	1.8	5.0	190	70	110	.3	.8	--
190	17N-06E-02 AAD	80-04-17	16	.7	1.5	80	20	22	.2	.3	--
191	17N-06E-05 AAA	80-04-11	39	1.4	5.0	120	32	56	.3	.6	--
192	17N-06E-05 BBA	80-04-10	25	.6	2.7	360	14	13	.5	.3	.06
193	17N-06E-07 DDC	80-04-10	110	9.7	1.5	230	18	6.5	.5	.1	--
194	17N-06E-10 BAA	80-04-11	15	.5	.7	150	16	11	.3	.1	--
195	17N-06E-14 CCC	80-04-10	17	.6	1.2	40	40	33	.1	--	--
196	17N-06E-16 CBB	80-04-10	15	.5	4.7	130	19	23	.2	.2	.00
197	17N-06E-20 CDC	80-04-10	51	1.3	3.6	370	17	35	.4	.2	--
198	18N-05E-11 AAB	80-04-16	1800	16	3.6	200	16	4600	.2	32	.01
199	18N-05E-12 BCB	80-04-16	110	1.7	1.5	190	.0	540	.2	4.0	--
200	18N-05E-22 BBA	80-04-22	84	1.9	1.9	330	92	83	.4	.5	.00
201	18N-05E-24 DDA	80-04-16	54	1.0	3.0	530	63	35	.5	.5	--
202	18N-05E-34 BBB	80-04-16	330	7.9	14	150	220	460	9.1	2.8	--
203	18N-05E-35 AAD	80-04-10	95	2.5	1.9	280	140	38	.4	.4	.01
204	18N-06E-07 CBB	80-04-16	98	2.2	1.7	270	26	200	.3	1.6	--

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
OKFUSKEE							
172	12N-08E-32 CCB	79-08-01	11	194	8	100	1.2
173	12N-08E-34 BBB	79-08-02	23	482	6	360	5.5
174	13N-07E-09 DAA	79-08-16	19	204	6	200	2.9
175	13N-07E-09 DAA	79-08-16	14	9530	50	8000	4.7
176	13N-07E-10 CBC	79-08-16	11	38000	500	93000	4.2
177	13N-07E-11 CCC	79-07-26	13	293	4	320	6.1
178	13N-07E-12 AAA	79-08-07	19	274	10	240	.9
179	13N-07E-17 ABB	79-07-26	8.9	241	<4	220	5.2
180	13N-07E-18 BAA	79-07-26	15	323	9	140	1.2
181	13N-07E-22 DCC	79-08-07	20	222	6	80	.9
182	13N-07E-24 DDD	79-08-07	12	303	<4	270	9.0
183	13N-07E-27 CCB	79-08-06	16	264	<4	220	3.4
184	13N-07E-30 BAB	79-08-06	6.0	161	<4	200	7.1
185	13N-07E-33 CCC	79-08-07	17	523	30	350	1.3
186	13N-08E-27 BBC	79-11-02	15	210	20	160	21
187	13N-08E-30 DDC	79-11-02	22	176	10	60	.8
188	13N-08E-33 DCD	79-11-02	14	81	10	50	4.3
PAYNE							
189	17N-05E-11 DDC	80-04-10	4.5	491	10	530	--
190	17N-06E-02 AAD	80-04-17	10	172	<4	80	--
191	17N-06E-05 AAA	80-04-11	7.5	285	7	300	--
192	17N-06E-05 BBA	80-04-10	12	389	5	350	--
193	17N-06E-07 DDC	80-04-10	12	311	7	170	--
194	17N-06E-10 BAA	80-04-11	10	211	8	180	--
195	17N-06E-14 CCC	80-04-10	11	238	--	--	--
196	17N-06E-16 CBB	80-04-10	2.5	229	<4	210	--
197	17N-06E-20 CDC	80-04-10	19	467	20	900	--
198	18N-05E-11 AAB	80-04-16	19	8090	50	4400	--
199	18N-05E-12 BCB	80-04-16	22	1290	20	700	--
200	18N-05E-22 BBA	80-04-22	19	587	20	500	--
201	18N-05E-24 DDA	80-04-16	13	646	8	850	--
202	18N-05E-34 BBB	80-04-16	9.3	1310	20	1100	--
203	18N-05E-35 AAD	80-04-10	14	569	20	490	--
204	18N-06E-07 CBB	80-04-16	15	638	10	430	--

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM- FLOW, INSTAN- TANEOUS (CFS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH FIELD (UNITS)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)
PAYNE											
205	18N-06E-23 CCC	80-04-17	1200	93	--	283	6.4	99	8	23	10
206	18N-06E-28 BCC	80-04-17	0930	238	--	630	7.3	240	2	61	21
207	18N-07E-28 ADD	80-04-18	1015	--	.10	2460	8.0	850	560	160	110
POTTAWATOMIE											
208	06N-05E-04 BCC	79-11-15	1400	176	--	484	7.2	120	0	25	14
209	06N-05E-06 AAA	79-11-15	1500	--	.10	6600	6.7	1100	800	240	120
210	06N-05E-32 BAB	79-12-05	1330	--	<.10	782	7.3	340	0	65	44
211	07N-05E-21 DCD	79-11-15	0930	--	.30	9244	7.3	1100	840	160	170
212	07N-05E-28 BBA	79-11-15	1200	208	--	1018	6.7	400	17	88	43
213	08N-05E-06 CDD	79-11-01	1700	220	--	5010	7.8	310	66	71	31
214	08N-05E-20 DDA	79-11-13	1600	216	--	1387	8.6	20	0	4.5	2.2
215	09N-04E-25 DDD	79-10-01	1730	--	1.5	1503	8.2	270	31	39	42
216	09N-05E-04 DCC	79-09-19	1100	248	--	3400	9.4	220	110	55	19
217	09N-05E-08 ABA	79-09-13	1530	87	--	400	7.1	180	0	47	15
218	09N-05E-16 ADD	78-09-28	1145	--	<.10	150000	6.8	--	--	--	--
		79-09-13	1630	--	.10	17500	6.7	2200	1800	600	170
219	09N-05E-18 CCB	79-11-01	1500	--	.10	714	7.9	320	7	69	35
220	09N-05E-29 ABA	79-10-01	1630	41	--	1264	7.1	390	130	83	45
221	11N-05E-09 ADA	79-09-11	1300	--	.10	491	7.1	200	0	51	18
222	11N-05E-13 ABB	79-07-17	1100	--	<.10	512	8.1	200	19	40	24
223	11N-05E-21 AAA	79-09-11	1430	54	--	350	5.6	110	73	28	8.7
224	11N-06E-04 CDC	79-07-16	1700	--	<.10	810	8.6	120	0	30	12
225	11N-06E-11 BAA	79-07-11	1500	211	--	510	7.3	170	0	38	17
226	11N-06E-16 DAD	79-07-17	1500	196	--	315	7.5	72	0	17	7.1
227	11N-06E-28 ADB	79-08-15	1730	--	E600	1440	8.4	370	160	93	34
SEMINOLE											
228	05N-05E-01 AAA	79-12-06	1700	197	--	694	7.0	140	0	27	18
229	05N-05E-11 BCC	79-12-06	1030	199	--	827	7.2	190	0	38	22
230	05N-05E-12 BCB	79-12-06	1500	--	.75	1320	7.8	390	120	91	40
231	05N-05E-15 BAB	79-12-05	1630	--	<.10	432	7.2	180	0	52	12
232	05N-06E-01 CBA	80-02-20	1400	179	--	713	--	180	0	52	12
233	05N-06E-18 CCC	79-12-06	1200	64	--	999	7.4	71	0	12	10

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	BROMIDE DIS-SOLVED (MG/L AS BR)	IODIDE, DIS-SOLVED (MG/L AS I)
					PAYNE						
205	18N-06E-23 CCC	80-04-17	15	.7	.6	91	16	12	.3	.2	--
206	18N-06E-28 BCC	80-04-17	35	1.0	2.5	240	71	5.6	.3	.1	.01
207	18N-07E-28 ADD	80-04-18	180	2.7	3.8	290	280	490	.4	3.0	.03
					POTTAWATOMIE						
208	06N-05E-04 BCC	79-11-15	82	3.3	2.4	260	21	7.8	.3	.2	--
209	06N-05E-06 AAA	79-11-15	880	12	9.9	300	24	1900	.3	8.4	--
210	06N-05E-32 BAB	79-12-05	46	1.1	2.1	400	18	23	.5	.3	--
211	07N-05E-21 DCD	79-11-15	1600	21	13	270	32	3200	.2	13	.06
212	07N-05E-28 BBA	79-11-15	58	1.3	3.0	380	30	70	.6	.6	--
213	08N-05E-06 CDD	79-11-01	1200	30	6.6	240	1300	230	1.8	1.0	.05
214	08N-05E-20 DDA	79-11-13	320	31	1.9	390	170	95	1.0	.4	--
215	09N-04E-25 DDD	79-10-01	200	5.3	4.6	240	74	300	.4	1.7	--
216	09N-05E-04 DCC	79-09-19	750	22	7.8	110	1600	96	1.0	.4	.01
217	09N-05E-08 ABA	79-09-13	16	.5	2.9	190	25	9.3	.4	.1	.01
218	09N-05E-16 ADD	78-09-28	49000	--	--	--	--	100000	--	220	--
		79-09-13	3400	32	27	420	78	6900	.5	40	.30
219	09N-05E-18 CCB	79-11-01	29	.7	3.4	310	17	47	.3	.4	--
220	09N-05E-29 ABA	79-10-01	96	2.1	1.8	260	44	230	.5	1.2	.32
221	11N-05E-09 ADA	79-09-11	35	1.1	2.5	260	12	9.2	.4	.2	--
222	11N-05E-13 ABB	79-07-17	33	1.0	3.6	180	17	57	.4	.5	--
223	11N-05E-21 AAA	79-09-11	19	.8	1.6	33	26	58	.1	.3	--
224	11N-06E-04 CDC	79-07-16	140	5.5	9.3	290	76	45	.5	.3	.04
225	11N-06E-11 BAA	79-07-11	47	1.6	3.4	260	9.8	20	.3	.1	.02
226	11N-06E-16 DAD	79-07-17	47	2.4	2.4	150	12	7.3	.3	.1	--
227	11N-06E-28 ADB	79-08-15	170	3.8	10	210	180	240	.7	1.1	.04
					SEMINOLE						
228	05N-05E-01 AAA	79-12-06	170	6.2	2.2	440	32	23	.5	.1	.01
229	05N-05E-11 BCC	79-12-06	120	3.8	2.1	380	33	47	.5	.6	--
230	05N-05E-12 BCB	79-12-06	120	2.6	3.2	270	43	250	.3	1.4	--
231	05N-05E-15 BAB	79-12-05	17	.6	1.0	180	15	21	.3	.1	--
232	05N-06E-01 CBA	80-02-20	94	3.1	2.6	330	37	8.5	.2	.0	--
233	05N-06E-18 CCC	79-12-06	220	11	3.1	520	12	28	.7	.3	.02

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
			PAYNE				
205	18N-06E-23 CCC	80-04-17	15	154	8	30	--
206	18N-06E-28 BCC	80-04-17	19	365	7	3000	--
207	18N-07E-28 ADD	80-04-18	5.1	1460	10	2000	--
			POTTAWATOMIE				
208	06N-05E-04 BCC	79-11-15	16	326	20	310	29
209	06N-05E-06 AAA	79-11-15	11	3750	50	3600	34
210	06N-05E-32 BAB	79-12-05	13	432	7	420	22
211	07N-05E-21 DCD	79-11-15	9.2	5920	90	5700	9.9
212	07N-05E-28 BBA	79-11-15	14	585	40	490	33
213	08N-05E-06 CDD	79-11-01	9.5	3840	40	1100	34
214	08N-05E-20 DDA	79-11-13	9.4	836	10	120	29
215	09N-04E-25 DDD	79-10-01	2.0	810	6	520	6.3
216	09N-05E-04 DCC	79-09-19	3.0	2530	30	1100	12
217	09N-05E-08 ABA	79-09-13	11	244	10	830	.6
218	09N-05E-16 ADD	78-09-28	--	205000	--	--	--
		79-09-13	12	12500	190	17000	5.4
219	09N-05E-18 CCB	79-11-01	13	412	10	310	35
220	09N-05E-29 ABA	79-10-01	19	699	20	350	1.5
221	11N-05E-09 ADA	79-09-11	19	313	10	250	3.5
222	11N-05E-13 ABB	79-07-17	6.9	303	5	230	4.4
223	11N-05E-21 AAA	79-09-11	34	264	20	220	1.8
224	11N-06E-04 CDC	79-07-16	6.8	560	7	260	5.1
225	11N-06E-11 BAA	79-07-11	18	305	10	890	.3
226	11N-06E-16 DAD	79-07-17	16	192	10	330	.0
227	11N-06E-28 ADB	79-08-15	3.7	847	30	1200	9.3
			SEMINOLE				
228	05N-05E-01 AAA	79-12-06	13	543	30	250	6.1
229	05N-05E-11 BCC	79-12-06	14	504	20	440	8.6
230	05N-05E-12 BCB	79-12-06	19	763	20	590	3.6
231	05N-05E-15 BAB	79-12-05	36	272	20	200	2.7
232	05N-06E-01 CBA	80-02-20	15	410	10	290	--
233	05N-06E-18 CCC	79-12-06	10	614	30	160	15

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM- FLOW, INSTAN- TANEOUS (CFS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH FIELD (UNITS)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)
SEMINOLE											
234	05N-06E-19 ABD	79-12-06	1400	--	.15	632	7.6	250	0	66	20
235	06N-05E-01 DDC	79-10-04	1030	86	--	868	7.0	410	140	82	49
236	06N-05E-02 BCC	79-11-15	1630	--	.10	4680	7.8	1100	740	200	140
237	06N-05E-22 BBB	79-12-05	1100	154	--	466	7.0	170	7	42	15
238	06N-05E-24 ABB	80-01-30	1230	78	--	703	7.2	150	0	22	24
239	06N-05E-26 BCB	80-02-20	1000	--	<.10	651	8.0	320	0	66	37
240	06N-05E-34 BBC	79-12-05	1530	187	--	832	6.9	250	0	39	36
241	06N-06E-04 CDC	80-01-30	1000	--	<.10	2250	7.3	630	320	140	69
242	06N-06E-15 CCB	80-01-31	1000	236	--	965	7.3	400	88	75	51
243	06N-06E-17 DDD	80-02-20	1100	--	<.10	1471	--	620	49	150	59
244	06N-06E-27 DAA	80-01-31	1500	242	--	480	6.9	220	11	52	22
245	06N-06E-33 BCC	80-01-30	1500	--	.20	1562	7.4	530	240	110	61
246	06N-06E-36 CCB	80-01-31	1600	--	<.10	1520	6.0	53	21	16	3.2
247	07N-05E-02 DCC	79-11-14	1800	122	--	905	6.8	160	0	25	24
248	07N-05E-15 AAD	79-11-14	1600	--	2.5	4928	8.0	890	700	200	93
249	07N-05E-25 CBC	79-10-04	1700	246	--	1763	8.5	25	0	6.7	2.0
250	07N-06E-01 BBD	79-10-02	1000	--	<.10	1962	8.0	440	190	82	58
251	07N-06E-04 CCC	79-10-02	1300	240	--	609	6.9	340	9	73	38
252	07N-06E-12 CCD	79-09-27	1330	240	--	565	7.3	270	0	53	34
253	07N-06E-17 AAA	80-02-21	1530	--	<.10	760	--	370	37	89	35
254	07N-06E-17 DDD	79-10-03	1530	117	--	1066	8.5	12	0	2.0	1.6
255	07N-06E-18 BCB	79-10-02	1515	114	--	980	7.0	390	0	70	51
256	07N-06E-19 BCC	79-10-03	1330	--	.40	1936	8.1	300	180	62	34
257	07N-06E-23 BCB	79-09-27	1545	--	<.10	14541	7.6	1500	1200	380	140
258	07N-06E-26 CBB	79-09-27	1745	110	--	3773	6.4	1300	1200	350	94
259	07N-06E-28 BAD	79-10-03	1600	--	.56	1654	8.0	280	150	66	28
260	07N-06E-30 DCC	79-10-04	1500	--	<.10	1528	8.0	460	140	110	44
261	07N-06E-33 CDC	79-10-04	1300	235	--	1071	8.9	4	0	.9	.4
262	07N-07E-05 ACD	79-09-27	1030	375	--	946	7.1	430	200	100	43
263	07N-07E-10 BBB	79-09-26	1600	59	--	900	6.8	510	120	100	63
264	07N-07E-20 BBA	79-09-26	1700	--	5.0	1891	8.2	360	140	78	41
265	08N-05E-13 ABB	80-02-21	1230	--	<.10	10192	--	1500	1300	350	150
266	08N-05E-14 BAB	79-11-14	1400	82	--	612	7.0	250	0	52	30
267	08N-05E-15 ACC	78-10-03	1550	--	<.10	50000	7.6	--	--	--	--
268	08N-05E-23 BBD	79-11-13	1730	--	2.5	1343	8.1	340	48	66	42
269	08N-05E-36 BBB	79-11-14	1030	156	--	1108	7.7	140	0	20	21

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	BROMIDE DIS- SOLVED (MG/L AS BR)	IODIDE, DIS- SOLVED (MG/L AS I)
					SEMINOLE						
234	05N-06E-19 ABD	79-12-06	38	1.1	1.8	250	22	49	.3	.3	.02
235	06N-05E-01 DDC	79-10-04	20	.4	2.7	270	86	61	.3	.7	--
236	06N-05E-02 BCC	79-11-15	890	12	8.9	340	21	1900	.3	8.6	--
237	06N-05E-22 BBB	79-12-05	41	1.4	.7	160	39	32	.3	.2	--
238	06N-05E-24 ABB	80-01-30	110	3.9	2.3	330	42	21	.2	.1	--
239	06N-05E-26 BCB	80-02-20	21	.5	1.6	330	12	16	.3	.3	--
240	06N-05E-34 BBC	79-12-05	98	2.7	3.5	400	20	30	.6	--	.02
241	06N-06E-04 CDC	80-01-30	240	4.2	2.1	310	19	540	.2	3.4	--
242	06N-06E-15 CCB	80-01-31	42	.9	3.5	310	34	92	.2	.6	.02
243	06N-06E-17 DDD	80-02-20	85	1.5	.7	570	73	120	.3	.8	.02
244	06N-06E-27 DAA	80-01-31	9.1	.3	1.4	210	19	18	.2	.2	--
245	06N-06E-33 BCC	80-01-30	140	2.7	4.1	290	170	250	.5	1.3	--
246	06N-06E-36 CCB	80-01-31	4.4	.3	1.5	32	16	16	.1	.1	.00
247	07N-05E-02 DCC	79-11-14	150	5.1	5.9	380	16	73	.3	.2	.01
248	07N-05E-15 AAD	79-11-14	750	11	10	190	51	1500	.3	12	--
249	07N-05E-25 CBC	79-10-04	650	57	2.2	750	100	450	5.2	2.6	.05
250	07N-06E-01 BBD	79-10-02	310	6.4	6.7	250	62	610	.4	2.3	.10
251	07N-06E-04 CCC	79-10-02	6.6	.2	1.1	330	15	8.8	.4	.1	.00
252	07N-06E-12 CCD	79-09-27	25	.7	3.9	290	15	30	.2	.2	--
253	07N-06E-17 AAA	80-02-21	23	.5	1.5	330	33	22	.2	.2	--
254	07N-06E-17 DDD	79-10-03	270	35	1.0	550	23	22	.6	.1	--
255	07N-06E-18 BCB	79-10-02	71	1.6	1.8	390	31	50	.5	.3	--
256	07N-06E-19 BCC	79-10-03	270	6.8	4.6	120	11	530	.3	2.3	.07
257	07N-06E-23 BCB	79-09-27	3400	38	46	380	50	6300	.3	29	.50
258	07N-06E-26 CBB	79-09-27	250	3.1	7.5	69	1200	440	.1	7.0	.01
259	07N-06E-28 BAD	79-10-03	230	6.0	4.5	130	13	450	.4	2.4	--
260	07N-06E-30 DCC	79-10-04	150	3.1	2.6	320	11	350	.5	2.9	--
261	07N-06E-33 CDC	79-10-04	280	62	.9	510	37	42	1.0	.2	--
262	07N-07E-05 ACD	79-09-27	33	.7	4.6	230	26	190	.2	1.1	--
263	07N-07E-10 BBB	79-09-26	11	.2	2.6	390	140	21	.2	.2	--
264	07N-07E-20 BBA	79-09-26	230	5.3	6.2	220	32	470	.3	1.0	--
265	08N-05E-13 ABB	80-02-21	1900	21	15	210	44	3800	.2	22	.09
266	08N-05E-14 BAB	79-11-14	43	1.2	1.3	310	25	14	.1	.1	--
267	08N-05E-15 ACC	78-10-03	9800	--	--	--	--	26000	--	90	--
268	08N-05E-23 BBD	79-11-13	160	3.8	4.4	290	52	230	.4	1.4	--
269	08N-05E-36 BBB	79-11-14	230	8.6	1.8	500	43	58	1.3	.3	.01

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
			SEMINOLE				
234	05N-06E-19 ABD	79-12-06	31	366	10	210	16
235	06N-05E-01 DDC	79-10-04	15	520	20	230	6.0
236	06N-05E-02 BCC	79-11-15	11	3020	--	--	30
237	06N-05E-22 BBB	79-12-05	20	295	6	160	.7
238	06N-05E-24 ABB	80-01-30	16	425	30	310	--
239	06N-05E-26 BCB	80-02-20	11	352	<4	230	9.7
240	06N-05E-34 BBC	79-12-05	20	480	40	590	16
241	06N-06E-04 CDC	80-01-30	9.8	1190	10	1000	5.5
242	06N-06E-15 CCB	80-01-31	8.6	540	30	550	19
243	06N-06E-17 DDD	80-02-20	7.5	874	7	1100	11
244	06N-06E-27 DAA	80-01-31	8.8	249	20	140	1.5
245	06N-06E-33 BCC	80-01-30	11	997	30	710	18
246	06N-06E-36 CCB	80-01-31	9.2	98	10	70	6.2
247	07N-05E-02 DCC	79-11-14	15	534	30	660	16
248	07N-05E-15 AAD	79-11-14	4.4	3020	50	3800	19
249	07N-05E-25 CBC	79-10-04	10	1690	20	60	12
250	07N-06E-01 BBD	79-10-02	3.2	1360	10	1100	7.6
251	07N-06E-04 CCC	79-10-02	15	337	8	310	2.6
252	07N-06E-12 CCD	79-09-27	8.7	337	20	670	.7
253	07N-06E-17 AAA	80-02-21	11	404	5	270	4.1
254	07N-06E-17 DDD	79-10-03	8.4	632	<4	30	1.4
255	07N-06E-18 BCB	79-10-02	12	571	30	300	4.5
256	07N-06E-19 BCC	79-10-03	3.0	1050	10	1100	6.5
257	07N-06E-23 BCB	79-09-27	12	11600	210	12000	8.6
258	07N-06E-26 CBB	79-09-27	9.6	2200	8	1000	1.9
259	07N-06E-28 BAD	79-10-03	3.1	899	9	970	4.5
260	07N-06E-30 DCC	79-10-04	18	906	9	330	5.2
261	07N-06E-33 CDC	79-10-04	10	666	<4	10	11
262	07N-07E-05 ACD	79-09-27	11	580	20	790	2.6
263	07N-07E-10 BBB	79-09-26	9.6	571	20	310	.5
264	07N-07E-20 BBA	79-09-26	4.8	1050	10	1100	5.1
265	08N-05E-13 ABB	80-02-21	2.5	6500	70	8200	8.9
266	08N-05E-14 BAB	79-11-14	16	360	20	160	3.5
267	08N-05E-15 ACC	78-10-03	--	43300	--	--	--
268	08N-05E-23 BBD	79-11-13	13	743	20	590	37
269	08N-05E-36 BBB	79-11-14	12	676	20	180	37

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM- FLOW, INSTAN- TANEOUS (CFS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH FIELD (UNITS)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)
					SEMINOLE						
270	08N-06E-07 CBA	80-02-19	1515	53	--	3150	--	850	660	180	97
271	08N-06E-09 ADA	78-08-10	0930	178	--	1650	8.5	--	--	--	--
		80-02-01	0900	178	--	726	7.8	35	0	8.4	3.4
272	08N-06E-10 DBC	79-12-04	1630	--	<.10	2553	10.8	46	0	14	2.7
273	08N-06E-13 DAD	79-09-20	1330	--	<.10	3442	7.6	650	460	140	72
274	08N-06E-23 AAD	78-08-09	1630	--	<.10	9400	8.1	--	--	--	--
		80-02-01	1030	--	<.10	6688	6.7	1500	1200	360	150
275	08N-06E-26 DDA	78-08-10	1700	--	<.10	15000	8.0	--	--	--	--
		80-02-21	1100	--	.10	9400	--	1400	1200	350	130
276	08N-06E-28 DDD	80-02-19	1700	--	<.10	766	--	360	0	81	37
277	08N-07E-02 ABB	79-09-25	1330	--	<.10	707	6.9	150	78	36	14
278	08N-07E-03 ADC	79-09-25	1530	102	--	143	5.0	32	21	7.7	3.2
279	08N-07E-05 ABA	79-09-20	1030	104	--	320	6.4	140	14	33	15
280	08N-07E-06 DDB	79-09-20	1200	--	<.10	329	6.7	130	24	32	13
281	08N-07E-16 BBB	79-09-25	1700	--	.16	2186	9.1	330	140	80	32
282	08N-07E-18 BAA	78-11-30	1300	--	<.10	4000	8.1	--	--	--	--
283	08N-07E-18 CBB	79-09-20	1430	170	--	26200	6.6	1400	1200	280	180
284	08N-07E-20 AAA	79-09-26	1200	67	--	151	5.3	32	16	6.2	4.0
285	08N-07E-22 ABA	79-09-26	1000	--	<.10	6820	7.3	240	86	53	25
286	08N-07E-29 ABB	80-02-20	1730	--	.10	1100	--	190	160	46	19
287	08N-07E-32 AAA	79-09-20	1700	94	--	269	5.3	42	31	9.8	4.3
288	08N-07E-34 DDD	80-02-20	1600	--	<.10	800	--	410	100	110	34
289	09N-05E-03 DAD	79-09-13	1400	--	.10	16500	7.9	2600	2400	650	230
290	09N-05E-03 DDD	79-09-18	1730	--	<.10	161000	6.9	20000	20000	5500	1400
291	09N-05E-13 CDA	79-11-16	1130	98	--	675	7.0	270	0	40	40
292	09N-05E-15 BBB	79-09-19	0930	114	--	656	6.4	210	67	53	18
293	09N-05E-24 BCB	79-09-28	0900	--	<.10	23217	7.5	1300	1200	--	310
294	09N-05E-27 AAA	79-11-01	1130	272	--	4446	7.1	1000	910	290	68
295	09N-05E-34 ABA	79-11-01	1400	--	<.10	813	7.5	370	0	74	46
296	09N-06E-03 AAB	78-08-02	1500	--	<.10	12000	7.7	--	--	--	--
297	09N-06E-04 BCA	79-07-20	0800	--	<.10	7210	7.8	1100	790	260	99
		78-08-02	1030	--	<.10	35500	7.3	--	--	--	--
		79-09-12	1630	--	<.10	22500	6.9	2400	2100	590	220
298	09N-06E-06 BBB	79-09-13	1730	265	--	700	7.1	310	0	61	38
299	09N-06E-08 CDD	79-09-12	1230	120	--	641	7.2	160	0	44	13
300	09N-06E-09 CDC	78-08-01	1600	--	.10	5200	8.6	--	--	--	--

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	BROMIDE DIS-SOLVED (MG/L AS BR)	IODIDE, DIS-SOLVED (MG/L AS I)
					SEMINOLE						
270	08N-06E-07 CBA	80-02-19	290	4.3	2.1	190	28	880	.2	3.2	.02
271	08N-06E-09 ADA	78-08-10	280	--	--	--	--	22	--	.3	--
		80-02-01	160	12	2.4	290	68	35	1.3	.2	--
272	08N-06E-10 DBC	79-12-04	510	33	2.7	590	250	290	1.4	2.0	.03
273	08N-06E-13 DAD	79-09-20	500	8.6	4.6	190	18	1000	.3	5.7	--
274	08N-06E-23 AAD	78-08-09	1500	--	--	--	--	2800	--	8.2	--
		80-02-01	1400	16	2.1	300	53	3100	.2	13	.12
275	08N-06E-26 DDA	78-08-10	2400	--	--	--	--	4700	--	21	--
		80-02-21	1400	16	7.2	200	26	3000	.2	27	.14
276	08N-06E-28 DDD	80-02-19	48	1.1	4.6	370	53	26	.3	.2	--
277	08N-07E-02 ABB	79-09-25	95	3.4	3.6	70	12	200	.2	1.1	--
278	08N-07E-03 ADC	79-09-25	12	.9	1.2	11	16	19	.1	.2	--
279	08N-07E-05 ABA	79-09-20	7.3	.3	1.1	130	13	17	.3	.1	--
280	08N-07E-06 DDB	79-09-20	16	.6	1.1	110	14	30	.4	.2	.02
281	08N-07E-16 BBB	79-09-25	320	7.6	11	190	56	550	.5	2.6	--
282	08N-07E-18 BAA	78-11-30	580	--	--	--	--	1200	--	5.0	--
283	08N-07E-18 CBB	79-09-20	110	1.3	16	230	8.3	1000	.2	6.1	.06
284	08N-07E-20 AAA	79-09-26	11	.8	1.0	16	8.8	18	.2	.2	--
285	08N-07E-22 ABA	79-09-26	64	1.8	.9	150	8.1	170	.2	1.2	--
286	08N-07E-29 ABB	80-02-20	120	3.8	3.6	30	24	300	.1	1.5	--
287	08N-07E-32 AAA	79-09-20	35	2.3	1.1	11	24	57	.1	.4	--
288	08N-07E-34 DDD	80-02-20	4.7	.1	.7	310	110	7.7	.2	.0	--
289	09N-05E-03 DAD	79-09-13	2900	25	23	190	54	6500	.3	30	.32
290	09N-05E-03 DDD	79-09-18	42000	131	620	1	570	91000	.4	280	10
291	09N-05E-13 CDA	79-11-16	50	1.3	2.5	330	15	22	.3	.2	--
292	09N-05E-15 BBB	79-09-19	72	2.2	.8	140	150	68	.2	.5	--
293	09N-05E-24 BCB	79-09-28	6300	--	25	100	130	9500	.3	40	.30
294	09N-05E-27 AAA	79-11-01	720	9.9	9.6	100	2300	62	.8	.4	--
295	09N-05E-34 ABA	79-11-01	52	1.2	2.9	440	18	41	.3	.3	.01
296	09N-06E-03 AAB	78-08-02	1700	--	--	--	--	3900	--	18	--
		79-07-20	1200	16	12	270	26	2500	.2	12	--
297	09N-06E-04 BCA	78-08-02	6100	--	--	--	--	9300	--	20	--
		79-09-12	3300	29	32	340	49	7300	.4	34	.68
298	09N-06E-06 BBB	79-09-13	42	1.0	1.8	310	19	67	.4	.4	--
299	09N-06E-08 CDD	79-09-12	83	2.8	3.7	290	51	17	.3	.1	--
300	09N-06E-09 CDC	78-08-01	780	--	--	--	--	1700	--	8.0	--

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS-SOLVED (MG/L)	LITHIUM DIS-SOLVED (UG/L AS LI)	STRON-TIUM, DIS-SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS-SOLVED (MG/L AS C)
			SEMINOLE				
270	08N-06E-07 CBA	80-02-19	31	1820	10	370	5.0
271	08N-06E-09 ADA	78-08-10	--	830	--	--	--
		80-02-01	9.6	464	20	130	6.6
272	08N-06E-10 DBC	79-12-04	20	1480	20	180	23
273	08N-06E-13 DAD	79-09-20	6.4	2190	4	1700	3.3
274	08N-06E-23 AAD	78-08-09	--	5310	--	--	--
		80-02-01	12	5730	110	7000	5.6
275	08N-06E-26 DDA	78-08-10	--	8530	--	--	--
		80-02-21	23	5560	40	6400	4.9
276	08N-06E-28 DDD	80-02-19	7.4	488	<4	280	14
277	08N-07E-02 ABB	79-09-25	2.9	423	5	560	5.6
278	08N-07E-03 ADC	79-09-25	14	81	<4	20	.6
279	08N-07E-05 ABA	79-09-20	13	184	20	40	1.8
280	08N-07E-06 DDB	79-09-20	16	194	10	90	2.9
281	08N-07E-16 BBB	79-09-25	3.8	1270	10	1100	11
282	08N-07E-18 BAA	78-11-30	--	2200	--	--	--
283	08N-07E-18 CBB	79-09-20	9.2	2360	20	4100	3.9
284	08N-07E-20 AAA	79-09-26	19	97	8	30	.8
285	08N-07E-22 ABA	79-09-26	19	414	7	310	2.0
286	08N-07E-29 ABB	80-02-20	14	611	<4	630	3.8
287	08N-07E-32 AAA	79-09-20	14	157	6	50	.4
288	08N-07E-34 DDD	80-02-20	6.6	484	<4	160	5.4
289	09N-05E-03 DAD	79-09-13	6.3	12000	100	13000	3.8
290	09N-05E-03 DDD	79-09-18	13	150000	1900	280000	--
291	09N-05E-13 CDA	79-11-16	14	391	30	330	9.0
292	09N-05E-15 BBB	79-09-19	20	451	8	150	2.1
293	09N-05E-24 BCB	79-09-28	16	17000	150	6500	4.9
294	09N-05E-27 AAA	79-11-01	12	3910	40	3000	1.8
295	09N-05E-34 ABA	79-11-01	16	521	30	320	52
296	09N-06E-03 AAB	78-08-02	--	7260	--	9400	--
		79-07-20	11	4880	50	4200	3.7
297	09N-06E-04 BCA	78-08-02	--	23900	--	40000	--
		79-09-12	11	13500	180	18000	4.2
298	09N-06E-06 BBB	79-09-13	19	430	30	310	.0
299	09N-06E-08 CDD	79-09-12	17	377	10	1100	.0
300	09N-06E-09 CDC	78-08-01	--	3110	--	2900	--

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM-FLOW, INSTAN-TANEOUS (CFS)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH FIELD (UNITS)	HARD-NESS (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
SEMINOLE											
301	09N-06E-09 CDC	79-07-20	1100	--	.10	1675	7.5	260	140	68	22
302	09N-06E-10 BBA	79-07-20	0930	--	<.10	4337	8.1	400	230	100	35
303	09N-06E-10 DAA	78-08-07	1800	--	<.10	15200	6.8	--	--	--	--
		79-09-12	1100	--	.10	1550	7.3	230	140	59	21
304	09N-06E-10 DDC	79-09-12	1430	100	--	434	7.1	240	3	54	26
305	09N-06E-13 DDA	78-08-03	1000	--	<.10	35000	7.6	--	--	--	--
		79-08-14	1545	--	<.10	29412	7.5	4300	4100	1100	360
306	09N-06E-17 BBA	78-08-01	1430	--	<.10	13300	8.2	--	--	--	--
		79-09-12	1430	--	.10	9500	8.0	940	670	250	74
307	09N-06E-23 DCC	78-11-30	0945	--	<.01	3800	7.3	--	--	--	--
308	09N-06E-25 CCB	80-01-29	1600	235	--	457	7.0	240	6	58	22
309	09N-06E-26 CCB	79-11-16	0900	--	.40	942	7.1	170	0	51	11
310	09N-06E-29 CCD	79-12-04	1500	--	.30	3670	7.5	560	420	140	51
311	09N-06E-31 BCB	79-09-28	1000	150	--	1231	7.3	250	0	43	35
312	09N-07E-03 CDC	79-08-13	1600	150	--	271	6.8	110	2	25	12
313	09N-07E-17 DDD	79-09-25	0845	--	<.10	2657	6.9	550	340	140	47
314	09N-07E-18 CBB	79-08-14	1700	119	--	593	7.3	290	17	57	35
315	09N-07E-19 DCD	78-11-29	1530	--	<.10	2650	8.1	--	--	--	--
316	09N-07E-22 DBA	79-09-25	1200	117	--	143	5.6	52	22	11	5.9
317	09N-07E-30 ADD	80-02-21	0930	--	<.10	475	--	200	0	42	23
318	10N-05E-12 ADA	79-07-18	1030	215	--	920	8.0	49	0	12	4.5
319	10N-05E-27 AAD	79-09-13	1230	44	--	657	6.6	190	0	44	20
320	10N-06E-08 DDC	79-07-18	1200	--	1.7	9900	7.7	1500	1300	380	140
321	10N-06E-14 BAA	79-07-19	0930	--	<.10	13140	7.5	1200	1100	310	110
322	10N-06E-15 ADD	79-07-19	1300	157	--	839	7.6	320	160	60	41
323	10N-06E-20 BBC	79-07-19	1400	90	--	562	7.3	220	0	43	28
324	10N-06E-30 CCC	79-07-18	1500	--	1.7	8600	7.9	1400	1200	340	140
325	10N-06E-31 CDD	79-07-18	1630	--	<.10	61250	7.3	9100	8900	2500	660
326	10N-06E-35 CCC	80-08-22	0945	129	--	656	7.1	300	11	64	34
327	10N-07E-02 ABA	79-08-03	0930	--	.12	823	7.4	260	120	64	24
328	10N-07E-02 BBB	79-08-03	0830	212	--	500	6.6	230	55	51	26
329	10N-07E-05 CCB	79-08-14	1030	119	--	441	6.7	260	28	62	25
330	10N-07E-15 CDC	79-09-19	1600	38	--	489	7.0	220	47	49	23
331	10N-07E-17 CDD	79-08-08	0930	--	<.10	3617	7.2	870	730	240	65
332	10N-07E-20 BBB	79-08-14	1200	83	--	664	7.0	400	16	48	67
333	10N-07E-24 DDC	79-08-14	1330	182	--	451	5.2	110	88	23	12

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	BROMIDE DIS-SOLVED (MG/L AS BR)	IODIDE, DIS-SOLVED (MG/L AS I)
					SEMINOLE						
301	09N-06E-09 CDC	79-07-20	220	5.9	4.0	120	8.8	480	.2	2.1	--
302	09N-06E-10 BBA	79-07-20	730	16	9.4	170	44	1300	.4	5.7	--
303	09N-06E-10 DAA	78-08-07	2300	--	--	--	--	4800	--	21	--
		79-09-12	240	6.8	4.4	91	16	470	.2	3.1	--
304	09N-06E-10 DDC	79-09-12	23	.6	2.3	240	46	17	.4	.2	--
305	09N-06E-13 DDA	78-08-03	6800	--	--	--	--	13000	--	13	--
		79-08-14	6200	42	57	150	150	13000	.2	64	.27
306	09N-06E-17 BBA	78-08-01	2100	--	--	--	--	4000	--	16	--
		79-09-12	1800	26	17	270	51	3400	.5	22	.17
307	09N-06E-23 DCC	78-11-30	510	--	--	--	--	1300	--	7.5	--
308	09N-06E-25 CCB	80-01-29	10	.3	3.6	230	23	17	.2	.1	.01
309	09N-06E-26 CCB	79-11-16	140	4.6	16	280	86	79	.6	.4	--
310	09N-06E-29 CCD	79-12-04	500	9.2	6.0	140	16	1100	.2	4.6	.12
311	09N-06E-31 BCB	79-09-28	160	4.4	5.7	330	120	140	.4	.4	--
312	09N-07E-03 CDC	79-08-13	5.8	.2	1.0	110	4.1	9.3	.2	.1	--
313	09N-07E-17 DDD	79-09-25	350	6.5	3.6	210	780	310	.2	.1	--
314	09N-07E-18 CBB	79-08-14	11	.3	1.9	270	8.6	37	.3	.2	--
315	09N-07E-19 DCD	78-11-29	290	--	--	--	--	770	--	4.7	--
316	09N-07E-22 DBA	79-09-25	6.3	.4	1.1	30	10	16	.1	.1	.00
317	09N-07E-30 ADD	80-02-21	22	.7	8.0	220	16	15	.3	.1	--
318	10N-05E-12 ADA	79-07-18	220	14	2.1	240	180	69	1.1	.5	--
319	10N-05E-27 AAD	79-09-13	64	2.0	1.2	230	13	66	.2	.5	--
320	10N-06E-08 DDC	79-07-18	1600	18	20	230	45	3300	.3	16	.31
321	10N-06E-14 BAA	79-07-19	2500	31	15	140	60	4600	.2	21	.29
322	10N-06E-15 ADD	79-07-19	48	1.2	8.9	160	120	110	.3	.2	--
323	10N-06E-20 BBC	79-07-19	48	1.4	3.1	310	11	20	.3	.1	--
324	10N-06E-30 CCC	79-07-18	1200	14	13	230	43	2800	.2	12	--
325	10N-06E-31 CDD	79-07-18	17000	78	170	120	230	38000	.1	130	--
326	10N-06E-35 CCC	80-08-22	22	.6	2.3	290	35	23	.4	.2	.16
327	10N-07E-02 ABA	79-08-03	84	2.3	3.8	140	13	220	.2	1.3	--
328	10N-07E-02 BBB	79-08-03	18	.5	2.2	180	22	52	.2	.4	--
329	10N-07E-05 CCB	79-08-14	14	.4	2.8	230	26	16	.2	.1	--
330	10N-07E-15 CDC	79-09-19	17	.5	1.5	170	14	44	.1	.3	--
331	10N-07E-17 CDD	79-08-08	430	6.4	3.4	140	23	1100	.2	8.4	.11
332	10N-07E-20 BBB	79-08-14	23	.5	1.7	380	24	10	.2	.1	--
333	10N-07E-24 DDC	79-08-14	47	2.0	3.2	19	54	70	.1	.5	--

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
			SEMINOLE				
301	09N-06E-09 CDC	79-07-20	7.7	953	20	1100	4.1
302	09N-06E-10 BBA	79-07-20	6.0	2520	60	2300	6.4
303	09N-06E-10 DAA	78-08-07	--	9340	--	--	--
		79-09-12	5.6	976	20	880	4.1
304	09N-06E-10 DDC	79-09-12	18	316	20	520	3.5
305	09N-06E-13 DDA	78-08-03	--	24100	--	1000	--
		79-08-14	8.7	24400	480	26000	6.3
306	09N-06E-17 BBA	78-08-01	--	6950	--	6100	--
		79-09-12	15	5830	90	5500	2.7
307	09N-06E-23 DCC	78-11-30	--	2250	--	--	--
308	09N-06E-25 CCB	80-01-29	8.9	264	20	890	3.5
309	09N-06E-26 CCB	79-11-16	19	556	20	600	39
310	09N-06E-29 CCD	79-12-04	4.9	2130	20	2300	3.9
311	09N-06E-31 BCB	79-09-28	15	690	40	740	1.0
312	09N-07E-03 CDC	79-08-13	12	143	0	140	.0
313	09N-07E-17 DDD	79-09-25	11	1640	20	1800	1.9
314	09N-07E-18 CBB	79-08-14	8.3	349	0	420	2.5
315	09N-07E-19 DCD	78-11-29	--	1530	--	--	--
316	09N-07E-22 DBA	79-09-25	15	87	7	40	.4
317	09N-07E-30 ADD	80-02-21	3.6	269	<4	230	11
318	10N-05E-12 ADA	79-07-18	7.6	625	10	130	--
319	10N-05E-27 AAD	79-09-13	25	429	30	240	3.1
320	10N-06E-08 DDC	79-07-18	8.3	6540	100	8900	8.3
321	10N-06E-14 BAA	79-07-19	7.1	8460	200	8300	3.7
322	10N-06E-15 ADD	79-07-19	17	480	10	1500	.0
323	10N-06E-20 BBC	79-07-19	22	354	20	480	.0
324	10N-06E-30 CCC	79-07-18	9.8	5580	60	--	7.3
325	10N-06E-31 CDD	79-07-18	9.3	54400	730	80000	3.6
326	10N-06E-35 CCC	80-08-22	16	365	20	730	--
327	10N-07E-02 ABA	79-08-03	14	561	6	430	4.3
328	10N-07E-02 BBB	79-08-03	13	322	20	180	1.9
329	10N-07E-05 CCB	79-08-14	12	278	9	480	33
330	10N-07E-15 CDC	79-09-19	11	296	20	100	1.0
331	10N-07E-17 CDD	79-08-08	20	2360	9	1700	3.7
332	10N-07E-20 BBB	79-08-14	10	395	20	250	1.4
333	10N-07E-24 DDC	79-08-14	20	287	20	220	1.6

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	TIME	DEPTH OF WELL, TOTAL (FEET)	STREAM- FLOW, INSTAN- TANEOUS (CFS)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH FIELD (UNITS)	HARD- NESS (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)
SEMINOLE											
334	10N-07E-27 BBB	79-08-13	1230	--	<.10	155	6.3	53	19	12	5.5
335	10N-07E-29 DDD	79-09-19	1430	41	--	236	5.4	63	28	16	5.6
336	10N-07E-30 CDC	79-08-13	1700	--	<.10	428	7.8	240	34	53	27
337	10N-08E-05 BBB	79-09-21	0900	84	--	205	6.0	43	0	11	3.8
338	11N-06E-19 CCC	79-08-15	0845	--	<.10	302	7.2	120	3	31	11
339	11N-06E-29 CCC	79-07-17	1600	180	--	1145	6.6	310	0	46	48
340	11N-06E-35 BCB	79-07-18	0900	120	--	710	7.6	140	0	41	8.1
341	11N-06E-35 CDC	79-07-18	1330	--	3.7	7500	7.2	1100	940	280	100
342	11N-07E-10 DDA	79-08-15	1400	62	--	82	5.3	12	0	3.0	1.0
343	11N-07E-14 CDD	79-08-15	1230	--	<.10	26	7.5	59	8	14	5.8
344	11N-07E-25 BBA	79-08-15	1100	122	--	95	5.7	29	11	7.6	2.4
345	11N-08E-09 AAA	79-08-02	1030	26	--	152	5.7	43	0	12	3.1
346	11N-08E-21 DDD	79-08-02	1400	58	--	715	5.7	240	37	60	21
347	11N-08E-22 ABB	79-08-02	1200	--	<.10	330	6.3	110	0	26	10
348	11N-08E-33 DCD	79-08-02	1530	--	<.10	3177	7.5	540	410	140	46

SITE NO.	LOCAL IDENT-I-FIER	DATE OF SAMPLE	SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	BROMIDE DIS-SOLVED (MG/L AS BR)	IODIDE, DIS-SOLVED (MG/L AS I)
					SEMINOLE						
334	10N-07E-27 BBB	79-08-13	7.6	.5	1.6	34	3.7	14	.3	.1	--
335	10N-07E-29 DDD	79-09-19	20	1.1	.5	35	16	35	.1	.3	.02
336	10N-07E-30 CDC	79-08-13	16	.4	1.5	210	20	22	.5	.2	--
337	10N-08E-05 BBB	79-09-21	25	1.7	.6	44	20	20	.2	.3	--
338	11N-06E-19 CCC	79-08-15	15	.6	5.9	120	3.8	21	.2	.2	--
339	11N-06E-29 CCC	79-07-17	200	4.9	3.9	380	270	70	.6	.3	--
340	11N-06E-35 BCB	79-07-18	120	4.5	3.8	190	190	22	.5	.1	--
341	11N-06E-35 CDC	79-07-18	1100	14	17	170	40	2400	.2	11	--
342	11N-07E-10 DDA	79-08-15	9.3	1.2	1.7	12	3.9	3.3	.1	.1	--
343	11N-07E-14 CDD	79-08-15	20	1.1	1.3	51	9.1	26	.2	.4	--
344	11N-07E-25 BBA	79-08-15	6.1	.5	.8	18	6.1	5.9	.3	.1	.02
345	11N-08E-09 AAA	79-08-02	8.6	.6	2.3	59	5.9	2.5	.1	.1	--
346	11N-08E-21 DDD	79-08-02	59	1.7	21	200	70	64	.3	.5	--
347	11N-08E-22 ABB	79-08-02	24	1.0	4.4	140	18	8.7	.4	.2	--
348	11N-08E-33 DCD	79-08-02	450	8.4	4.6	130	30	950	.2	5.9	.09

SITE NO.	LOCAL IDENT- I- FIER	DATE OF SAMPLE	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, RESIDUE AT 180 DEG. C DIS- SOLVED (MG/L)	LITHIUM DIS- SOLVED (UG/L AS LI)	STRON- TIUM, DIS- SOLVED (UG/L AS SR)	CARBON, ORGANIC DIS- SOLVED (MG/L AS C)
			SEMINOLE				
334	10N-07E-27 BBB	79-08-13	6.7	79	2	180	2.7
335	10N-07E-29 DDD	79-09-19	25	142	7	70	.8
336	10N-07E-30 CDC	79-08-13	16	266	0	220	6.4
337	10N-08E-05 BBB	79-09-21	26	137	7	140	1.1
338	11N-06E-19 CCC	79-08-15	3.3	178	0	280	18
339	11N-06E-29 CCC	79-07-17	13	880	40	720	1.4
340	11N-06E-35 BCB	79-07-18	13	507	10	900	.7
341	11N-06E-35 CDC	79-07-18	7.0	4820	80	2100	17
342	11N-07E-10 DDA	79-08-15	29	73	2	140	1.4
343	11N-07E-14 CDD	79-08-15	31	155	0	250	1.8
344	11N-07E-25 BBA	79-08-15	11	57	2	140	3.3
345	11N-08E-09 AAA	79-08-02	9.9	78	<4	90	.9
346	11N-08E-21 DDD	79-08-02	6.9	501	10	290	4.8
347	11N-08E-22 ABB	79-08-02	39	217	10	180	3.1
348	11N-08E-33 DCD	79-08-02	15	1950	4	2100	4.2