CAPITAL AREA GROUND WATER
CONSERVATION COMMISSION

BULLETIN NO. 2

SUBSIDENCE
IN THE CAPITAL AREA GROUND WATER
CONSERVATION DISTRICT

-- AN UPDATE

BY

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FOREWORD

Because of the ground-water users' active participation in conservation activities, the Board of Commissioners is pleased to report that the annual rate of land subsidence since 1969 has decreased. This is the result of decreased ground-water pumping and accompanying rising water levels in most aquifers. The total maximum amount of subsidence in the Baton Rouge area as of 1976 was 1.67 feet. By comparison, in the Houston area there has been, in some places, 8 feet or more of land subsidence.

Although the results of this study are encouraging, the users in the district must not relax in the development of and use of conservation practices that will ensure a long-term supply of ground water of good quality. The monitoring of pumpage, water levels, and land subsidence shall and will be continued by the Commission as well as local, federal, and other State agencies.

This report, which was prepared under the direction of the Commission, will serve as base for future studies and supplements previously-completed studies.

On the basis of the findings in this report, the Commission recommends that:

1. The subsidence monitoring wells in the Baton Rouge industrial district, operated by the U.S. Geological Survey in cooperation with the Louisiana Office of Public Works, DOTD, and the East Baton Rouge City-Parish Council, be observed indefinitely.
2. Plans be considered for the installation of additional subsidence-monitoring wells on the perimeter of the area of concentrated pumpage.
3. First order leveling of selected key benchmarks in the district should be scheduled on a 5-year or 10-year basis and correlated with ground-water pumpage. The frequency should be dependent upon data obtained from subsidence-monitoring wells and changes in ground-water pumpage rates and location.
4. Local and other State governmental entities should implement plans for determining the amount and effects of subsidence associated with the Baton Rouge fault system and other known faults. Special consideration should be given to those areas where a fault may underlie the Mississippi River levee system.

The Commission thanks and is indebted to the U.S. Corps of Engineers and the National Geodetic Survey for expanding the 1976-1977 first-order vertical control data program to include new and old benchmarks needed in the Commission's study of subsidence.

Raymond R. Loup
Chairman

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SUMMARY

The two types of localized subsidence, previously identified as occuring in the Capital Area Ground Water Conservation District are continuing to occur -- these in addition to the long-term, widespread, slow, regional subsidence due to tectonic adjustment. One is the subsidence associated with fault zones, the other is associated with local water-level declines caused by ground-water pumpage.

The differences in land-surface elevation that have occurred between 1964 and 1976 along the lines leveled and releveled by the NGS (National Geodetic Survey, formerly named the U.S. Coast and Geodetic Survey) are shown in maps and profiles in Figures 3 through 10. The line of levels that traversed the industrial area of Baton Rouge shows a maximum rate of land subsidence of about 0.035 ft. per year for the period 1964 to 1976, due primarily to ground-water pumpage. Total subsidence in the industrial area for the 1935 to 1976 period has been about 1.67 ft. -- 1.26 ft. due to local effects of ground-water pumping and approximately 0.41 ft. due to natural regional subsidence, assumed to be 0.01 ft. per year. In 1969 the maximum amount of total subsidence in the same area was 1.5 feet. South of the Baton Rouge fault the maximum subsidence rate near the fault was about 0.017 ft. per year, on the River Road 0.9 miles south of the Interstate 10 bridge. About 7.5 miles west of Baton Rouge, in West Baton Rouge Parish where the line run by the NGS crosses the trace of the Baton Rouge fault, a subsidence rate of 0.030 ft. per year was found south of the fault.

Recommendations include the periodic releveling of the NGS level lines as well as the network of benchmarks established by East Baton Rouge Parish and the Louisiana Water Resources Research Institute. The existing network of benchmarks should be extended to other areas so that the magnitude of changes of land-surface elevation can be correlated with the rate of ground-water offtake, and reliable predictions made in conjunction with model studies of the aquifers. In addition, attention is called to the relationship between the active faults and the levees that cross the faults and the need to locate these intersections.

INTRODUCTION AND PURPOSE

Background

The natural subsidence of land is a feature widely found in the Gulf Coastal Plain where the Capital Area Ground Water Conservation District is located. It is caused by the slow compaction of the sediments, the clays and silts in particular, due to the weight of the accumulating overburden. If all sediments were uniform, and if there were no other causes, then subsidence would be substantially uniform and, except for surface drainage, there would be no reason to be concerned with the phenomenon. However, sediments are not uniform and, on a large scale, entire blocks tend to slip gulfward. These blocks are outlined on the surface, more or less, by linements called "faults". The Baton Rouge area has two principal fault zones; the Baton Rouge fault and the Denham Springs fault (Durham, Moore and Parsons, 1967). The accumulation of oil and gas at depth is associated with these geologic features. The surface traces are of concern because the slow movement at the faults may cause differential settlement of such features as buildings, streets, pipes, sewers, levees, and bridges that lie athwart a fault. Figure 1 is a map of natural subsidence rates due to tectonic adjustments (unrelated to faulting and ground-water withdrawals) determined for the Gulf Coast by Holdahl and Morrison (1974). They also indicate areas of anomalous subsidence such as the Houston and New Orleans areas.

In addition to regional subsidence, and the natural subsidence associated with faults, local areas may be subsiding due to manmade causes. Areas of concentrated ground-water withdrawals in the coastal plain such as Houston and Baton Rouge are subsiding at rates in excess of the general regional subsidence.

Davis and Rollo (1969) compared elevation data from surveys principally of 1934-45, 1938, 1964, and in some areas data as early as 1880, to compute subsidence in the Baton Rouge area. They found that the maximum amount of subsidence between 1900 and 1965, mainly due to ground-water pumpage in Baton Rouge, was more than 0.98 ft. west of the Mississippi River, which is west of the center of the Baton Rouge industrial area. They also showed that the Baton Rouge fault, along the southern part of the city, limited the area affected by subsidence due to pumpage. Wintz, Kazmann, and Smith (1970) used data from the NGS relevelings of the 1930's, 1964, and the East Baton Rouge Parish releveling for 1959 and Louisiana Water Resource Research Institute data of 1969 in their study of subsidence in Baton Rouge. By estimating the amount of regional subsidence, they determined the maximum subsidence in the industrial area was 1.5 ft. between 1938 and 1969. They predicted that if water levels remained constant at 1970 levels, or continued to decline at a steady rate, subsidence would amount to 3 to 5 ft. (or more) respectively

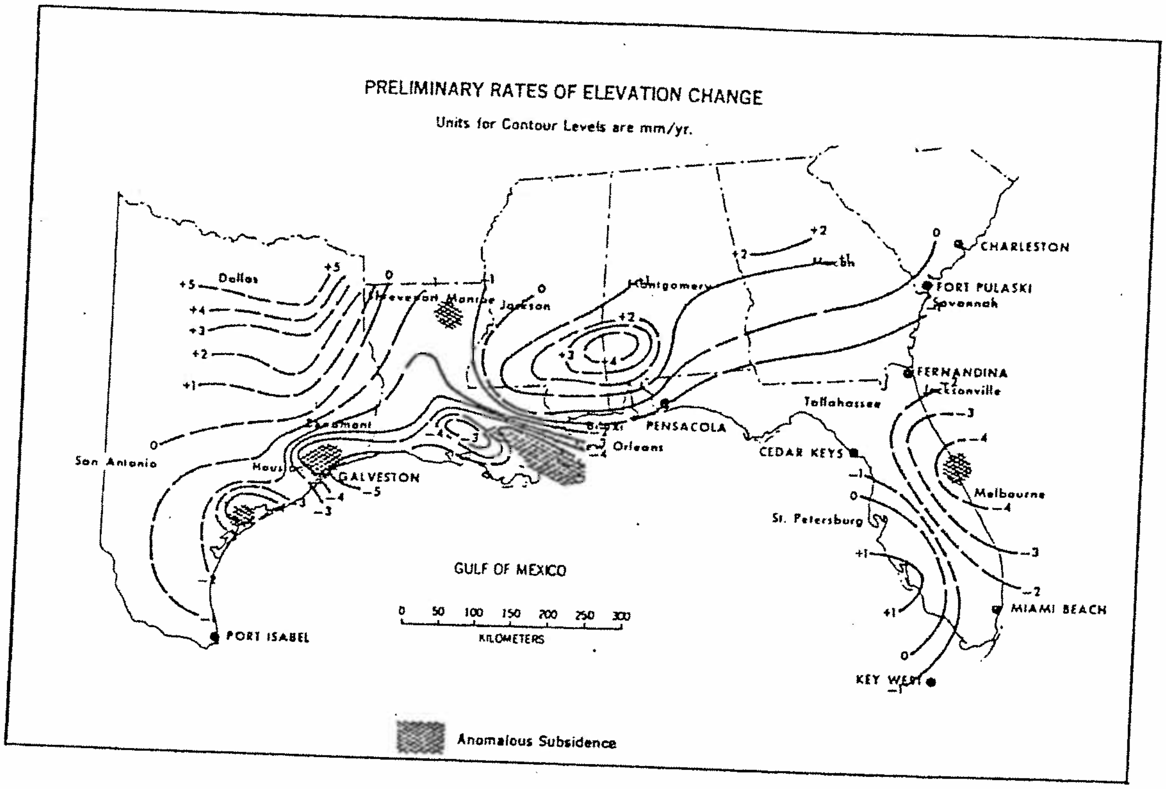

Fig. 1. Preliminary rates of elevation change in the Gulf Coast (from Holdahl and Morrison, 1974).

by 1990. They showed that a second source of local subsidence is the natural movement of the land surface along the downthrown (south) side of the Baton Rouge fault. They believed that this movement would continue at the observed rate of as much as 0.02 ft. per year and was not due to ground-water withdrawals.

In 1976 the NGS, in a program financed by the U.S. Corps of Engineers, releveled benchmarks to determine the amount of vertical movement along the Mississippi River levee. At the request of the Capital Area Ground Water Conservation Commission, the Corps of Engineers and the NGS added lines for the purpose of determining the amount of subsidence in the District. Even though, at this writing (1978), the data are not adjusted to the 1927 sea level elevation, it is possible to analyze the information, relate it to previous measurements and to gain a useful insight into the vertical motion of the land surface, especially along the lines which were surveyed.

Purpose

The purpose of the study reported upon here was to compare the results of the most recent leveling (1976) with the 1964 leveling and with the profiles produced by Davis and Rollo (1969) and by Wintz, Kazmann, and Smith (1970) and to call attention to significant changes in land surface elevations.

Acknowledgements

We express our gratitude to Mr. William Addison, of the East Baton Rouge City-Parish Engineering Department, who altered his program of leveling to furnish us with releveling data in areas of interest not included in the NGS work.

THE LEVELING DATA AND ITS EVALUATION

Background

In explaining the procedure used in this study, the goal must be stated and the limitations of the available data pointed out. It is best to start by comparing the procedure used by Wintz, Kazmann, and Smith (1970) who started out to relate the subsidence in the Baton Rouge area to the withdrawal of water from each aquifer. They were fortunate in that the East Baton Rouge Parish, before starting on a sewer construction program, had employed the consulting firm of Pyburn and Odom to establish elevations throughout the area to be sewered. These consultants tied their work to an established benchmark in the downtown area when they made their survey in 1959. In 1969 all of these benchmarks were resurveyed, an established north-south line, which had been resurveyed by the NGS in 1964, was releveled in 1969, and the results were analyzed. The two principal findings were that, (1) the cone of depression in the potentiometric surface of each major aquifer was overlain by a shallow saucer of land surface subsidence, and (2) that the Baton Rouge fault was active and that its evaluation as a roll-over fault was essentially correct.

The present evaluation differs from the one described above because, basically, in this study the elevations had to be compared on a line-for-line basis. Consequently, the data is best presented in a series of subsidence profiles showing the differences in elevation at each point that occurred during the interval between the first-order surveys of land elevation. However, these profiles provide subsidence information in areas not before reported and, in some cases, increase the amount of detail available.

Procedure

The first step was to develop a computer program to plot the location of each benchmark used in the 1964 and 1976 relevelings. These points were plotted on a map of the District using the latitude and longitude data supplied by NGS. The program also had the capability to plot the difference in elevation (1964-1976) at each point along each line. Correction factors were determined so that the "free adjustment" of all lines run in each separate leveling epoch could be accomplished. The "free adjustment" process is discussed later in this report.

To determine the total subsidence in the District, the subsidence determined for the 1964-1976 period was added to the subsidence determined for the 1934-1964 period by Davis and Rollo (1969). Maps of subsidence for the

1934-1976 and the 1964-1976 periods are shown in Figures 3 and 4.

It should be noted that the absolute difference in elevation at any benchmark cannot be obtained by directly using the observed elevations and the amount of regional subsidence at any point cannot be precisely determined for reasons noted previously. However, the relative difference can be calculated by selecting a single point (or pair of points) in the network and assuming that point to be stable.

Davis and Rollo (1969) and Wintz, Kazmann, and Smith (1970) selected benchmarks well outside of the city of Baton Rouge, which had constant differences in elevation; that is, if the difference between Point A (north of the city) and Point B (south of the city) was 1.00 ft. in both the 1934 and 1964 relevelings, it was assumed that the regional subsidence was uniform (and undetectable without running lines to tidal stations), and that any differences in elevation found at other points on the same line must be due to a cause other than regional subsidence.

Figure 2 is a map showing the locations of benchmarks and survey lines included in the NGS relevelings of 1976 and 1964 in the Capital Area Ground Water Conservation District. A small number of these benchmarks were included in the 1934 releveling epoch. Selected benchmark designators (i.e., PBM 2, B-198, etc.) are included in the map. The numbers shown on each line are benchmark index numbers and are used in Figures 5 through 10 and in Appendix A. For simplicity, only every fifth benchmark and end benchmarks are numbered in the maps and profiles. The 1976 releveling program also established numerous new benchmarks along the lines shown in Figure 2. These are not included in this report because the historical elevation data at these points, which would enable subsidence determinations to be made, are lacking. Two new lines were established, one is between St. Francisville and Slaughter, and the other is between Port Allen and Plaquemine. Persons interested in the location and observed elevations of these new benchmarks can obtain the data from the NGS or the files of the Capital Area Ground Water Conservation Commission.

To determine the amount of local subsidence in the District, observed elevations were used, as recommended by N. Morrison of the NGS (Personal communication, 1977). Observed elevations are elevations measured in the field, corrected for any errors but not adjusted for closure errors or changes in sea level. A line-by-line comparison of observed elevations from different epochs (i.e., 1964 and 1976)* is probably the most accurate method of determining the amount and location of subsidence due to ground-water pumping or fault movement. Observed elevations of each line of a particular epoch can

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*Releveling of benchmarks in the Baton Rouge area usually requires more than one year to complete. Therefore, in the report the 1964 epoch refers to releveling accomplished mainly in 1964, but also in 1965 and 1966. A small portion of the releveling in the 1976 epoch occurred in 1977.

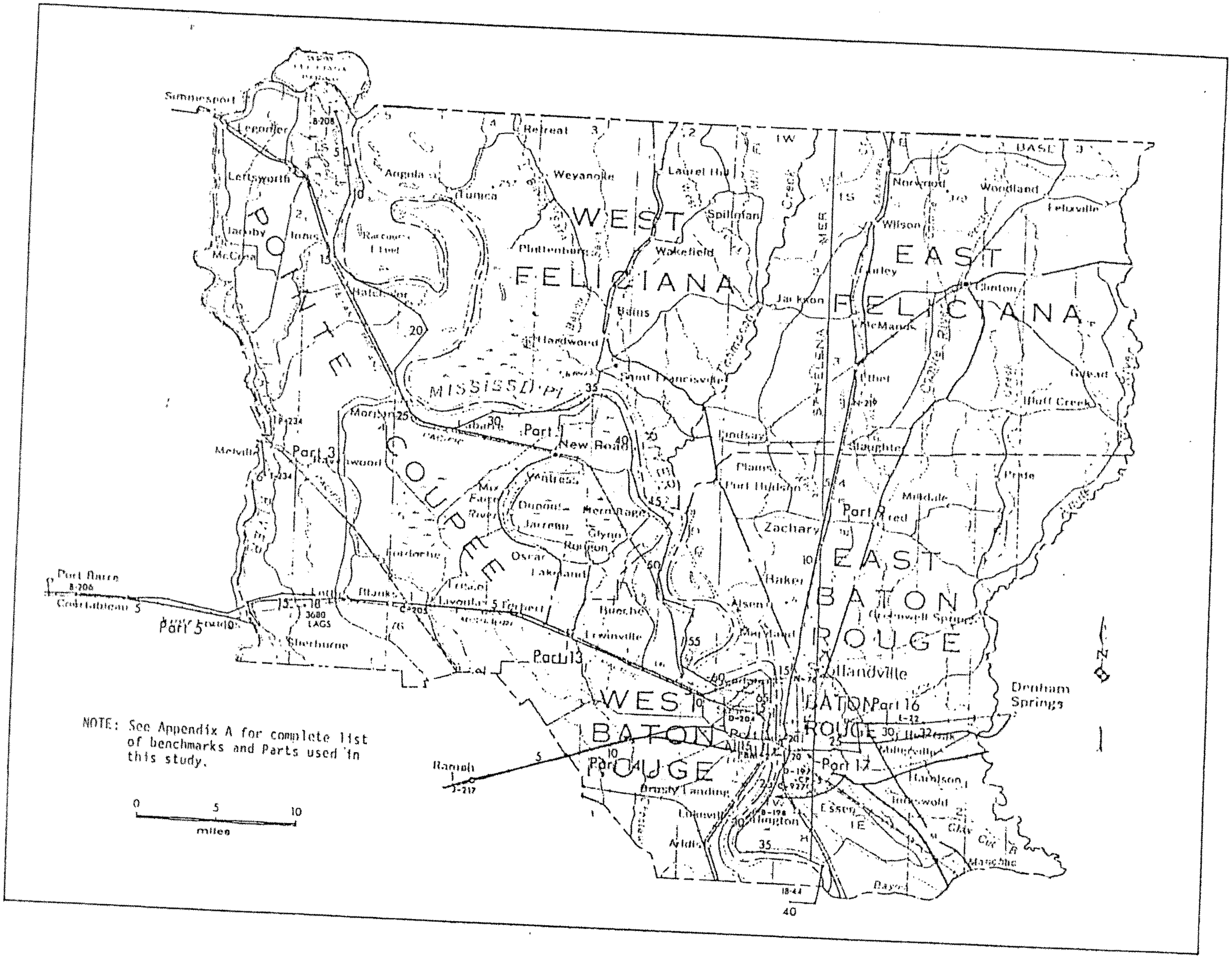
can be made consistent with other lines in the epoch by a process termed a "free adjustment". This procedure was used to adjust all lines of one epoch to the same elevation base. For example, NGS lines designated Parts 1, 10, and 13 of the 1976 epoch, all included a common benchmark at their termini--P-287 located 0.7 miles north of Port Allen on State Highway 983. Because Parts 10 and 13 were initiated from P-287, they were assigned the same elevation for that benchmark, 27.6690 ft. (8.4335 m). Part 1 originated at Simmesport and ran south to P-287 in Port Allen where the elevation for that benchmark was found to be 27.8520 feet (8.4893 m) for this particular survey. To make Part 1 compatible with Parts 10 and 13, it is necessary to eliminate the differences in elevations determined for P-287 in the various surveys. This was done by adding the elevation difference at P-287 to all other benchmark elevations in Parts 10 and 13. The technique of "free adjustment" makes it possible to make all observed elevations of one epoch compatible so that all elevations of the 1976 survey can be related to a common base and compared with all lines of the 1964 epoch.

In this report, B-198, located on River Road south of Baton Rouge (see Figure 2) is assumed to be the stable benchmark for purposes of comparing elevation changes in the District during the last 12 years. In fact, B-198 probably has subsided an amount approximately equal to the regional subsidence rate for the area. From the map of Holdahl and Morrison (1974) (Fig. 1) the minimum regional subsidence rate in the Baton Rouge area is about 0.003 ft. per year. Thus, B-198 probably has subsided about 0.04 ft. during the 12 years since the 1964 survey. This possible movement has not been included in the elevation data or profiles in this study; B-198 is treated as a stable benchmark.

To construct the profiles, the observed elevation for B-198 in 1976 was set equal to the 1964 elevation, based on the assumption that the amount of regional subsidence occurring at B-198 is zero. Thus, the profiles show only local subsidence or include regional subsidence if it is greater than that which may have occurred at B-198. According to Holdahl and Morrison's map, the rate of regional subsidence differs from place to place over the area. Thus, the elevation differences shown in the profiles may overstate man-caused subsidence where rates of regional subsidence are greater than that experienced at B-198.

Subsidence Profiles

The releveling information developed during the 1976 survey in the District includes eight principal lines or Parts (Fig. 2). In the profiles in this report, Part 9 and a portion of Part 17 are combined to produce a single profile running north-south through Baton Rouge. The east-west portion of Part 17 was combined with Parts 13 and 16 to construct a single profile from Lottie through Baton Rouge and east as far as benchmark data for the two epochs exist. These profiles and Part 1 (Simmesport to Port Allen) are along the same three lines used by Davis and Rollo (1969) for their determinations of subsidence between 1934 and 1964. In the profiles illustrated in this report the "A" portion of each figure is the detailed subsidence profile for the 1964-1976 period and the "B" portion of the figure shows the total subsidence along the same line shown in "A" but for a longer period -- 1934 to 1976. Profiles of subsidence for the 1934-1976 period were constructed by adding the subsidence measured for the 1964-1976 period to the subsidence determined for the 1934-1964 period by Davis and Rollo (1969).



NOTE: See Appendix A for complete list of benchmarks and Parts used in this study.

Fig. 2. Location of benchmarks and survey lines used in profiles in this study.

SUBSIDENCE IN THE DISTRICT

General

Areas of land subsidence determined from the relevelings of 1964 and 1976 are shown in the map in Figure 3. The detailed data used to create this map is presented in the profiles later in this report. Because benchmarks are located only along major lines generally radiating out from Baton Rouge, the contours drawn between lines are extrapolations. The map is most reliable in the vicinity of Baton Rouge where six separate lines join. This is also the area of greatest subsidence. The two major centers of subsidence in Baton Rouge are the industrial area where 0.42 ft. of subsidence has occurred at N-76 in 12 years and south of the Baton Rouge fault where a maximum of 0.20 ft. of subsidence has occurred at benchmark D-197 located on the River Road (see Fig. 2). Subsidence south of the fault is also present west of the Mississippi River along Interstate 10 in West Baton Rouge Parish. The contours of maximum subsidence south of the fault are oriented nearly east-west to conform with the position of the Baton Rouge fault as mapped by Smith (1976) and to conform with the east-west orientation of the 0.15 ft. contours showing subsidence just north of the fault.

The Atchafalaya River defines the approximate center of a second subsidence area unrelated to the subsidence centered on Baton Rouge. This feature may be due to the natural compaction of alluvial sediments.

Areas of minimum subsidence in the district for the 1964-1976 period are, (1) along Part 17 in the vicinity of B-198 (Fig. 2) south of LSU, which is the point assumed to be stationary in this study, and (2) along the Mississippi River in the extreme southern part of East Baton Rouge Parish, well south of Baton Rouge, and (3) in the vicinity of Torbert along U.S. Highway 190 in Pointe Coupee Parish.

The map of subsidence in the District for the 1934-1976 period (Fig. 4) was constructed by adding the subsidence reported by Davis and Rollo (1969) for the 1934-1964 period to the subsidence determined for the 1964-1976 period. Earlier leveling data (i.e., 1900) was not included because it is not available for the entire area. The map of total subsidence is more general than Figure 3 because fewer benchmarks were available for the longer period. Therefore, the Baton Rouge industrial area is the only center of significant subsidence shown in Figure 4 for the 1934-1976 period. The subsidence associated with the Baton Rouge fault is not clearly distinguishable from the subsidence centered on the industrial area, but the effect of the fault is to elongate the subsidence bowl into south Baton Rouge. Effects of faulting are apparent west of the Mississippi River where benchmarks are affected by high subsidence rates in both the 1934-1964 and 1964-1976 periods.

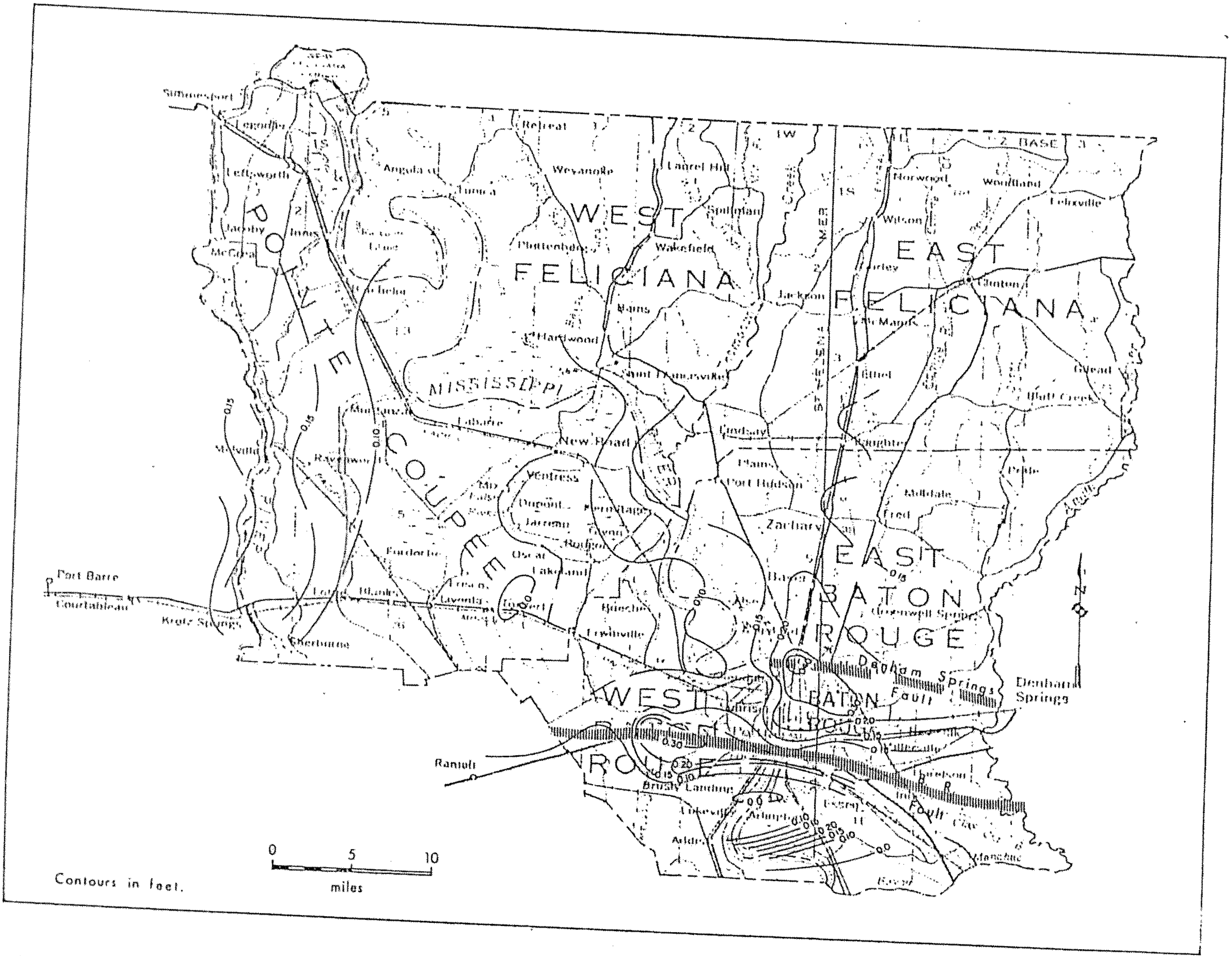
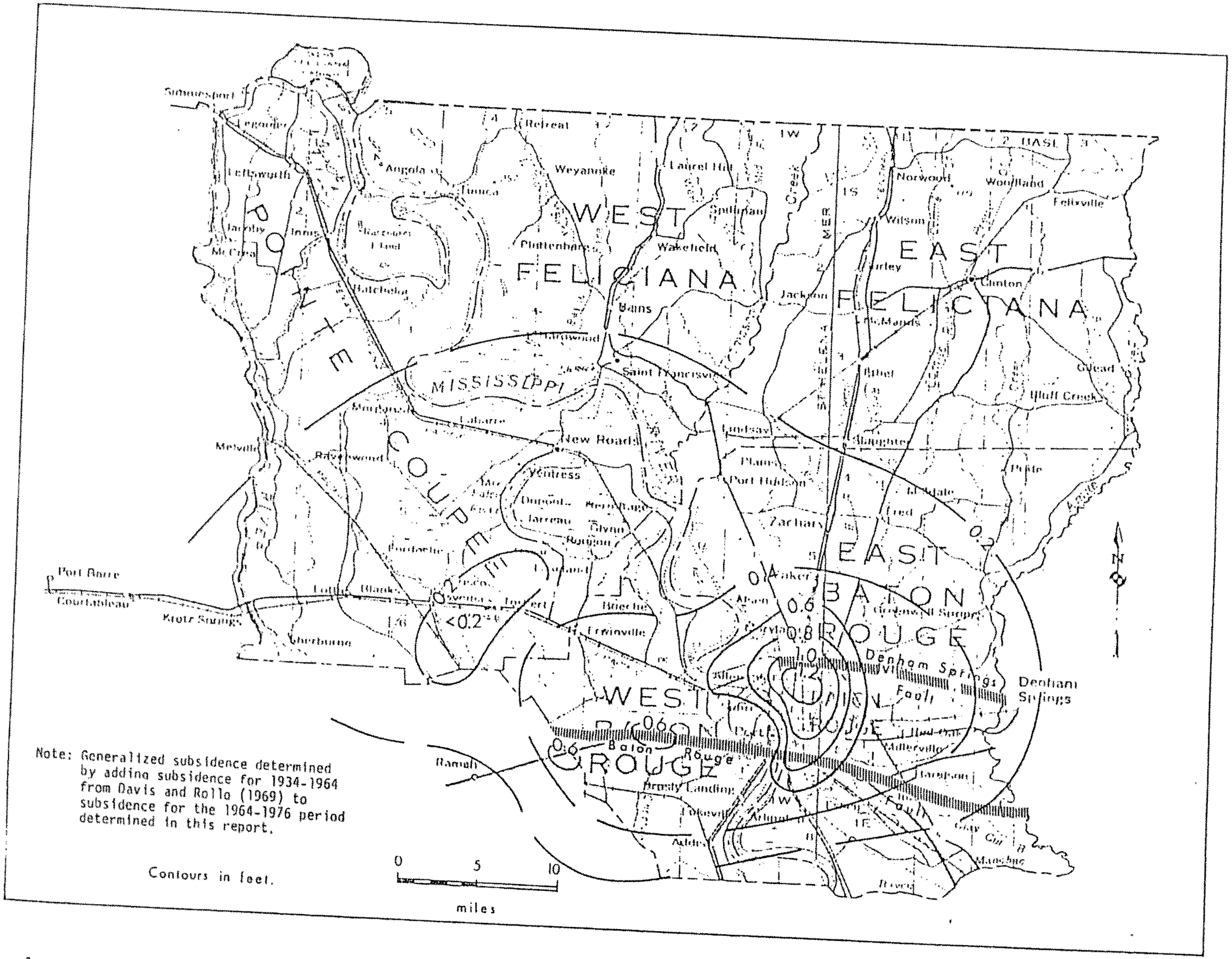


Fig. 3. Subsidence in the Capital Area Ground Water Conservation District: 1964 to 1976.



Note: Generalized subsidence determined by adding subsidence for 1934-1964 from Davis and Rollo (1969) to subsidence for the 1964-1976 period determined in this report.

Contours in feet.

Fig. 4. Generalized Subsidence in the Capital Area Ground Water Conservation District: 1934 to 1976.

The elongated subsidence bowl south of, and paralleling the fault, is apparent in Figure 3.

Parts 9 and 17. North-South Profile

Figure 5-A is the north-south profile through Baton Rouge for the 1964-1976 period. North from benchmark B-198 the entire area has been affected by subsidence. In the Baton Rouge industrial area, benchmark N-76 dropped (including regional subsidence) 1.67 ft. since 1935 and 0.49 ft. since 1964. If regional subsidence is excluded, the subsidence at this benchmark has been 1.26 ft. since 1935 and 0.42 ft. since 1964. This benchmark dropped more than the next benchmark to the south, B-216, which was the point of maximum subsidence -- 1.50 ft. for the 1938-1969 period (Wintz, Kazmann, and Smith, 1970). Although the area is on the downthrown side of the Denham Springs fault, most of the subsidence in the industrial area is the result of groundwater pumpage. The annual rate of subsidence for N-76 (neglecting regional subsidence) for the period 1964-1976 was 0.035 ft. Unless the rate of groundwater pumping is increased, it is assumed that this annual rate of subsidence will remain the same or possibly decrease with time.

In Figures 5-A and 5-B, it can be seen that north of the industrial area to Slaughter, subsidence has amounted to more than 0.2 ft. since 1964. This finding is in contrast to results of both previous studies (Davis and Rollo, 1969; Wintz, Kazmann, and Smith, 1970), which showed this area more stable than or equally as stable as B-198 south of Baton Rouge. Assuming that the free adjustment procedure joining Parts 9 and 17 is valid, then the subsidence must be attributed to pumpage from well fields north of the city of Baton Rouge.

Another important area of subsidence in Baton Rouge is along the downthrown side of the Baton Rouge fault (Figure 3, 5-A and 5-B). Benchmark D-197 is the first benchmark south of the fault. Subsidence at this point was 0.20 ft. between 1964 and 1976. The calculated rate of subsidence for D-197 is therefore 0.017 ft. per year -- about equal to the 0.02 ft. per year rate predicted by Wintz, Kazmann, and Smith (1970). Subsidence rates determined along the fault at several benchmarks are summarized below.

Part	Index No.	Benchmark	Period	Subsidence Rate (ft. per year)
17	24	D-197	1964-1976	0.017
17	25	C-927	1964-1976	0.001
14	11	C-217	1964-1976	0.030

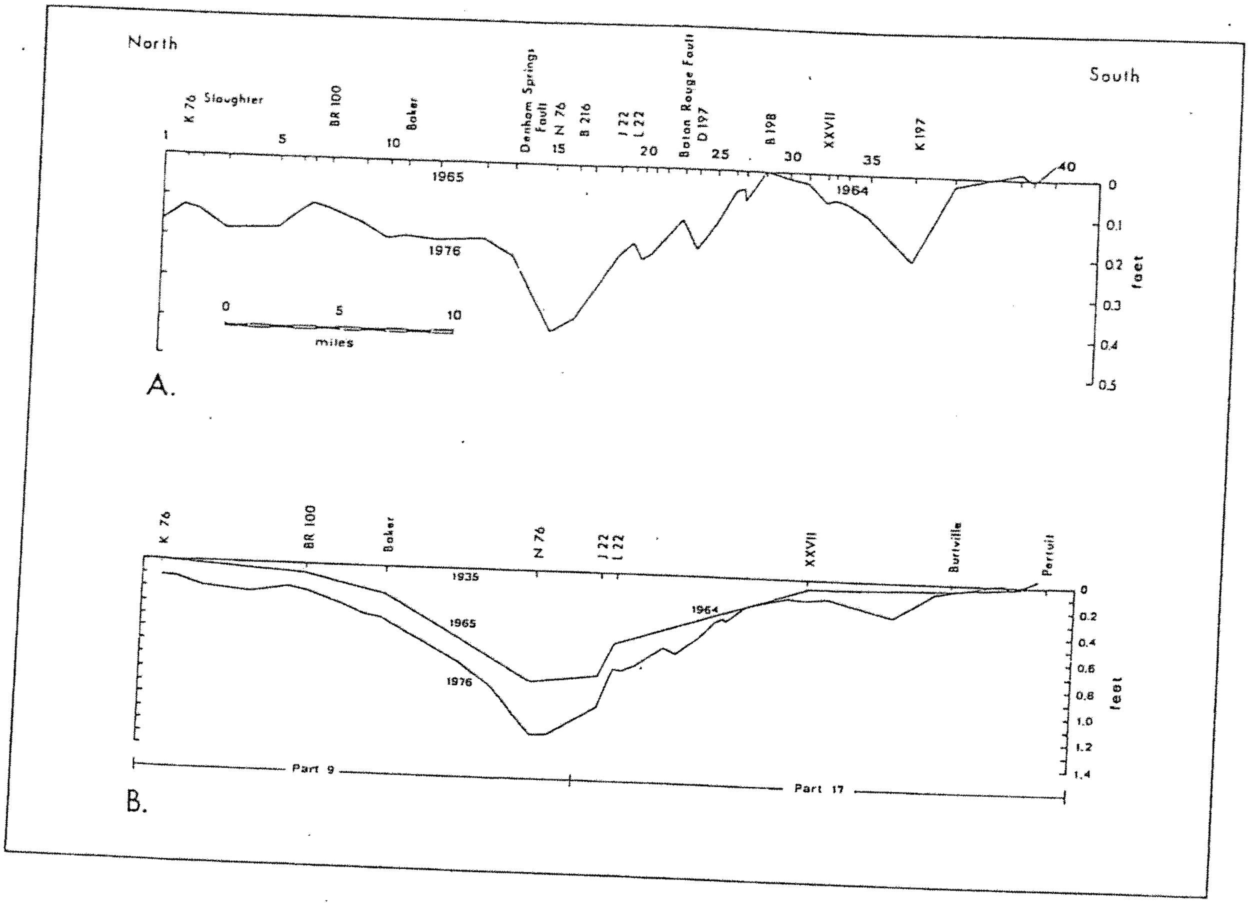


Fig. 5. North-south subsidence profiles through Baton Rouge (Parts 9 and 17) for the periods (A) 1964/65 to 1976 and (B) 1935/38 to 1976.

A heretofore unreported area of subsidence begins at B-198 and extends southward for approximately six miles. The maximum amount of subsidence is 0.215 ft. and occurs at K-197. South from K-197, subsidence decreases to a minimum equivalent to that to B-198.

Parts 13, 17, and 16. West-East Profile

This profile begins in Pointe Coupee Parish between Blanks and Livonia (see Fig. 2), continues eastward along U.S. 190, through Baton Rouge along Florida Boulevard and Greenwell Springs Road and ends about 3 miles east of Airline Highway. The area of least subsidence occurs in the western end of the line, in the Livonia-Torbert area (Fig. 3). East from Torbert, subsidence increases steadily into the central Baton Rouge area where ground water pumping has produced a land surface drop of approximately 0.2 ft. since 1964 (PBM-2, Fig. 6-A). Subsidence decreases eastward along Part 17 toward

Airline Highway. However, beginning at benchmark T-216 in Part 16, subsidence shows a localized increase east of Airline Highway along Greenwell Springs Road. Here subsidence between 1965 and 1976 is slightly more than observed in the center of Baton Rouge along this profile.

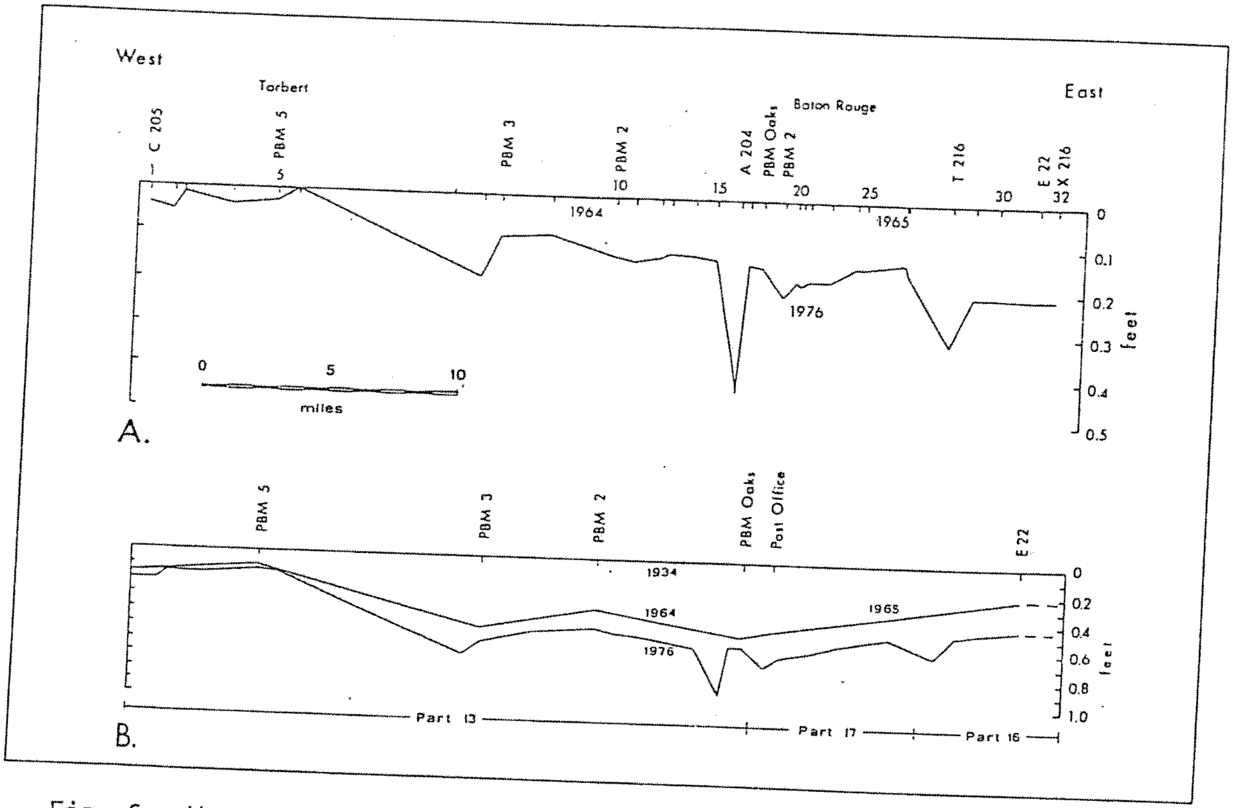


Fig. 6. West-east subsidence profiles through Baton Rouge (Parts 13, 16, and 17) for the periods (A) 1964/65 to 1976 and (B) 1934 to 1976.

Two benchmarks showed unusually high rates of subsidence between 1965 and 1976. These are A-204 (at the junction of Highway 986 and Third Street in Port Allen) and T-216 (approximately 2,500 feet west of Airline Highway at the intersection of Wooddale Boulevard and the Illinois Central Railroad). The movement at A-204 appears to be very local, perhaps resulting from some local disturbance unrelated to land subsidence. T-216, on the other hand, may be responding to effects of ground-water pumping. At this time, there is no explanation for the increase in subsidence at benchmarks 29 through 32 in Figure 6-A. Davis and Rollo (1969) had shown this area was the eastern limit of subsidence centered in the industrial area for the 1934-1965 period (Fib. 6-B). With this exception, areas of maximum and minimum subsidence for the 1964-1976 period correspond closely with the subsidence pattern for the

1934-1964/5 period.

Part 1. Simmesport to Port Allen

The Simmesport to Port Allen line (Fig. 7) is the longest continuous releveling line of the 1976 survey. Subsidence occurs over broad areas shown in this profile, averaging 0.065 to 0.13 ft. during the 1964-1976 period. The southern end of the profile extends into the subsidence bowl of the Baton Rouge industrial area. Here the local maximum subsidence at E-206, located at the west end of the old Mississippi River bridge, is 0.24 ft. in 12 years. The northern part of the line, between benchmarks 1 and 20 of Figure 7-A, has subsided slightly more than 0.1 ft. since 1964. Benchmarks 9 (L-208) and 19 (M-207) appear to be affected by unusually high local subsidence. The most stable area in Part 1 is between benchmarks 20 (PBM 11) and 35 (C-207), in the Morganza to New Roads area, where subsidence averages approximately 0.07 ft. since 1964.

The 1964-1976 profile contrasts with the 1929-1964 profile of Davis and Rollo (1969) (Fig. 7-B) in that their profile showed a steady increase in subsidence south from PBM 19 to PBM 25 with an increase in the amount of subsidence into the industrial area. The 1964-1976 data indicate three distinct areas exist northwest of the industrial area along this profile. Two areas between benchmarks 1 and 20, and between 34 and 55, average more than 0.1 ft. of subsidence and are separated by a third area between benchmarks 20 and 34 of less than 0.1 ft. of downward movement. The subsidence profile in the area north from PBM 19 (Fig. 7-B) was not computed because of difficulties in correlating the data obtained prior to 1964.

Part 14. Ramah to Port Allen

The Ramah to Port Allen line (Fig. 8) shows an increase in subsidence eastward into the Baton Rouge area resulting from the ground-water pumping in Baton Rouge. Benchmarks 7, 8, and 11 (H-18, K-217, and C-217 respectively) in Figure 8-A are sites of the greatest elevation decline on the profile. This movement is probably due to natural downward movement on the south side of the Baton Rouge fault. These locations were also the sites of the greatest elevation change during the 1934-1965 period. Figure 8-B combines the subsidence measured between 1934 and 1976 (G-18 is assumed to be the point of no subsidence for the 1934-1965 period). Clearly, the pattern of vertical land movement along this profile has remained relatively constant since 1964.

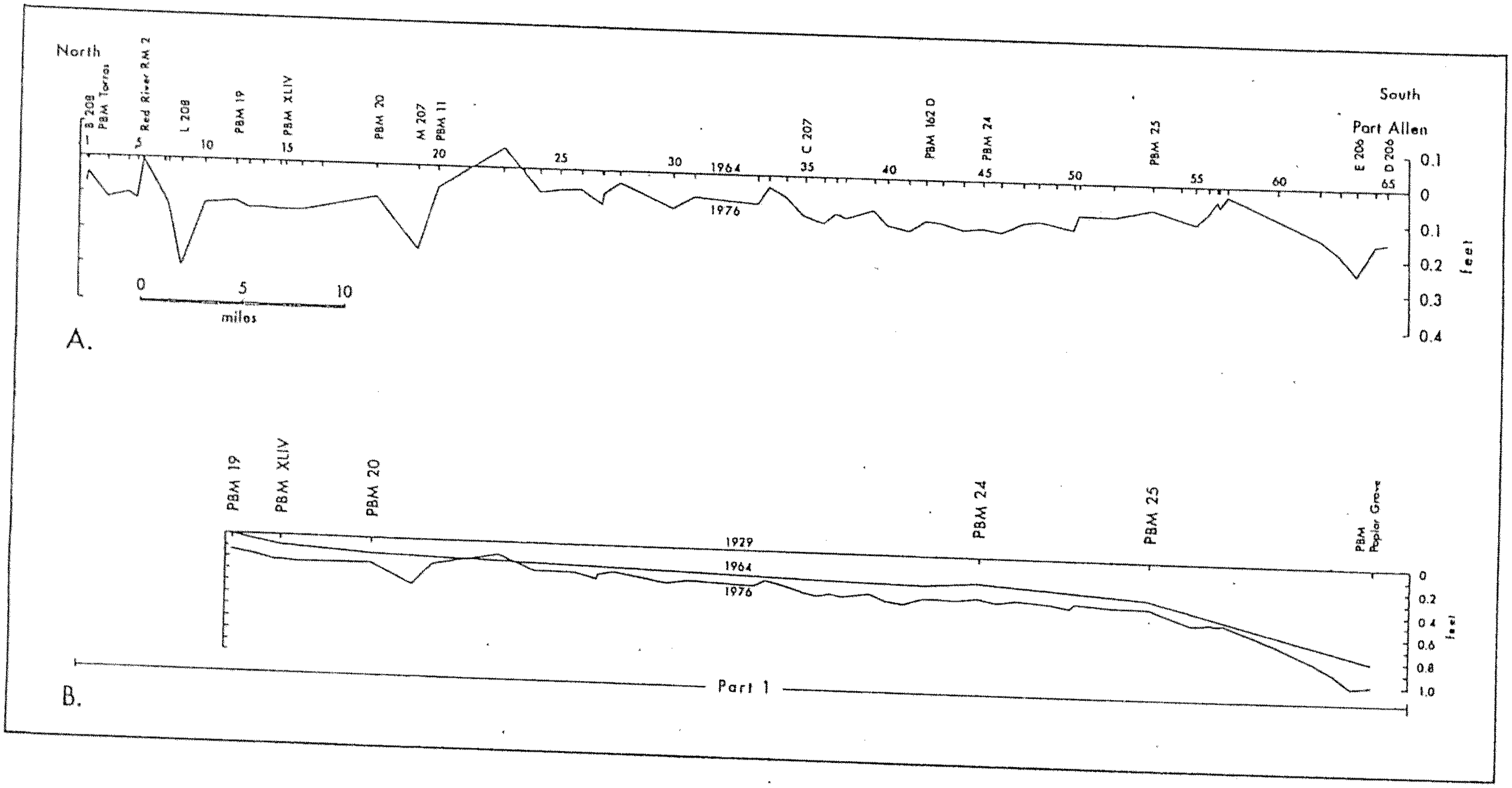


Fig. 7. Simmesport to Port Allen subsidence profiles (Part 1) for the periods (A) 1964 to 1976 and (B) 1929 to 1976.

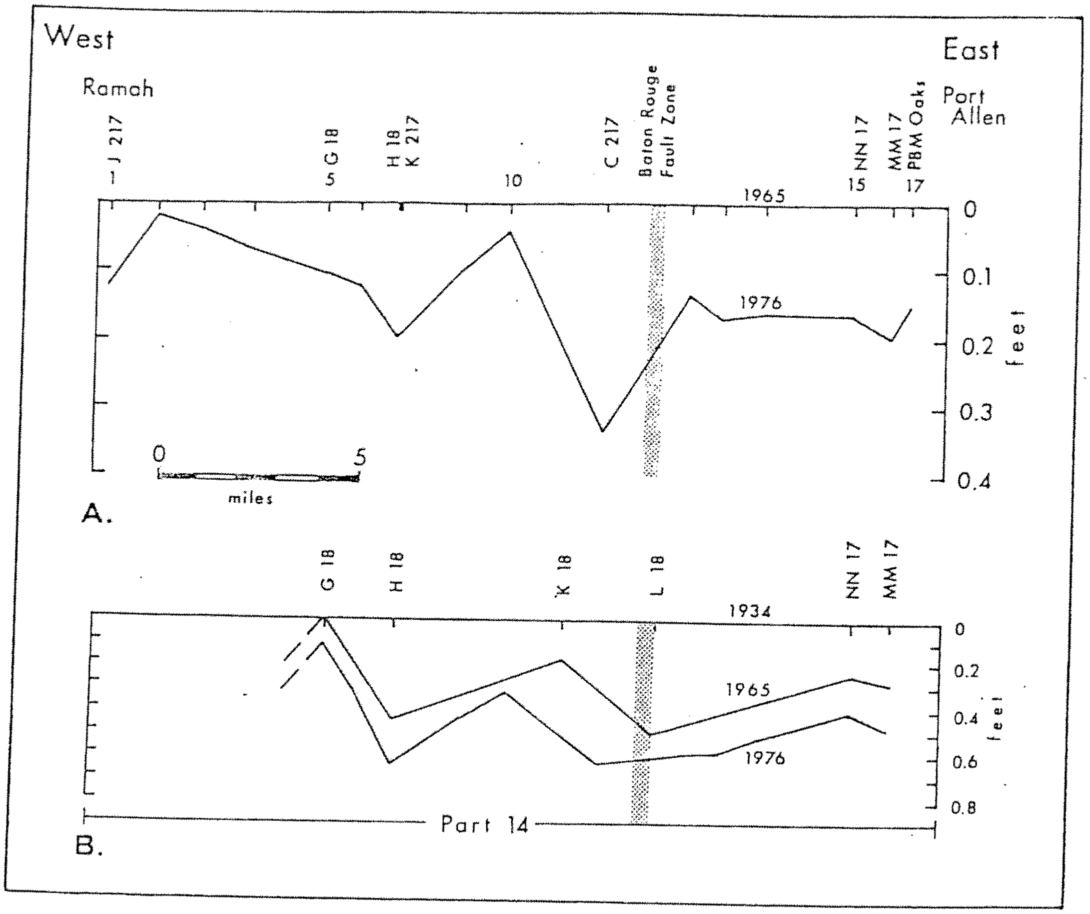


Fig. 8. Ramah to Port Allen subsidence profiles (Part 14) for the periods (A) 1965 to 1976 and (B) 1934 to 1976.

Part 5. Lottie to 6.8 Miles West of Krotz Springs

The general trend of the 1964-1976 profile (Fig. 9-A) of Part 5 indicates Krotz Springs is near the center of an area of subsidence that diminishes westward and eastward. The maximum subsidence of 0.24 ft. is at benchmark 14 (M-205), less than 1 mile east of the Atchafalaya River. Only one benchmark (PBM-9) was included in relevelings of the three epochs from 1929 to 1976 (Fig. 9-B). The subsidence measured at PBM-9, near Krotz Springs, between 1929 and 1964 by Davis and Rollo (1969) is shown in Figure 9-B. A comparison of subsidence before and after 1964 indicates this benchmark is dropping at a rate greater than that before 1964. In other words, PBM-9 moved downward about 0.17 ft. between 1964 and 1976 and 0.27 ft. in the 35 years between 1929 and 1964. This apparent increase in subsidence rate should be confirmed by future relevelings, which can be more accurately adjusted to lines continuing into Baton Rouge than the pre-1964 lines.

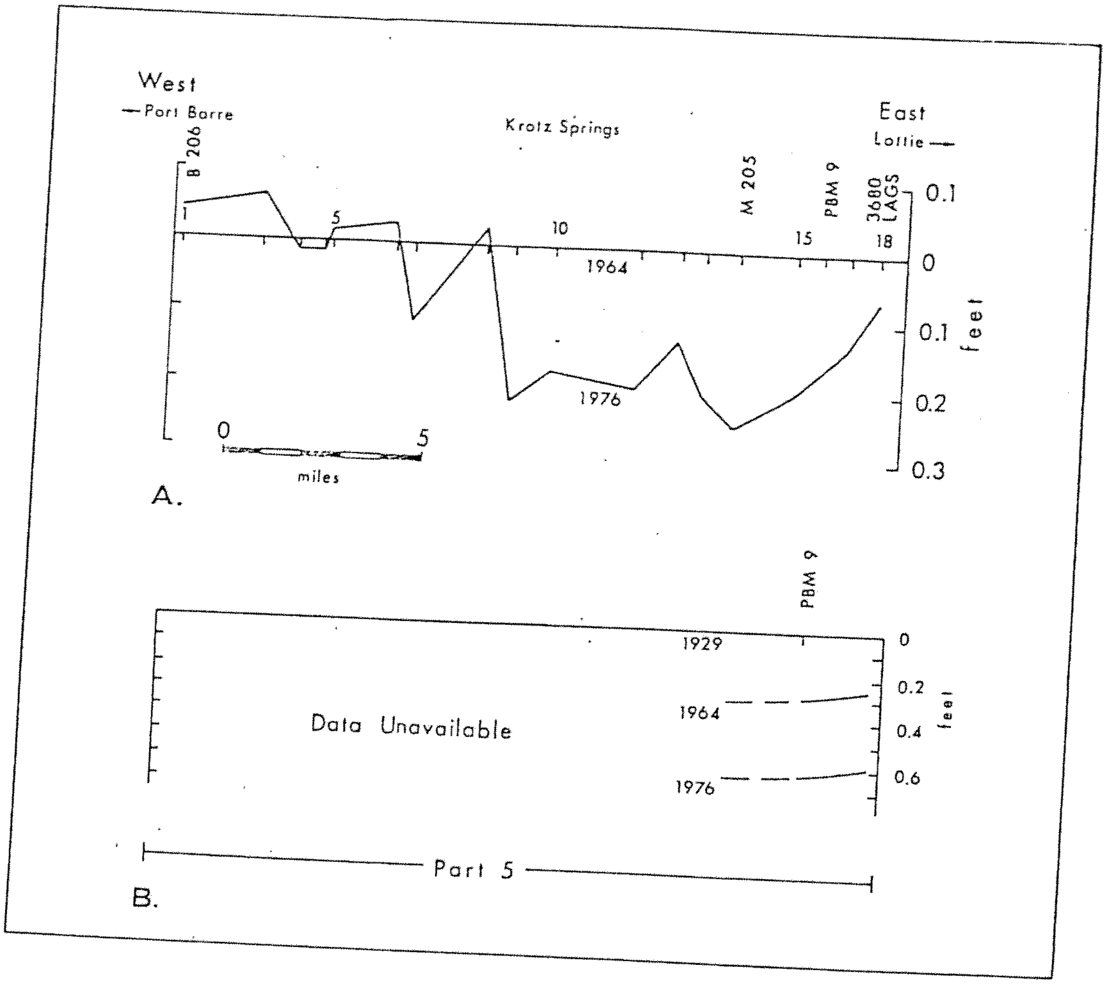


Fig. 9. Lottie to 6.8 miles west of Krotz Springs subsidence profiles (Part 5) for the periods (A) 1964 to 1976 and (B) 1929 to 1976.

Subsidence along this line is clearly unrelated to subsidence associated with ground-water use in Baton Rouge. Figure 2 shows the two subsidence areas separated by a stable "boundary" (no subsidence relative to B-198 in south Baton Rouge) centered near Torbert in Pointe Coupee Parish.

Part 3. Simmesport to Krotz Springs

This is the final profile included in the District study. The line includes 7 benchmarks, all in the Melville, Louisiana area. Generally, most points have declined approximately 0.2 to 0.3 ft. in elevation between 1964 and 1976. PBM-13 shows an unusual amount of downward movement, slightly more than 1 ft.

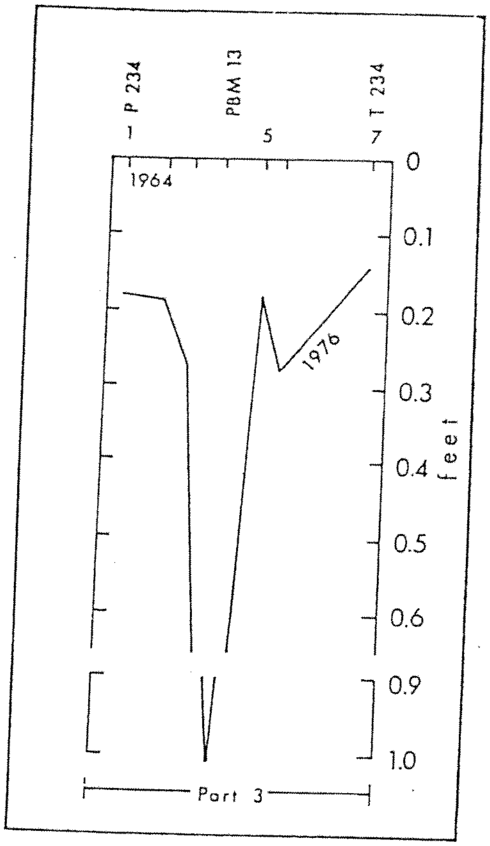


Fig. 10. Subsidence profile in the Melville area (Part 3) for the period 1964 to 1976.

CONCLUSIONS

The Capital Area Ground Water Conservation District is subject to natural subsidence amounting to between about 0.003 and 0.016 ft. per year (Holdahl and Morrison, 1974) due to tectonic adjustments. This subsidence affects large areas and is not a source of differential settling, which could cause problems in the structural integrity of foundations. Local areas of subsidence, due to natural fault movement, sediment compaction and/or pressure reduction due to the pumping of water from artesian aquifers, add to the effects of regional subsidence and, in addition, have the potential for damaging foundations and hydrologic structures (i.e., levees, canals, sewers). Local subsidence associated with withdrawal of ground water from the industrial area of Baton Rouge has been reported by Davis and Rollo (1969) and Wintz, Kazmann, and Smith (1970). The 1976 releveling of the NGS adds a substantial amount of data, which is the basis for a detailed comparison of subsidence over the entire District in the 12 years since the 1964 survey.

The two most important sources of local subsidence in the district are, (1) ground-water pumping from artesian aquifers, and (2) natural downward movement of the south side of the Baton Rouge fault. Maximum subsidence in the Baton Rouge industrial area was 0.49 ft. between 1964 and 1976 and 1.67 ft. between 1935 and 1976. Eliminating effects of regional subsidence -- assumed to be 0.01 ft. per year (Wintz, Kazmann and Smith, 1970) -- these subsidence figures become 0.42 and 1.26 ft. respectively.

In the present study, the average subsidence rate in the industrial area (benchmark N-76) is computed to be 0.035 ft. per year for the 1964-1976 period. This rate is lower than the 0.046 ft. per year rate computed for the same benchmark for the 1964-1969 period from Wintz, Kazmann, and Smith (1970). This difference may in part result from comparison of adjusted elevation differences used by Wintz, Kazmann, and Smith with unadjusted elevations in this study or it may indicate an actual reduction in the subsidence rate since 1969 owing to the decline in ground-water withdrawals of about 5 percent over the same period. If the subsidence rate measured -- 0.035 ft. per year -- during the last 12 years continues, the total subsidence in the industrial area in 1990 will only be about 2.25 ft., as compared to the 3 ft. of subsidence predicted by Wintz, Kazmann, and Smith (1970).

South of the Baton Rouge fault more than 0.2 ft. of subsidence was measured between 1964 and 1976 in the NGS survey in an east-west trending zone approximately one mile wide. This natural rate of movement, consistant with earlier studies, would produce a total of about 1 ft. of subsidence for the 1935 to 1990 period.

As an addition to the subsidence noted in earlier studies of Davis and Rollo (1969) and Wintz, Kazmann, and Smith (1970), the areas east of Airline

Highway along Greenwell Springs Road and north from Baton Rouge to Slaughter appear to be subsiding at a higher rate than previously measured.

The relevelings of 1964 and 1976 by the National Geodetic Survey have greatly added to the fundamental data on land surface elevations in the Capital Area Ground Water Conservation District. This data base will improve the precision of future relevelings to determine areas and rates of subsidence.

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APPENDIX

NATIONAL GEODETIC SURVEY LINES

OBSERVED ELEVATIONS and ADJUSTED ELEVATION DIFFERENCES

This appendix lists all benchmarks used in this study. The benchmarks are organized as they appear in Figures 5 though 10. The index number for each benchmark corresponds to the index numbers used in maps and profiles in the report. All available observed elevation data supplied for these benchmarks by the National Geodetic Survey are listed in meters and feet.

The computed elevation difference for the 1964 to 1976 period was derived by adjusting all Parts of the 1964 and 1976 surveys using the "free adjustment" technique described in the text and then adding a constant to the 1964 observed elevations so that the difference in the 1964 and 1976 elevations at benchmark B-198 is "0".

For a complete listing of benchmarks, descriptions, and observed elevations in the District, the user should contact the National Geodetic Survey.

NORTH-SOUTH PROFILE

(Fig. 5)

PART 9

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
1.	M 219	1976	43.6773	143.2902		
	M 219	1965	43.6641	143.2549	-0.0514	-0.1686
2.	K 76	1976	40.9404	134.3189		
	K 76	1965	40.9145	134.2339	-0.0387	-0.1270
	K 76	1935	41.0910	134.8130		
3.	L 219	1976	40.2435	132.0325		
	L 219	1965	40.2209	131.9503	-0.0420	-0.1378
4.	E 219	1976	37.6304	123.4593		
	E 219	1965	37.6219	123.4314	-0.0561	-0.1840
5.	G 219	1976	30.5408	100.2257		
	G 219	1965	30.5388	100.1929	-0.0546	-0.1791
6.	H 219	1976	30.9791	101.6375		
	H 219	1965	30.9550	101.5584	-0.0405	-0.1329
7.	J 219	1976	30.3353	99.5252		
	J 219	1965	30.3056	99.4270	-0.0349	-0.1145
8.	BR 100	1976	30.1313	98.8560		
	BR 100	1965	30.1052	98.7703	-0.0365	-0.1263
	BR 100	1935	30.3033	99.4203		
9.	M 216	1976	24.2899	79.6913		
	M 216	1965	24.2745	79.6408	-0.0492	-0.1614
10.	L 216	1976	24.9918	81.9941		
	L 216	1965	24.9071	81.9787	-0.0599	-0.1965
11.	BAKER	1976	24.2492	79.5578		
	BAKER	1965	24.2471	79.5344	-0.0575	-0.1886
12.	J 216	1976	21.6594	71.0610		
	J 216	1965	21.6549	71.0463	-0.0601	-0.1972
13.	G 216	1976	21.9028	71.8596		
	G 216	1965	21.8962	71.8379	-0.0580	-0.1902
14.	D 216	1976	20.2836	66.5472		
	D 216	1965	20.2890	66.5650	-0.0700	-0.2296
15.	N 76	1976	17.2410	56.5649		
	N 76	1965	17.3048	56.7742	-0.1284	-0.4212
	N 76	1935	17.7384	58.1969		
16.	B 216	1976	18.9978	62.3207		
	B 216	1965	19.0512	62.5039	-0.1180	-0.3871
17.	A 216	1976	19.7869	64.9176		
	A 216	1965	19.8229	65.0356	-0.1006	-0.3301

PART 17

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
18.	J 22	1976	15.6755	51.4288		
	J 22	1965	15.6555	51.3632	-0.0688	-0.2257
	J 22	1935	16.0682	52.7172		
	J 22	1934	16.1398	52.9521		

PART 17 (continued)

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
19.	L 22	1976	20.0471	65.7713		
	L 22	1965	20.0177	65.6749	-0.0534	-0.1948
	L 22	1964	20.0161	65.6696		
	L 22	1938	20.3262	66.6870		
	L 22	1934	20.4261	67.0140		
20.	C 204	1976	13.4004	43.9646		
	C 204	1964	13.3827	43.9065	-0.0711	-0.2333
21.	PBM Z	1976	11.5660	37.9462		
	PBM Z	1964	11.5430	37.8707	-0.0658	-0.2159
	PBM Z	1938	11.6350	38.0207		
	PBM Z	1934	11.9200	39.1273		
22.	M 197	1977	11.3530	37.2500		
	M 197	1964	11.3190	37.1358	-0.0540	-0.1772
23.	C 198	1977	14.7277	48.3192		
	C 198	1964	14.6769	48.1526	-0.0380	-0.1247
24.	D 197	1976	11.0695	36.3172		
	D 197	1964	11.0426	36.2290	-0.0619	-0.2031
25.	C 927	1976	7.7149	25.3113		
	C 927	1964	7.6672	25.1548	-0.0411	-0.1348
26.	C 929	1976	7.7340	25.3740		
	C 929	1964	7.6609	25.1342	-0.0157	-0.0515
27.	C 930	1976	7.5956	24.9199		
	C 930	1964	7.5204	24.6732	-0.0136	-0.0446
28.	PBM ARLINGTON	1976	7.6576	25.1234		
	ARLINGTON	1964	7.5924	24.9094	-0.0236	-0.0774
	PBM ARLINGTON	1938	7.6819	25.2031		
29.	B 198	1976	7.6076	24.9593		
	B 198	1964	7.5188	24.6680	0.0000	0.0000
30.	W 94 RESET 58	1977	8.5632	28.0945		
	W 94 RESET 58	1964	8.4798	27.8209	-0.0054	-0.0177
31.	C 936	1977	9.3712	30.7454		
	C 936	1964	9.2903	30.4800	-0.0079	-0.0259
32.	PBM XXVII	1977	9.3158	30.5636		
	PBM XXVII	1964	9.2499	30.3474	-0.0229	-0.0751
33.	C 940	1977	11.6873	38.3441		
	C 940	1964	11.6192	38.1207	-0.0207	-0.0679
34.	E 197	1977	8.9040	29.2126		
	E 197	1964	8.8381	28.9964	-0.0229	-0.0751
35.	C 944	1977	12.8226	42.0689		
	C 944	1964	12.7661	41.8835	-0.0323	-0.1060
36.	K 197	1977	7.4974	24.5978		
	K 197	1964	7.4740	24.5210	-0.0654	-0.2146
37.	A 198	1976	8.2269	26.9911		
	A 198	1964	8.1446	26.7211	-0.0065	-0.0213
38.	H 197	1976	7.4095	24.3094		
	H 197	1964	7.3160	24.0026	0.0047	0.0154
39.	PBM 16	1976	7.7331	25.3710		
	PBM 16	1964	7.6456	25.0840	-0.0013	-0.0043
40.	IB 44	1976	7.2457	23.7720		
	IB 44	1964	7.1449	23.4413	0.0120	0.0394

EAST-WEST PROFILE

(Fig. 6)

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
	PART 13					
1.	C 205	1976	7.9104	25.9527	-0.0123	-0.0404
	C 205	1964	7.8339	25.7010		
2.	B 205	1976	9.1346	30.6253	-0.0167	-0.0548
	B 205	1964	9.2625	30.3888		
3.	A 205	1976	7.9673	26.1394	-0.0042	-0.0138
	A 205	1964	7.8217	25.6619		
4.	Y 204	1976	7.3699	24.1795	-0.0119	-0.0390
	Y 204	1964	7.2930	23.9272		
5.	PBM 5	1976	5.6943	18.6821	-0.0086	-0.0282
	PBM 5 BOLT	1964	5.6141	18.4190		
	PBM 5 BOLT	1929	5.7862	18.9836		
6.	W 204	1976	5.3259	17.4734	0.0007	0.0023
	W 204	1964	5.2364	17.1798		
7.	3066	1976	6.0642	19.8957	-0.0571	-0.1873
	3066	1964	6.0325	19.7917		
8.	PBM 3	1976	5.9779	19.6125	-0.0285	-0.0935
	PBM 3	1964	5.9176	19.4147		
	PBM 3	1934	6.1971	20.3317		
	PBM 3	1929	6.2015	20.3461		
9.	L 204	1976	7.1581	23.4846	-0.0264	-0.0866
	L 204	1964	7.0957	23.2798		
10.	PBM 2	1976	6.0359	19.8028	-0.0407	-0.1335
	PBM 2 BOLT	1964	5.9878	19.6450		
	PBM 2	1929	7.4729	24.5174		
11.	H 204	1976	6.8743	22.5535	-0.0433	-0.1421
	H 204	1964	6.8288	22.4042		
12.	G 204	1976	8.2418	27.0400	-0.0407	-0.1335
	G 204	1964	8.1937	26.8822		
13.	F 204	1976	6.7771	22.2346	-0.0374	-0.1227
	F 204	1964	6.7257	22.0659		
14.	E 204	1976	6.4296	21.0945	-0.0386	-0.1266
	E 204	1964	6.3794	20.9298		
15.	D 204	1976	5.6200	18.4383	-0.0409	-0.1342
	D 204	1964	5.5721	18.2812		
	PART 11					
16.	A 204	1964	8.0396	26.3766	-0.1323	-0.4341
	A 204	1976	8.0831	26.5193		
17.	LL 17	1976	8.0337	26.3573	-0.0441	-0.1447
	LL 17	1964	7.9890	26.2106		
	LL 17	1934	8.2807	27.1676		
18.	PBM OAKS	1976	7.4291	24.3737	-0.0455	-0.1493
	PBM OAKS BOLT	1964	7.3858	24.2316		
	PBM OAKS BOLT	1929	7.6806	25.1988		

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
	PART 17					
19.	PBM 2	1976	11.5660	37.9462	-0.0658	-0.2159
	PBM 2	1964	11.5430	37.8707		
	PBM 2	1938	11.8350	38.8287		
	PBM 2	1934	11.9260	39.1273		
20.	M 197	1977	11.3540	37.2500	-0.0540	-0.1772
	M 197	1964	11.3190	37.1358		
21.	N 197	1977	15.1852	49.8202	-0.0574	-0.1883
	N 197	1964	15.1536	49.7172		
22.	P 197	1977	17.1959	56.4170	-0.0539	-0.1768
	P 197	1964	17.1610	56.3025		
23.	Q 197	1977	13.5481	44.4491	-0.0545	-0.1788
	Q 197	1964	13.5138	44.3366		
24.	R 197	1977	15.6582	51.3720	-0.0442	-0.1450
	R 197	1964	15.6136	51.2257		
25.	W 197	1977	16.9709	55.6788	-0.0450	-0.1476
	W 197	1964	16.9271	55.5351		
26.	U 197	1977	16.0980	52.8150	-0.0410	-0.1345
	U 197	1964	16.0502	52.6581		
27.	V 197	1977	15.7823	51.7792	-0.0470	-0.1542
	V 197	1964	15.7405	51.6421		
	PART 16					
28.	T 216	1976	17.1675	56.3230	-0.0964	-0.3162
	T 216	1965	17.1751	56.3487		
29.	U 216	1976	16.3560	53.6614	-0.0629	-0.2063
	U 216	1965	16.3301	53.5764		
30.	V 216	1976	15.6991	51.5062	-0.0637	-0.2090
	V 216	1968	15.6740	51.4239		
31.	E 22	1976	15.9982	52.4875	-0.0646	-0.2119
	E 22	1965	15.9740	52.4081		
	E 22	1934	16.2841	53.4255		
32.	K 216	1976	14.9461	49.0358	-0.0645	-0.2116
	K 216	1965	14.9218	48.9560		

PART 1
Simmesport to Port Allen
(Fig. 7)

PART 1

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
1.	H208	1976	15.4548	50.7047		
	H208	1964	15.4674	50.7460		
2.	PBM TORRAS BOLT	1976	13.9197	45.6683	-0.0227	-0.0745
	PBM TORRAS BOLT	1964	13.9236	45.6811		
	PBM TORRAS BOLT	1938	13.9401	45.0791	-0.0140	-0.0459
	PBM TORRAS BOLT	1929	13.9417	45.7405		
3.	A208	1976	13.3417	43.7720		
	A208	1964	13.3662	43.8524		
4.	C208	1976	14.5645	47.7838	-0.0346	-0.1135
	C208	1964	14.5846	47.8497		
5.	N208	1976	14.5507	47.7385	-0.0102	-0.0991
	N208	1964	14.5768	47.8241		
6.	RED RIVER BM 2	1976	12.9375	42.4459	-0.0362	-0.1188
	RED RIVER BM 2	1964	12.9296	42.4199		
	RED RIVER BM 2	1938	12.8270	42.0833	-0.0022	-0.0072
	RED RIVER	1929	12.7654	41.8812		
7.	O 108	1976	12.0574	42.1031		
	O 108	1964	12.8791	42.2543		
	O 108	1938	12.6634	41.5663	-0.0318	-0.1043
8.	M 208	1976	14.6537	48.0764		
	M 208	1964	14.6830	48.1752		
9.	L 208	1976	14.6012	47.9042	-0.0402	-0.1319
	L 208	1964	14.6838	48.1752		
10.	E 207	1976	15.0778	49.4678	-0.0927	-0.3041
	E 207	1964	15.1049	49.5567		
11.	PBM 19	1976	13.0376	42.7808	-0.0372	-0.1220
	PBM 19 BOLT	1964	13.0645	42.8625		
	PBM 19 BOLT	1929	13.0795	42.9117	-0.0350	-0.1148
12.	F 207	1976	14.4712	47.4777		
	F 207	1964	14.5015	47.5771		
13.	PBM 4A	1976	13.7021	44.9544	-0.0404	-0.1325
	PBM 4A	1964	13.7321	45.0528		
14.	G 207	1976	13.5783	44.5482	-0.0401	-0.1316
	G 207	1964	13.6095	44.6506		
15.	PBM XLIV	1976	13.7164	45.0669	-0.0413	-0.1355
	PBM XLIV	1964	13.7674	45.1686		
	PBM XLIV	1929	13.7629	45.1539	-0.0411	-0.1348
16.	H 207	1976	13.5892	44.5840		
	H 207	1964	13.6208	44.6877		
17.	J 207	1976	13.2005	43.3087	-0.0417	-0.1368
	J 207	1964	13.4402	44.0951		
18.	PBM 20	1976	13.1954	43.2920	-0.2498	-0.8196
	PBM 20 BOLT	1964	13.2132	43.3504		
	PBM 20 BOLT	1929	13.2233	43.3835	-0.0279	-0.0915
19.	K 207	1976	12.6599	41.5351		
	K 207	1964	12.7222	41.7395		
20.	PBM 11 A CAP	1976	12.6473	41.4938	-0.0724	-0.2375
	PBM 11 A	1964	12.6561	41.5226		
	PBM 11	1929	13.5343	44.4039	-0.0189	-0.0620

PART 1
(continued)

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
21.	P 207	1976	11.4589	37.5948		
	P 207	1964	11.4321	37.5069	0.0167	0.0548
22.	O 207	1976	16.1366	52.9416		
	O 207	1964	16.3608	53.6771	-0.2341	-0.7686
23.	PBM PLAUCHE CAP 1964	1976	11.6221	38.1302		
	PBM PLAUCHE CAP 1964	1964	11.6129	38.1657	-0.0209	-0.0686
24.	PBM PLAUCHE BOLT	1976	10.3874	34.0794		
	PBM PLAUCHE BOLT	1964	10.3973	34.1119	-0.0200	-0.0656
25.	R 207	1976	10.5898	34.7434		
	R 207	1964	10.5979	34.7700	-0.0182	-0.0597
26.	S 207	1976	10.5393	34.5777		
	S 207	1964	10.5465	34.6014	-0.0173	-0.0568
27.	NEW ROADS WEST BASE BM 3	1976	10.0080	32.8346		
	NEW ROADS WEST BASE BM 3	1964	10.0281	32.9006	-0.0302	-0.0991
28.	NEW ROADS WEST BASE BM 4	1976	10.0821	33.0777		
	NEW ROADS WEST BASE BM 4	1964	10.0931	33.1138	-0.0211	-0.0692
29.	T 207	1976	9.5363	31.2871		
	T 207	1964	9.5368	31.2887	-0.0106	-0.0348
30.	V 207	1976	11.7524	38.5577		
	V 207	1964	11.7730	38.6279	-0.0315	-0.1033
31.	W 207	1976	12.3050	40.3734		
	W 207	1964	12.3161	40.4072	-0.0204	-0.0669
32.	Z 207	1976	10.0812	33.0748		
	Z 207	1964	10.0961	33.1237	-0.0250	-0.0820
33.	PBM SHAMROCK	1976	9.5170	31.2237		
	PBM SHAMROCK BOLT	1964	9.5161	31.2215	-0.0094	-0.0308
34.	D 207	1976	10.7964	35.4212		
	D 207	1964	10.8046	35.4482	-0.0183	-0.0600
35.	C 207	1976	13.4927	44.2674		
	C 207	1964	13.5175	44.3487	-0.0349	-0.1145
36.	B 207	1976	12.6614	41.5400		
	B 207	1964	12.6911	41.6375	-0.0398	-0.1306
37.	PBM 161 C	1976	10.7522	35.2762		
	PBM 161 C BOLT	1964	10.7738	35.3471	-0.0317	-0.1040
	PBM 161 C BOLT	1929	11.2639	36.9550		
38.	PBM 23	1976	10.8492	35.5945		
	PBM 23 BOLT	1964	10.8746	35.6778	-0.0355	-0.1165
	PBM 23 BOLT	1929	11.2400	36.8796		
39.	PBM WALKER	1976	9.2870	30.4718		
	PBM WALKER BOLT	1964	9.3052	30.5289	-0.0275	-0.0902
40.	BM GAGE 41 BOLT	1976	10.4260	34.2060		
	BM GAGE 41 BOLT	1964	10.4558	34.3038	-0.0399	-0.1309
	BM GAGE 41 BOLT	1929	10.8073	35.4570		
41.	Z 206	1976	13.0326	42.7579		
	Z 206	1964	13.0677	42.8730	-0.0452	-0.1483
42.	PBM 162 D	1976	11.4856	37.6824		
	PBM 162 D	1964	11.5109	37.7654	-0.0354	-0.1161
	PBM 162 D CAP	1929	11.5591	37.9236		
43.	Y 206	1976	10.3344	33.9055		
	Y 206	1964	10.3614	33.9941	-0.0371	-0.1217
44.	X 206	1976	10.9875	36.0482		
	X 206	1964	11.0202	36.1555	-0.0428	-0.1404

PART 1

PART 1
(continued)

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
45.	PBM 24	1976	10.0341	32.9203		
	PBM 24	1964	10.0650	33.0217	-0.0410	-0.1345
	PBM 24 BOLT	1929	10.1022	33.1437		
46.	W 206	1976	10.0686	33.0335		
	W 206	1964	10.1029	33.1460	-0.0444	-0.1457
47.	PBM DEFERN	1976	9.7859	32.1060		
	PBM DEFERN BOLT	1964	9.8113	32.1893	-0.0355	-0.1165
48.	V 206	1976	10.2432	33.6063		
	V 206	1964	10.2665	33.6027	-0.0334	-0.1096
49.	U 206	1976	9.5739	31.4104		
	U 206	1964	9.6005	31.4977	-0.0367	-0.1204
50.	T 206	1976	10.5143	34.4957		
	T 206	1964	10.5445	34.5948	-0.0403	-0.1322
51.	S 206	1976	8.9043	29.4760		
	S 206	1964	9.0017	29.5331	-0.0275	-0.0902
52.	R 206	1976	9.4218	30.9114		
	R 206	1964	9.4404	30.9724	-0.0287	-0.0942
53.	PBM 25	1976	8.7537	28.7195		
	PBM 25 BOLT	1964	8.7652	28.7572	-0.0216	-0.0709
	PBM 25 BOLT	1929	8.8342	28.9836		
54.	PBM SMITHFIELD	1976	8.4318	27.6634		
	PBM SMITHFIELD	1964	8.4506	27.7251	-0.0289	-0.0948
55.	N 206	1976	11.4551	37.5823		
	N 206	1964	11.4779	37.6572	-0.0329	-0.1079
56.	PBM ORANGE GROVE	1976	8.0646	26.4586		
	PBM ORANGE GROVE	1964	8.0701	26.5029	-0.0236	-0.0774
57.	PBM PAYNES	1976	7.9117	25.9570		
	PBM PAYNES BOLT	1964	7.9148	25.9672	-0.0132	-0.0433
58.	M 206	1976	8.6963	28.5312		
	M 206	1964	8.7053	28.5607	-0.0191	-0.0627
59.	PBM FOREST	1976	7.4568	24.4646		
	PBM FOREST BOLT	1964	7.4546	24.4573	-0.0079	-0.0259
60.	J 206	1976	8.2630	27.1096		
	J 206	1964	8.2801	27.1657	-0.0272	-0.0892
61.	G 206	1976	8.9809	29.4649		
	G 206	1964	9.0136	29.5722	-0.0428	-0.1404
62.	F 206	1976	8.5883	28.1768		
	F 206	1964	8.6342	28.3274	-0.0560	-0.1837
63.	E 206	1976	9.5705	31.3993		
	E 206	1964	9.6342	31.6083	-0.0738	-0.2421
64.	PBM POPLAR GROVE	1976	8.3258	27.3156		
	PBM POPLAR GROVE	1964	8.3631	27.4380	-0.0474	-0.1555
	PBM POPLAR GROVE	1929	8.5784	28.1443		
65.	D 206	1976	8.8027	28.8802		
	D 206	1964	8.8380	28.9987	-0.0462	-0.1516

PART 14
Ramah to Port Allen
(Fig. 8)

PART 14

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
1.	J 217	1976	5.1009	16.7352		
	J 217	1965	5.0503	16.5652	-0.0382	-0.1253
2.	N 217	1976	5.1621	16.9360		
	N 217	1965	5.0758	16.6660	-0.0065	-0.0213
3.	H 217	1976	4.2423	13.5182		
	H 217	1965	4.1655	13.6663	-0.0120	-0.0394
4.	G 217	1976	4.2420	13.5173		
	G 217	1965	4.1747	13.6965	-0.0215	-0.0705
5.	G 18	1976	6.5550	21.5055		
	G 18	1965	6.4976	21.3176	-0.0314	-0.1030
	G 18	1934	6.6733	21.8940		
6.	F 217	1976	4.4050	14.4652		
	F 217	1965	4.3574	14.2959	-0.0372	-0.1220
7.	H 18	1976	4.6853	15.3048		
	H 18	1965	4.6556	15.2074	-0.0591	-0.1939
	H 18	1934	4.9679	16.2985		
8.	K 217	1976	4.2188	13.8412		
	K 217	1965	4.1854	13.7447	-0.0594	-0.1949
9.	PJH TT 41	1976	5.1022	16.7395		
	PJH TT 41	1965	5.0434	16.5466	-0.0300	-0.0984
10.	D 217	1976	4.1309	13.5528		
	D 217	1965	4.0549	13.3035	-0.0128	-0.0420
11.	C 217	1976	5.8355	19.1585		
	C 217	1965	5.8511	19.1965	-0.1004	-0.3294
12.	B 217	1976	4.6357	15.2090		
	B 217	1965	4.5875	15.0505	-0.0406	-0.1332
13.	A 217	1976	5.1154	16.7959		
	A 217	1965	5.0817	16.6722	-0.0511	-0.1677
14.	Z 216	1976	5.8856	19.2572		
	Z 216	1965	5.8292	19.1247	-0.0484	-0.1588
15.	NN 17	1976	6.4950	21.3222		
	NN 17	1965	6.4556	21.1929	-0.0494	-0.1621
	NN 17	1934	6.7071	22.0049		
16.	MM 17	1976	7.4562	24.4626		
	MM 17	1965	7.4260	24.3661	-0.0594	-0.1949
	MM 17	1934	7.6827	25.2057		
17.	PBM OAKS	1976	7.4291	24.3737		
	PBM OAKS BOLT	1964	7.3858	24.2316	-0.0455	-0.1493
	PBM OAKS BOLT	1929	7.6806	25.1988		

PART 5
Lottie to 6.8 Miles West of Krotz Springs
(Fig. 9)

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
1.	P 234	1976	9.3022	30.5190		
	P 234	1966	9.1756	30.1037	-0.0564	-0.1850
2.	PBM SHUSTER	1976	9.4066	30.8615		
	PBM SHUSTER	1966	9.3090	30.5413	-0.0854	-0.2802
	PBM SHUSTER	1929	9.7789	32.0830		
3.	PBM IJ BOLT	1976	7.5950	24.9180		
	PBM IJ BOLT	1966	7.7359	25.3802	-0.3239	-1.0627
	PBM IJ BOLT	1929	7.6250	25.0164		
4.	PBM MELVILLE USE	1976	10.0640	33.0184		
	PBM MELLVILLE CAP	1966	9.9386	32.6069	-0.0576	-0.1890
	PBM MELLVILLE CAP	1929	10.1031	33.1467		
5.	R 234	1976	16.5053	54.1512		
	R 234	1966	16.4089	53.8350	-0.0866	-0.2841
6.	T 234	1976	9.7567	32.0102		
	T 234	1966	9.6194	31.5597	-0.0457	-0.1499

PART 3
Simmesport to Krotz Springs
(Fig. 10)

Index No.	Benchmark	Year	Observed (meters)	Elevation (feet)	Computed Elevation Difference (meters)	Computed Elevation Difference (feet)
1.	B 206	1976	6.8463	22.4616		
	B 206	1964	6.7446	22.1279	0.0129	0.0423
2.	Z 205	1976	6.1705	20.2444		
	Z 205	1964	6.0619	19.8881	0.0198	0.0650
3.	Y 205	1976	9.1615	30.0574		
	Y 205	1964	9.0772	29.7808	-0.0045	-0.0148
4.	X 205	1976	13.0603	42.8487		
	X 205	1964	12.9753	42.5699	-0.0038	-0.0125
5.	W 205	1976	14.0000	45.9317		
	W 205	1964	13.9062	45.6240	0.0050	0.0164
6.	V 205	1976	14.5118	47.6109		
	V 205	1964	14.4146	47.2920	0.0084	0.0276
7.	U 205	1976	14.3747	47.1611		
	U 205	1964	14.3202	46.9823	-0.0343	-0.1125
8.	T 205	1976	14.5290	47.6673		
	T 205	1964	14.4324	47.3504	0.0078	0.0256
9.	S 205	1976	14.3633	47.1237		
	S 205	1964	14.3424	47.0551	-0.0679	-0.2228
10.	R 205	1976	6.8572	22.4974		
	R 205	1964	6.8219	22.3816	-0.0535	-0.1755
11.	U 201	1976	8.1008	26.5774		
	U 201	1965	8.0722	26.4836	-0.0602	-0.1975
12.	P 206	1976	12.9367	42.4432		
	P 205	1966	12.8856	42.2756	-0.0377	-0.1237
	P 205	1965	12.8858	42.2762		
	P 205	1964	12.8868	42.2795		
13.	N 205	1976	15.4266	50.6122		
	N 205	1966	15.3987	50.5207	-0.0609	-0.1998
	N 205	1964	15.3998	50.5243		
14.	M 205	1976	7.6603	25.1322		
	M 205	1964	7.6480	25.0919	-0.0765	-0.2510
15.	K 205	1976	7.5990	24.9311		
	K 205	1964	7.5715	24.8409	-0.0613	-0.2011
16.	PBM 9 BOLT	1976	5.7103	18.7346		
	PBM 9 BOLT	1964	5.6728	18.6115	-0.0513	-0.1683
	PBM 9 BOLT	1929	5.9048	19.3727		
17.	3681 LAGS	1976	7.2769	23.8743		
	3681 LAGS	1964	7.2284	23.7152	-0.0403	-0.1322
18.	3680 LAGS	1976	7.2352	23.7375		
	3680 LAGS	1964	7.1662	23.5111	-0.0198	-0.0650

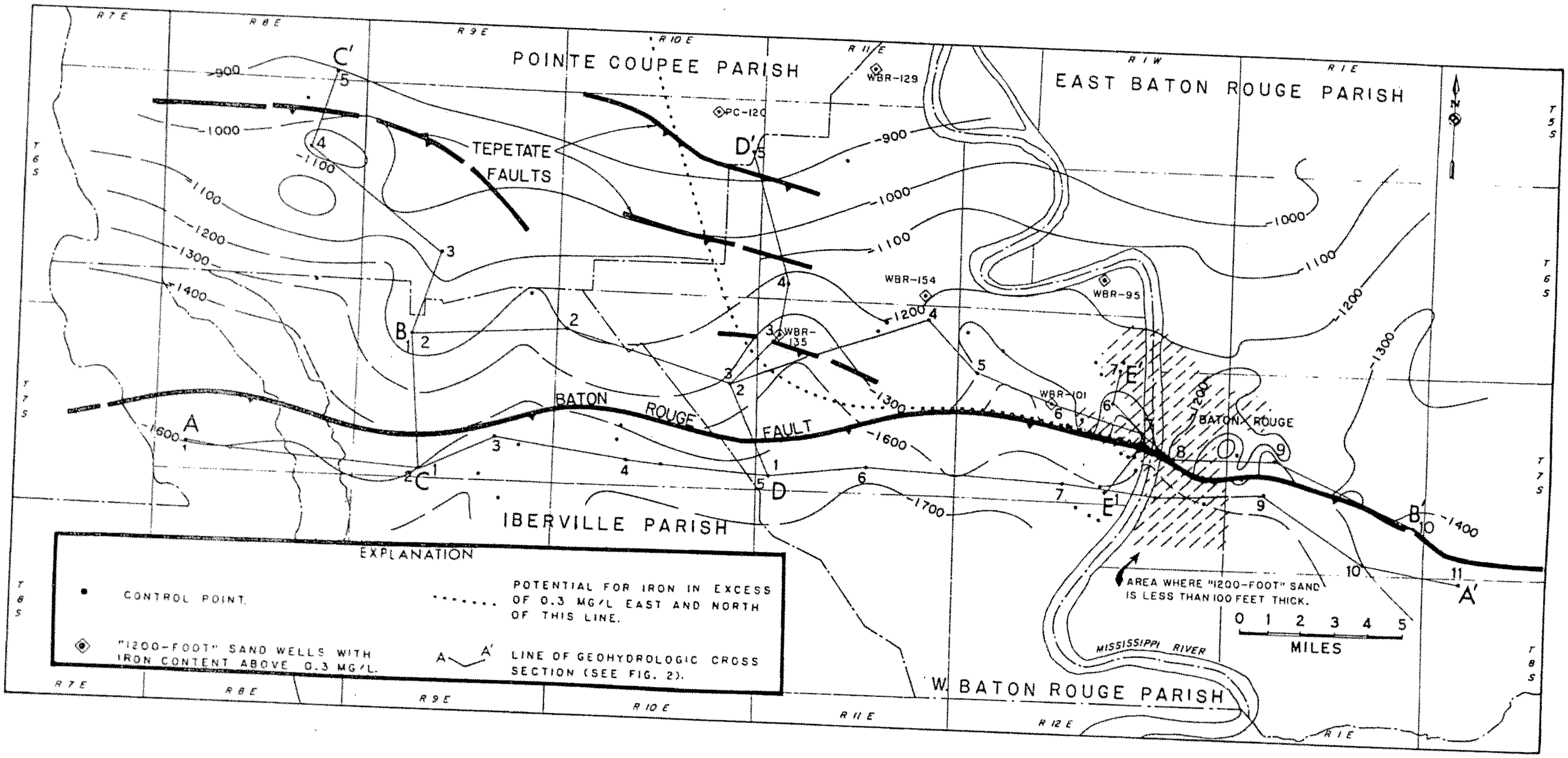

Figure 1. Generalized structure map on the base of the "1,200-foot" sand. (Datum-mean sea level)

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.

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[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).

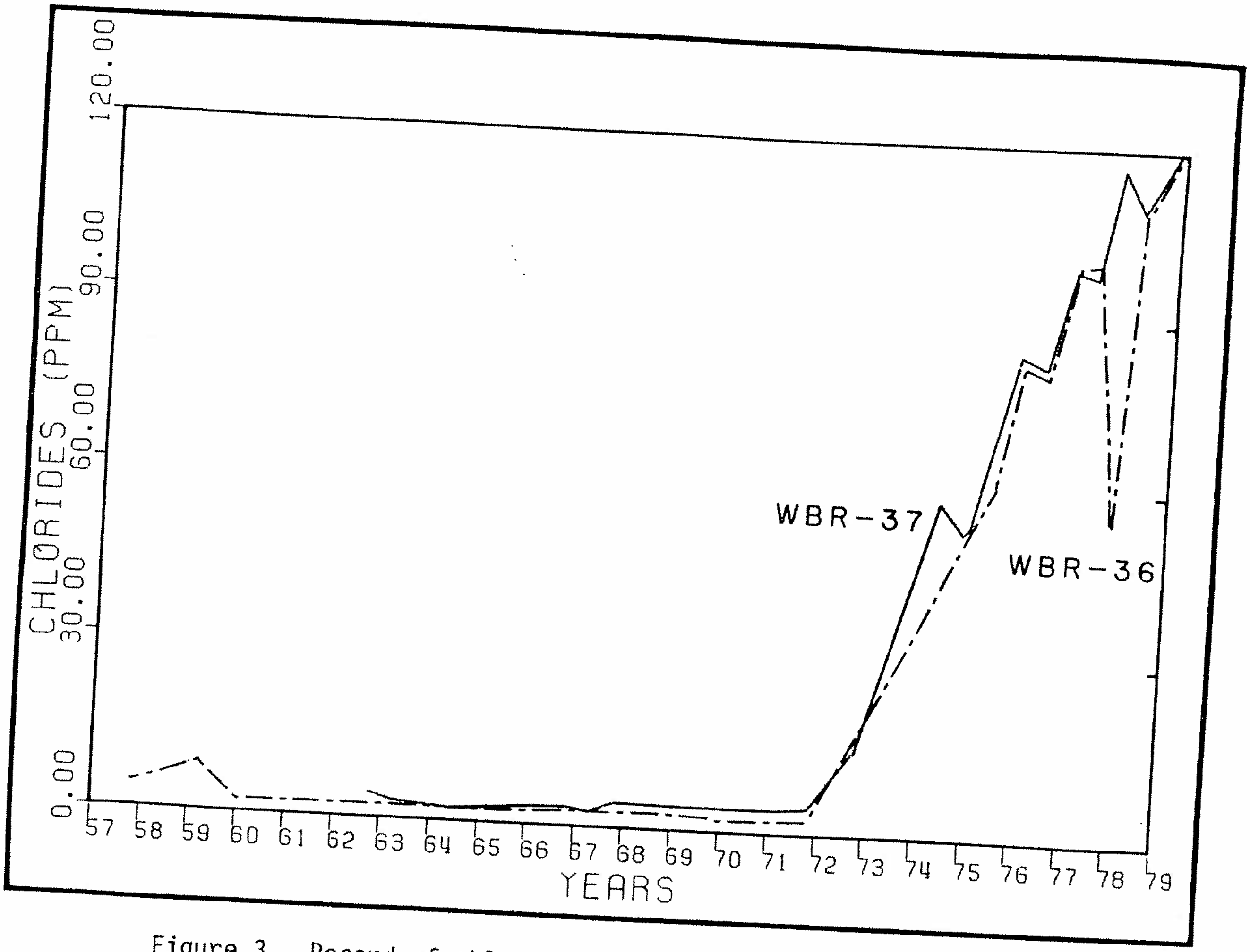

Figure 3. Record of chloride concentration changes in the Greater Baton Rouge Port Commission wells WBR-36 and WBR-37.

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).

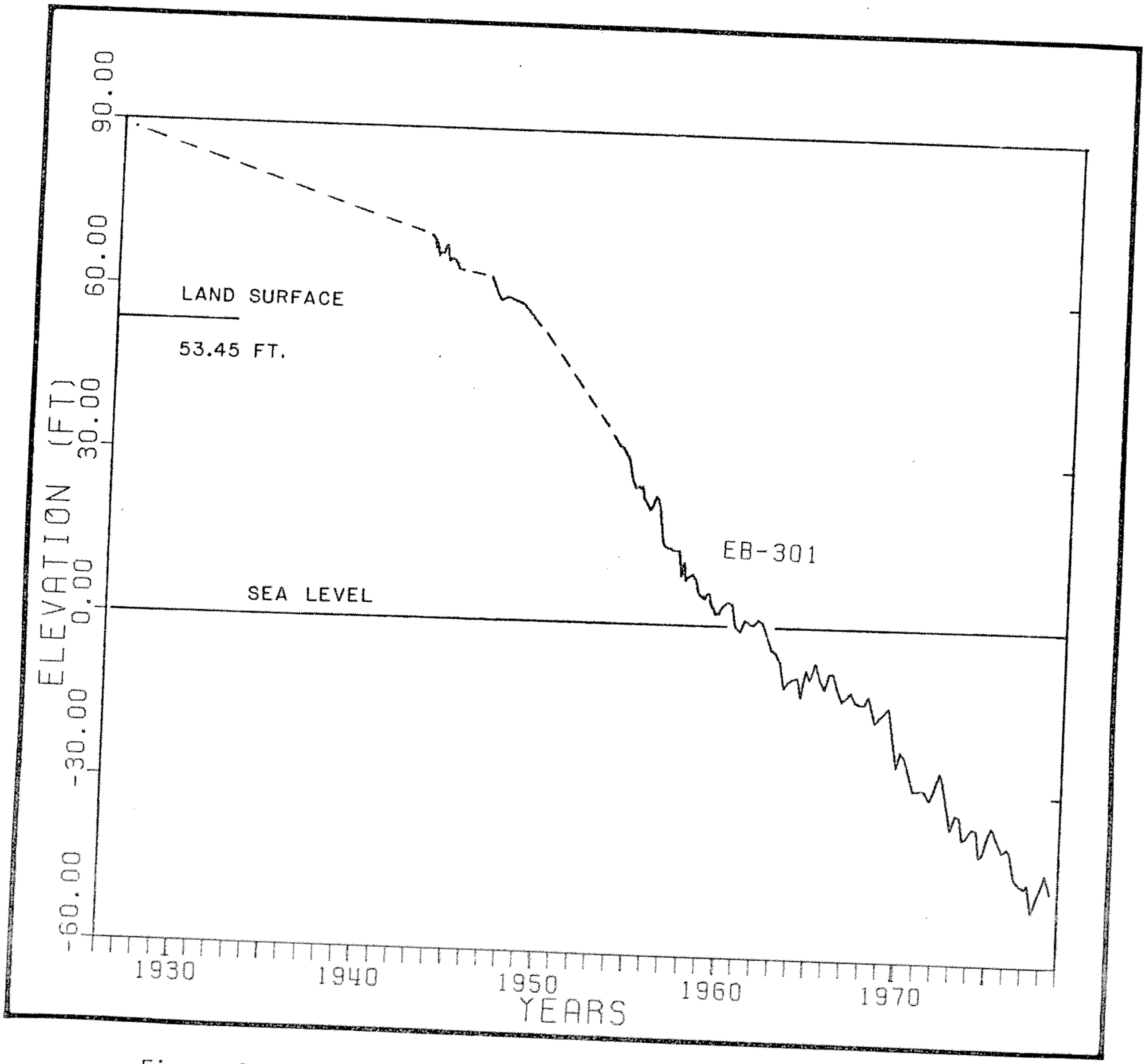

Figure 4. Water level trend in the "1,200-foot" sand at well EB-301 (see Figure 5 for location).

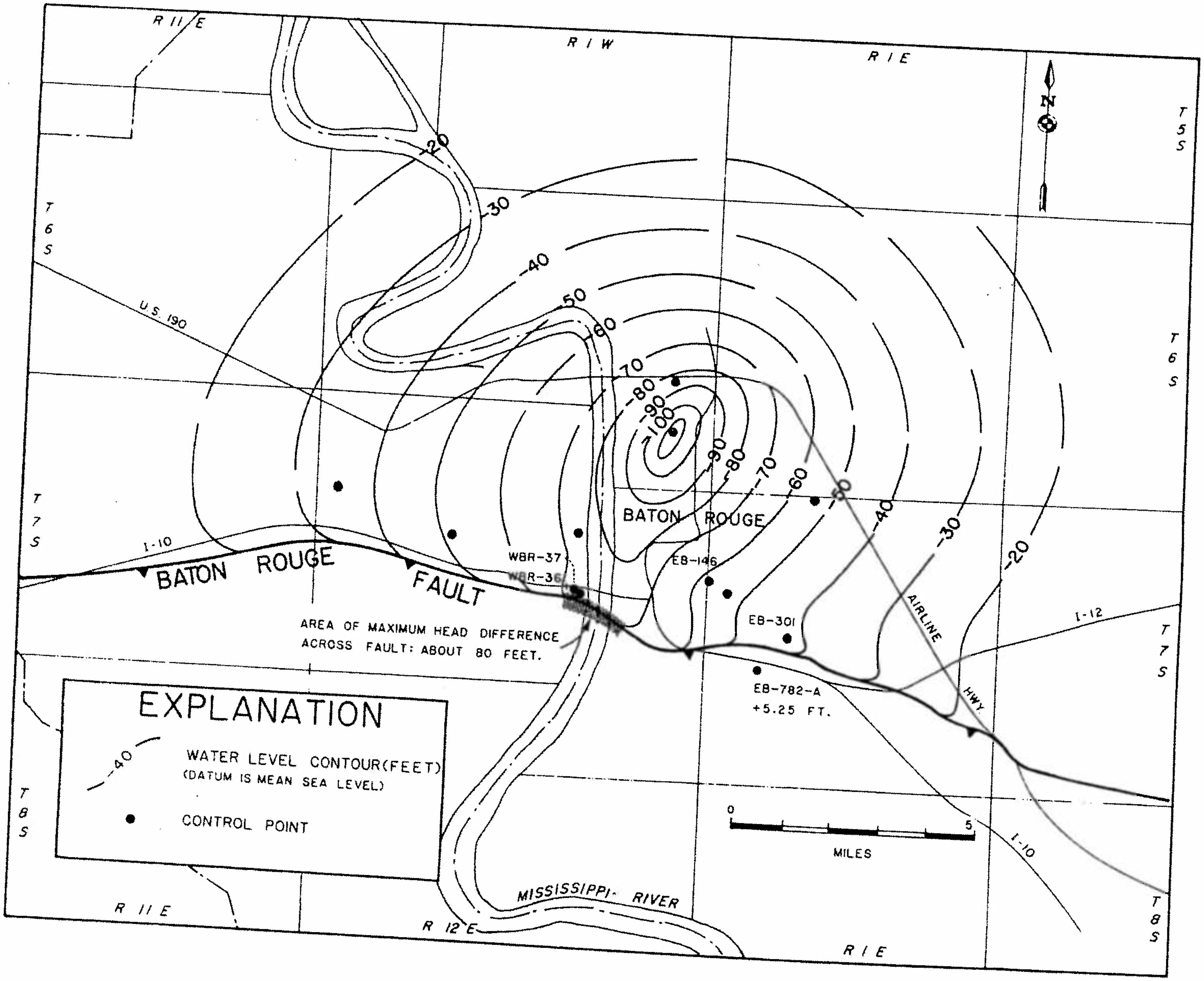

Figure 5. Potentiometric surface of the "1,200-foot" sand, March, 1978.

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.

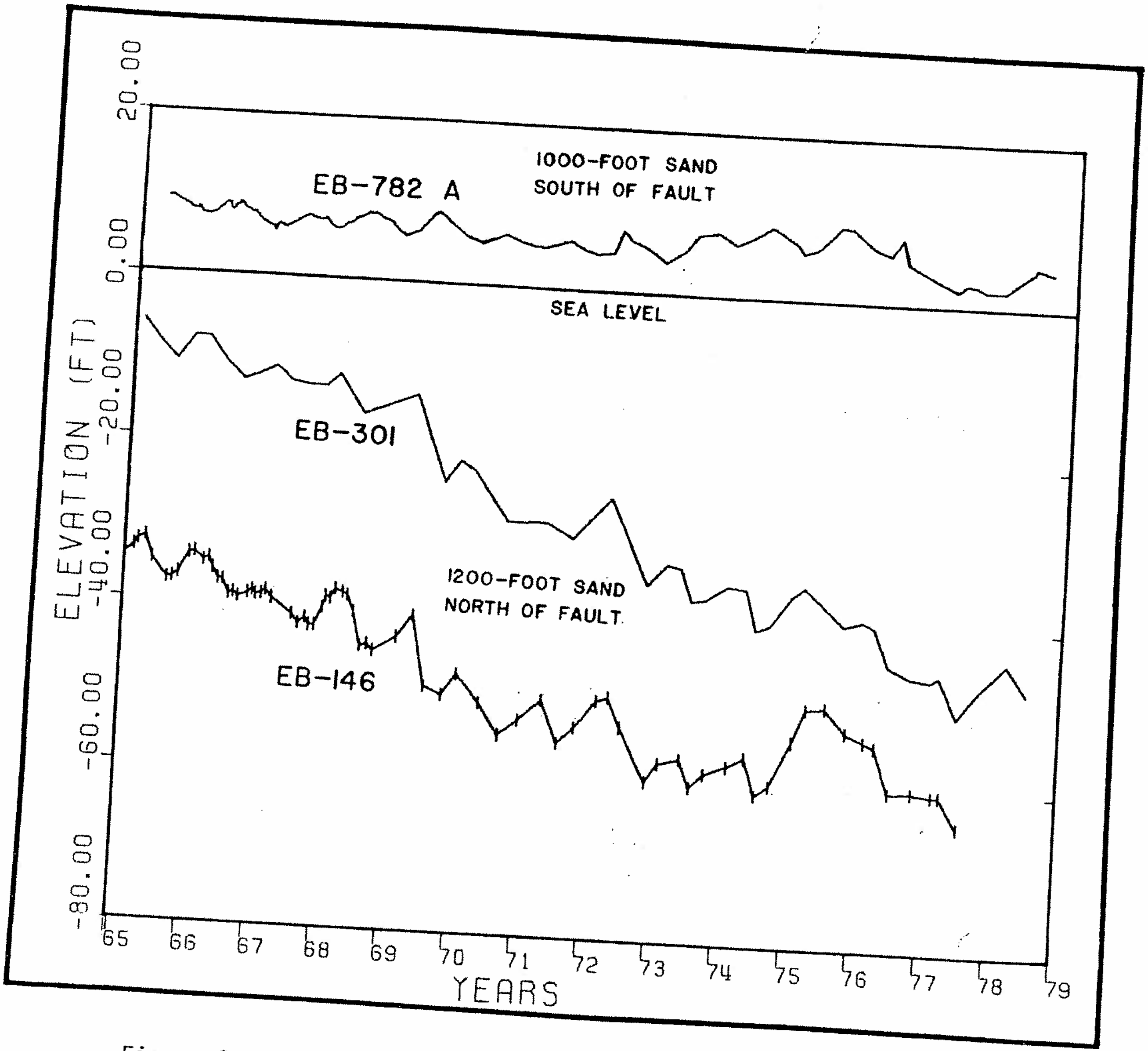

Figure 6. Representative hydrographs of the "1,000-foot" and "1,200-foot" sands (see Figure 5 for well locations).

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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