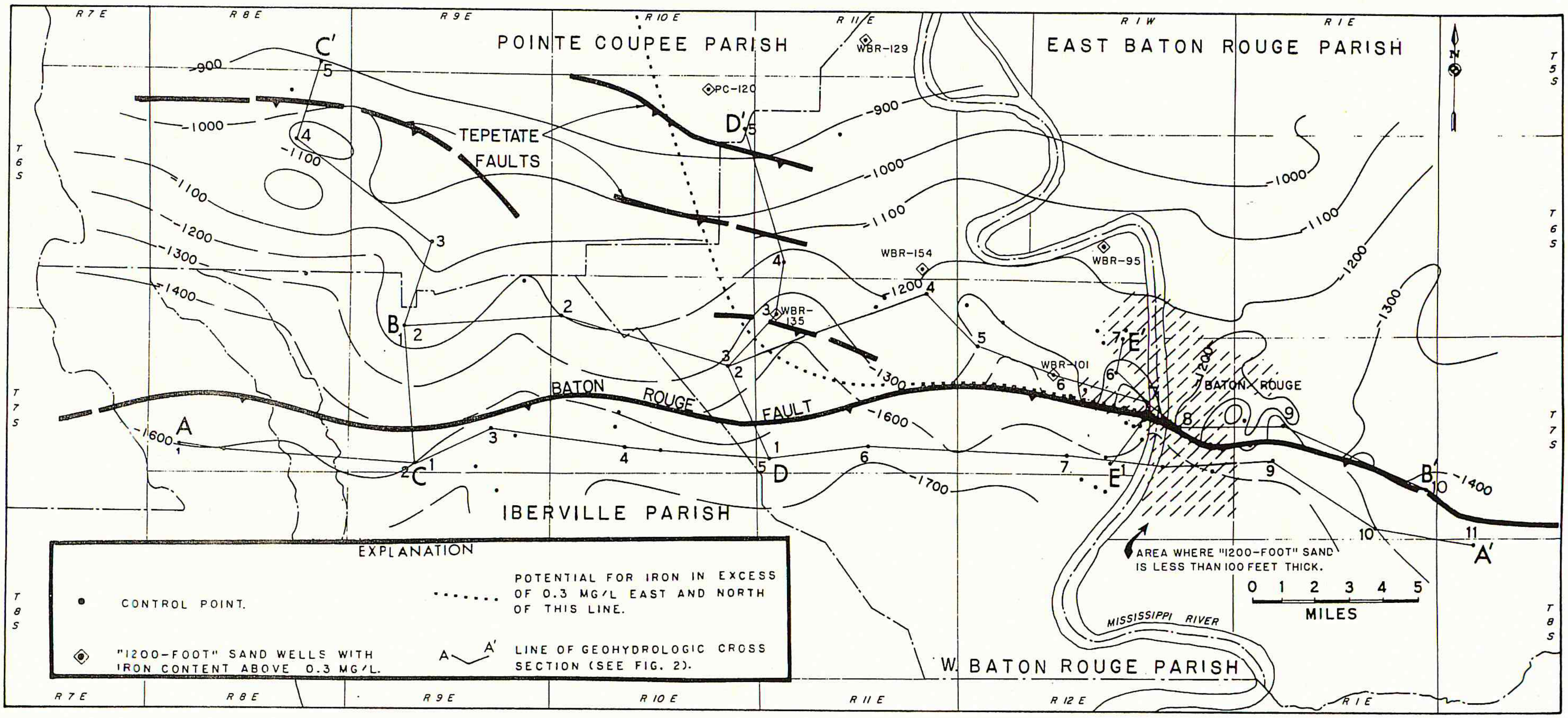

Figure 1. Generalized structure map on the base of the "1,200-foot" sand.
(Datum-mean sea level)

Except for the Port Allen and Baton Rouge areas, data points (from well logs) for determining the depth and thickness of the aquifer are widely scattered. However, existing control does indicate the aquifer is 100 to 200 feet thick throughout most of the area shown in Figure 1, with one exception. This is the area where the Baton Rouge fault crosses the Mississippi River. Here the aquifer consists of several thin sands (about 20 feet thick) alternating with clay layers. Fortunately, this reduction in aquifer thickness, along with the effects of the Baton Rouge Fault, results in a reduction of rate of ground water flow locally. This occurs in the area of the Baton Rouge fault where water level declines are greatest and hence, salt water encroachment is most likely. If salty water crosses the fault in this area, its northward movement will be slower than in areas to the east or west where the aquifer is a thicker, more massive sand.

Faults

The surface position of the Tepetate and Baton Rouge fault systems is shown in Figure 1. The Baton Rouge fault is the most significant and is discussed in more detail below. The Tepetate faults appear to displace the "1,200-foot" sand, but because ground water observation wells are few and well control is limited in the area of the faults, they do not appear to significantly effect the occurrence or movement of ground water in the aquifer.

Variations in the salinity of ground water and the relationship of the "1,200-foot" sand to other sands and clays and to faulting in the District is illustrated in the cross sections in Figure 2.

The most obvious discontinuity in the District is the Baton Rouge fault system, a dominant geologic feature of the Baton Rouge area. Some of the best data for the location and displacement of the fault occurs in oil and gas well logs where deep sands (about 10,000 feet below sea level) are displaced several hundred feet across the fault, creating structural traps that account for several oil and gas fields, from Happytown in northern St. Martin Parish, to Mallets Bluff field near the East Baton Rouge - Livingston Parish line. The fault plane can be traced in well logs to the surface at an angle of about 55 to 60 degrees, where the Baton Rouge aquifers are displaced as much as 300 feet. In East Baton Rouge Parish the surface trace of the fault is represented by a scarp 20 feet high and occasional cracks in pavements and foundations. The position of the fault is not as well known west of the Mississippi River because the younger flood plain sediments are not noticably displaced at the surface. Here the position of the fault in the shallow aquifers was determined by projecting the fault plane from the deep oil and gas wells.

East-west geohydrologic cross sections (Figure 2-A and 2-B) were constructed south and north of the Baton Rouge fault respectively to illustrate the correlation of the "1,200-foot" sand and to show the relationship of fresh water to salt water in the aquifers. Except for a few limited zones in the

"1,200-foot" sand, fresh water[3] occurs only in the upper few hundred feet of sands near the surface, or below a depth of about 2,200 feet south of the fault.

In contrast, all aquifers to a depth of 2,100 feet contain fresh water immediately north of the fault, except for limited areas of salt-water encroachment (Figure 2-B). Salt water is limited to a tongue at the base of the Alluvial Aquifer in the most westerly well. This cross section also illustrates the massive nature of the "1,200-foot" sand in most of the District with the noteable exception of the area (see well no. 8, EB-794) near Highland Road and Washington in Baton Rouge. From this area to Port Allen the aquifer is composed of several sand "stringers" having a maximum individual sand thickness of about 20 feet.

The north-south correlation of the "1,200-foot" sand and the effects of the Baton Rouge fault are illustrated in Figures 2-C, 2-D, and 2-E. The most westerly cross section (Figure 2-C) shows the obvious separation of the salt-water portion of the aquifer from the fresh-water portion caused by the fault. The "1,200-foot" sand is enveloped by clays and fresh water sands north of the fault. The only salt water in the interval shown on this section is in the base of the Alluvial Aquifer and the equivalent beds of the "400-600-foot" sand of the Baton Rouge area. These hydrologic units are adequately separated from the deeper "1,200-foot" sand by clay layers. In the vicinity of well No. 1 on the cross section (Figure 2-C) the "1,200-foot" sand may be partially connected to a salt-water bearing sand south of the fault between depths of 1,000 to 1,200 feet.

The relationship of the "1,200-foot" sand to other aquifers in Pointe Coupee Parish, as categorized by Winner and others (1969), is shown in Figure 2-D. The effect of downward displacement at three faults along this north-south cross section -- the Baton Rouge fault and the two Tepetate faults -- is apparent. However, part of the apparent displacement across the Tepetate faults may be due to changes in the position of the base of the aquifer as a result of depositional variations. Again, salt water in the "1,200-foot" sand south of the Baton Rouge fault is contrasted to fresh water for the entire aquifer interval pictured north of the fault.

Correlations of the aquifers in the Port Allen area (Figure 2-E) were based on data from supply wells and test wells, which were drilled specifically to define the location of the Baton Rouge fault. Logs of wells WBR-36 and -100 occur in the area where the "1,200-foot" sand is made up of thin sands alternating with thin layers of clay. This condition apparently extends eastward to well EB-794 (Figure 2-B). Sands immediately south of the fault at WBR-147 (log depth of 1,340 to 1,385 feet), which are probably connected with the "1,200-foot" sand at the fault, contain salt water with an estimated dissolved solids concentration of 1,500 mg/l.

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[3] Ground water salinity was estimated from resistivity values recorded on well logs. A long-normal resistivity of 20 ohm m^2/m was used as the demarcation between fresh water (more than 20 ohm m^2/m) and salt water.

In all east-west cross sections (Figure 2), the "1,200-foot" sand is drawn as a continuous sand between data points. This continuity is supported, at least in West Baton Rouge and East Baton Rouge Parishes, by water level fluctuations among observation wells in the aquifer. However, the correlation on cross sections also shows the elevation of the base and top of the aquifer varies considerably from well to well. In some places the aquifer appears to be hydrologically connected with shallower or deeper sands, allowing flow from one aquifer to the other. Despite the apparent connections, except for possible leakage across the Baton Rouge fault, the "1,200-foot" sand appears to be protected from encroachment of salt water from other sands.

Water Quality

Winner and others (1968, Pl. 2) grouped the "1,200-foot" sand with shallow aquifers in the zone 1 hydraulic system of Pointe Coupee Parish. They found that the shallower sands to the north (Winner and others, 1968, p. 23) in zone 1 were hydraulically connected with the Mississippi River alluvium. Thus, a source of recharge for the "1,200-foot" sand is, in part, indirect recharge or water from the Alluvial Aquifer. Additional recharge probably is derived from connections with other sands above and below the aquifer and by movement of water within the aquifer from the outcrop area.

Winner and others (1968, p. 24) described the water quality of the zone 1 aquifers in Pointe Coupee Parish as:

> "moderately hard to hard, calcium bicarbonate type in areas where the sand is in close hydraulic connection with the overlying alluvial aquifer. As water moves downdip, it is modified through the process of ion exchange to a soft, sodium bicarbonate type."

The "1,200-foot" sand contains fresh water south from Pointe Coupee Parish to the Baton Rouge fault, with the possible exception of the area immediately north of the fault at Port Allen, where chloride concentrations are rising at wells WBR-36 and -37. South of the Baton Rouge fault the "1,200-foot" sand contains a limited amount of fresh water at the top of the aquifer in eastern East Baton Rouge Parish (Figure 2-A).

Despite the generally excellent water quality in the aquifer north of the Baton Rouge fault zone, two potential problems exist. First is the long-term possibility of salt water encroachment across the fault and second is high iron concentration in water from some wells, particularly in West Baton Rouge and Pointe Coupee Parishes.

Salt Water Encroachment

In the report on salt-water encroachment in aquifers of the Baton Rouge area, Rollo (1969, p. 29) noted no evidence of encroachment in the "1,200-foot" sand north of the Baton Rouge fault. He specifically noted this was true even in the vicinity of the GBRPC's facility in West Baton Rouge Parish. The Port has two wells (WBR-36 and -37) that are not more than a few hundred feet north of the fault and in the area of largest head differential across the fault in the "1,200-foot" sand. This is the location where salt-water encroachment would occur first. Thus, the sudden increase in the chloride content shown in Figure 3 in water from these two wells was to be expected.[4/] The chloride content increased in 1971 from a background level of less than 5 mg/l to 120 mg/l in 1978. Because of this increase in chlorides, the large head differential across the fault, and the occurrence on the south side of the fault of a salt-water bearing sand opposite the "1,200-foot" sand on the north side of the fault, it is tentatively concluded that the increase in chlorides is due to salt-water encroachment.

Other possible sources for the salt water found in the Port Commission's wells were considered. These were (1) a casing leak at a shallower, salt-water sand, or (2) upward coning of salt water from the basal part of the "1,200-foot" sand below the well screen. Because the chloride level in the two wells has risen steadily since 1972, which would be expected in the case of encroachment, these two alternatives are considered less likely than salt-water encroachment.

Of the above possibilities, the most serious implications would arise if salt water was moving across the fault. If this is happening, the salt water in WBR-37 could be expected to approach a dissolved solids content of 1,500 mg/l in the distant future under the present pumping configuration. This is equal to the approximate maximum concentration of dissolved solids in the adjacent aquifer south of the fault. At the present rate of increase in WBR-37, a chloride content of 250 mg/l would be reached in about 6 years.

Rollo (1969, p. 30) anticipated the possibility that salt water might be drawn across the fault in the vicinity of wells WBR-36 and -37. He calculated that it would take 60 to 65 years for water from this area to reach the principal pumping center in Baton Rouge.

If the chloride concentrations continue to increase in wells WBR-36 and -37, remedial measures might be required to prevent salt water from moving further north and contaminating an important portion of the aquifer. The actual rate of movement of salt water northward will probably be attenuated due to the complex arrangement of sands and clays in the "1,200-foot" sand in the Port Allen area. However, if salt water encroachment becomes significant it could probably be minimized by locating any new wells farther from the fault and by reducing pumpage from the "1,200-foot" sand. Rollo (1969, p. 17) discussed the possible use of a barrier well system and/or scavenger wells to reduce the effect of salt-water encroachment. However, these methods are costly, will require extensive planning, and must be accomplished within environmental guidelines.

4/ The strong similarity in chloride increases in these two wells probably results from the fact that the wells are connected by a prime-line that feeds water from one well to the other (Whiteman, 1979).

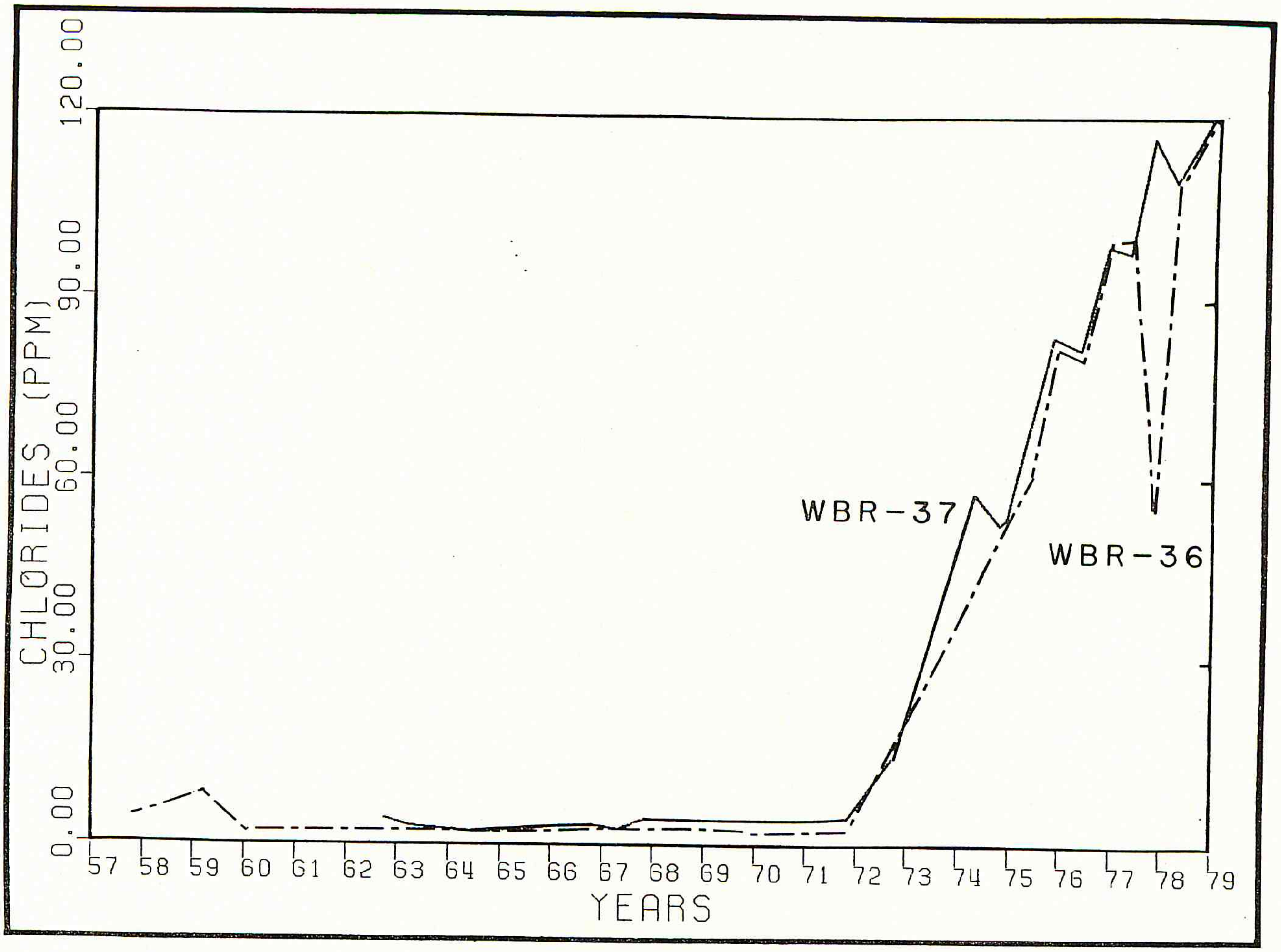

Figure 3. Record of chloride concentration changes in the Greater Baton Rouge Port Commission wells WBR-36 and WBR-37.

Rollo (1969, p. 30, Pl. 4) also expressed concern that salt-water encroachment could also occur in the vicinity of Acadian and College Drive (near EB-781) because the "1,200-foot" sand is apparently opposite salt-water sands south of the fault. Analyses of water from a monitoring well (EB-298), which is north of the fault on Government Street near Acadian Thruway nearest the area of potential encroachment in the "1,200-foot" sand, has shown no increase in chloride concentration. In the earliest water sample collected in 1968, the chloride content was measured at 3.2 mg/l and in 1978 the concentration was 1.3 mg/l.

Iron in Ground Water

In some areas of the District, development of water supplies from the

"1,200-foot" sand could be adversly affected by high iron concentrations. Table 2 lists wells in northern West Baton Rouge Parish and eastern Pointe Coupee Parish that have yielded water with more than 0.3 mg/l of iron.[5] Most recently, well WBR-154, completed in the "1,200-foot" sand south of Highway 190 at Winterville, produced water with as much as 2.0 mg/l iron. According to the U.S. Geological Survey's records, the "1,200-foot" sand contains excessive iron in water from other wells in northern East Baton Rouge Parish.

Table 2. Iron content and pH of water from selected "1,200-foot" sand wells.

Well No.	Location	Iron (mg/l)	pH	Date
WBR-95 A&B	Hwy. 190; T 6 S, R 12 E	1.0	-	07-24-63
WBR-101	2 mi. west of Port Allen; T 7 S, R 12 E	0.43	-	03-18-66
WBR-129 C	East of Lakeland; T 5 S, R 11 E	2.2	6.8	05-07-75
WBR-135 B	South of Erwinville; T 7 S, R 11 E	1.5	7.0	10-20-75
WBR-154	Winterville, Hwy. 190; T 6 S, R 11 E	2.0	6.5	02-05-79
PC-120	Southeast of Lakeland; T 6 S, R 10 E	0.36	6.9	03-06-64

The wells listed in Table 3 are north of the center of township 6 south and east of the center of range 10 east (Figure 1). To the south or west of this area, there are no wells known yielding water with excessive iron from the "1,200-foot" sand. Although all wells that fall northeast of these boundaries are not expected to yield water with excessive iron, development in this area should proceed with the knowledge that water produced from the "1,200-foot" sand may require treatment for some uses.

Ground Water Levels

The "1,200-foot" sand is an artesian aquifer; that is, the water in the aquifer is under sufficient pressure to cause it to rise in wells to a height

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[5] 0.3 mg/l is the upper limit established by EPA (1976, p. 79).

above the elevation of the top of the aquifer. Before extensive development of the aquifer, water levels were high enough to permit wells to flow naturally. As development of the aquifer proceeded the water level declined. The record of water level changes (hydrograph) of well EB-301 illustrates the history of water level declines in the "1,200-foot" sand since 1926 (Figure 4). This well is located north of the Baton Rouge fault in East Baton Rouge Parish (see Figure 5).

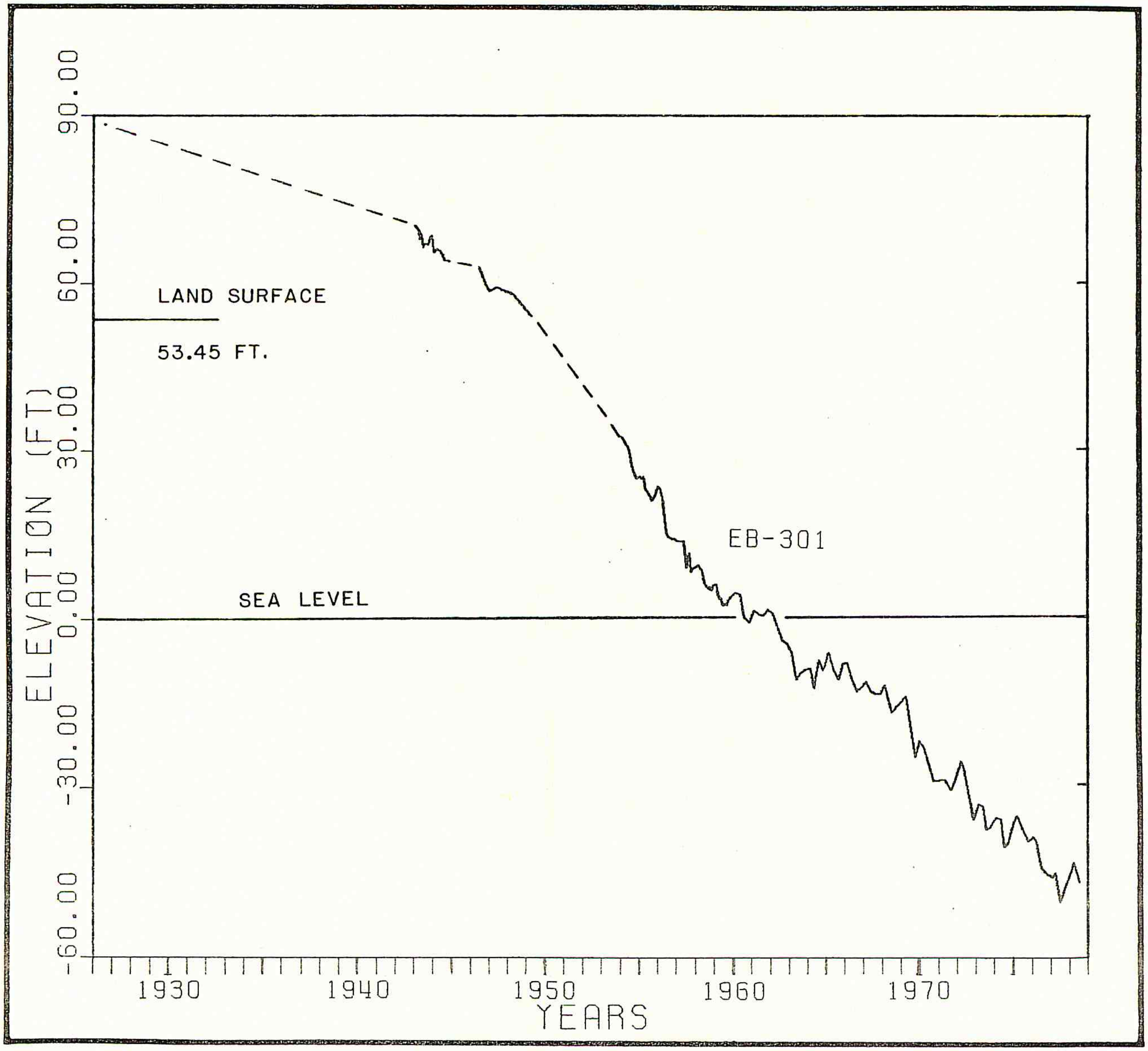

Figure 4. Water level trend in the "1,200-foot" sand at well EB-301 (see Figure 5 for location).

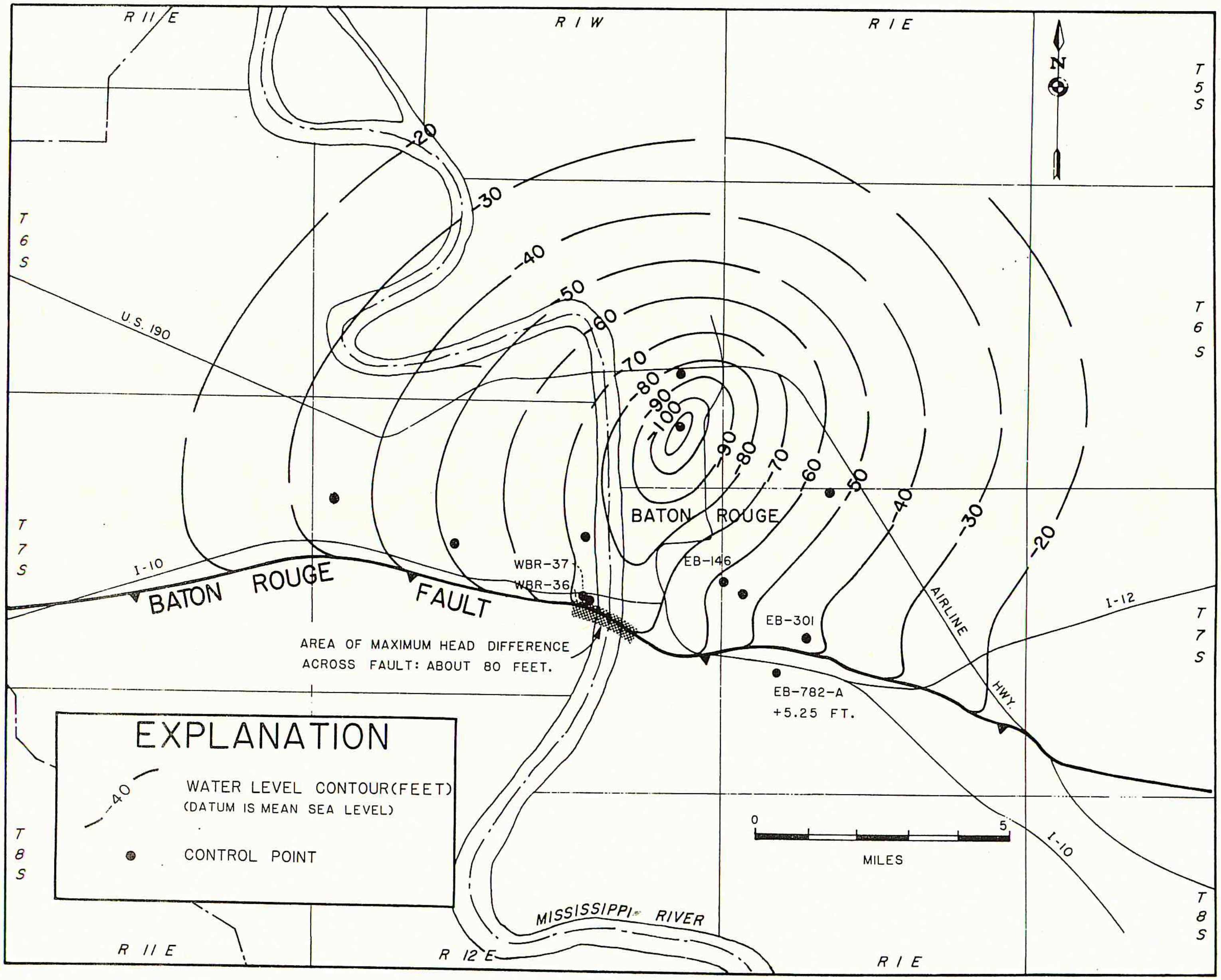

Figure 5. Potentiometric surface of the "1,200-foot" sand, March, 1978.

Water levels are presently below the land surface throughout the District. Figure 5 is a map showing the potentiometric surface (head of water, with reference to mean sea level) of the "1,200-foot" sand for the District in March, 1978. This map was constructed by contouring the elevation of the water level of the "1,200-foot" sand in observation wells maintained by the USGS. The "cone of depression" is clearly centered in the Baton Rouge industrial area -- the area of greatest pumpage -- where the water level elevation is more than 110 feet below mean sea level. The elongation of the cone of depression to the south is due to a reduced ground-water flow rate from this region caused by the hydraulic barrier effects of the Baton Rouge fault and changes in bed thickness. Water levels south of the fault are generally above mean sea level in all aquifers. However, water levels cannot be mapped south of the fault in Figure 4 because only two observation wells (WBR-147 and EB-782 A) are available in the aquifer of interest. The maximum water level difference across the fault in the "1,200-foot" sand is estimated to be 70 to 80 feet and occurs in the area where the fault crosses the Mississippi River.

Hydrographs of observation wells completed in the "1,000-foot" and "1,200-foot" sands were compared in Figure 6 to evaluate possible hydraulic connections between these aquifers near the Baton Rouge fault. Water level records for wells EB-146 and EB-301 represent changes in the "1,200-foot" sand north of the fault. Well EB-782 A is completed in the "1,000-foot" sand south of the fault at Acadian Thruway. The hydrograph of this well is included because the brackish aquifer (420 mg/l chlorides in 1978) in this well is likely in partial contact with the "1,200-foot" sand north of the fault (see Rollo, 1969, Pl. 4). This is the only hydrograph available south of the fault at a depth equivalent to the "1,200-foot" sand to the north. Thus, if salt water were moving from the "1,000-foot" sand across the fault into the "1,200-foot" sand, the hydrograph of EB-782 A should be similar to hydrographs of the "1,200-foot" sand north of the fault.

It is apparent from Figure 6 that the water level differences across the fault have significantly increased since measurements began in EB-782 A in 1965. While the water levels in EB-146 and EB-301 have declined 27 feet and 43 feet respectively, the water level in EB-782 A, which is nearly totally isolated by the fault from the effects of pumping in the Baton Rouge industrial center, declined only about 4 feet. This relationship indicates that the hydraulic connection across the fault between these two aquifers is slight. Rollo (1969, p. 31) found the same is true for the "1,500-foot" sand. Thus, it appears that encroachment of water from south of the fault at this location is insignificant.

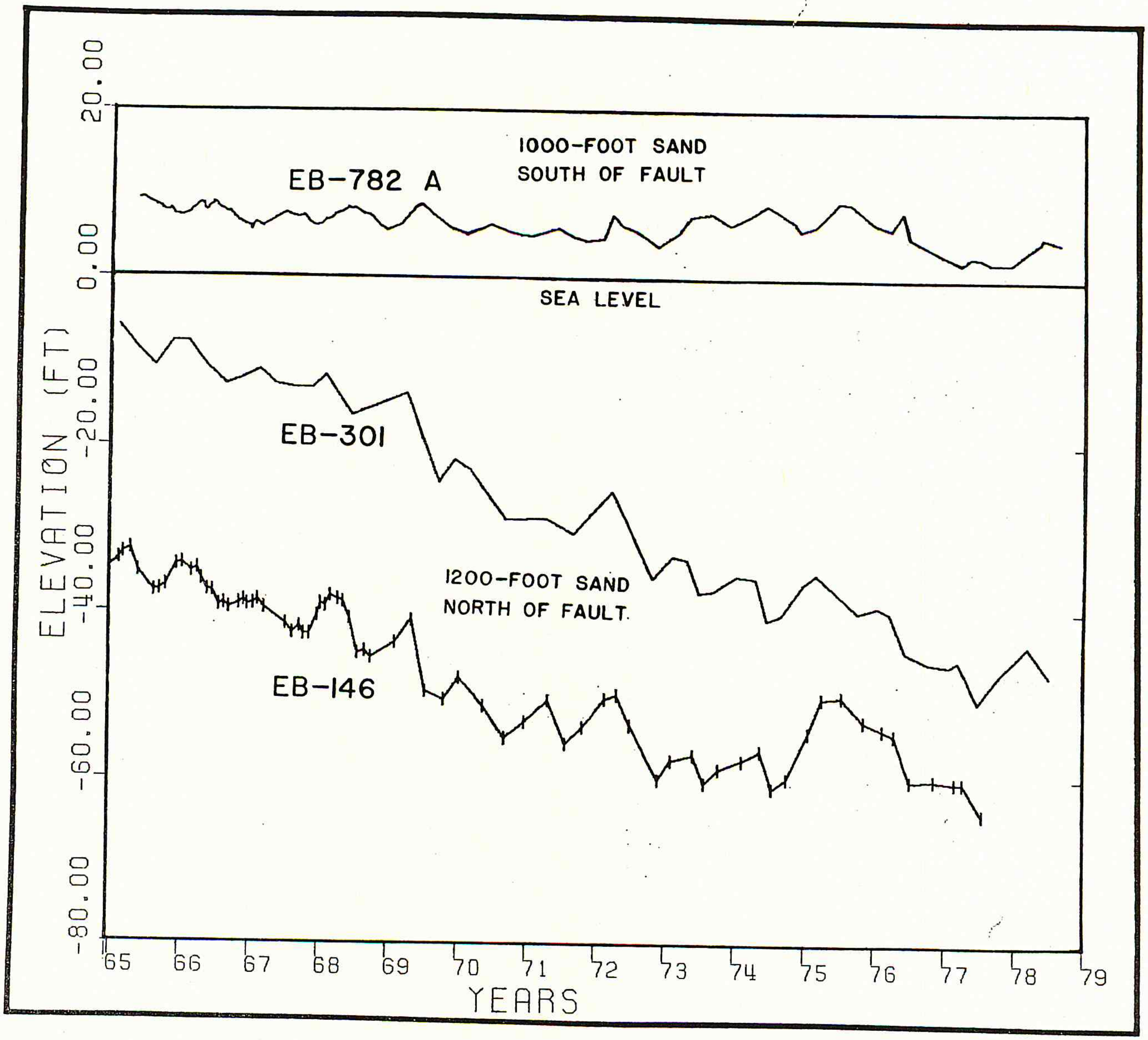

Figure 6. Representative hydrographs of the "1,000-foot" and "1,200-foot" sands (see Figure 5 for well locations).

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APPENDIX

List of Wells Used in Geologic Cross Sections (Fig. 2)

Well No.	Company	Lease	La.Cons.Dept. Serial No.	Location Sec.	T.	R.
		Cross Section A-A'				
1	Markley-Bankhead	Iberville Ld. Co. #1	27182	111	7S	8E
2	Southwest Gas	Wilbert & Sons #1	53435	111	7S	9E
3	Texas Gulf	E. B. Schwing #1	52155	64	7S	9E
4	Southwestern O & R	D. Angelloz #1	29302	42	7S	10E
5	Sohio Petr.	Wilbert & Sons #B-1	43357	31	7S	11E
6	J. L. Loeb	Wilbert & Sons #1	45164	34	7S	11E
7	Amerada Petr.	Aillet #1	36962	102	7S	12E
8	U.S. Geol. Survey	EB-783	-	54	7S	1W
9	U.S. Geol. Survey	EB-778	-	94	7S	1E
10	Goldking	D. H. Holmes #1	156159	57	7S	1E
11	U.S. Geol. Survey	EB-803	-	5	8S	2E
		Cross Section B-B'				
1	Bakke and Salt Dome	A. R. Albritton #1	69579	97	7S	9E
2	J. L. Loeb	Slack Bros. #1	45694	7	7S	10E
3	Drew Cornell	Baist C. & L. #1	72926	97	7S	10E
4	Humble	Lobdell O. Unit #4	50039	39	7S	11E
5	U.S. Geol. Survey	WBR-102	-	7	7S	12E
6	U.S. Geol. Survey	WBR-101	-	91	7S	12E
7	U.S. Geol. Survey	WBR-100	-	68	7S	12E
8	U.S. Geol. Survey	EB-794	-	52	7S	1W
9	U.S. Geol. Survey	EB-790	-	95	7S	1E
10	U.S. Geol. Survey	EB-804	-	70	7S	1E
		Cross Section C-C'				
1	Southwest Gas	Wilbert & Sons $1	53435	111	7S	9E
2	Bakke and Salt Dome	A. R. Albritton #1	68579	97	7S	9E
3	Magnolia Petr.	J. K. Nicholson #1	53237	92	6S	9E
4	Humble	J. O. Long #B-2	43323	32	6S	8E
5	Franks Petr.	SWD #5	-	35	5S	8E
		Cross Section D-D'				
1	Sohio Petr.	Wilbert & Sons #B-2	43357	31	7S	11E
2	Drew Cornell	Baist C. & L. #1	72926	97	7S	10E
3	La. Dept. Public Works	WBR-134	-	7	7S	11E
4	Humble	Southern Land #1	65320	31	6S	11E
5	U.S. Geol. Survey	PC-78	-	12	6S	10E
		Cross Section E-E'				
1	W.B.R. Water District	WBR-99	-	75	7S	12E
2	City of Plaquemine	WBR-113	-	70	7S	12E
3	U.S. Geol. Survey	WBR-147	-	70	7S	12E
4	G.B.R. Port Comm.	WBR-36	-	69	7S	12E
5	U.S. Geol. Survey	WBR-100	-	68	7S	12E
6	La. Dept. Public Works	WBR-134	-	7	7S	11E
7	Sunrise Well #1	WBR-150	-	63	7S	12E