Circular 180

Ground-Water Levels and Pumpage in the Metro-East Area, Illinois, 1986-1990

by Richard J. Schicht and Andrew G. Buck

Illinois State Water Survey
A Division of the Illinois Department of Natural Resources

1995

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Ground-water levels throughout the entire area were stable but elevated during 1986 and 1987. Water levels declined from 1988 to 1989 and increased in 1990. Factors contributing to this pattern were above-normal precipitation, the Midwestern drought of 1988-1989, changes in river stages, and the response of water levels to annual pumpage changes.

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Indexing Terms: Metro-East area, ground water, public water supplies, industrial water supplies, water levels, water-level changes, pumping, ground-water withdrawals.

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ABSTRACT

This report discusses ground-water levels and pumpage in the Metro-East area just south of Alton, Illinois, to Dupo, Illinois, and between the Mississippi River and the river bluffs from 1986-1990. Large quantities of ground water, primarily for industrial and municipal use, are withdrawn from wells penetrating a sand-and-gravel aquifer along the valley lowlands of the Mississippi River.

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INTRODUCTION

Previous Illinois State Water Survey (ISWS) reports have referred to the area from just south of Alton, Illinois, to Dupo, Illinois, and between the Mississippi River and the river bluffs (figure 1) as the East St. Louis area. Starting with this report, however, the area will be referred to as the Metro-East area, a more common description of the area by local and regional planning agencies. The ground-water resources of a sand-and-gravel aquifer underlying the area, one of the most heavily populated and industrialized areas in Illinois, have been developed extensively. It is estimated that during 1990, 58.7 mgd were withdrawn, primarily for industrial and municipal use.

A period of intensive data collection was initiated in 1941 after local industries observed alarming water-level recessions, culminating in ISWS Report of Investigation 51 (Schicht, 1965). The report describes in detail the ground-water resources of the area. Several previous reports have summarized water levels and pumpage in the area, which aided in the preparation of Report of Investigation 51 (Bruin and Smith, 1953; Schicht and Jones, 1962). Ground-water geology of the area had been described previously by the Illinois State Geological Survey (Bergstrom and Walker, 1956).

Report of Investigation 51 included an estimate of the aquifer yield of the sand-and-gravel aquifer based on a pumping center configuration described in the same report. This yield (188 mgd) was never realized due to the area's general economic decline and shifts in pumpage to the Mississippi River.

Data collection was originally continued to validate the predictions of Report of Investigation 51 and to delineate problem areas and now monitors the effects of rising ground-water levels and shifts in pumpage. Additional data will also be useful in calibrating and revising the digital computer ground-water model developed by Ritchey, Schicht, and Weiss (1984). In recent years, Water Survey staff have conducted studies related to ground-water contamination, and continued data collection at the scale described in this report is a valuable supplement to data collected for these contamination studies.

With the completion of the Mel Price Lock and Dam located 1.6 miles down river from the old lock and dam at Alton, it is important to continue monitoring water levels and pumpage just south of Alton to determine the effects, if any, on water levels in the area. Previous summaries of pumpage and water levels have been published (Reitz, 1968; Baker, 1972; Emmons, 1979; Collins and Richards, 1986; Kohlhase, 1987). This report summarizes water-level and pumpage data collected from 1986-1990.

Acknowledgments

This report was prepared under the direction of Adrian P. Visocky, Director of the Office of Ground-Water Resources Evaluation & Management. The authors gratefully acknowledge the assistance of Mark Sievers in providing computer-generated maps and tables, which were used in the preparation of the potentiometric maps. Kristopher Klindworth and John Blomberg provided data used to estimate ground-water withdrawals, Ellis Sanderson and Robert Olson helped interpret data from the highway dewatering sites, and Mr. Sanderson reviewed the final report and provided much useful advice. Linda Hascall prepared the illustrations, Pamela Lovett provided word processing expertise, and Eva Kingston did the final editing and layout. Special thanks go to those who participated in the water-level data collection efforts: Stuart Cravens, Ken Hlinka, Ellis Sanderson, Robert Olson, and Scott Meyer. The U.S. Army Corps of Engineers office in St. Louis provided information on Mississippi River stages and general information on dewatering at the Mel Price Lock and Dam.

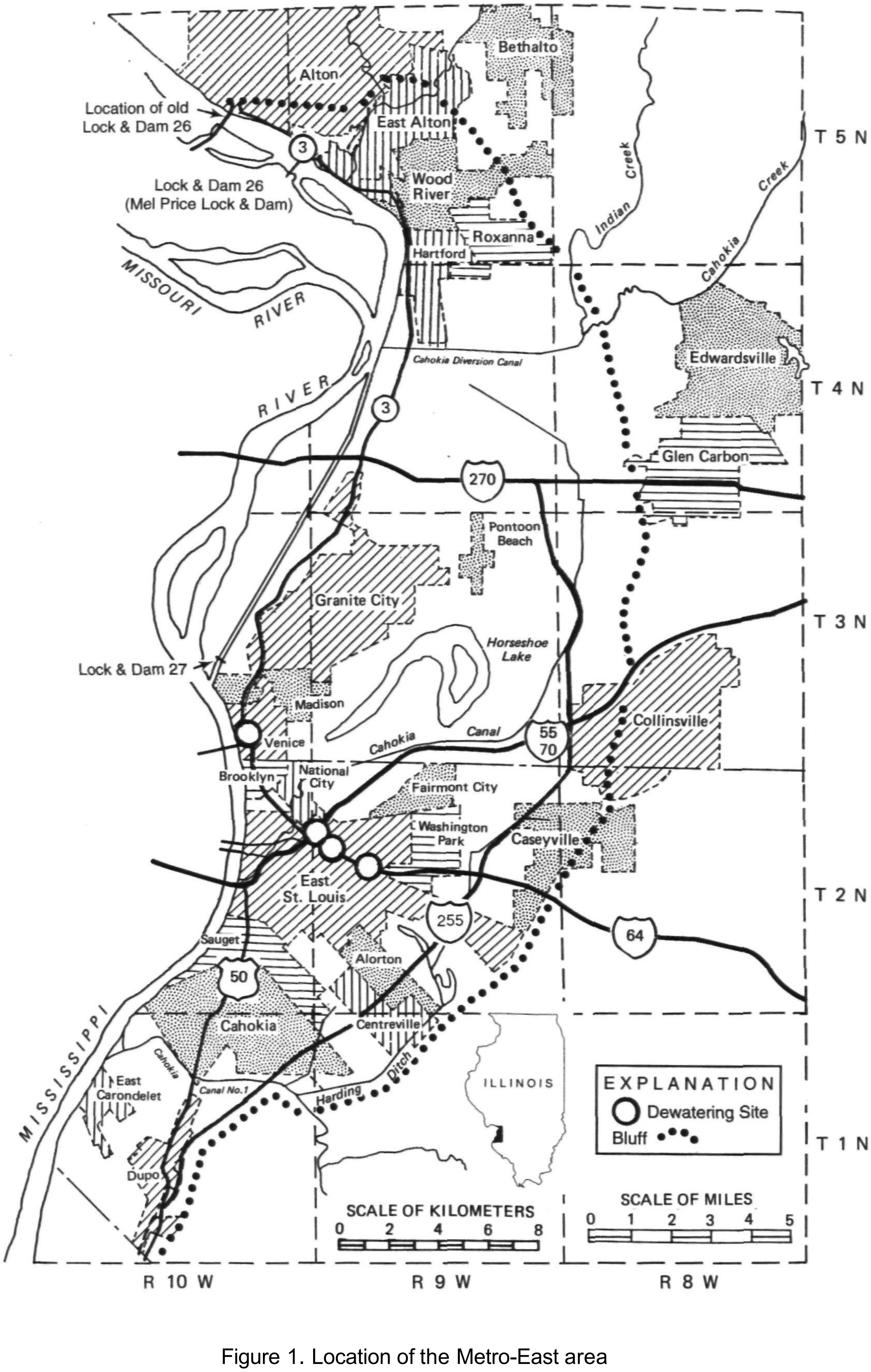


Figure 1. Location of the Metro-East area

GEOLOGY AND HYDROLOGY

Large supplies of ground water, mainly for industrial use, are withdrawn from wells finished in the permeable sand-and-gravel deposits in the unconsolidated valley fill in the Metro-East area. According to Bergstrom and Walker (1956), the valley fill is composed of recent alluvium and glacial valley-train material underlain by Mississippian and Pennsylvanian rocks of low permeability. Because of the bedrock's low permeability and poor water quality with depth, it is not an important aquifer in the area.

The valley fill averages 120 feet in thickness. The thickness is greatest, 170 feet, near the city of Wood River. Near the bluffs there are bedrock outcrops. Generally, the thickness of the valley fill is greatest and exceeds the average in places near the center of a buried bedrock valley that longitudinally bisects the area, as shown in figure 2. The valley fill becomes progressively coarser with depth, and the coarsest deposits most favorable for development are commonly encountered near bedrock and often average between 30 and 40 feet in thickness.

Ground water in the valley fill occurs under leaky artesian and water-table conditions. Because ground water occurs under leaky artesian conditions in most places, the surface to which water rises in wells is referred to as the potentiometric surface in this report.

Recharge within the Metro-East area is from precipitation, infiltration of surface water from the Mississippi River and lesser water bodies in the area, and subsurface flow from the bluffs bordering the area. A fraction of the annual precipitation seeps downward through surface materials and into the valley fill material. Recharge by the river and other water bodies in the area occurs where the potentiometric surface elevation is lower than surface water elevations. Pumping centers adjacent to the river maintain ground-water levels well below the river stage, inducing large quantities of river water into these pumping centers.

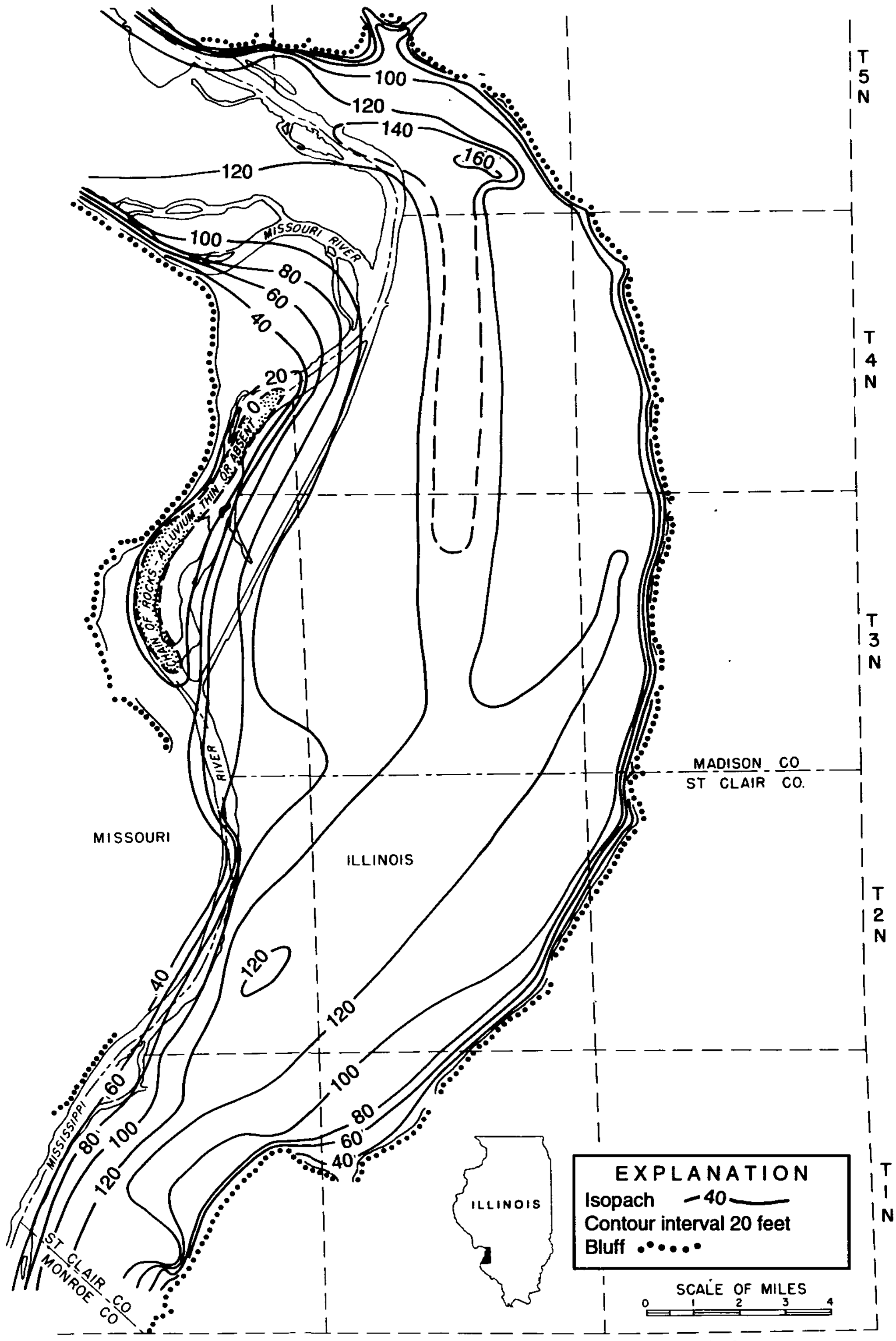


Figure 2. Thickness of valley fill deposits

PUMPAGE FROM WELLS

The first significant withdrawal of ground water in the Metro-East area started in the late 1890s. Estimated pumpage from wells increased from 2.1 mgd in 1900 to 111.0 mgd in 1956, as shown in figure 3. Pumpage declined sharply to 92 mgd in 1958 and then increased to 110.0 mgd in 1964. After 1966, pumpage declined steadily to 54.4 mgd in 1981. By 1990, pumpage had increased slightly to 58.7 mgd. Pumpage would have been significantly less had it not been for dewatering wells maintained by the Illinois Department of Transportation (IDOT) along roadways in the area to prevent water levels from rising above the road surface. Withdrawals for dewatering began in 1963, and an estimated 11.2 mgd was pumped from dewatering wells during 1990. Figure 1 shows locations of dewatering sites, and more recent information on these dewatering sites is available (Sanderson and Olson, 1993).

Within this report pumpage data are classified according to four categories: 1) *public,* including municipal and institutional; 2) *industrial,* including dewatering; 3) *domestic,* including rural farm nonirrigation and rural nonfarm; and 4) *irrigation,* including farms, golf courses, and cemeteries. Most water-supply systems furnish water for multiple uses. A public supply commonly includes water used for drinking and other domestic uses, manufacturing processes, and lawn sprinkling. Industrial supplies may also be used in part for drinking and other domestic uses. No attempt has been made to determine the final use of water within the public and domestic categories; for example, any water pumped by a municipality is called a public supply, regardless of the use of the water. However, the final use of the water within the industrial category has been determined in part, and any water pumped by an industry and furnished to a municipality is included in the public category.

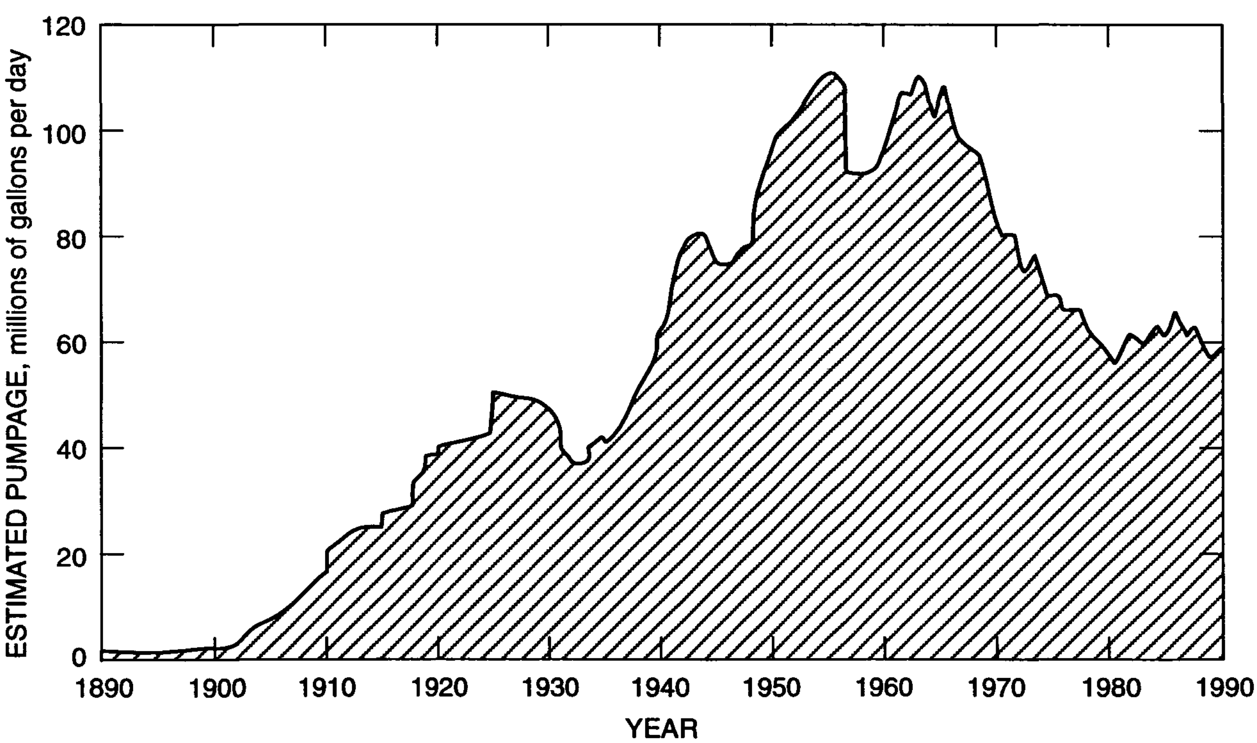


Figure 3. Estimated pumpage, 1890-1990

Pumpage, 1986-1990

Table 1 shows total pumpage, including all water use categories for the period 1986-1990. Total pumpage declined from 62.8 mgd in 1986 to 58.7 mgd in 1990. Distribution of 1990 pumpage is as follows: public supply systems (20.8 percent or 12.2 mgd), industrial pumpage (76.2 percent or 44.7 mgd), domestic pumpage (1.0 percent or 0.6 mgd), and irrigation pumpage (2.0 percent or 1.2 mgd).

Public Supplies. Municipal and institutional uses are included in public supplies. Pumpage for institutional use in the area has been negligible, however. Figure 4 shows the estimated pumpage for public supplies, which averaged 12.2 mgd for each year except 1988 when it was 13.3 mgd.

Pumpage of public supplies reflects seasonal variations to some extent. For example, municipal pumpage is generally 25 to 30 percent higher during the summer months than during the winter months because of lawn sprinkling, car washing, and other summer use of water.

Industrial Supplies. The major industrial users of ground water in the Metro-East area include oil refineries, chemical plants, ore refineries, meat packing plants, and steel plants. With its system of dewatering wells, IDOT is a major industrial user. Most industries do not meter their pumpage, and pumpage estimates are typically based on the number of hours the pump operated, on pump capacity, and in some cases on production capacity. Industrial pumpage generally is more uniform throughout the year than public pumpage unless large air-conditioning systems are used, the industry is seasonal, or a change in operation occurs as a result of strikes or vacation shutdowns. Industrial pumpage (figure 4) declined from 49.2 mgd in 1986 to 44.7 mgd in 1990.

Domestic Supplies. Estimates of domestic pumpage considered rural populations as reported by the U.S. Bureau of the Census and the per capita use of 84 gallons per day (gpd) used by Kohlhase (1987). On the basis of this per capita use, average domestic use in 1990 was estimated to be 600,000 gpd.

Irrigation Supplies. In 1989, a questionnaire was mailed to all known irrigators in the Metro-East area requesting information for 1988 on number of acres irrigated, type of crop irrigated, frequency of irrigation, and quantity of water applied. Based on the survey results, it was estimated that an average of about 0.7 mgd of ground water was withdrawn for irrigation during 1988. Respondents included 18 farmers who irrigated a total of 2000 acres. Estimated irrigation was 0.8 mgd in 1986 and 1989,1.2 mgd in 1990, and less than 0.1 mgd in 1987, based on June-August rainfall measured at Belleville (table 2).

Table 1. Annual Pumpage (mgd), 1986-1990

Year	*Pumpage*
1986	62.8
1987	60.4
1988	61.6
1989	58.1
1990	58.7

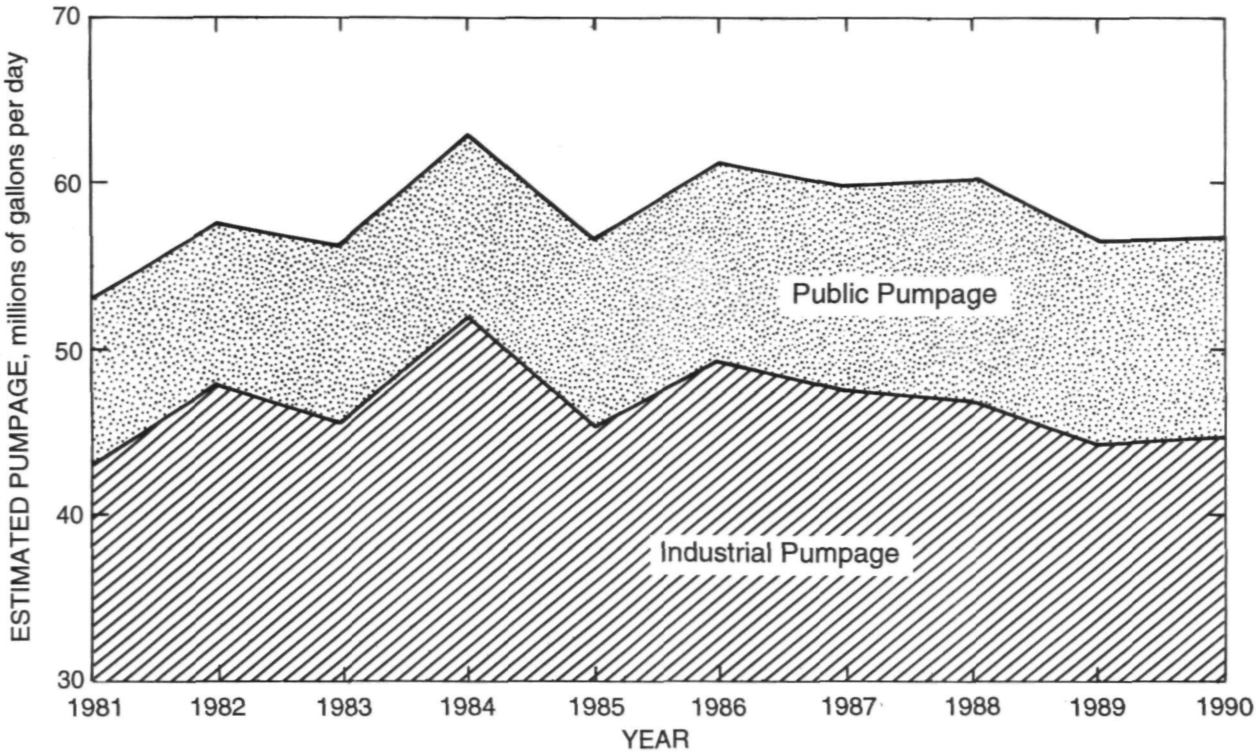


Figure 4. Estimated industrial and public pumpage, 1981-1990

Table 2. Rainfall (inches) June-August 1986-1990

Year	*Rainfall*
1986	11.45
1987	17.38
1988	10.10
1989	9.32
1990	5.82

Dewatering Pumpage during Construction of Mel Price Lock and Dam. Large quantities of ground water were withdrawn in the Alton area because of dewatering activities during construction of the Mel Price Lock and Dam. The Corps of Engineers estimated that withdrawals during the third phase of construction near the Illinois shore averaged 78,000 gallons per minute (gpm). A significant part of this pumpage was from ground water. Phase 3 began on May 31,1990, and concluded in January 1993. Dewatering during phase 1 (1980-1984) was for a cofferdam on the Missouri side of the river. Dewatering during phase 2 (1985-1988) was for a cofferdam in the middle of the river. Based on available information, it is not possible to determine the ratio of river water to ground water pumped during dewatering operations.

Distribution of Pumpage

Figure 5 shows the distribution of the 1990 pumpage and locations of the pumping centers. Pumpage in the area is concentrated at five major pumping centers (Alton, Wood River, Roxana, National City, and Granite City) and four minor pumping centers (Poag, Glen Carbon, Collinsville, and Venice).

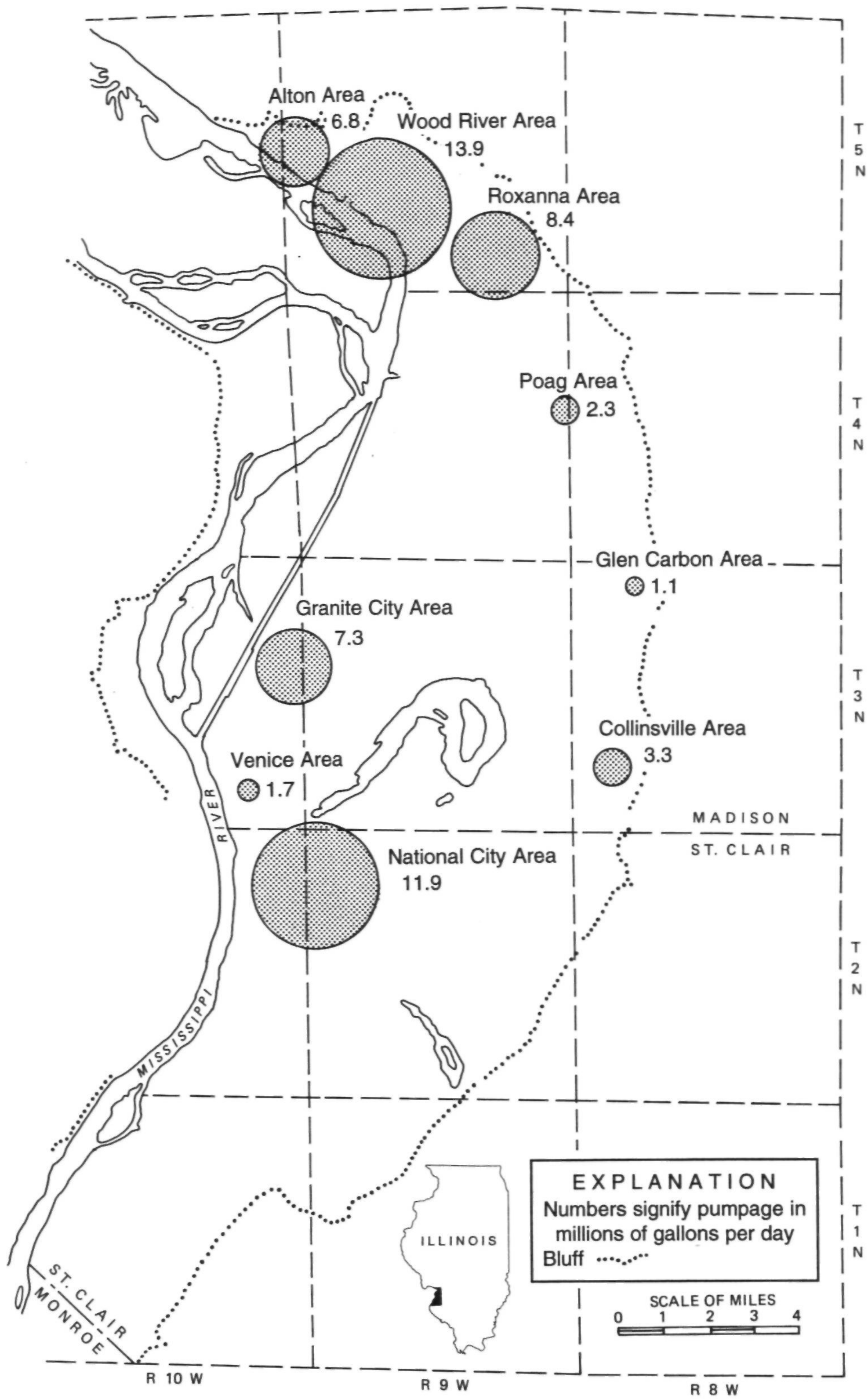


Figure 5. Distribution of estimated pumpage, 1990

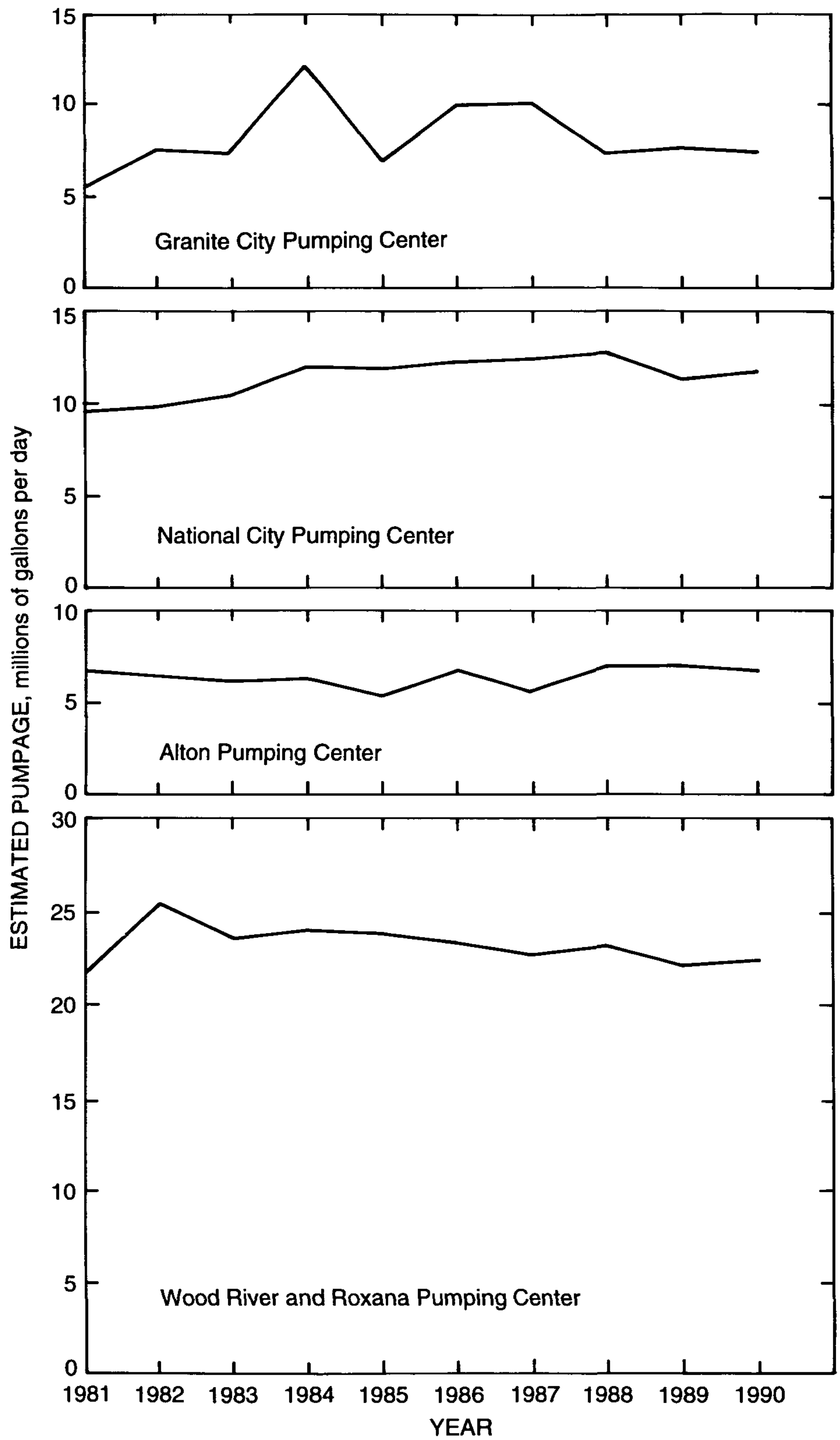


Figure 6. Estimated pumpage at major pumping centers, 1981-1990

Previous reports have included pumpage from the highway dewatering site at Venice in the total for National City. Sauget is no longer listed as a minor pumping center (Kohlhase, 1987), and pumpage there was negligible in 1990.

Figure 6 shows pumpage for 1981 -1990 for each major pumping center. Ground-water withdrawals in the Alton area are primarily from wells owned by two industries and a municipality. During the 1986-1990 period pumpage at Alton varied from 6.7 mgd to 7.0 mgd, except during 1987 when pumpage was only 5.6 mgd because of reduced industrial activity.

The Wood River/Roxana area is the largest pumping center in the Metro-East area. Annual pumpage during 1986-1990 was fairly stable, varying from 22.3 mgd to 23.3 mgd. Pumpage in the Wood River/Roxana area is mainly for oil refineries and municipalities.

Ground-water pumpage in the Granite City area was about 10 mgd in 1986 and 1987. Pumpage declined to 7.4 mgd in 1988 and was 7.3 mgd in 1990. Steel production industries are the major ground-water users in the area.

Ground-water withdrawals in the National City area are mainly from wells at the interstate dewatering sites shown in figure 1 and at a paint pigment plant. Withdrawals for the meat packing industry, formerly large users, averaged only about 0.25 mgd in 1990. Since the goal of the dewatering sites is to maintain the ground-water elevations within the pumping centers at a relatively constant elevation, pumpage from wells at the sites fluctuates in response to changes in river stages, changes in recharge from precipitation, and changes in ground-water pumpage in the vicinity of the sites. Pumpage for the 1986-1990 period was highest in 1988 (12.8 mgd) and lowest (11.5 mgd) in 1989.

Figure 7 shows combined pumpage for the minor pumping centers. Except for the dewatering site at Venice, pumpage from these centers was mainly by municipalities. Pumpage for the period was highest (9.7 mgd) in 1989 and lowest (8.6 mgd) in 1990.

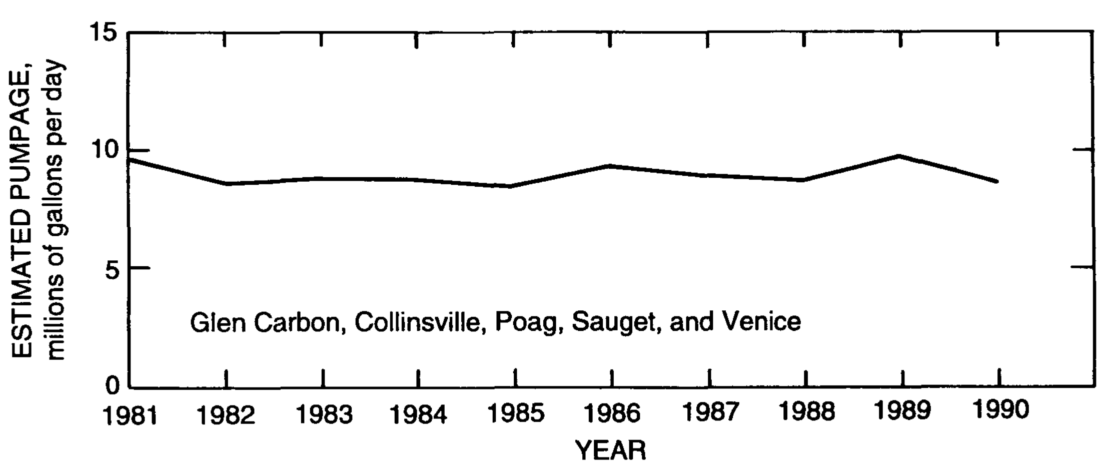


Figure 7. Estimated pumpage at minor pumping centers, 1981-1990

WATER LEVELS IN WELLS

Water levels in wells in the Metro-East area have been measured periodically for more than 50 years by the Illinois State Water Survey and others from the public and private parties. Figure 8 shows the locations of ISWS observation wells active from 1986-1990.

Water levels in wells generally recede in late spring, summer, and early fall when one, or a combination of the following, exceeds recharge from precipitation and infiltration induced from surface water bodies:

a) discharge from the ground-water reservoir by evapotranspiration
b) discharge of ground water to streams and lakes
c) discharge of ground water by pumpage

Ground-water levels generally begin to recover in early winter when conditions are favorable for recharge from precipitation. Recovery of ground-water levels is especially pronounced during the spring months when precipitation recharge exceeds evapotranspiration and discharge to streams, resulting in most of the annual recharge to the aquifer.

The water level measured in a well at a particular time reflects not only seasonal variation, but also factors such as recent climatic conditions, nearby pumpage, and the water levels of nearby surface water bodies. Figure 9(a-d) shows the average monthly high and low water levels observed during the period of record for four wells located in the Metro-East area. These graphs indicate that ground-water levels are usually highest from April to June and lowest in September, October, and November. The graphs also reveal the influence of nearby hydrologic features.

Well MAD3N9W-16.8a is located approximately 2000 feet from Horseshoe Lake. The north and eastern end of Horseshoe Lake can be considered a ground-water recharge area, whereas the southwestern tip of the lake is a ground-water discharge area. This "flow-through" hydrologic system coupled with man-made flood control systems diverting surface water into and out of the lake contribute to the lake's nearly constant water surface elevation, which in turn limits fluctuations of the surrounding ground-water levels. As a result of these factors, the annual fluctuation at Well MAD3N9W-16.8a is only about one foot (see figure 9a).

Well MAD5N9W-29.5g2, located near the Mississippi River at Alton, is influenced mainly by river stage fluctuations and pumpage (see figure 9b). It is not unusual for ground-water levels at this well to be at land surface or for ponded water to occur during high river stages. Well MAD3N10W-14.4b is located in the west-central part of the area near Chain of Rocks Canal. Water levels in this well have fluctuated on average about 7 to 8 feet annually during the last ten years (figure 9c). This is less than at Well MAD5N9W-29.5g2, probably because of less pumpage influence and because of the stabilizing effect of Lock and Dam No. 27 on river stages. In contrast, Well STC2N9W-26.8f2 is located near the bluff in the southern part of the area and is not greatly affected by pumpage or surface water influence, and the annual fluctuation is about 2 feet (figure 9d).

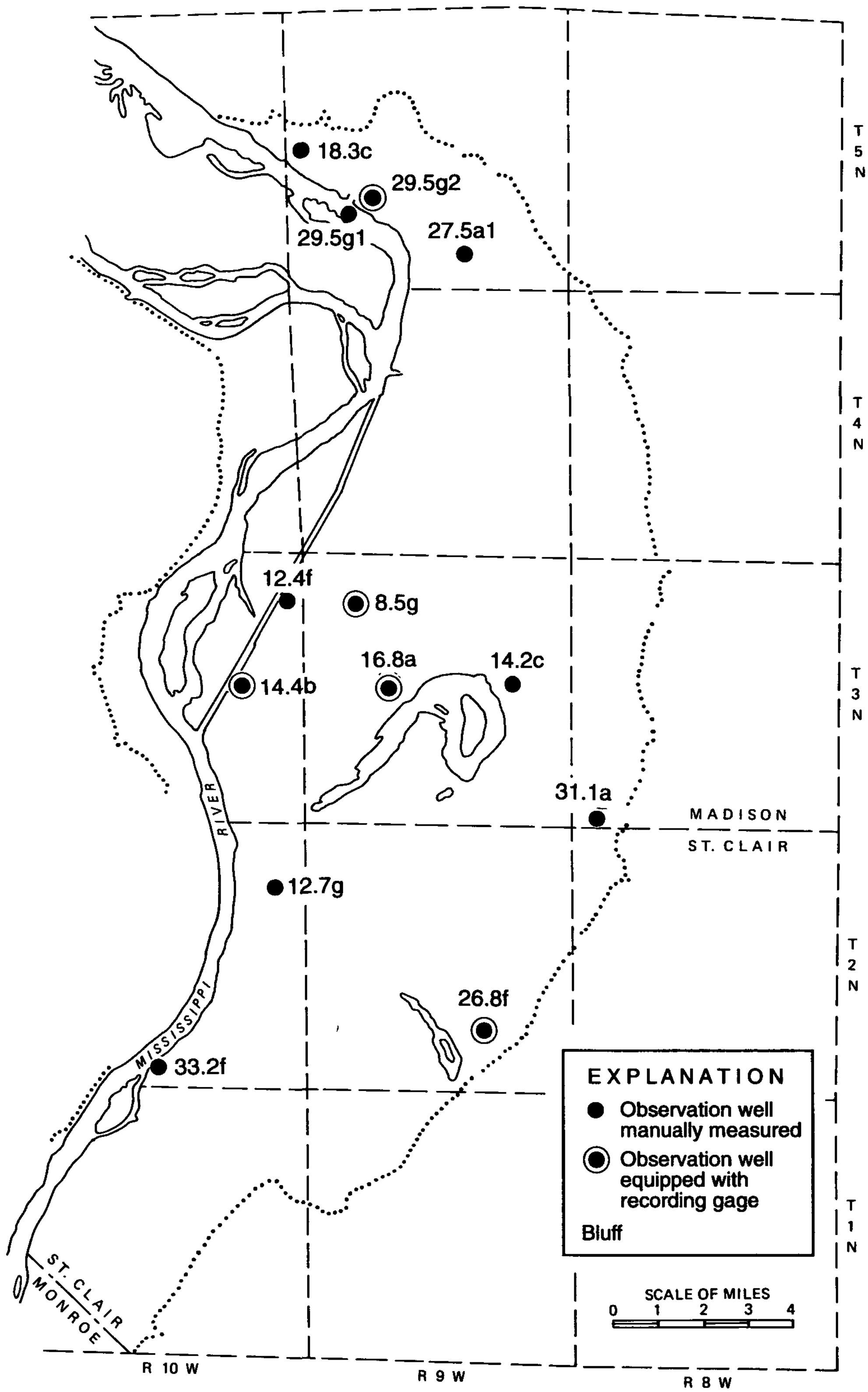


Figure 8. Locations of Illinois State Water Survey observation wells

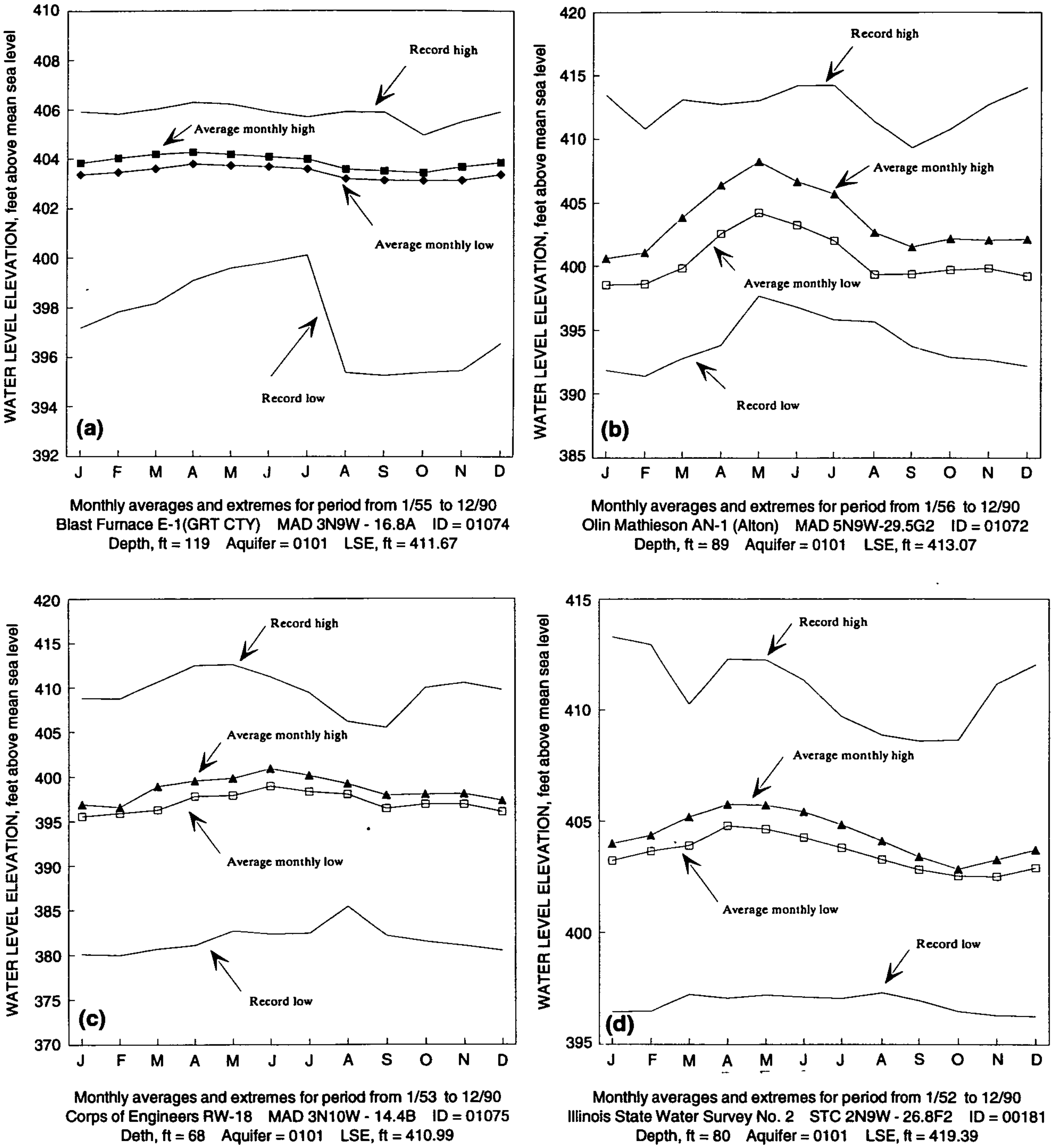


Figure 9. Average and record monthly high and low water levels at four wells in the Metro-East area: a) January 1955-December 1990, b) January 1956-December 1990, c) January 1953-December 1990, and d) January 1952-December 1990

Since 1900, ground-water levels have changed appreciably at the five major pumping centers. According to Schicht and Jones (1962), the greatest water-level declines for the period from 1900 to November 1961 occurred in major pumping: 50 feet in the Sauget area (formerly a major pumping center), 40 feet in the Wood River area, 20 feet in the Alton area, 15 feet in the National City area, and 10 feet in the Granite City area. Part of the declines, 2 to 12 feet, was attributed to the construction of levees and drainage ditches.

Reitz (1968) and Baker (1972) described the changes in ground-water levels from 1962-1971. Ground-water levels generally continued to decline through 1964, but began to rise about 1965 as the effects of decreased pumpage and above-average precipitation and river stages became noticeable.

Ground-water levels generally continued to rise for the period from 1972-1977 (Emmons, 1979). Decreases in pumpage caused ground-water levels to rise 2 feet in the Sauget and Wood River areas and 5 feet in National City. Little change was observed in the Alton and Granite City pumping centers. In Alton, a change of observation wells to a site nearer the center of pumpage obscured the rise in ground-water levels resulting from a decrease in pumpage. Erratic pumpage in the Granite City area produced small observed changes in ground-water levels.

During the period from 1978-1980 ground-water levels outside pumping centers showed little change (Collins and Richards, 1986). Trends established between 1971 and 1977 continued near pumping centers. Decreases in water levels in areas near the Mississippi River were generally due to low river stages. Decreases in water-level elevations of more than 5 feet in the Wood River area, however, were attributed to a change in the spatial distribution of pumpage. Ground-water levels in the Granite City area generally rose in proportion to decreased pumpage. Increased pumpage in the National City area expanded the area of declining ground-water levels near the river. Ground-water levels continued to recover in the Sauget area with reduced pumpage.

The trend in ground-water levels from 1981-1985 was for increasing water levels during 1981 and 1982, with apparent stabilization within an elevated range during 1983-1985 (Kohlhase, 1987). Above-normal precipitation and river stages from 1982-1985, coupled with the response of water levels to annual pumpage changes, were the main factors contributing to this trend in water levels. From 1981-1982, ground-water level increases of as much as 17 feet were observed in the National City and Alton areas, 8 feet to 16 feet in the Granite City region, 12 feet in the Wood River area, and 7 to 14 feet in areas near the bluff. Water levels stabilized at an elevated state after this trend of increasing water levels.

Figure 10 shows the mean monthly Mississippi River stages for the period from 1981-1990, and figure 11 shows the observed annual precipitation for the same period at Belleville (the raingage lies one mile south of Scott Air Force Base). Figure 12 shows hydrographs of selected wells for this period. A single line hydrograph represent water levels for wells at which the water level is measured monthly. A double line represents water levels for wells equipped with continuous recorders; the lines represent the observed monthly high and low ground-water levels.

The hydrographs show that these wells all share a similar fluctuation pattern from 1986-1990, differing only in magnitude of fluctuation. The general trend during this period was for stable water

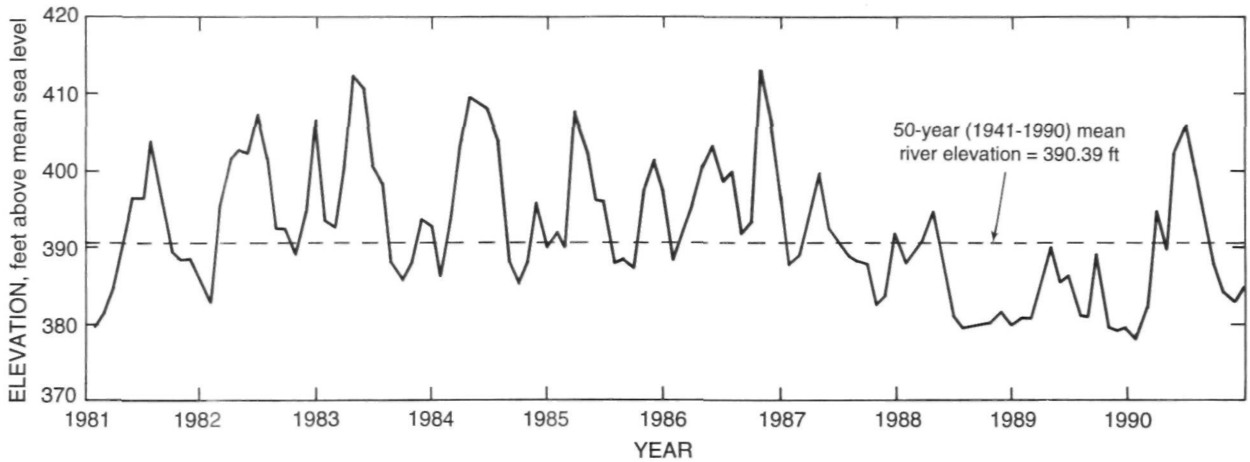


Figure 10. Mean monthly Mississippi River stages, St. Louis gaging station, 1981-1990

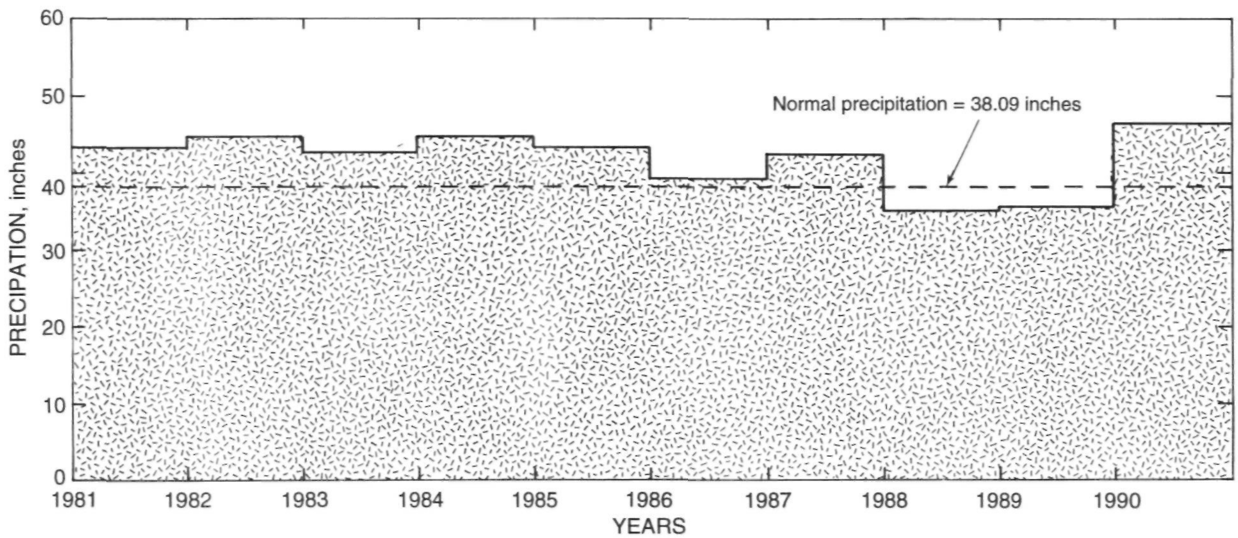


Figure 11. Annual precipitation at Belleville, 1981-1990

levels within an elevated range in 1986-1987, falling ground-water levels in 1988 and 1989, followed by increasing water levels in 1990. Factors contributing to this pattern were above-normal precipitation from 1981-1987, the Midwestern drought of 1988-1989, river stages, and water-level responses to annual pumpage changes. Annual precipitation was approximately 12 percent above normal from 1981-1987. Much of Illinois and the surrounding states experienced a substantial shortfall in precipitation during 1988-1989. Precipitation in the Belleville area was about 92 percent of normal during this period. However, the data from the climate site near Belleville are not indicative of the severity of the drought experienced by other parts of Illinois and the surrounding states. Based on the Palmer Drought Index during September 1988 and September 1989, Kunkel, Angel, and Wendland (1992) described the Metro-East area as being under mild drought conditions, whereas much of the Mississippi River valley to the north and the surrounding areas were classified as being under extreme drought conditions. During 1990, precipitation was significantly above normal. Fluctuations in the mean monthly river stages

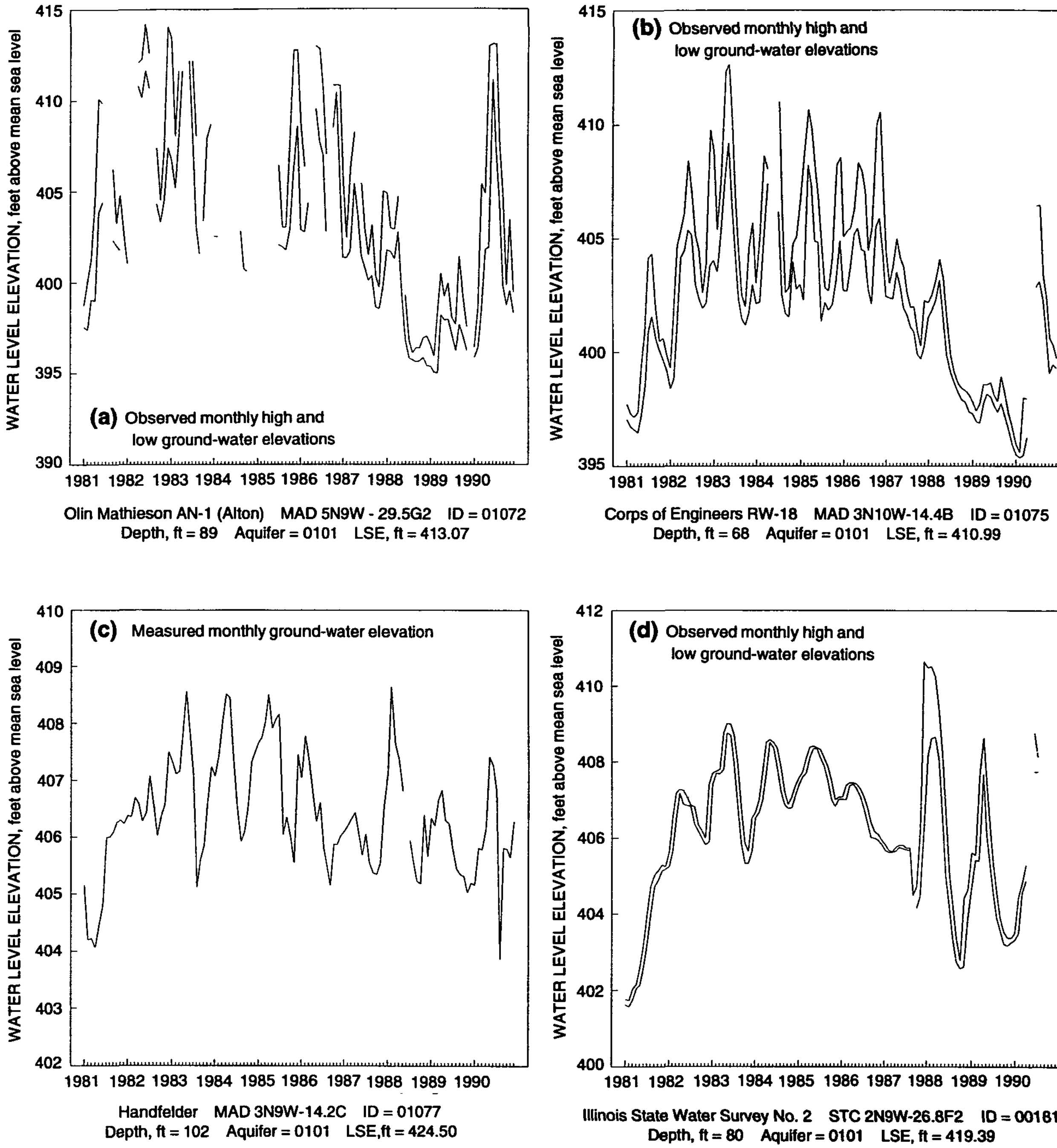
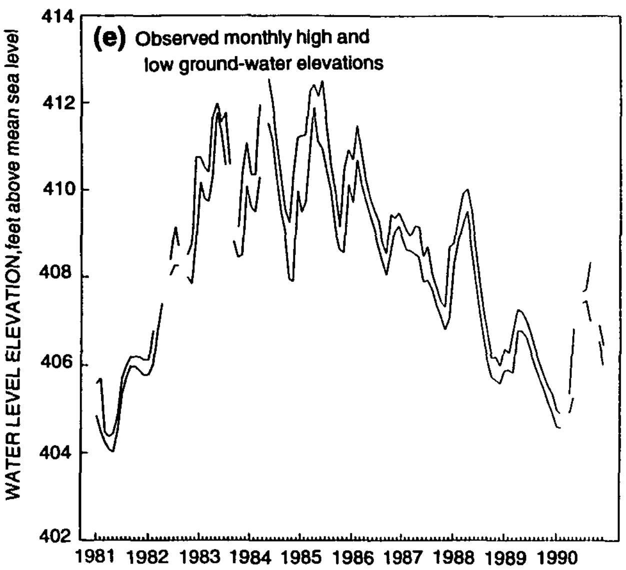
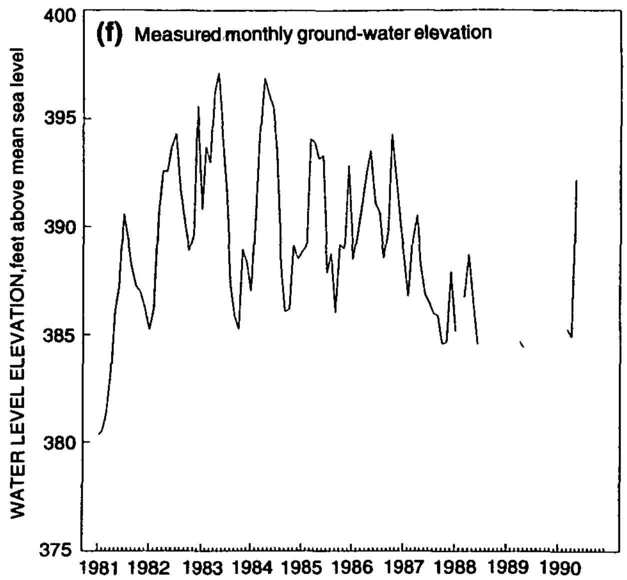


Figure 12. Hydrographs of eight selected wells, 1981-1990



Nameoki PZ3B MAD 3N9W-8.5G1 ID = 01080
Depth, ft = 64 Aquifer = 0101 LSE, ft = 417.7



Terminal Ice No. 2 STC 2N10W-12.7G ID = 01224
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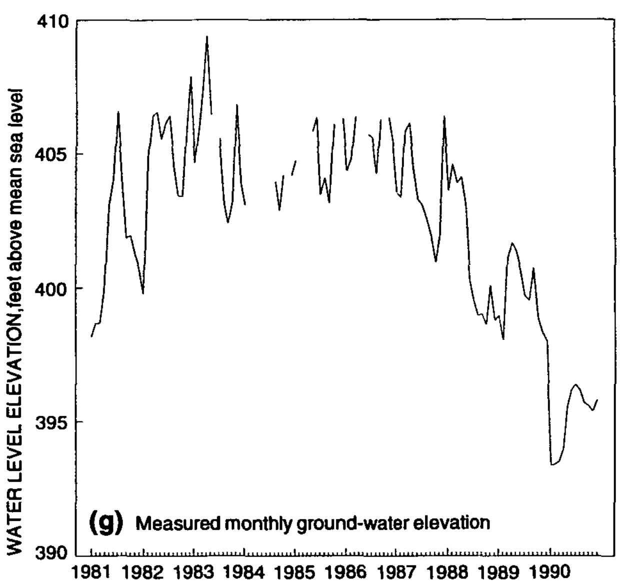
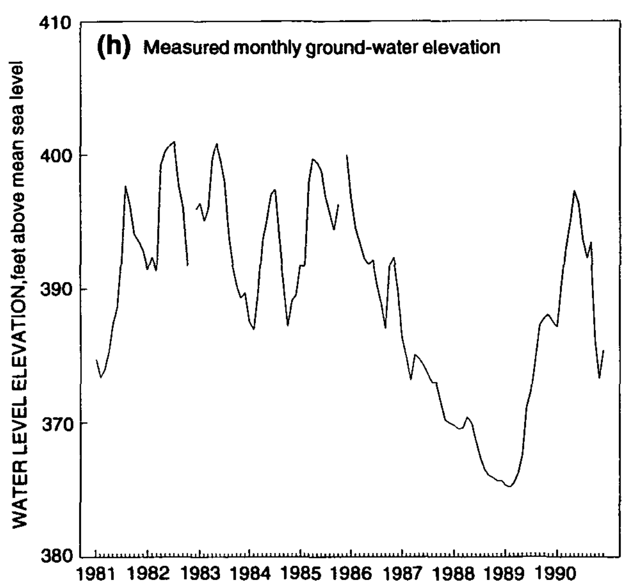


Corps of Engineers RW-70 MAD 3N10W-12.4F ID = 01076
Depth, ft = 58 Aquifer = 0101 LSE, ft = 406.4



LaClede Steel No. 1 MAD 5N9W-18.3C ID = 01070
Depth, ft = 80 Aquifer = 0101 LSE, ft = 430

Figure 12. Concluded

correlated closely to ground-water fluctuations for the same time period. In relation to the 120-year mean river elevation, river stages during this time period had a below- and above-average pattern similar to the precipitation pattern.

From 1986-1990, ground-water levels in Well MAD5N9W-29.5g2 (figure 12a) and Well MAD3N10W-14.4b (figure 12b) generally reflect Mississippi River stages. Corresponding peaks in both ground-water hydrographs reflect high and low river stages. The effects of the drought of 1988-1989 are very evident (declining water levels) in both the mean monthly Mississippi River stage graph (figure 11) and in the hydrographs for both wells.

The magnitude of water-level change from 1986-1990 was controlled by each well's proximity to pumping centers and to the Mississippi River and other surface water bodies. Well MAD3N9W-14.2c (figure 12c) near the northeast end of Horseshoe Lake is a good example of a well that is not strongly affected by a pumping center and that has the stabilizing influence of Horseshoe Lake nearby and no drainageway in the immediate area. These conditions result in an annual fluctuation of water levels in this well of about 3 feet, more variation than in Well MAD3N9W-16.8a (figure 10a) discussed previously. The lesser fluctuation at Well MAD3N9W-16.8a is explained by the presence of the adjacent drainageway and the well's proximity to Horseshoe Lake.

Ground-water levels in Well STC2N9W-26.8f2 (figure 12d) and Well MAD3N9W-8.5gl (figure 12e) vary in an almost identical manner, probably because both wells are in urban areas. The presence of high-density buildings and large paved areas limits the area through which vertical recharge can occur. Also, as a result of the network of storm drainage in urban areas, potential recharge from precipitation is carried away quickly, resulting in moderate water-level changes. In contrast, water levels in Well STC2N10W-12.7g (figure 12f) are impacted heavily by pumpage and by river-stage levels. The resulting impact of these influences is an annual water-level change of 5 feet. During the period 1986-1990, pumpage increased approximately 13 percent over the previous five-year period at the National City pumping center and low river stages during the drought of 1988-1989, which contributed to water levels receding below the bottom of Well STC2N10W-12.7g from July 1988 to March 1990. Rapid and dramatic water-level changes occur at Well MAD3N10W-12.4f (figure 12g) and Well MAD5N9W-18.3c (figure 12h) because of the effect of fluctuations in the Mississippi River. Declining water levels during this same period reflect below-average precipitation and river stages during 1988 and 1989 in the hydrographs for Wells MAD3N10W-12.4f and MAD5N9W-18.3c. This downward trend in ground-water levels was reversed during 1990 when precipitation and Mississippi River stages were well above normal.

Figure 13 (a-d) shows hydrographs of selected wells for the entire period of record. Well M AD3N8 W-31.1a (figure 13a) reflects the slight downward trend of water levels in the Collinsville area as a result of the growing pumping cone. Wells MAD3N9W-16.8a (figure 13b), MAD3N10W-12.4f (figure 13c), and MAD5N9W-27.5al (figure 13d) indicate that the trend of continuously rising water levels, experienced in the area since 1965 because of the overall decrease in ground-water use and shifts in the distribution of pumpage, has ceased. From 1985-1990, hydrographs for these wells have shown a stabilized to a slight downward trend. Relatively consistent pumpage from 1981-1990 has led to these pumping centers having less influence on the surrounding water levels. The controlling factors in water-level trends between 1981 and 1990 appear to be precipitation and stream levels.

When a major ground-water user began using the Mississippi River as a water-supply source after June 1957, water levels in nearby wells recovered quickly, averaging 12 feet per year through 1961. This dramatic trend is shown in the hydrograph for Well MAD3N9W-16.8a (figure 13b).

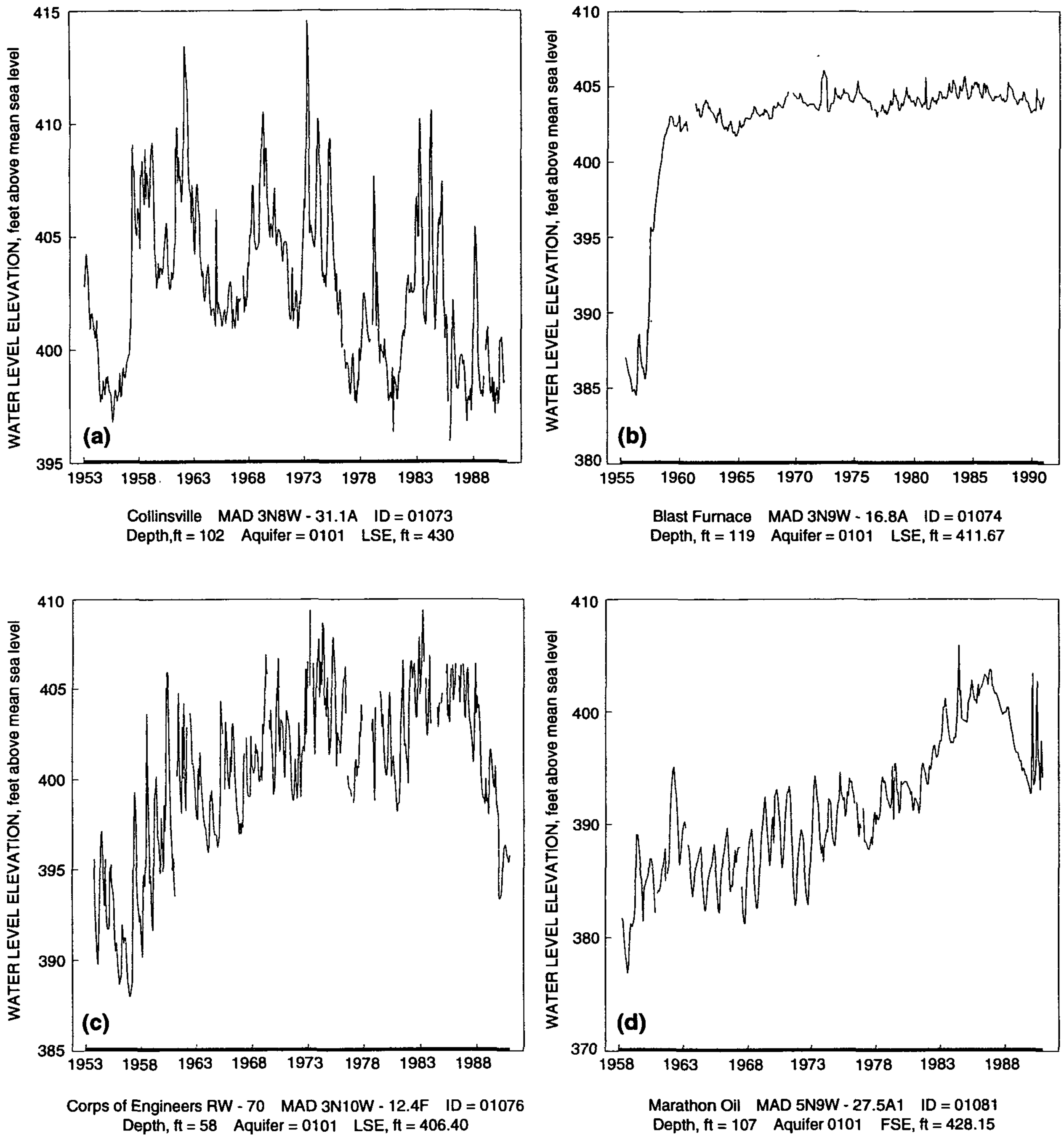


Figure 13. Hydrographs of four selected wells for entire period of record: a) 1953-1988, b) 1955-1990, c) 1953-1988, and d) 1958-1988

POTENTIOMETRIC SURFACE: NOVEMBER 1990

A potentiometric surface map (figure 14) was prepared from water levels measured in 269 wells during late October and early November 1990 when water levels are usually near minimum stages. Figure 15 provides locations of wells, and the appendix provides ground-water level data used to prepare the map. Tables 3 and 4 indicate surface water elevations used in preparing the potentiometric surface map.

Prior to development of large ground-water supplies, ground-water movement was toward the Mississippi River and other streams and lakes. During high river stages, flow was from the river. With the development of large ground-water supplies, however, the general pattern of ground-water flow has been toward the cones of depression created by pumpage or the Mississippi River and lakes and other streams. In places where cones of depression are near the river, hydraulic gradients from the river have been established and significant quantities of river water are diverted into the pumping centers.

The main features of the November 1990 potentiometric map (figure 14) are the deep cones of depression along the Mississippi River just south of Alton and near National City. The cone of depression at Alton was formed by pumping for dewatering during construction of the Mel Price Lock and Dam. The cone of depression near National City is the result of dewatering to maintain ground-water elevations below the highway surface in areas where the highway is depressed below the original land surface.

Other features include cones of depression associated mainly with industrial pumpage just south of the bluffs near Alton and at Wood River, Roxana, and Granite City. A cone of depression along the bluffs near Collinsville is the result of pumpage for municipal use. Withdrawals in the vicinity of Sauget were negligible in 1990. Consequently, the cone of depression associated with industrial pumpage at Sauget has disappeared, and ground-water movement in the vicinity was toward the river.

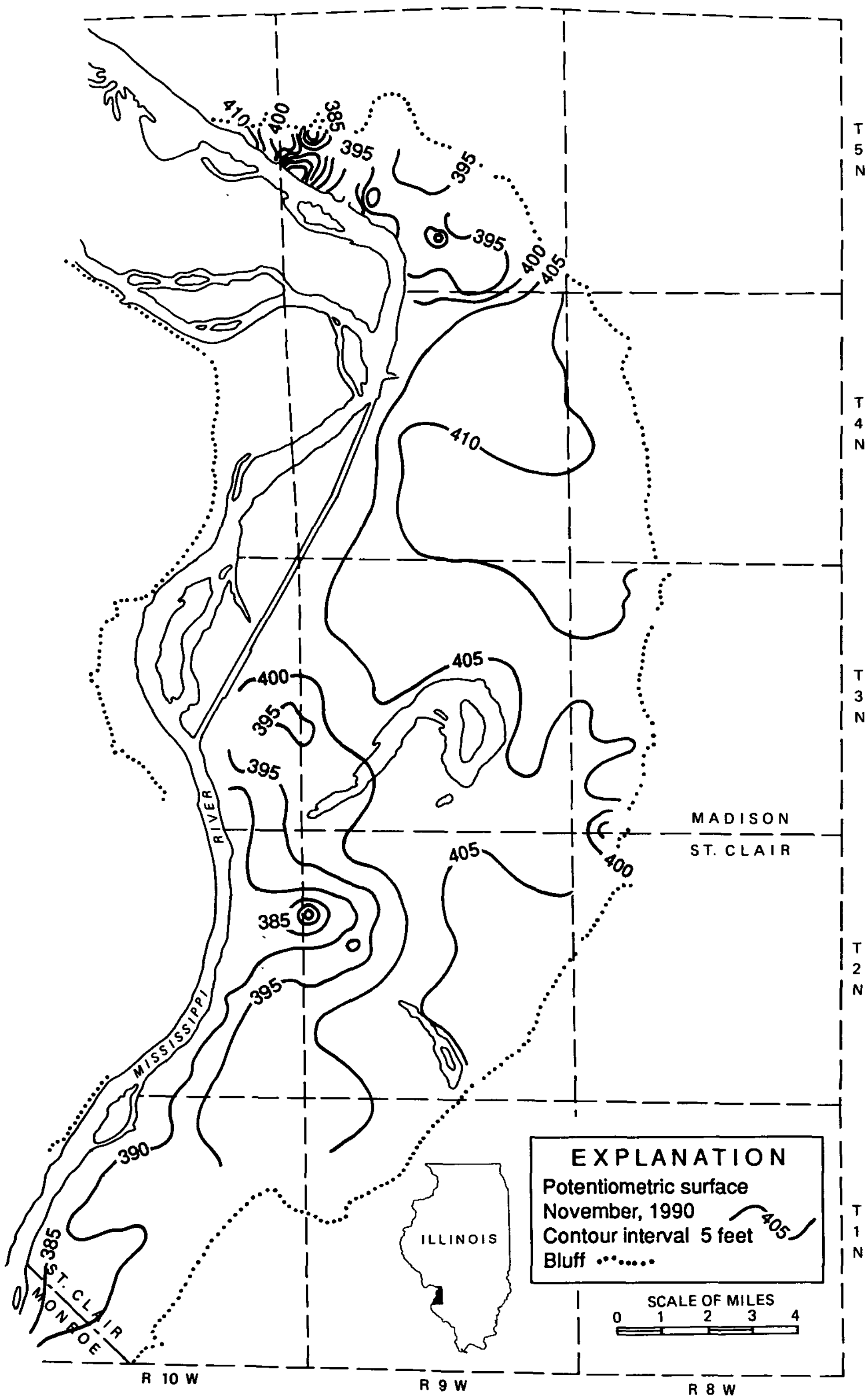


Figure 14. Approximate elevation of potentiometric surface, November 1990

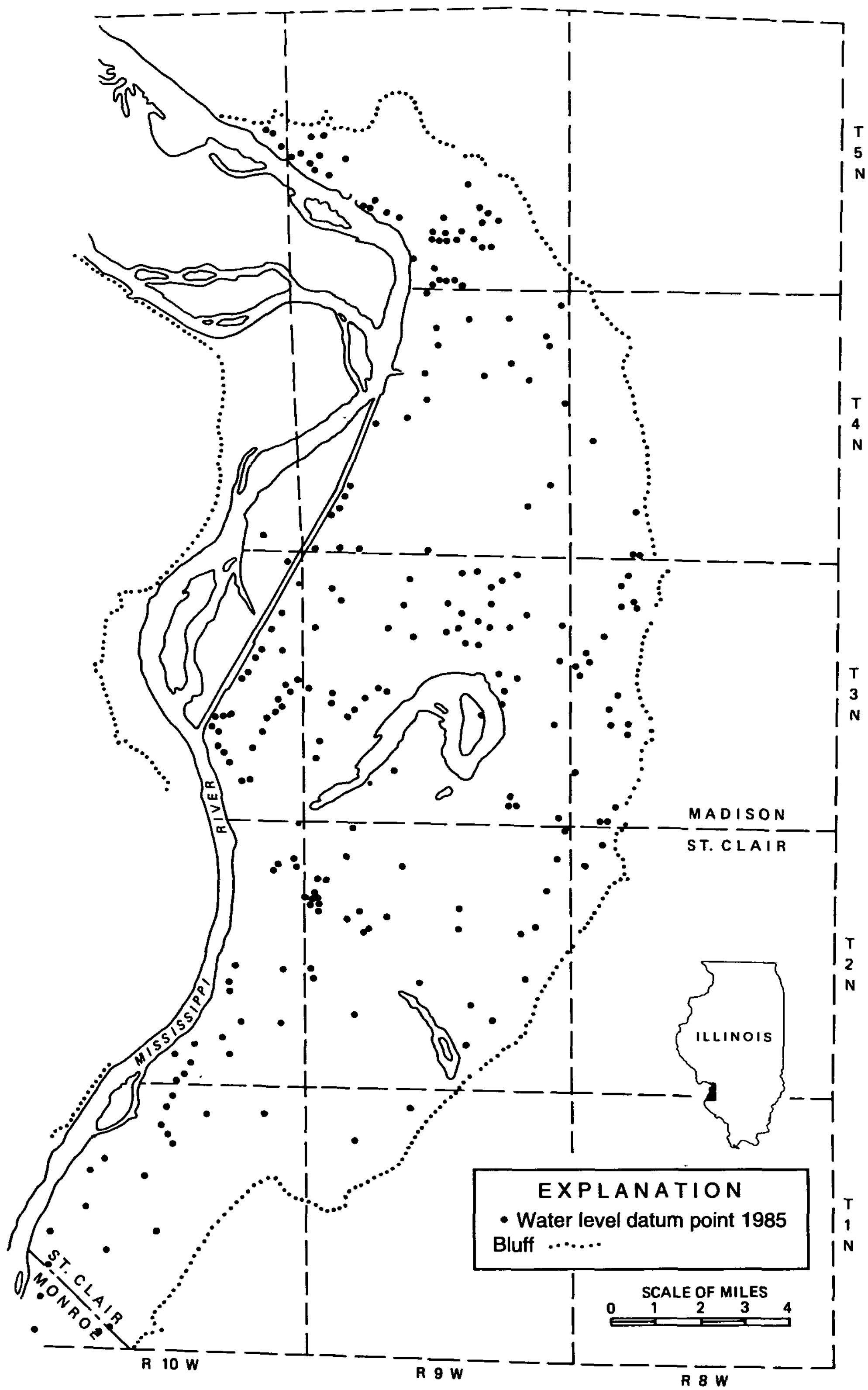


Figure 15. Location of datum points used for 1990 mass measurement

Table 3. Stream Elevations

Location of gage	*Elevation of measuring point (feet above msl)*	*Water-surface elevation (feet above msl)*	
		Nov. 1985	*Nov. 1990*
Illinois Route 203 Bridge, NW corner, Sec. 5, T2N, R9W	415.30	400.27	400.61
Black Lane Bridge, Canteen Creek, near center Sec. 36, T3N, R9W	420.80	401.55	-
Sand Prairie Road Bridge, Canteen Creek, near center Sec. 35, T3N, R9W	418.04	401.11	400.19
Sand Prairie Road Bridge, NW corner, Sec. 35, T3N, R9W	418.55	400.45	399.93
Highway Bridge, 1, NE corner, Sec. 16,T4N,R9W	444.36	414.39	414.02
Highway Bridge, 2, NW corner, Sec. 14, T4N, R9W	440.42	414.23	413.79
Highway Bridge, 3, NW corner, Sec. 13,T4N,R9W	441.38	414.26	413.88

Table 4. Mississippi River Stages

Gage description	*Mississippi River mile number*	*Water-surface elevation (feet above msl)*		
		11/12/80	*11/11/85*	*11/1/90*
Lock and Dam No. 26 Alton, IL (lower)	202.7	418.9	408.48	408.48
Mel Price (upper)	201.1	-	-	418.69
Mel Price (lower)	200.5	-	-	400.78
Hartford, IL	196.8	399.3	406.83	400.32
Lock and Dam No. 27 Granite City (upper)	185.3	-	-	399.86
Lock and Dam No. 27 Granite City (lower)	185.1	-	-	386.91
St. Louis, MO	179.6	383.4	394.34	384.84
Engineer Depot, MO	176.8	382.7	393.58	383.58

CHANGES IN GROUND-WATER LEVELS

November 1985-1990

Figure 16 shows ground-water level changes from November 1985-November 1990. Changes were estimated by comparing potentiometric surface maps for 1985 (figure 17) and 1990 (figure 14). Significant declines exceeding 25 feet occurred along the Mississippi River a few miles south of Alton adjacent to the Mel Price Lock and Dam as a result of dewatering during construction of the lock and dam. Ground-water level declines exceeded 5 feet in an area extending from Granite City to Sauget, and continuing in a narrow band south along the river to the edge of the study area. These changes were attributed to a significant change in river stage (figure 10) between November 1985 and November 1990. No changes were recorded in the vicinity of the main highway dewatering area near National City where pumpage is adjusted to maintain constant water levels. Ground-water levels were less than 5 feet below 1985 levels in the rest of the area except for a large area in the vicinity of Wood River and Roxana where declines exceeded 5 feet. These changes were attributed to below normal precipitation in 1988 and 1989 (figure 11). Although precipitation was above normal during 1990, ground-water levels had not recovered completely.

November 1966-1990

To show the impact of large declines in ground-water pumpage, a water-level change map for the period November 1966-1990 (figure 18) was estimated by comparing the potentiometric surface maps for 1966(figure 19) and 1990(figure 14). Ground-water pumpage was 108.1 mgd in 1966, near the peak of 111.0 mgd recorded in 1956 (Reitz, 1968). By 1990, ground-water pumpage declined to 58.7 mgd. Table 5 shows declines in pumping for each major pumping center. Pumping for dewatering during construction of the Mel Price Lock and Dam near Alton was not included in the Alton total because it is difficult to estimate and is only temporary.

Except for a narrow strip along the bluffs from Collinsville to just south of Cahokia Diversion Canal, an area in the vicinity of Alton, and a small area in the vicinity of East Carondelet along the Mississippi River, ground-water levels rose between November 1966 and November 1990, mainly because of the reduction in pumpage.

With the exception of the Alton area, ground-water levels in the vicinity of pumping centers rose during the 1966-1990 period. At Alton the impact of a large decline in estimated pumpage (7.6 mgd) was balanced by the dewatering pumpage at the Mel Price Lock and Dam and water levels not significantly different in 1990 than in previous years. The greatest recovery occurred at the Sauget pumping center where water levels rose more than 65 feet. Pumpage at Sauget for the period declined 27.3 mgd. Water-level recovery exceeded 10 feet at Wood River and exceeded 15 feet at Granite City and north of the National City pumping center. Because of the large quantities of ground water withdrawn for the highway dewatering system, ground-water level recovery was significantly less along interstate highways in the vicinity of National City as shown in figure 18. Recovery of water levels was less than 10 feet and in some areas less than 5 feet in a broad band along the interstate highway.

Ground-water levels declined in a narrow band along the bluffs from the Cahokia Diversion Channel to Collinsville. Declines also occurred along the Mississippi River south of Cahokia Canal and in small areas in Wood River and East Alton.

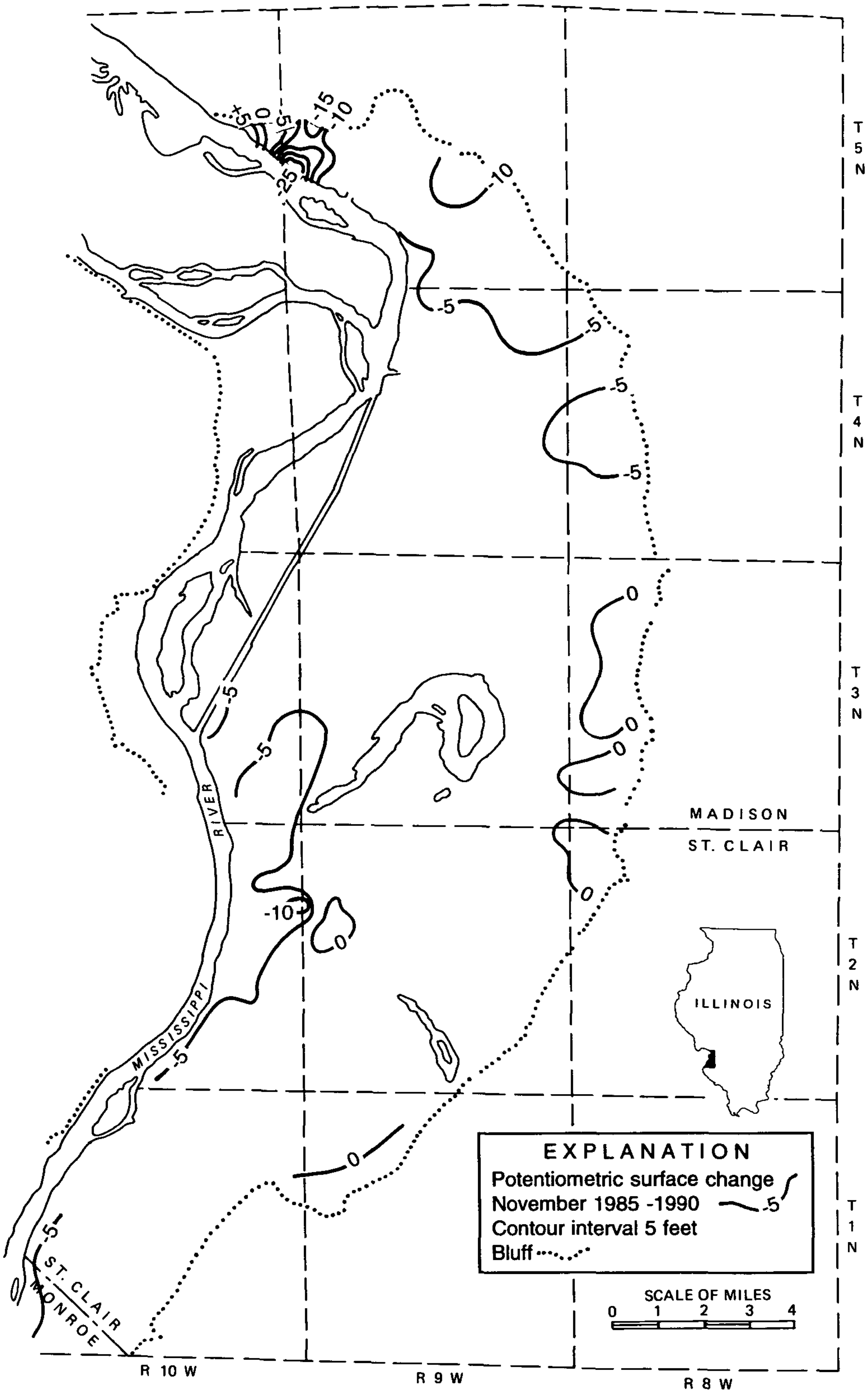


Figure 16. Changes in potentiometric surface, November 1985-November 1990

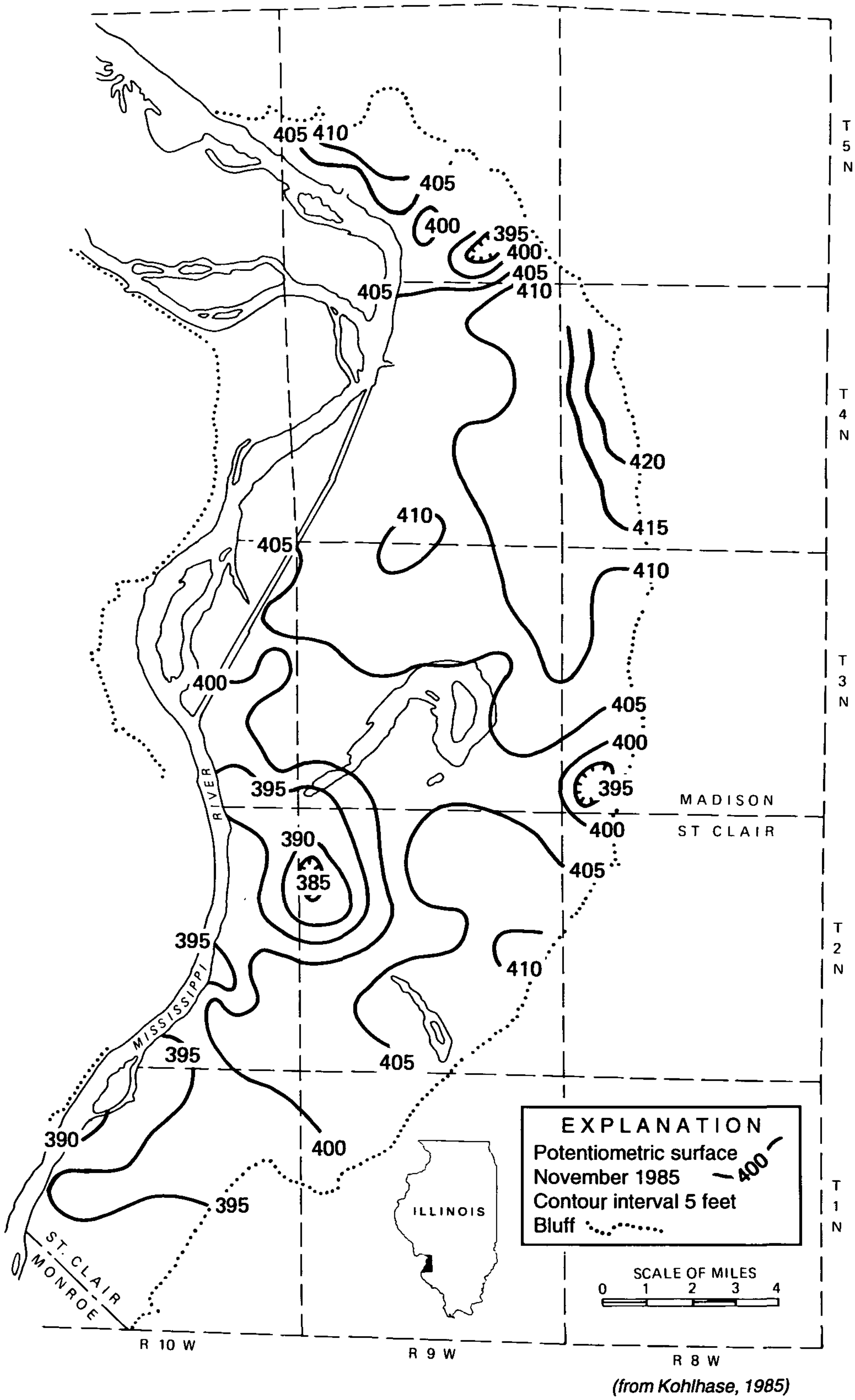


Figure 17. Appproximate elevation of potentiometric surface, November 1985 (from Kohlhase, 1985)

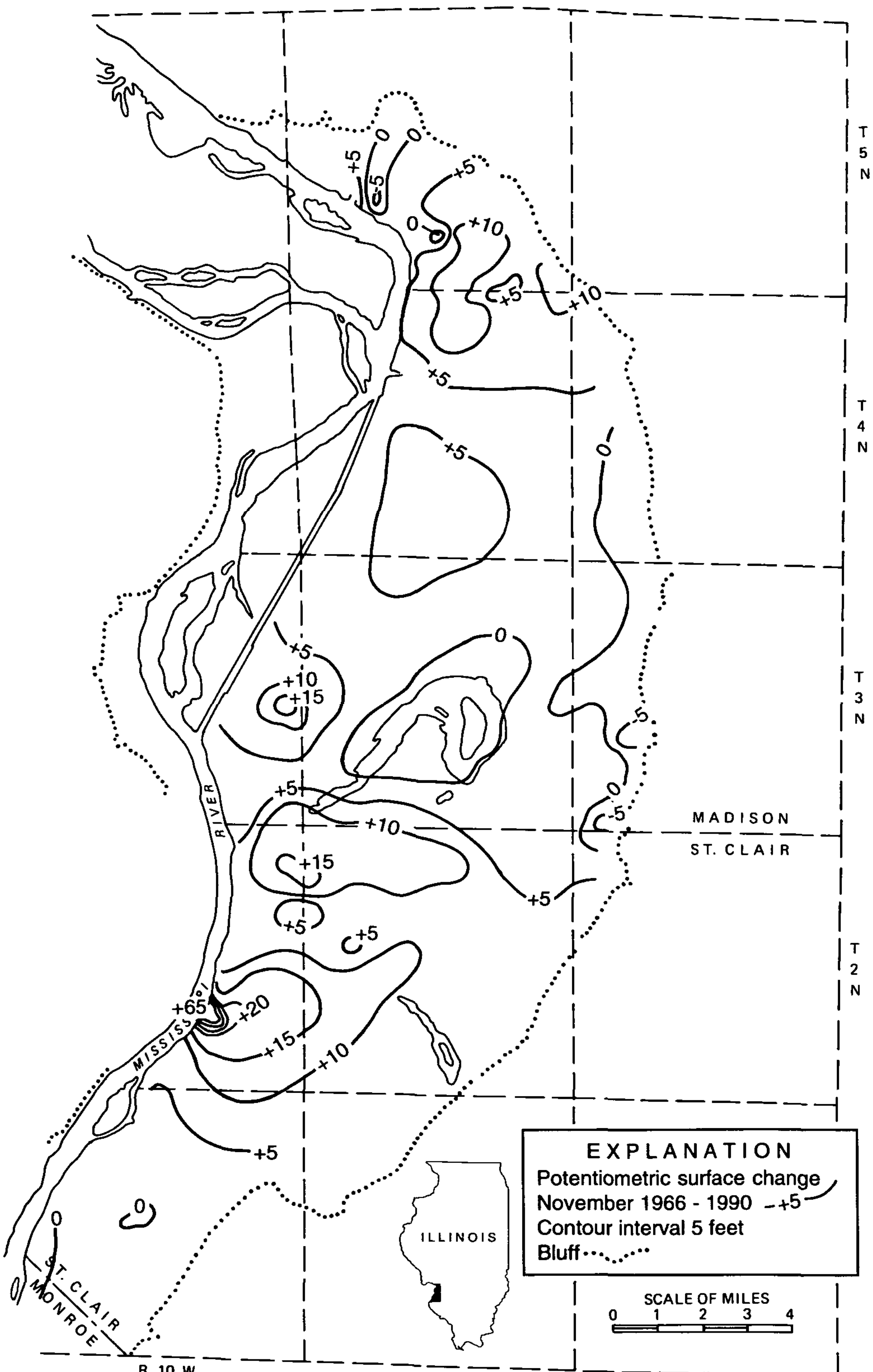


Figure 18. Changes in potentiometric surface, November 1966-November 1990

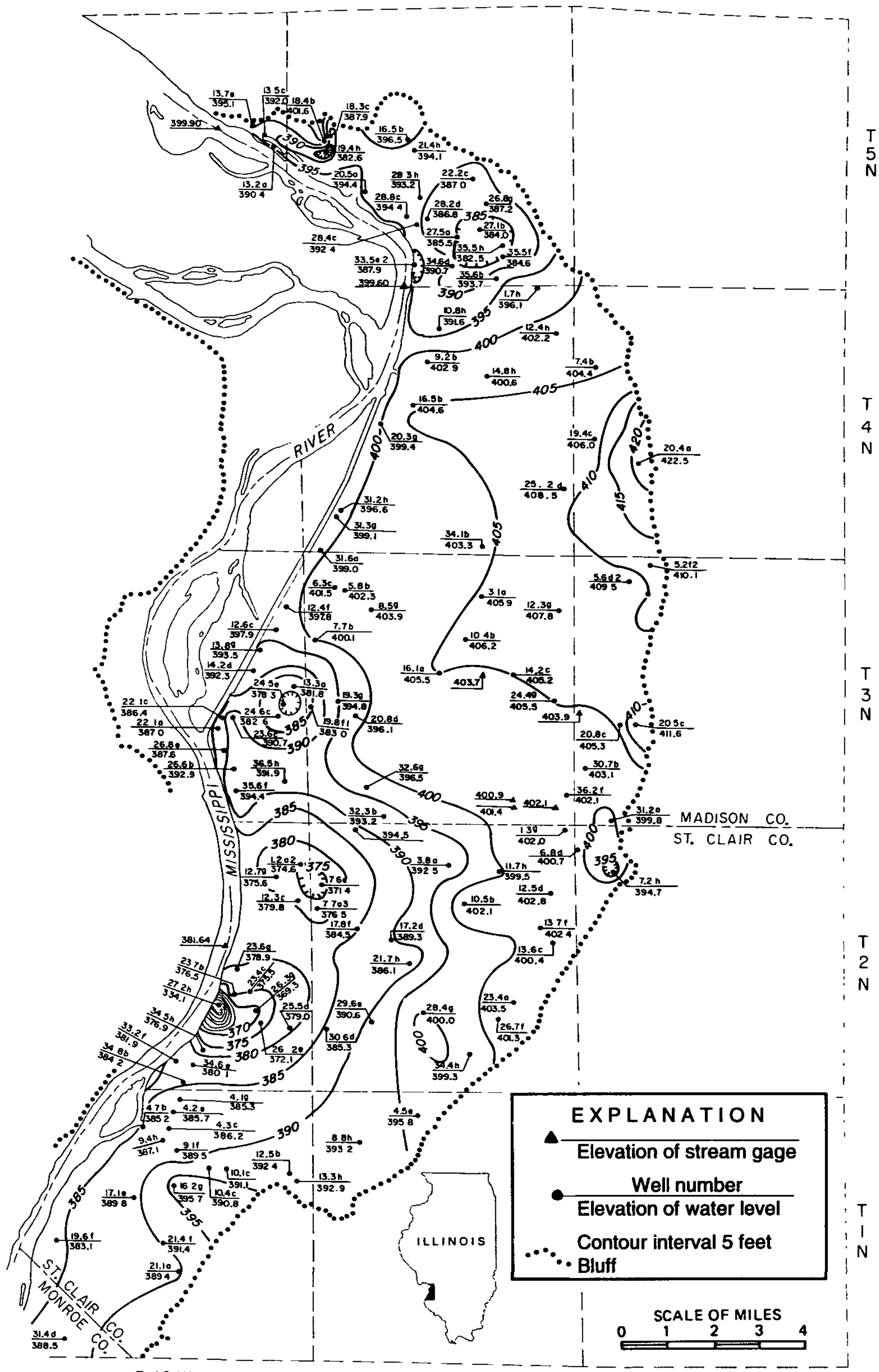


Figure 19. Approximate elevation of potentiometric surface for 1966 (from Reitz, 1968)

Table 5. Declines in Pumpage (mgd): Major Pumping Centers, 1966-1990

Pumping center	*Pumpage decline (mgd)*
Alton	7.6
Wood River	8.6
Granite City	5.3
National City	2.1
Sauget	27.3

Note: Total for Alton does not include pumpage due to dewatering for Mel Price Lock and Dam.

AREAS OF DIVERSION

Figure 20 shows boundaries of areas of diversion of pumping centers for November 1990. The boundaries delimit areas within which the general movement of ground water is toward pumping centers. In areas where ground-water levels are near the land surface, ground-water may discharge into streams, lakes, or both. It has been more difficult to determine areas of diversion of pumping centers because ground-water levels have recovered significantly in recent years. For this study only, areas of diversion that are easily recognizable on the potentiometric surface are shown.

Hydraulic gradients were established from the Mississippi River toward the pumping centers in the Alton and Wood River areas of diversion. As a result the river contributes a large part of the pumpage.

For the areas of diversion for Granite City, Venice, and National City, a ground-water divide exists between the pumping center and the river. It should be noted that the ground-water areas of diversion shown exist for only the period that water levels weremeasured. Areas of diversion may be distorted markedly by changes in river stage, particularly significant increases in stage and significant rainfall recharge events and significant changes and shifts in pumpage.

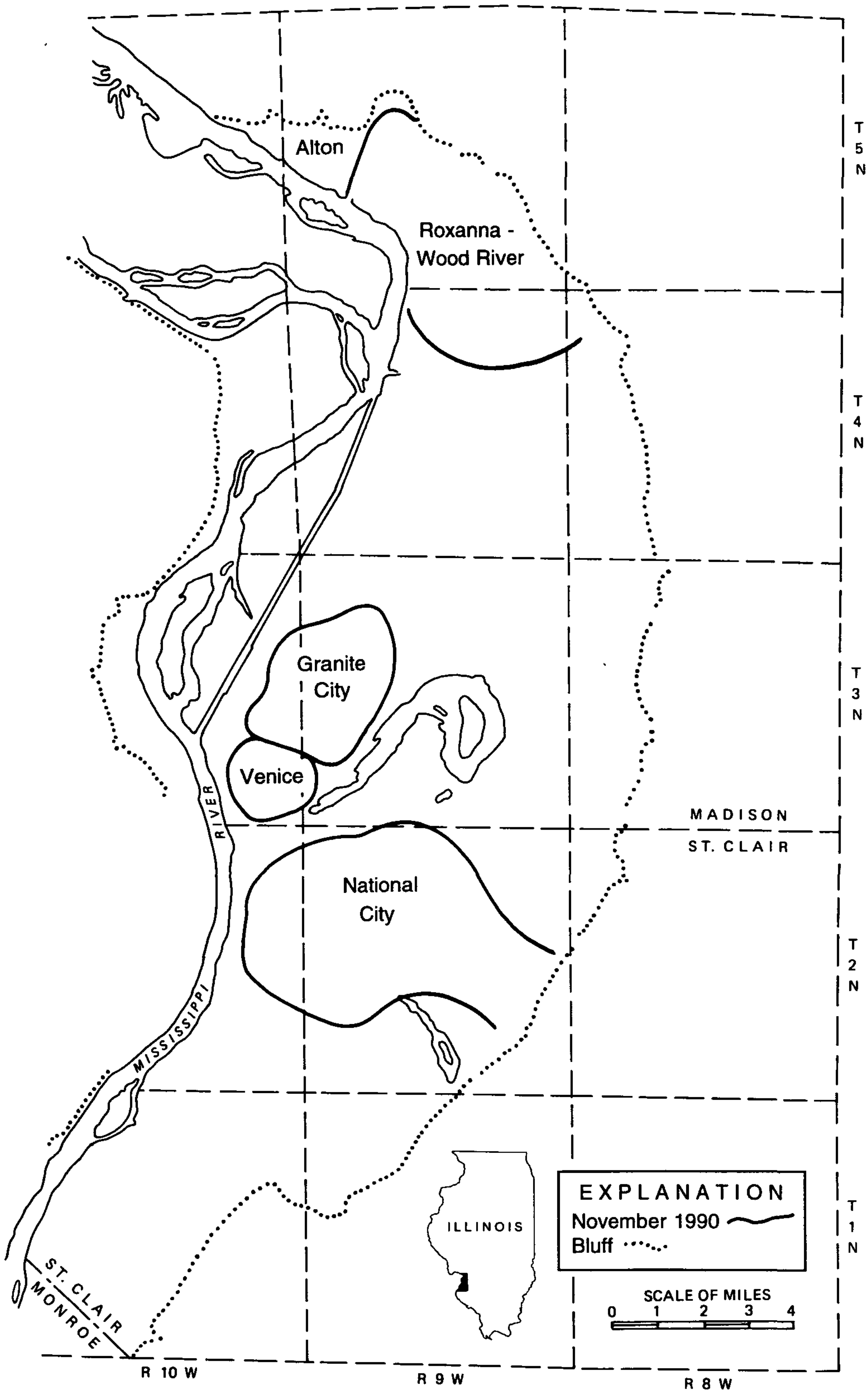


Figure 20. Approximate areas of diversion, November 1990

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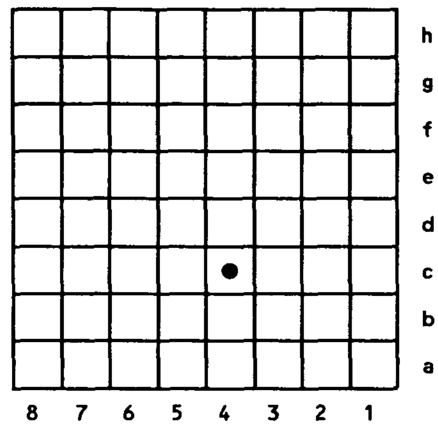
APPENDIX A. WELL NUMBERING SYSTEM

The well-numbering system used in this report is based on the location of the well, and uses the township, range, and section for identification. The well number consists of five parts: county abbreviation, township, range, section, and coordinate within the section (subsection or 10-acre plot). Sections are divided into rows of 1/8-mile squares. Each 1/8-mile square contains 10 acres and corresponds to a quarter of a quarter of a quarter section. A normal section of 1 square mile contains 8 rows of 1/8-mile squares; an odd-sized section contains more or fewer rows. Rows are numbered from east to west and lettered from south to north as shown in the diagram.

Example: St. Clair County
T2N, R10W
Section 23



The location of the well shown above is STC 2N10W-23.4c. Where there is more than one well in a 10-acre square, each well is identified by arabic numbers after the lower-case letter in the well number. Any number assigned to the well by the owner is shown in parentheses after the location well number. The abbreviations for counties discussed in this report are:

Madison	MAD	Monroe	MON	St. Clair	STC

There are parts of the East St. Louis area where section lines have not been surveyed. For convenience in locating observation wells, normal section lines were assumed to exist in areas not surveyed.

APPENDIX B. WATER-LEVEL ELEVATIONS AND CHANGES IN THE METRO-EAST AREA, 1985-1990

County location	*Owner*	*Water-level elevation 1985 (ft)*	*Water-level elevation 1990 (ft)*	*Water-level change 1985-1990 (ft)*
Madison				
3N08W05.2d	SCHWARTZ		407.83	
3N08W05.2f2	V OF GLEN CARBON #2 (sealed > 1982)			
3N08W05.2D	V OF GLEN CARBON #3 (sealed > 1982)			
3N08W05.4al	V OF MARYVILLE #1		404.80	
3N08W05.4a2	V OF MARYVILLE #2		404.30	
3N08W05.4a3	V OF MARYVILLE #3		405.60	
3N08W05.4a4	MARYVILLE WELL FIELD - ME4		403.81	
3N08W05.4h	LOHR BROS CONST	413.23	403.52	-9.71
3N08W05.5e	V OF GLEN CARBON #6	409.99	409.12	-0.87
3N08W05.6dl	V OF GLEN CARBON #4	410.43	409.96	-0.47
3N08W05.6d2	V OF GLEN CARBON #5	411.06	410.08	-0.98
3N08W08.4g	KELLER #3			
3N08W08.6h	WILLAREDT, HARLEY	408.00	410.38	2.38
3N08W18.7e	ARLINGTON GOLF COURSE		408.95	
3N08W19.1f	FERD STRACKETJAHN	408.66	408.93	0.27
3N08W19.7e	HADLEY BRIDGE			
3N08W20.5al	V OF TROY WELL #1	403.04	402.90	-0.14
3N08W20.5a2	V OF TROY WELL #2	401.94	402.98	1.04
3N08W20.5a3	V OF TROY WELL #3	403.88	402.31	-1.57
3N08W20.5a4	V OF TROY WELL #4		403.75	
3N08W20.5c	TED KOSTEN JR.		405.05	
3N08W20.8c	E FOURNIE	406.36	406.37	0.01
3N08W30.7b	V W ECKMANN	403.83	403.89	0.06
3N08W31.1al	COLLINSVELLE OB WELL ID#1073	397.68	398.63	0.95
3N08W31.1a2	C OF COLLINSVILLE #7	390.25	390.05	-0.20
3N08W31.1a3	C OF COLLINSVILLE #8		388.00	
3N08W31.1a4	C OF COLLINSVILLE #11		392.43	
3N08W31.2al	C OF COLLINSVILLE #9		391.66	
3N08W31.2a2	C OF COLLINSVILLE #10	390.44		
3N08W32.8d	WATSON		399.72	
3N09W03.1a	CARL ELLIS	408.29	406.95	-1.34
3N09W04.5el	C OF GRANITE CITY P-2			
3N09W04.5e2	MARYVILLE SCHOOL - ME1		408.40	
3N09W06.1a	HERBERT BISCHOFF #1	408.56	406.27	-2.29
3N09W06.3c	HERBERT BISCHOFF #2	407.81	405.46	-2.35
3N09W07.6d	A O SMITH CO WELL A	407.07	403.73	-3.34
3N09W08.1d	C OF GRANITE CITY P-5	408.52	406.91	-1.61
3N09W09.4cl	MIKE GRAVES			
3N09W09.4c2	PARKVIEW SCHOOL - ME3		408.53	
3N09W10.2a	WILBERT ENGELKE (S of tracks)	406.58	406.15	-0.43
3N09W10.4b	WILBERT ENGELKE (destroyed > 1985)	408.03		
3N09W10.4gl	C OF GRANITE CITY P-4			
3N09W10.4g2	C OF GRANITE CITY P-4A	408.72	407.96	-0.76
3N09W10.5d	GOLF COURSE (THE REGENCY)		418.28	
3N09W10.6c	M ORASCO			
3N09W12.3g	CHARLES LUEHMANN	413.42	412.84	-0.58

APPENDIX B. (Continued)

County location	Owner	Water-level elevation 1985 (ft)	Water-level elevation 1990 (ft)	Water-level change 1985-1990 (ft)
Madison				
3N09W14.2c	HANDFELDER	405.05	404.29	-0.76
3N09W14.4a	L J ROSS LUMBER CO	405.04	404.69	-0.35
3N09W16.8a	BLAST FURNACE E-2 (covered 1970)			
3N09W17.2al	LAKE SCHOOL - ME15		404.77	
3N09W17.3a	V BISCHOFF	406.48	405.37	-1.11
3N09W18.8al	C OF GRANITE CY P-6	402.60		
3N09W18.8a2	C OF GRANITE CY P-6A	402.59	398.87	-3.72
3N09W19.3g	GRANITE CY STEEL #1	400.18	400.85	0.67
3N09W19.3h	GROVE PLUMB & HEAT	404.02	401.68	-2.34
3N09W19.8fl	GRANITE CY STEEL #3			
3N09W20.7e	GRANITE CY STEEL #4	404.14	402.57	-1.57
3N09W20.8d2	GRANITE CY STEEL #12	402.88	401.40	-1.48
3N09W20.8d3	GRANITE CY STEEL #6	402.45		
3N09W20.8d4	GRANITE CY STEEL #14 (NEW)	402.74	401.01	-1.73
3N09W23.5f	DEPT OF CONSERV #1	403.24	403.23	-0.01
3N09W23.8el	DEPT OF CONSERV #2	404.86	404.37	-0.49
3N09W23.8e2	DOC @ WALKER'S ISLAND - ME5		404.15	
3N09W24.3c	V BRUNS		404.06	
3N09W24.4g	HOLIDAY PK MOB HOMES	410.44		
3N09W25.5f	HERBERT BISCHOFF	405.10	405.07	-0.03
3N09W25.8e	WM BRUNS #1	406.11	405.67	-0.44
3N09W28.5a	BIG BEND ROAD - ME7		402.50	
3N09W29.1a	WILLIAM STEIMAN	400.23	404.40	4.17
3N09W30.5hl	MADISON MIDDLE SCHOOL - ME6		396.77	
3N09W30.6e	MADISON HIGH SCHOOL		399.04	
3N09W32.3b	HENRY MUELLER			
3N09W32.6g	ESTELLA AUFDERHEID	400.43	398.85	-1.58
3N09W35.3d	ST OF ILLINOIS	404.04	403.53	-0.51
3N09W36.1f	VICTOR ECKMANN SR (sealed > 1977)			
3N09W36.3b	KREITNER SCHOOL - ME8		403.05	
3N10W01.1c	E ST L D&L DIS RW98	405.01	401.50	-3.51
3N10W12.4f	E ST L D&L DIS RW69	404.56	401.29	-3.27
3N10W12.6c	E ST L D&L DIS RW56	404.43	401.00	-3.43
3N10W13.1b3	NESTLES CO WELL #3	402.13	399.31	-2.82
3N10W13.1b4	NESTLES CO WELL #4			
3N10W13.2b	NESTLES CO WELL #5	398.84		
3N10W13.4a	DON PARTNEY--CS2	397.61	394.35	-3.26
3N10W13.4gl	PRATHER SCHOOL - ME2		401.70	
3N10W13.8g2	APEX OIL CO	414.21	410.90	-3.31
3N10W13.8g3	E ST L D&L DIS RW37	408.48	401.64	-6.84
3N10W14.1f	E ST L D&L DIS RW33 (SOUTH)	403.33	400.22	-3.11
3N10W14.3c	E ST L D&L DIS RW24	402.61	399.63	-2.98
3N10W14.4b	E ST L D&L DIS RW18	403.14	400.02	-3.12
3N10W22.1al	E ST L D&L DIS RW43			
3N10W22.1a2	E ST L D&L DIS RW44	398.19	392.54	-5.65
3N10W22.1cl	E ST L D&L DIS RW33 (NORTH)			
3N10W22.1c2	E ST L D&L DIS RW32	397.57	392.33	-5.24
3N10W23.6c	E ST L D&L DIS RW7	399.87	396.25	-3.62

APPENDIX B. (Continued)

County location	*Owner*	*Water-level elevation 1985 (ft)*	*Water-level elevation 1990 (ft)*	*Water-level change 1985-1990 (ft)*
Madison				
3N10W23.7c	E ST L D&L DIS RW20	398.05	393.21	-4.84
3N10W24.1c	GRANITE CY STEEL #2		391.96	
3N10W24.3h	PRAIRE FARMS DAIRY	401.27	398.00	-3.27
3N10W24.5e	GRANITE CY STEEL #14	396.47	393.52	-2.95
3N10W24.5f	GRANITE CY STEEL #16	397.01	394.22	-2.79
3N10W24.6d	GRANITE CY STEEL #15	401.41	398.50	-2.91
3N10W24.7c	GRANITE CY STEEL #17	399.33	396.42	-2.91
3N10W25.8h	COVALCO	401.10	398.40	-2.70
3N10W26.2el	DUNBAR SCHOOL - ME16		398.76	
3N10W26.6b	E ST L D&L DIS RW78	397.44	392.73	-4.71
3N10W26.7d	E ST L D&L DIS RW70		392.84	
3N10W26.8e	E ST L D&L DIS RW64	398.85	394.16	-4.69
3N10W26.8h	E ST L D&L DIS RW53	397.72	393.09	-4.63
3N10W35.3f	IDOT DEWATERING #4	394.46		
3N10W35.4f	IDOT DEWATERING #1	394.03		
3N10W35.6f	E ST L D&L DIS RW96			
3N10W35.6g	E ST L D&L DIS RW91	397.28		
3N10W35.6h	E ST L D&L DIS RW87	396.87		
3N10W36.5g	MAD INDUS COMPLEX#ll	401.10		
3N10W36.5h	LACLEDE STEEL CO #9	400.36		
4N08W17.8b1	SIU EDWRD WELL 1	425.57		
4N08W17.8b2	SIU EDWRD WELL 2	421.13	415.03	-6.10
4N08W18.4c	BROCKMEIR WELL 2	416.36		
4N08W19.4e	I.J. HITTNER		409.85	
4N08W20.4a	BROCKMEIR WELL 1	424.78		
4N08W20.5d	SIU WELL 3	418.91		
4N08W29.4a	OTTO BAUMANN	416.32	414.06	-2.26
4N08W32.3a	VERNON KELLER WELL 1	421.09	413.55	-7.54
4N08W32.4a	VERNON KELLER WELL 2		412.31	
4N09W01.2e	LOSCH FARMS	417.87	410.22	-7.65
4N09W01.7hl	MARRIN DENTON			
4N09W02.3b	VIL OF ROXANA	413.09	407.18	-5.91
4N09W03.2b	EXPLORER PIPELINE CO	409.88	405.49	-4.39
4N09W03.2g	SHELL OIL CO	402.11		
4N09W03.6f	SHELL OIL CO			
4N09W04.2g3	VIL OF HARTFORD WELL 1		397.99	
4N09W04.2g4	VIL OF HARTFORD WELL 2	403.04	396.34	-6.70
4N09W04.2g5	VIL OF HARTFORD WELL 4		404.45	
4N09W04.3f	CITY OF HARTFD WELL 3	404.58	399.56	-5.02
4N09W04.5f	NAT MARINE SERVICE WELL 1			
4N09W04.6e	NAT MARINE SERVICE WELL 2			
4N09W04.7h	HARTFORD, IL RM196.8			
4N09W09.2b	HOEHN WELL (destroyed > 1980)			
4N09W10.8e	CONOCO PIPELINE CO		405.65	
4N09W10.8h	HARTFORD TERMINAL	408.01	404.53	-3.48
4N09W11.3bl	ROXANA DISTR SYSTEM #8			
4N09W11.3b2	ROXANA DISTR SYSTEM #9	410.36		
4N09W11.3b3	ROXANA DISTR SYSTEM #10		405.69	

APPENDIX B. (Continued)

County location	Owner	Water-level elevation 1985 (ft)	Water-level elevation 1990 (ft)	Water-level change 1985-1990 (ft)
Madison				
4N09W12.4f	LOSCH FARMS, ROCK HOUSE		409.71	
4N09W12.4hl	LOSCH FARMS IRRIGATION	417.94	411.95	-5.99
4N09W12.4h2	CHARLES LOSCH ABAND.	414.90	409.14	-5.76
4N09W12.4h3	LOSCH FARMS HOUSE	413.88		
4N09W13.1d4	CY OF EDWRDSVE WELL 4			
4N09W13.1d5	CY OF EDWRDSVE WELL 5	413.17	410.47	-2.70
4N09W13.1d7	CY OF EDWRDSVE WELL 7	415.37	410.28	-5.09
4N09W13.1d8	CY OF EDWRDSVE WELL 8	414.96	411.96	-3.00
4N09W13.1d9	CY OF EDWRDSVE WELL 9		409.66	
4N09W14.8h2	E SD LEVEE SAN DIST RW3	405.20	402.62	-2.58
4N09W16.2cl	CHEMETCO METALS CORP WELL 1	408.23	405.91	-2.32
4N09W16.2c2	CHEMETCO METALS CORP WELL 2	407.11	402.98	-4.13
4N09W20.3g	E ST L D&L DIS RW196	406.61	403.44	-3.17
4N09W21.5h	BEN KILLAM		412.86	
4N09W23.5d	SWS DRIVEN PIEZOMETER	411.01		
4N09W25.4e	EDWIN RAPP	412.48	410.69	-1.79
4N09W25.8a2	SWS DRIVEN PIEZOMETER	412.02	411.19	-0.83
4N09W25.8al	UNKNOWN			
4N09W29.8d	E ST L D&L DIS RW161	405.52	403.08	-2.44
4N09W30.1b	E ST L D&L DIS RW155	405.53	403.07	-2.46
4N09W31.2h	E ST L D&L DIS RW150	405.40	402.92	-2.48
4N09W31.3g	E ST L D&L DIS RW145	405.43	402.69	-2.74
4N09W31.6a	E ST L D&L DIS RW126	405.32	403.09	-2.23
4N09W33.2d	TRI CITY SPEEDWAY	410.38		
4N09W33.4b	CY OF GRANITE CITY PI	410.79		
4N09W34.1b	M. THEIS			
4N10W35.3g	CHAIN OF ROCKS RM190.4			
5N09W18.3cl	ALTON BOX BRD CO WELL 10	391.88		
5N09W18.3c2	ALTON BOX BRD CO WELL 19			
5N09W18.4b	ALTON BOX BRD CO (DIESEL HOUSE)			
5N09W18.4c2	ALTON BOX BRD CO WELL 18		373.71	
5N09W18.5cl	ALTON BOX BRD CO WELL 15	406.16		
5N09W18.5c2	ALTON BOX BRD CO WELL 16	390.50		
5N09W18.6c	ALTON BOX BRD CO WELL 20	394.17	378.87	-15.30
5N09W18.7a	ALTON BOX BRD CO WELL 22	404.85	396.54	-8.31
5N09W18.8b	ALTON BOX BRD CO WELL 23			
5N09W18.8c	LACLEDE STEEL-ALTON PLANT			
5N09W19.3c	WOOD RIVER D&L DIS RW100	407.80		
5N09W19.3d	WOOD RIVER D&L DIS RW99		390.23	
5N09W19.4g	FED METALURGICAL #3			
5N09W19.4hl	FED METALURGICAL #1	399.61	381.27	-18.34
5N09W19.4b2	FED METALURGICAL #2	400.01	383.03	-16.98
5N09W19.6el	WOOD RIVER D&L DIS RW87XX	406.39	376.94	-29.45
5N09W19.6e2	WOOD RIVER D&L DIS RW80XX	406.65	364.04	-42.61
5N09W19.8g	WOOD RIVER D&L DIS RW68X	406.40	379.22	-27.18
5N09W20.2e	OLIN MATHIESON CHEM CORP #1			
5N09W20.4hl	CY OF E ALTON #1	404.31		
5N09W20.4h2	CY OF E ALTON #2	403.98	392.38	-11.60

APPENDIX B. (Continued)

County location	*Owner*	*Water-level elevation 1985 (ft)*	*Water-level elevation 1990 (ft)*	*Water-level change 1985-1990 (ft)*
Madison				
5N09W20.4h3	CY OF E ALTON #3	404.41	392.50	-11.91
5N09W20.4h4	CY OF E ALTON #4		394.21	
5N09W20.4h5	CY OF E ALTON #5		398.00	
5N09W20.5a	WOOD RIVER D&L DIS RW105			
5N09W20.8gl	AIRCO INDUST GAS #1			
5N09W20.8g2	AIRCO INDUST GAS #2		397.80	
5N09W21.5c	DOME RAILWAY SERV #1	411.30		
5N09W21.Shl	CY OF E ALTON #15			
5N09W21.5h2	CY OF E ALTON #16			
5N09W21.5h3	CY OF E ALTON #19			
5N09W21.5h4	CY OF E ALTON #11			
5N09W22.2cl	VIL OF BETHAL #1			
5N09W22.2c2	VIL OF BETHAL #2			
5N09W22.2c3	VIL OF BETHAL #3			
5N09W22.2c6	VIL OF BETHAL #6	403.34	392.45	-10.89
5N09W22.2c7	VIL OF BETHAL #7	401.78	391.17	-10.61
5N09W22.2c8	VIL OF BETHAL #8	401.78	392.32	-9.46
5N09W22.2c9	VIL OF BETHAL #9	402.12	391.48	-10.64
5N09W22.2cl0	VIL OF BETHAL #10	399.20	388.50	-10.70
5N09W22.2cll	VIL OF BETHAL #11		392.03	
5N09W22.2c12	VIL OF BETHAL #12	399.42	389.92	-9.50
5N09W22.4e	CY OF WOOD RIVER, BELK PARK			
5N09W26.7f	CY OF WOOD RIVER #17	405.89	397.60	-8.29
5N09W26.8dl	VIL OF ROXANA #6			
5N09W26.8d2	WOOD RIVER D&L DIS #136	404.38	398.68	-5.70
5N09W26.8e	VIL OF ROXANA #7			
5N09W26.8gl	CY OF WOOD RIVER #12	408.18		
5N09W26.8g2	CY OF WOOD RIVER #15	405.94		
5N09W26.8g3	CY OF WOOD RIVER #18		397.06	
5N09W27.1b2	VIL OF ROXANA #3			
5N09W27.1b4	VIL OF ROXANA #5			
5N09W27.5al	MARATHON PLINE S WELL	400.85	395.04	-5.81
5N09W27.5a2	MARATHON OIL N WELL	400.68	393.02	-7.66
5N09W27.7a	AM OIL CO WR REF #60	395.35	390.71	-4.64
5N09W27.7b	AM OIL CO WR REF #42		389.94	
5N09W27.7el	AM OIL CO WR REF #50	402.68	394.87	-7.81
5N09W27.7e2	AM OIL CO WR REF #51	395.64		
5N09W27.7e3	AM OIL CO WR REF #53	402.91	397.06	-5.85
5N09W27.8al	AM OIL CO WR REF #58	396.38	388.86	-7.52
5N09W27.8a2	AM OIL CO WR REF #61	396.53	392.16	-4.37
5N09W27.8bl	AM OIL CO WR REF #56	397.38		
5N09W27.8b2	AM OIL CO WR REF #55	411.62		
5N09W27.8b3	AM OIL CO WR REF #65			
5N09W27.8c	AM OIL CO WR REF #33	398.64		
5N09W27.8dl	AM OIL CO WR REF #30			
5N09W27.8d2	AM OIL CO WR REF #52			
5N09W28.1al	AM OIL CO WR REF #59	398.96	393.09	-5.87
5N09W28.1a2	AM OIL CO WR REF #62	398.37		

APPENDIX B. (Continued)

County location	*Owner*	*Water-level elevation 1985 (ft)*	*Water-level elevation 1990 (ft)*	*Water-level change 1985-1990 (ft)*
Madison				
5N09W28.1b1	AM OIL CO WR REF #46			
5N09W28.1b2	AM OIL CO WR REF #57	399.50	393.47	-6.03
5N09W28.2d	AM OIL CO WR REF TEST			
5N09W28.4c	WOOD R D&L DIS RW146	407.75		
5N09W28.5b1	AMOCO - RIVER WELL #1		398.45	
5N09W28.5b2	AMOCO - RIVER WELL #2		386.03	
SN09W28.5b3	AMOCO - RIVER WELL #3		390.78	
5N09W28.5b4	AMOCO - RIVER WELL #4		389.28	
5N09W28.7el	CY OF WOOD RIVER #3	410.77		
5N09W28.7e3	CY OF WOOD RIVER #6	405.90		
5N09W28.7e4	WOOD R D&L DIS RW140		398.32	
5N09W28.8el	CY OF WOOD RIVER #1	402.46		
5N09W28.8e2	CY OF WOOD RIVER #2			
5N09W28.8e5	CY OF WOOD RIVER #5			
5N09W28.8e6	WOOD R D&L DIS RW138	404.11		
5N09W29.1e	WOOD R D&L DIS RW135	405.15	398.80	-6.35
5N09W29.3hl	O MATHIESON CH CO #3			
5N09W29.3h2	0 MATHIESON CH CO #4		385.16	
5N09W29.3h3	0 MATHIESON CH CO #5	393.87	383.92	-9.95
5N09W29.4g3	0 MATHIESON CH CO #2	395.56		
5N09W29.4gl	WOOD R D&L DIS RW114	409.53	402.01	-7.52
5N09W29.4g2	WOOD R D&L DIS RW121			
5N09W29.5f	OLIN CORP		400.99	
5N09W29.5gl	OLIN CHEM - AE1		400.49	
5N09W29.5g2	OLIN CHEM - AN1		399.34	
5N09W33.1a	CLARK OIL & REF - B3-W		398.07	
5N09W33.1d	CLARK OIL & REF - B34-W		397.25	
5N09W33.5el	SHELL OIL REF N TEST			
5N09W33.5e2	SHELL OIL REF S TEST			
5N09W33.5f	SHELL OIL MIS RTV #4		390.95	
5N09W34.3el	ANLIN CO #1 (aka ANLIN EAST)			
5N09W34.3e2	ANLIN CO #2 (aka ANLIN WEST)			
5N09W34.4al	CLARK OIL CO REF #5			
5N09W34.4a2	CLARK OIL CO REF - B25-E		392.44	
5N09W34.5al	CLARK OIL CO REF #3			
5N09W34.5b	CLARK OIL CO REF - B9-E		396.13	
5N09W34.6al	CLARK OIL CO REF #1			
5N09W34.6a2	CLARK OIL CO REF #2	400.76		
5N09W34.6b	CLARK OIL CO REF #4			
5N09W34.7b	CLARK OIL CO REF - B6-E		395.49	
5N09W34.7dl	INT'L SHOE CO - WEST WELL	402.86		
5N09W34.7d2	INT'L SHOE CO - EAST WELL	401.35		
5N09W34.8b	CLARK OIL CO REF - B38-W		398.00	
5N09W35.5f	SHELL OIL REF W #52	400.40		
5N09W35.5h	SHELL OIL REF W #41	400.36	391.11	-9.25
5N09W35.6b	SHELL OIL REF W #60			
5N09W35.8h	SHELL OIL CO TW#1	402.40	393.77	-8.63
5N09W36.4c	SHELL OIL CO K H WELL			

APPENDIX B. (Continued)

County location	*Owner*	*Water-level elevation 1985 (ft)*	*Water-level elevation 1990 (ft)*	*Water-level change 1985-1990 (ft)*
Madison				
5N10W13.1al	LACLEDE STL CO (ALTON) #1		394.80	
5N10W13.1a2	LACLEDE STL CO (ALTON) #3	407.10		
5N10W13.1b	LACLEDE STL CO (ALTON) #2	401.25		
5N10W13.2al	WOOD RIVER D&R DIS RW41X		403.92	
5N10W13.2a2	WOOD RIVER D&R DIS RW42X	407.09	403.44	-3.65
5N10W13.4cl	OWENS IL GLASS CO #1			
5N10W13.4c3	OWENS IL GLASS CO #3	402.03		
5N10W13.4c6	OWENS IL GLASS CO #6	402.03		
5N10W13.4c7	OWENS IL GLASS CO #7	401.18		
5N10W13.4c8	OWENS IL GLASS CO - COE WELL		404.80	
5N10W13.5c	WOOD RIV D&L DIS RW20	408.84	411.17	2.33
5N10W13.5dl	WOOD RIV D&L DIS RW16			
5N10W13.5d2	WOOD RTV D&L DIS RW18	410.50		
5N10W14.4e	LOCK & DAM #26			
5N10W24.1h	WOOD RTV D&L DIS RW51	407.50	397.69	-9.81
St. Clair				
lN09W04.5e	E WESTERHEIDE			
lN09W04.6fl	LaLUMIER SCHOOL - ME22		402.50	
lN09W06.1e	SWS PIEZOMETER			
lN09W08.8h	VA RISTER	401.28	400.11	-1.17
lN10W01.8dl	CAHOKIA HIGH SCHOOL - ME13		397.33	
lN10W02.8e	SWS PIEZOMETER			
lN10W03.3cl	HUFFMAN SCHOOL - ME14		395.12	
lN10W04.1g	E ST L D&L DIS RW196	393.90	391.05	-2.85
lN10W04.2e	E ST L D&L DIS RW207	393.36	389.46	-3.90
lN10W04.3b	E ST L D&L DIS RW237		389.86	
1N10W04.3C	E ST L D&L DIS RW223			
lN10W04.7b	PRAIR DUP D&L RW23	390.81	386.95	-3.86
lN10W08.2h	PRAIR DUP D&L RW28	390.33	388.41	-1.92
1N10W08.5C	PRAIR DUP D&L RW34	390.84	389.45	-1.39
lN10W08.7a	PRAIR DUP D&L RW45	390.36	389.02	-1.34
lN10W09.1f	E ST L D&L DIS RW262	394.21	391.99	-2.22
lN10W09.2h	E ST L D&L DIS RW251	395.36	392.09	-3.27
lN10W09.4h	PRAIR DUP D&L RW15	392.92	389.01	-3.91
IN10W1O.1C	E ST L D&L DIS RW273			
1N10W10.4C	E ST L D&L DIS RW263			
lN10W12.5b	E ST L D&L DIS RW278	398.61	398.16	-0.45
lN10W13.3h	E ST L D&L DIS RW286	397.74	398.21	0.47
lN10W16.2g	WALTER DRESCHER	397.63		
lN10W16.6h	OSCAR KELLING	395.60	394.74	-0.86
lN10W17.1e	OSCAR KELLING			
lN10W17.5g	D CHARTRAND			
lN10W17.8b	D CHARTRAND	399.64	397.23	-2.41
lN10W19.6f	PRAIR DUP D&L RW46	390.40	386.77	-3.63
1N10W20.4C	C LINDHORST	390.91	389.22	-1.69
lN10W20.5f	D CHARTRAND			
lN10W20.6a	D CHARTRAND			

APPENDIX B. (Continued)

County location	Owner	Water-level elevation 1985 (ft)	Water-level elevation 1990 (ft)	Water-level change 1985-1990 (ft)
St. Clair				
lN10W21.1a	BUCK RANGE			
lN10W21.4f	MO PAC RR (PIEZ #3)	391.65	390.29	-1.36
lN10W30.6h	PRAIR DUP D&L RW55	390.50	386.13	-4.37
lN10W30.8b	PRAIR DUP D&L RW69	391.51	384.91	-6.60
lN10W31.4d	LLOYD PULCHER	393.28		
1N10W31.7C	LLOYD PULCHER			
lN10W31.8d	PRAIR DUP D&L RW80	397.04	392.83	-4.21
lN10W32.3e	L W BIELLER	395.30	393.51	-1.79
lN10W32.5d	CLIFFORD CATES	393.24	391.46	-1.78
2N08W06.1e	KELLER BROS #2	399.76	400.38	0.62
2N08W06.5a	C WEISSERT #2	401.33	400.64	-0.69
2N08W06.5h	KELLER BROS #1			
2N08W07.2h2	AUTO WH INC #2			
2N08W07.2h3	ATLAS LEATHER #3			
2N09W01.1h	MOUND PUB WAT DIST #3	401.56	404.16	2.60
2N09W01.3b	A WEISSERT #2	403.80	402.17	-1.63
2N09W01.3g	MOUND PUB WAT DIS #2	402.36		
2N09W02.4e	CAHOKIA MOUNDS ST PK			
2N09W03.2g	FS SERVICE INC #1			
2N09W04.1a	MOBIL CHEM CO			
2N09W04.7al	ROSELAKE SCHOOL - ME18		401.08	
2N09W06.1b	I70/I55-RTE203 - ME17		396.33	
2N09W07.5el	CIRCLE PACKING CO #1	388.56		
2N09W07.5e2	CIRCLE PACKING CO #2	389.02	390.18	1.16
2N09W07.5e3	CIRCLE PACKING CO #3			
2N09W07.6al	IDOT DEWAT 164 #1	380.95	374.35	-6.60
2N09W07.6a2	IDOT DEWAT 164 #2	382.94	377.04	-5.90
2N09W07.6a3	IDOT DEWAT 164 #3	385.48	378.92	-6.56
2N09W07.6a4	IDOT DEWAT 164 #4	385.47	380.27	-5.20
2N09W07.6b1	IDOT DEWAT 170 #10	371.74	370.45	-1.29
2N09W07.6b2	IDOT DEWAT 170 #11	380.43	371.36	-9.07
2N09W07.6b3	IDOT DEWAT 170 #12	385.01		
2N09W07.6c	BOWMAN PUMP STA - ME19		379.49	
2N09W07.6el	HUNTER PACKING CO #1			
2N09W07.6e3	HUNTER PACKING CO #3	388.91	389.38	0.47
2N09W07.7al	IDOT DEWAT 164 #11	374.24	376.62	2.38
2N09W07.7a2	IDOT DEWAT 164 #12	383.53		
2N09W07.7bl	IDOT DEWAT 170 #2	381.21		
2N09W07.7b2	IDOT DEWAT 170 #3	369.09	372.14	3.05
2N09W07.7b3	IDOT DEWAT 170 #4	378.77	370.02	-8.75
2N09W07.7b4	IDOT DEWAT 170 #7A	382.25		
2N09W07.7b5	IDOT DEWAT 170 #8A	380.86		
2N09W07.7b6	IDOT DEWAT 170 #9A	379.63		
2N09W07.8bl	IDOT DEWAT 170 #1	375.78	376.30	0.52
2N09W07.8b2	IDOT DEWAT 170 #5	375.76		
2N09W07.8b3	IDOT DEWAT 170 #6	381.87	373.48	-8.39
2N09W10.5a	J E JOUGTARD	410.20	409.00	-1.20
2N09W11.4c	HYTLA			

APPENDIX B. (Continued)

County location	Owner	Water-level elevation 1985 (ft)	Water-level elevation 1990 (ft)	Water-level change 1985-1990 (ft)
St. Clair				
2N09W12.5dl	BILL HENSON (ex VERNON STAFFORD)	407.57	406.34	-1.23
2N09W12.5d2	BILL HENSON #2		407.75	
2N09W13.7f	J COURTNEY	408.14	406.69	-1.45
2N09W14.2e	BLUFFVIEW PARK - ME21		408.68	
2N09W14.3d	NAGLE			
2N09W14.3f	C WEISSERT #3	405.47		
2N09W14.6h	FRANK TOJO			
2N09W15.5el	C WEISSERT #1	402.10	401.39	-0.71
2N09W15.5e2	A WEISSERT #1	408.63	406.69	-1.94
2N09W16.7a	ESL CASTINGS CO			
2N09W17.2g	CY OF E ST L JONES P	397.63	397.02	-0.61
2N09W17.7hl	CHAS PFIZER INC #12	386.69	384.95	-1.74
2N09W17.7h2	CHAS PFIZER INC #14	389.39	389.67	0.28
2N09W18.1g	ATHLETIC FIELD - ME9		391.53	
2N09W18.6hl	IDOT DEWAT 164 #5	386.37	382.09	-4.28
2N09W18.6h2	IDOT DEWAT 164 #13	385.26	379.70	-5.56
2N09W18.6h3	IDOT DEWAT 164 #14	386.96		
2N09W18.6h4	IDOT DEWAT 164 #15	387.09	383.77	-3.32
2N09W19.7dl	OBER NESTOR GLASS CO (SE WELL)	400.53	399.23	-1.30
2N09W19.7d2	OBER NESTOR GLASS CO (NW WELL)	399.65	398.24	-1.41
2N09W19.8fl	CERTAIN-TEED PROD #1		394.40	
2N09W19.8f2	CERTAIN-TEED PROD #2	396.28	394.85	-1.43
2N09W21.4d	ESL HIGH SCHOOL - ME20		404.37	
2N09W23.1e	RICHARD POPP	410.88	409.98	-0.90
2N09W24.6e	MITCHELLS	410.42		
2N09W26.7e	SWS#2	408.70	407.81	-0.89
2N09W27.3g2	KENNEDY-KING SCHOOL - ME11		406.93	
2N09W27.8g	HOLTEN ST PK (GRAND MARIOS)			
2N09W28.3a	De MANGE			
2N09W28.4g	HOLTEN ST PK (GRAND MARIOS)	408.91	408.32	-0.59
2N09W29.8fl	CHEMTEK PRODS INC #14			
2N09W29.8f2	CHEMTEK PRODS INC #3	405.01	403.97	-1.04
2N09W29.8i3	CHEMTEK PRODS INC #7	405.57		
2N09W29.8f4	CHEMTEK PRODS INC #10			
2N09W29.8f5	CHEMTEK PRODS INC #12			
2N09W29.8f6	CHEMTEK PRODS INC #16		403.66	
2N09W33.1e	VINCE DEMANGE			
2N09W34.4h	H W THOMAS	407.57	406.07	-1.50
2N10W01.2h	USS AG CHEMICALS	390.44	388.32	-2.12
2N10W01.3a	ARMOUR AND CO WELL #2	392.19	390.73	-1.46
2N10W11.4el	E ST L D&L DIS RW105			
2N10W11.4e2	E ST L D&L DIS RW108			
2N10W12.2h3	NATIONAL CY COLD STRG #6			
2N10W12.3g	SWIFT AND CO #17			
2N10W12.3hl	ARMOR AND CO WELL #4	392.87	392.85	-0.02
2N10W12.3h2	SWIFT AND CO #18	390.88		
2N10W12.6hl	ROYAL PACKING CO #1	395.69		
2N10W12.6h2	ROYAL PACKING CO #2	396.02	389.58	-6.44

APPENDIX B. (Concluded)

County location	*Owner*	*Water-level elevation 1985 (ft)*	*Water-level elevation 1990 (ft)*	*Water-level change 1985-1990 (ft)*
St. Clair				
2N10W12.7g	TERMINAL ICE PLANT	396.96	393.43	-3.53
2N10W14.7e	MISSISSIPPI RM 179.6			
2N10W23.3a3	AM ZINC CO #9	401.46		
2N10W23.4c	MISSISSIPPI AVE WH			
2N10W23.6f	E S T L D&L DIS RW118	394.62	387.19	-7.43
2N10W23.6g	E S T L D&L DIS RW111	395.10		
2N10W23.7a	E ST L D&L DIS RW136	392.72		
2N10W23.7bl	E ST L D&L DIS RW126			
2N10W23.7b2	E ST L D&L DIS RW135		389.35	
2N10W23.7c	E ST L D&L DIS RW127	400.60	393.80	-6.80
2N10W24.4fl	ROBINSON SCHOOL - ME 10		395.30	
2N10W25.5dl	MOBIL OIL CO - FIRE HOUSE WELL	398.57	398.11	-0.46
2N10W25.5d2	MOBIL OIL CO #21		398.89	
2N10W25.6e	MOBIL OIL CO #6			
2N10W25.7b	LEFTON IRON & MET #2			
2N10W26.1gl	MONSANTO CHEM CO #13A			
2N10W26.1g2	MONSANTO CHEM CO #8A			
2N10W26.2e	MONSANTO CHEM CO #SR-2 (TEST WELL)			
2N10W26.3g	MONSANTO CHEM CO #14			
2N10W26.4f	MONSANTO CHEM CO #20			
2N10W26.5d2	CERRO COPPER&BRASS #5			
2N10W26.5d3	CERRO COPPER&BRASS #6	394.92		
2N10W26.5d4	CERRO COPPER&BRASS WCD#3		395.51	
2N10W26.5d5	CERRO COPPER&BRASS WCD#8		395.67	
2N10W26.6g	MONSANTO CHEM CO #R-2			
2N10W26.8a2	MIDWEST RUBBER RECLAIM #8			
2N10W26.8a3	MIDWEST RUBBER RECLAIM #10	395.68	393.15	-2.53
2N10W26.8a5	MIDWEST RUBBER RECLAIM SOUTH RES		394.83	
2N10W26.8g	SAUGET WASTE TREAT PLANT			
2N10W27.2hl	MONSANTO CHEM CO #XS-1 TEST WELL			
2N10W27.2h2	MONSANTO CHEM CO #S-1 TEST WELL			
2N10W27.3g	MONSANTO CHEM CO #21			
2N10W27.3h	MONSANTO CHEM CO RANNEY WELL			
2N10W33.1f	FOX TERMINAL	395.17	387.62	-7.55
2N10W33.2h	ENGINEER DEPOT RM 176.8			
2N10W34.5g	E ST L D&L DIS RW138	397.10		
2N10W34.5h	E ST L D&L DIS RW137		390.83	
2N10W34.6e	E ST L D&L DIS RW159	393.92	389.82	-4.10
2N10W34.7c	E ST L D&L DIS RW169	394.09	391.14	-2.95
2N10W34.8b	E ST L D&L DIS RW180	394.74	391.39	-3.35
2N10W35.3e	SWS DRIVEN PIEZOMETER			
2N10W35.7fl	PITZMAN SCHOOL - ME12		396.30	

[redacted]