CAPITAL AREA GROUND WATER CONSERVATION COMMISSION

BULLETIN NO. 4

STATUS OF SALTWATER ENCROACHMENT IN THE "600-FOOT" SAND OF THE BATON ROUGE AREA, 1999

By
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June 2000

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FOREWORD

The Capital Area Ground Water Conservation District was formed in January 1975 under the authority of Act 678 of the 1974 Legislature. The purpose of the District is to manage the ground-water resources of the five-parish capital area, which includes East and West Baton Rouge parishes, East and West Feliciana parishes, and Pointe Coupee Parish. A 15-member Board of Commissioners determines management policies and administers affairs of the District. Included in the Board's authority is a requirement that they "... take all necessary steps to prevent intrusion of saltwater or any other form of pollutant into any aquifer or aquifers". In fulfillment of this responsibility, the Board has set up and maintained cooperative projects with the U.S. Geological Survey (U.S.G.S.), Water Resources Division, to monitor salinity in key wells in all major aquifers in the southern part of the District. This information is evaluated annually by the District staff and U.S.G.S. personnel to detect saltwater movement in aquifers and to assess the adequacy of the monitoring network. The Board also cooperates with the U.S.G.S. in special studies to assess conditions in specific areas or aquifers and to update the status of saltwater encroachment in areas of concern. In many of these latter studies, the Water Resources Section of the Department of Transportation and Development also cooperates.

Until the late 1960s to early 1970s the "600-foot" sand (in combination with the "400-foot" sand) was the most heavily pumped aquifer in the Baton Rouge area. It is still an important aquifer, with 16.6 mgd pumped in 1999 from the "400-foot", "600-foot" and "800-foot" sands. The "600-foot" sand was the first aquifer in the District in which saltwater encroachment was detected. However, the distribution of pumping from the aquifer has changed significantly in the past 20 years. Originally all pumpage was from a relatively small area in the original Baton Rouge industrial district west of Scenic Highway and south of Mengel Road. Pumpage in 1999 is distributed among three widely separated areas. At present it appears that saltwater encroachment is not an imminent concern for users pumping from the "600-foot" sand.

Freshwater is defined as water containing 250 milligrams per liter or less of chloride and saltwater as water containing more than 250 milligrams per liter. Thus the boundary (interface) between fresh and saltwater is defined as the zone where chloride concentrations reach 250 milligrams per liter. The chloride concentration in freshwater north of the interface in the "600-foot" sand and other aquifers in the Baton Rouge area is less than 10 milligrams per liter and generally less than 5 milligrams per liter.

Status of Saltwater Encroachment in the "600-foot" Sand of the Baton Rouge, Louisiana, Area, 1999

Purpose, Scope and Conclusions of this Report

This report was planned to document work done by G.T. Cardwell and D.C. Dial in 1996 to evaluate the adequacy of the chloride-monitoring network for the "600-foot" sand and to select possible sites for additional observation/monitor wells. Included in the analysis of log data was evaluation of possible stratigraphic connections between the "600-foot" and "800-foot" sands. The solution of this question became critical when the proposal for the "800-foot" sand/"1,500-foot" sand connector well was submitted in 1995. The conclusion reached, following an in-depth assessment, was that the current network, consisting of wells EB-793 and EB-870 (fig.1), is adequate to monitor the northward movement of saltwater toward the pumping center in the old Baton Rouge industrial district. However, several more observation wells are needed to accurately determine the potentiometric surface of the aquifer and, thus, clearly define ground-water flow. None of the logs analyzed for this study showed a connection between the "600-foot" and "800-foot" sands.

Because of the effort expended in analyzing the logs to evaluate the monitor-well network, it was decided to summarize current information on the "600-foot" sand and to include the tabulated log data and maps prepared for the analysis in a formal report. To make the report current, data were updated through 1999.

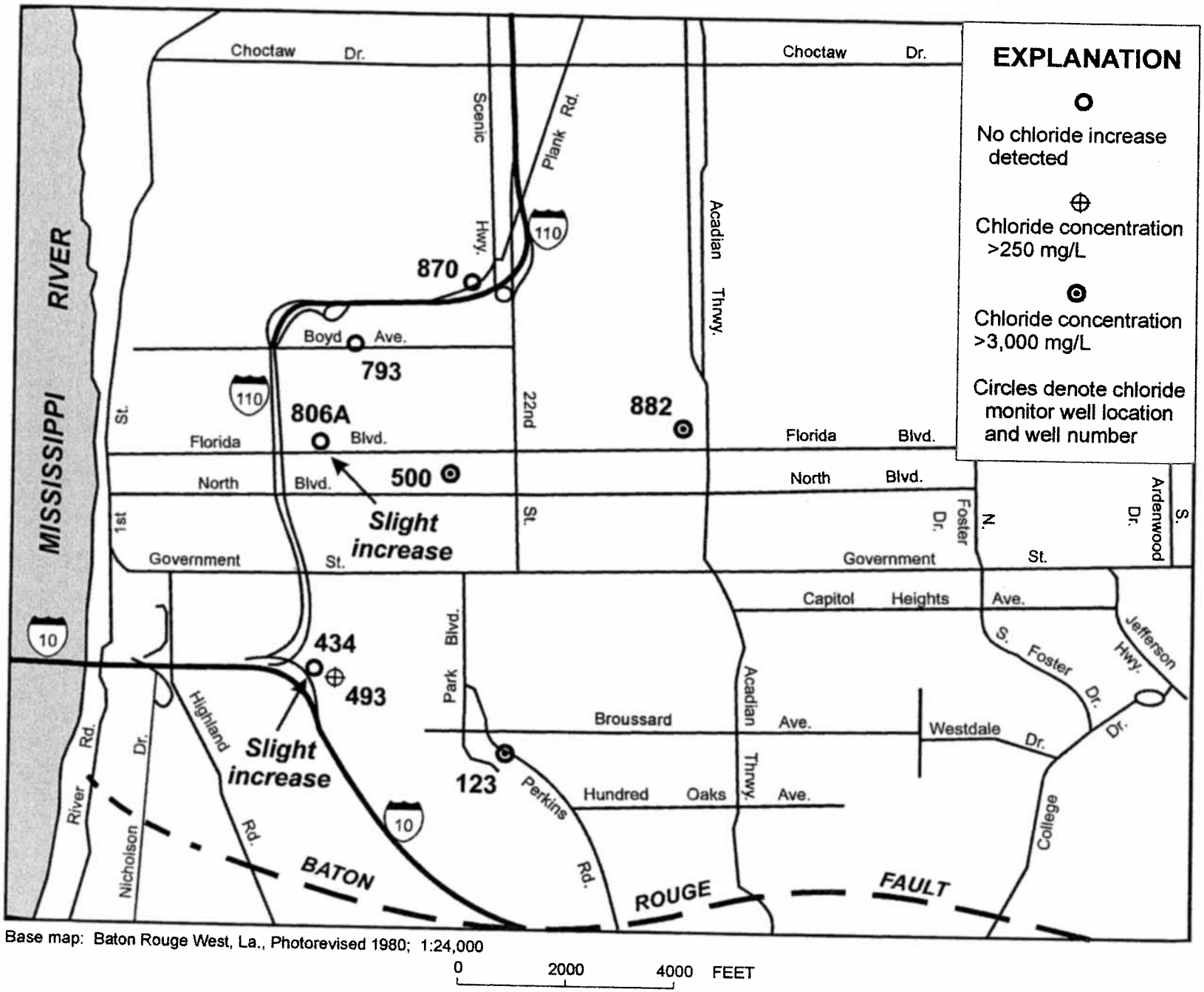

Figure 1.--Chloride monitor wells, "600-foot" sand.

Summary of Saltwater Encroachment in the "600-foot" Sand

Saltwater was first detected in the "600-foot" sand in 1948 when a well at City Park in south Baton Rouge (EB-123, fig.1) began producing slightly salty water and was abandoned. (This well was about 0.5 mile north of the Baton Rouge fault and 4 miles south of the center of pumping from the "400 and 600-foot" sands.) Subsequently, saltwater was detected in the following wells by monitoring chloride levels.

EB-493, 0.7 mile WNW of EB-123, 1952
EB-500, 1.0 mile NNW of EB-123, 1956
EB-882, 1.3 mile NNE of EB-123, 1972
(See fig.2 and table 1 for history of chloride increases in these wells.)

In 1948 pumpage from the "400 and 600-foot" sands in the industrial district, centered in the area of the Exxon and old Ethyl plants, was 30 mgd (million gallons per day) and averaged 25 mgd, 1940-59. Pumpage totals have always been combined for the "400 and 600-foot" sands because many wells in the industrial district are screened in both sands and accurate estimates for each sand cannot be made. Also, the sands are interconnected to the north and west of the pumping center. Water levels in the two sands generally differ by only about five feet or less.

Beginning in 1960, pumpage slowly declined. In 1966 pumpage was 21.4 mgd and the hydraulic gradient in the vicinity of the saltwater front varied seasonally from about 7-13 ft/mi, 1966-67. The gradient was about 10 ft/mi, in April 1976 when the average pumping rate was 17.9 mgd. Assuming an average hydraulic conductivity of 93.5 ft/day (700 gpd/ft$^{2)}$ for the "600-foot" sand, a porosity of 25% and a gradient of 10 ft/mi, the estimated average rate of saltwater movement in 1976 was about 260 ft/yr. This is near the average rate of 300 ft/yr estimated in the 1960s by the U.S.G.S.

In 1977 pumpage was 18.9 mgd and then slowly declined as indicated below:

1978 - 16.2 mgd	1982 - 12.7 mgd
1979 - 14.8 mgd	1983 - 13.8 mgd
1980 - 14.4 mgd	1984 - 8.7 mgd
1981 - 13.6 mgd	1996 - 7.0 mgd
	1999 - 5.7 mgd

As shown, a sharp decline in pumpage in the old industrial district occurred in 1984 with closure of the Ethyl plant. Since then, pumpage in the old industrial district has remained about the same. In 1996, when the pumping rate was 7.0 mgd, the hydraulic gradient in the area of the saltwater front was 2-3 ft/mi. (See figure 3 and table 2.) The estimated rate of saltwater movement under these conditions would be about 80 ft/yr (66 years to move 1 mile).

In 1984 the Georgia Pacific paper mill at Port Hudson began pumping from the "400-foot" sand, and by 1996 pumpage from the merged "400 and 600-foot" sands at Port Hudson had

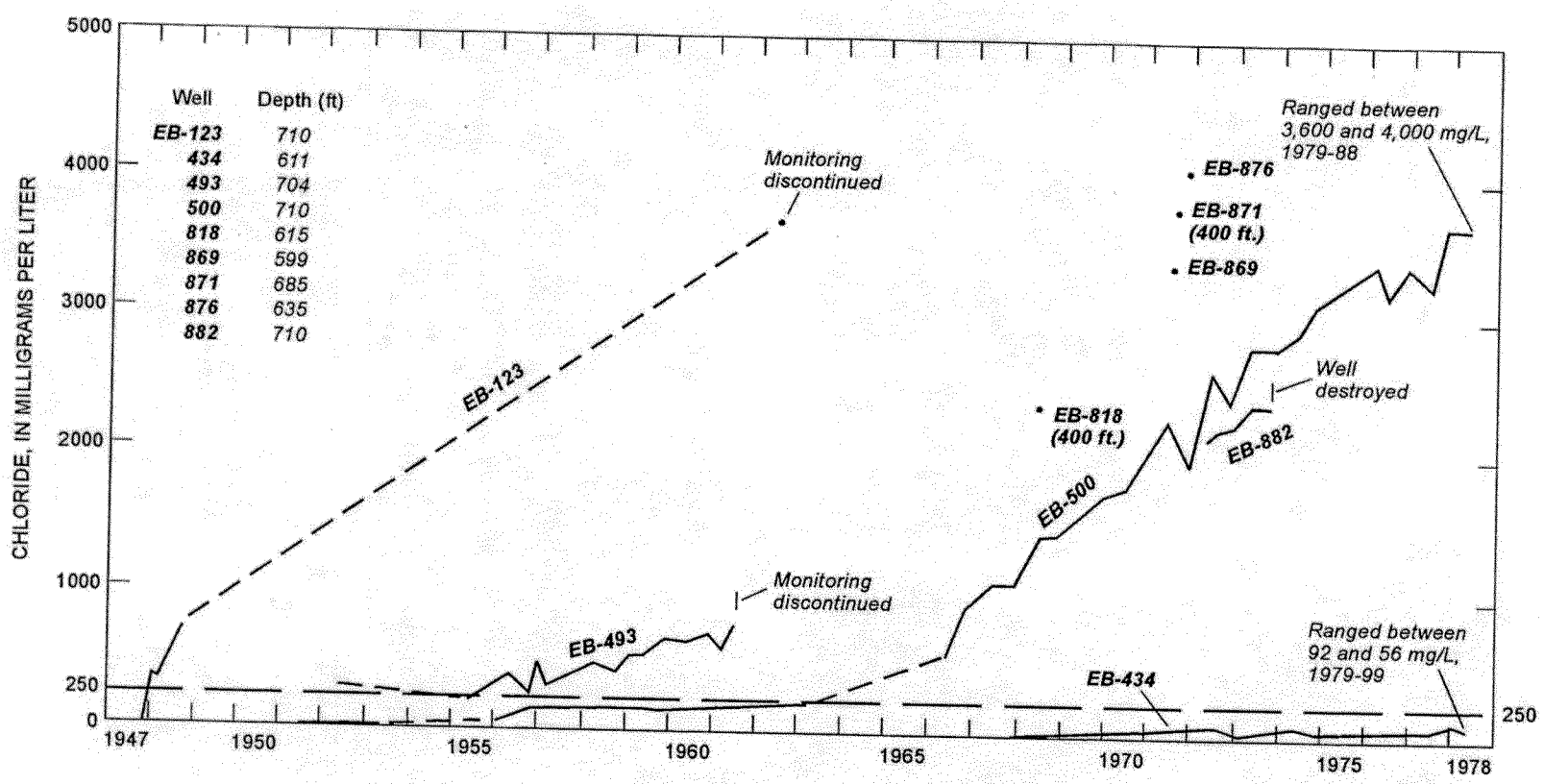

Figure 2.--Chloride concentration in water from selected wells in the "400-foot" and "600-foot" sands (Whiteman, 1979, figure 4, modified)

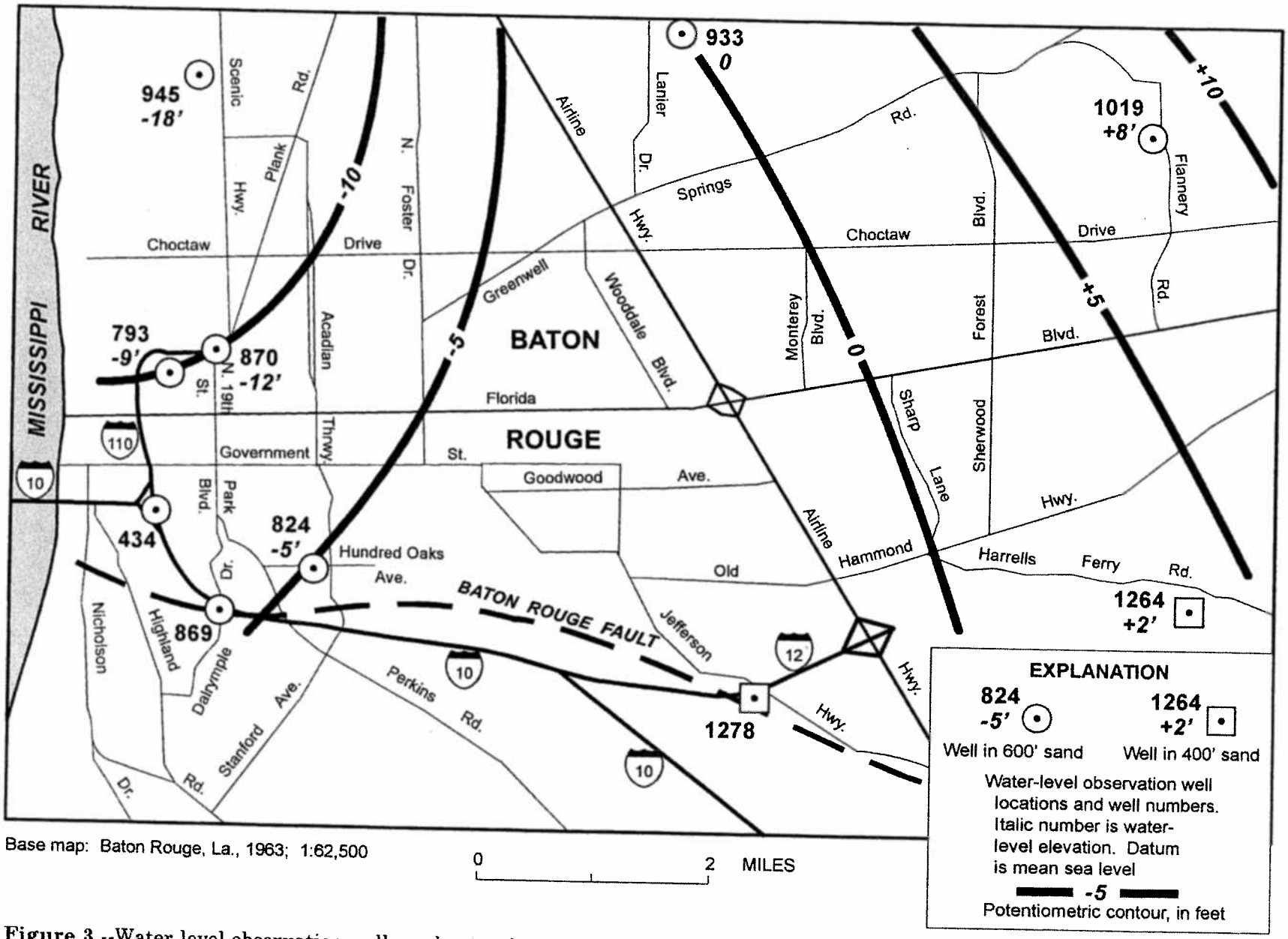

Figure 3.--Water-level observation wells and potentiometric contours, "600-foot" sand, June 1995.

increased to 11.8 mgd. In 1999 the pumpage was only 4.9 mgd. Because of the plant location near the Mississipi River, about 12 miles north of the old industrial district pumping center, the pumping at Port Hudson has had no appreciable effect on the cone of depression at the latter location. Also, in the past 20 years, pumping from the "400-foot", "600-foot", and "800-foot" sands for public supply in the southeastern part of East Baton Rouge Parish has gradually increased to 6.0 mgd in 1999 (3.2 mgd from "600-foot" sand). The wells are dispersed over an area of several square miles, the center being about 10 miles from the industrial pumping center. This pumping does tend to reduce the northerly gradient of the saltwater, but has not reversed the gradient.(figure 3.)

Factors Affecting Saltwater Movement

In addition to gradient, hydraulic conductivity, and porosity, the rate at which the saltwater advances is affected by physical barriers within the aquifer and by increases or decreases in aquifer storage space locally. For example, in table 3, which lists aquifer thickness data from logs of 48 wells in the Baton Rouge area, thickness ranges from a maximum of 225 feet (well EB-534, industrial district) to 38 feet (well WBR-150, Sunrise). The base of the aquifer is a highly irregular surface that ranges greatly in altitude as the thickness changes. Stratigraphic highs in the base of the aquifer create storage that must be filled by saltwater before the front can advance, thus, slowing the rate of encroachment. Conversely, in zones having high hydraulic conductivity, encroachment rates may increase.

Under the influence of head differences induced by pumping, saltwater in the "600-foot" sand moves slowly in a northward direction (figs. 3 and 4) from the vicinity of City Park in southern Baton Rouge. The source is saltwater moving across the Baton Rouge fault from the down faulted "400-foot" sand south of the fault. (See fig. 5). Whiteman (1979) indicated that water levels in the "400-foot" sand south of the fault were about 50 feet higher than levels in the "600-foot" sand immediately north of the fault. Whiteman estimated that the rate that saltwater was moving northward across the fault was about 500,000 gpd (gallons per day) in 1971. By 1990 the head difference had decreased to about 20 feet (Tomaszewski, 1996). Under 1990 conditions, the volume of saltwater that was moving across the fault probably was only about 200,000 gpd.

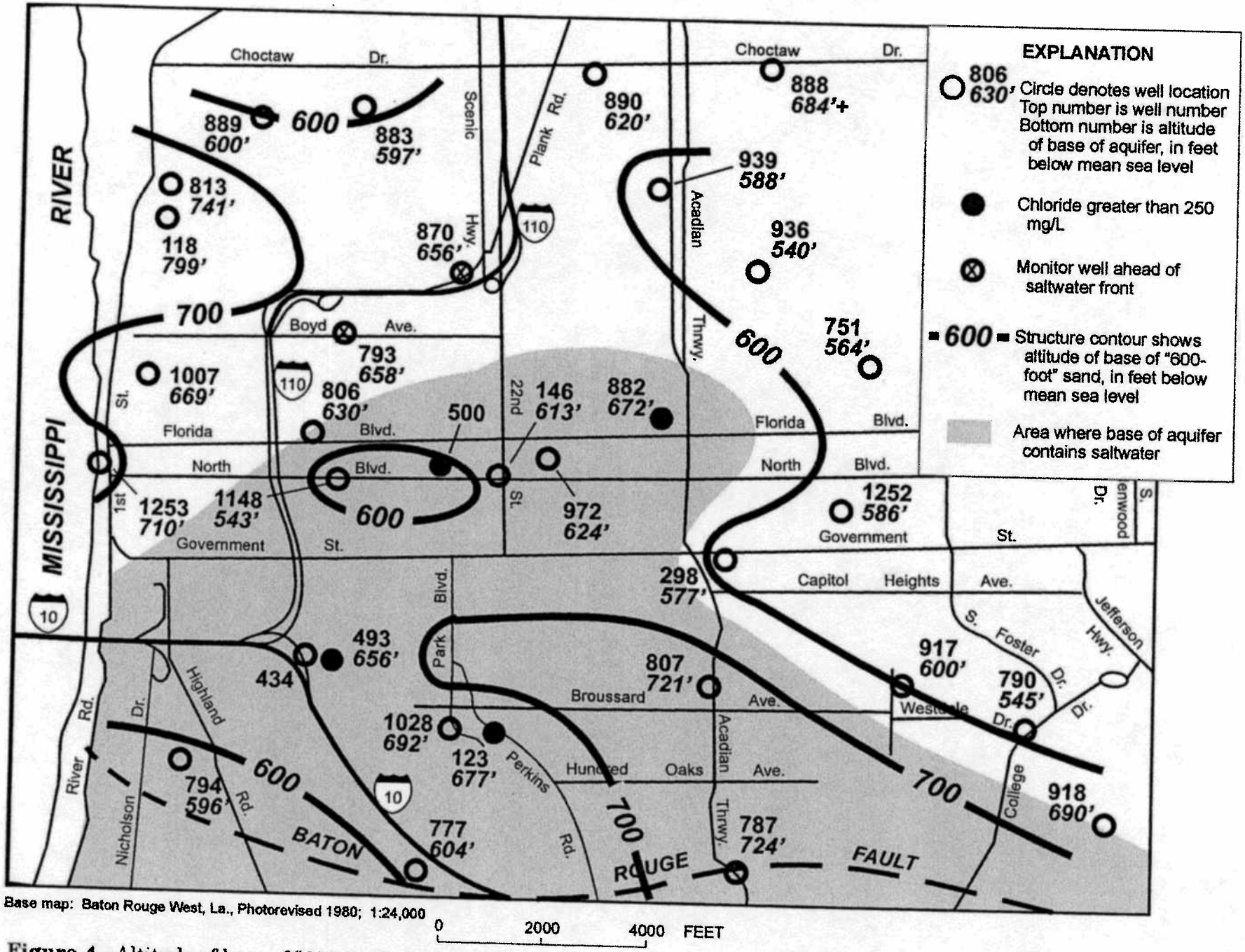

Figure 4.--Altitude of base of "600-foot" sand and estimated area where base of aquifer contains saltwater.

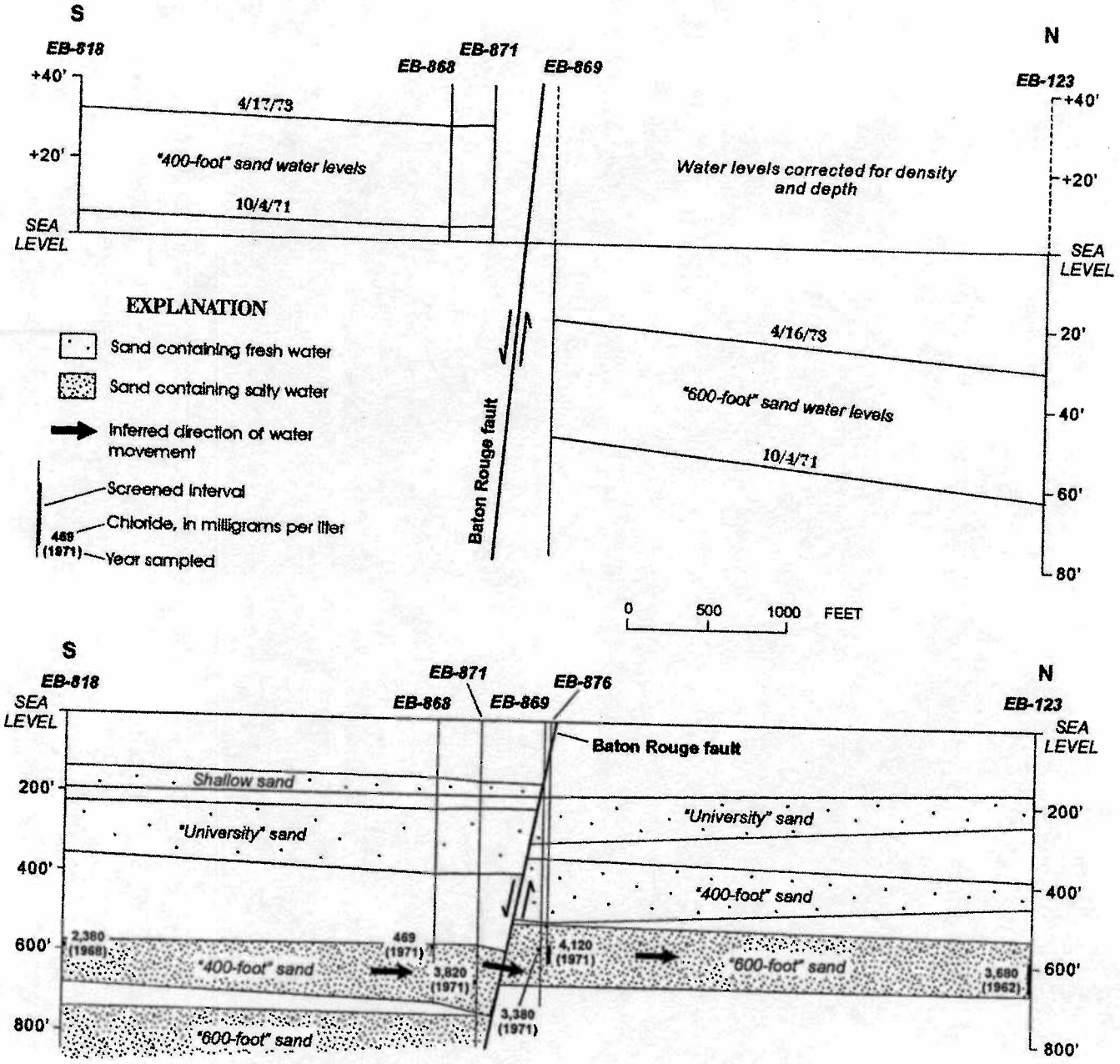

Figure 5.--Water-level profiles and geohydrologic section showing the "400 and 600-foot" sands near the Baton Rouge fault (Whiteman, 1979).

Current Conditions

Analysis of well log data, as compiled in figure 4, indicates that the two wells north of the interface that are now monitored (EB-793 and EB-870, fig.1) are well positioned to detect further northward movement of saltwater in the "600-foot" sand. Through 1999, chloride levels in these wells have remained below background levels (<10 milligrams/liter). As estimated previously in this report, the rate of movement has slackened from about 300 ft/yr in the 1960s and 1970s to a maximum of about 80 ft/yr now. The estimated rate is considered a maximum because stratigraphic barriers and aquifer storage tend to slow actual rates of movement compared to calculated rates.

Monitoring data indicates that saltwater has moved steadily from the source area near City Park northward toward the industrial pumping center. However, as it reaches the vicinity of monitor well EB-793 (fig. 1) the direction of movement should become more northwesterly because of the influence of the deepening base of the aquifer (fig. 4). Test drilling along Choctaw Drive in 1972 (wells EB-883, -888, -889, -890) revealed an eastward trending stratigraphic "high" that would likely divert the saltwater westward.

The possibility of saltwater moving east-southeastward along the north side of the Baton Rouge fault under the influence of pumping in the southeastern part of the parish was considered a possible concern when this analysis was begun. A deep "trough" in the base of the "600-foot" sand appears to trend eastward for several miles along the north side of the Baton Rouge fault. However the few logs available between the known body of saltwater and the southeastern area of pumping indicate that the trough does not extend to the area of pumping. About 6.0 mgd (1999) is pumped from the "400-foot", "600-foot" and "800-foot" sands in the southeastern part of the parish, but only about 3.2 mgd from the "600-foot" sand. The wells are relatively widely scattered and no well-defined cone of depression has developed. A well to monitor water levels and water quality in the "600-foot" sand was planned for a site adjacent to well EB-621 (fig. 3). However, because of problems encountered during drilling, the well was completed in the "400-foot" sand.

Another concern that was considered as a part of the log analysis was the possibility of local vertical connections between the "600-foot" and "800-foot" sands. Such connections, if occurring, could attenuate the rate of northward movement of saltwater while contaminating the "800-foot" sand. Kuniansky and others (1989, pl.19) indicated that the two aquifers might be connected in the area near and south of the saltwater front. However, a careful scrutiny of logs in that area did not yield any evidence of a direct connection between the aquifers.

The electrical-log data were assessed to see if the shape of the freshwater-saltwater interface could be mapped. Elevation of the interface, as interpreted from logs, is shown in table 4. If the "600-foot" sand were a vertically continuous, uniform sand, it should be possible to map the interface if sufficient contemporaneous data points were available. However, because of the wide time differences in the log data, coupled with the stratigraphic irregularities, the data does not yield a rational interface shape. The data may be useful in considering local saltwater problems.

Reports on Ground Water in the Baton Rouge Area,
including a summary of the Relation to Saltwater Encroachment in the "600-foot" Sand

Kuniansky, Eve L., Dial, D. C., and Trudeau, D. A., 1989, Maps of the "400-foot", "600-foot" and adjacent aquifers and confining beds, Baton Rouge area, Louisiana: Louisiana Department of Transportation and Development Water Resources Technical Report No. 48, 15 p., 28 pl.

Includes maps of the base of both aquifers and confining beds at regional and local scales, although the local-scale map of the base of the "600-foot" sand is not sufficiently detailed to assess the impact of the configuration of the base of the aquifer on saltwater movement.

Kuniansky, Eve L., 1989, Geohydrology and simulation of ground-water flow in the "400-foot" and adjacent aquifers, Baton Rouge area, Louisiana: Louisiana Department of Transportation and Development Water Resources Technical Report No. 49, 90 p.

Contains no information related to saltwater encroachment, except for a gross estimate of the transmissivity of the Baton Rouge fault as 1-2 orders of magnitude smaller than that of the "600-foot" sand (10-100 times smaller).

Meyer, R.R. and Turcan, A.N., Jr., 1955, Geology and ground-water resources of the Baton Rouge area, Louisiana: U.S. Geological Survey Water-Supply Paper 1296, 138 p.

First formal reporting and documentation of saltwater encroachment in "600-foot" sand. Includes documentation of pumpage from "400 and 600-foot" sands, 1940-52.

Rollo, J.R., 1969, Saltwater encroachment in aquifers of the Baton Rouge area, Louisiana: Louisiana Department of Conservation, La. Geological Survey, and Louisiana Department of Public Works Water Resources Bulletin No. 13, 45p.

First detailed evaluation of saltwater encroachment by aquifer. Presents detailed sections of aquifer groups based on extensive drilling that first demonstrated the effect of the Baton Rouge fault on area aquifers.

Tomaszewski, Dan J. and Anderson, Mary L., 1995, Data from wells in a chloride-monitoring network, Baton Rouge area, La., 1965-94: La. Department of Transportation and Development Water Resources Basic Records Report no. 19, 40p.

Lists chloride data for all monitor wells in the Baton Rouge area, by aquifer. Includes descriptive and location data for wells and periods of record.

Tomaszewski, Dan J., 1996, Distribution and movement of saltwater in aquifers in the Baton Rouge area, La., 1990-92: Louisiana Department of Transportation and Development Water Resources Technical Report no. 59, 44p.

Updates status of saltwater encroachment in sands of the Baton Rouge area, with emphasis on the "1,500-foot", "2,000-foot" and "2,800-foot" sands.

Whiteman, C.D., Jr., 1979, Saltwater encroachment in the "600-foot" and "1,500-foot" sands of the Baton Rouge area, La., 1966-78, including discussion of saltwater in other sands: Louisiana Department of Transportation and Development, Office of Public Works, Water Resources, Technical Report No. 19, 49p.

Updates situation based on interim data and confirms movement of saltwater across Baton Rouge fault as source of saltwater.

TABLE 1.--CHLORIDE CONCENTRATIONS IN MONITOR WELLS (Mg/l)
Date/Chloride

EB-123	EB-434	EB-493	EB-500	EB-789A	EB-806A
Depth 710'	Depth 611'	Depth 704'	Depth 710'	Depth 711'	Depth 663'
Elev. 51'	Elev. 45'	Elev. 48'	Elev. 57'	Elev. 37'	Elev. 46.5
11/18/47 7	08/01/51 15	08/29/52 235	08/02/51 3.2	06/25/65 284	04/20/66 3.4
01/20/48 362	10/22/68 47	04/20/59 534	02/25/56 85	(Ranged 248-289 1966-83)	04/29/68 79
07/24/50 716	11/09/71 107	05/18/59 587	04/20/59 175	10/22/84 300	04/30/68 80
08/10/61 3310	04/24/72 120	11/04/59 674	01/13/60 175	12/19/85 300	05/17/68 (Range 80-92 in ppg test)
	10/27/77 123	06/13/60 690	06/13/60 177		10/22/68 74
	10/27/81 81	07/08/60 725	12/08/60 171		05/27/69 67
	12/03/82 76	12/09/60 742	06/06/61 184		(1968 & 69 results questionable)
	12/15/83 69	08/08/61 790	12/06/61 184		
	10/16/84 71		06/12/62 178		
	11/19/85 68		09/13/62 197		
	09/16/86 67		03/13/63 232		
	09/01/88 70		04/13/66 600		
	12/15/89 66		11/02/66 920		
	09/20/90 67		05/26/67 1100		**EB-882**
	10/23/91 68		05/15/68 1420		Depth 710'
	10/04/93 61		05/26/69 1600		Elev. 44'
	10/03/94 56		04/13/70 1800		03/29/72 2200
	01/26/96 61		05/10/71 2290		04/21/72 2240
	11/26/96 58		04/20/72 2630		10/26/72 2300
	12/17/97 57		04/04/73 2800		04/05/73 2400
	01/04/99 57		05/06/74 2900		10/31/73 2400
	12/14/99 51		12/31/74 3100		(Subsequently destroyed by vandals)

TABLE 2.-- WATER LEVELS IN OBSERVATION WELLS IN THE "600-FOOT" SAND, JUNE 1995

USGS WELL NO.	DATE	WATER[1] LEVEL	ELEVATION[2]	W.L. ELEVATION
EB-793	06/22/95	44.50	35.3	-9.2
EB-824	06/15/95	38.41	33.56	-4.85
EB-870	06/14/95	61.87	50	-11.87
EB-933	06/13/95	50.74	51	+0.26
EB-945	06/06/95	77.19	59	-18.19
EB-1019	June	41 Estimate	49	+8
EB-1264	June	36.5 Estimate	38	+1.5

[1]In feet below land-surface datum.

[2]In feet above mean sea-level.

TABLE 3.--GEOPHYSICAL - LOG DATA FOR THE "600-FOOT" SAND

[GR, gamma-ray log; SW, sand contains saltwater at base or throughout; broken, sand interrupted by clay intervals]

WELL	ELEVATION (datum msl)	SAND INTERVAL (below land surface)	SAND THICKNESS	BASE ELEVATION (datum msl)	LOCATION and REMARKS
East Baton Rouge Parish					
EB-83	54	620-715	95	661	Gov't & 17th Sts., GR.
EB-118	51	730-850	120	799	Old OLOL, GR.
EB-123	51	590-728	138	677	City Park, GR , SW.
EB-146	52	555-665	110	613	22nd St., GR.
EB-298	48	597-625	28	577	Gov't St., GR.
EB-327	55	604-703	99	648	Greenwell Springs Rd.,GR, broken.
EB-400	34	605-810	200±	776	Jeff. Hwy at Inniswold, GR.
EB-444	48	680-750	70	702	Convention & Front Sts.
EB-453	54	440-703	115±	649	Cortana, broken.
EB-534	50	440-665	225	615	Entergy La. Station, Type log.
EB-590	50	662-787	125	737	Harrells Ferry Rd.
EB-621	33	755-814	59	781	Jeff. Hwy. & Drusilla.
EB-632	51	650-750	100	699	Cortana.
EB-751	50	558-614	56	564	45th St.
EB-753	55	655-805	150	750	Choctaw near Ardenwood.
EB-777	50	570-654	84	604	City Park SW, SW.
EB-781	28	675-752	77	724	Acadian near Dawson Cr.
EB-789	40	602-782	180	742	Jeff. Pl. subdiv.
EB-790	45	548-590	52	545	College at Westdale, broken.
EB-793	36	525-694	90±	658	N. end N. 14th St.
EB-794	45	584-641	57	596	Highland Rd & Chatsworth St.

TABLE 3.--GEOPHYSICAL - LOG DATA FOR THE "600-FOOT SAND--continued

WELL	ELEVATION (datum msl)	SAND INTERVAL (below land surface)	SAND THICKNESS	BASE ELEVATION (datum msl)	LOCATION and REMARKS
EB-804	49	630-726	94	677	Airline & Jeff. Hwy.
EB-806	46.5	520-676	80±	630	Old BR Jr. H.S., broken, SW(?).
EB-807	34	705-755	50	721	Broussard St., SW.
EB-813	59	590-609 742-800		741	Old OLOL site.
EB-870	50	555-706	151	656	Memorial Stadium.
EB-882	44	617-716	99	672	Laurel & Kernan Sts., SW.
EB-883	55	530-652	122	597	Madison & N.15th Sts.
EB-888	50	715-734+	19+	684+	Monroe & W. Belfair.
EB-889	55	500-655	155	600	Pittsburgh & Sorrell.
EB-890	58	504-678	174	620	Monroe & 28th Sts.
EB-917	50	555-650	95	600	Webb Park, broken.
EB-918	40	?-610 700-730		690	Witter Est., 400' & 600' sands merge.
EB-936	50	495-590	95	540	NW Cor. Roselawn Cem.
EB-939	54	531-642	111	588	Jefferson & N. Acadian.
EB-972	43	512-667	155	624	Convention & 25th Sts., broken, SW.
EB-990	44	625-700	75	656	Aubin Ln. near Weiner Cr.
EB-1007	56	540-725	185	669	La. DNR Bldg.
EB-1017	36	744-890	146	854	Stumberg Lane.
EB-1028	40	662-732	70	692	City Park, SW.
EB-1148	57	530-600	70	543	Convention & 12th Sts., broken.
EB-1252	51	570-637	67	586	Gov't St. Sta.
EB-1253	40	690-750	60	710	Convention & Front Sts.

TABLE 3.--GEOPHYSICAL - LOG DATA FOR THE "600-FOOT SAND--continued

WELL	ELEVATION (datum msl)	SAND INTERVAL (below land surface)	SAND THICKNESS	BASE ELEVATION (datum msl)	LOCATION and REMARKS
West Baton Rouge Parish					
WBR-5	35	600-708	108	673	Port Allen
WBR-100	29	608-734	126	705	N. end G.B.R. Port.
WBR-110	23	600-740	140	717	West side of Port Allen.
WBR-121	34	571-698	127	664	I-10 bridge, river side of levee.
WBR-150	20	590-628	38	608	Sunrise

TABLE 4.-- ELEVATION OF SALTWATER INTERFACE IN THE "600-FOOT" SAND AS ESTIMATED FROM ELECTRICAL LOGS OF WATER WELLS

Well	Elevation of Base of Sand	Depth of Interface on log	Elevation of Interface	Date logged	Remarks
East Baton Rouge Parish					
EB-621	781	----------	----------	12/04/56	No saltwater.
EB-777	604	Above 570	Above 520	02/15/65	No freshwater.
EB-781	724	610	582	04/07/65	
EB-789	742	710	670	06/04/65	
EB-794	596	Above 584	Above 584	Above 539	No freshwater.
EB-806	630	665	618	04/09/66	Break between "600-foot", and "800-foot" sands, 676'-693.
EB-807	721	720	676	04/28/66	
EB-882	672	700	656	03/28/72	Single-point log.
EB-972	624	630	587	02/06/76	
EB-1007	669	----------	----------	05/19/78	No saltwater.
EB-1028	692	Above 662	Above 622	05/13/81	No fresh water.
EB-1148	543	----------	----------	07/18/86	No saltwater
EB-1253	710	----------	----------	07/20/93	No saltwater.
EB-1252	586	----------	----------	04/08/93	No saltwater.
West Baton Rouge Parish					
WBR-100	705	----------	----------	01/17/66	No saltwater.
WBR-110	717	----------	----------	06/12/66	No saltwater.
WBR-150	608	----------	----------	06/19/78	No saltwater.

1. Interpreted from electrical logs.