A MONITORING WELL NETWORK FOR THE GULF COAST MIOCENE AQUIFER SYSTEM

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INTRODUCTION

The Pliocene-Miocene Aquifer System covers roughly the southern one-third of Mississippi. This system consists of alternating sands and clays. The base of the fresh water section ranges from ground level at the updip limit of the Miocene to 3,000 feet below sea level in Hancock County (Figure 1). The formations that comprise this aquifer system are, in ascending order, the Catahoula, Hattiesburg, Pascagoula, Graham Ferry, and Citronelle (Figure 2). The Pascagoula and Graham Ferry Aquifers are each further broken down into upper and lower units. The main aquifers being utilized along the coast are the Graham Ferry, the Pascagoula, and, to a lesser extent, the Hattiesburg.

For most of the coastal area, the water quality in these aquifers is relatively good. There is, however, an increase in chloride concentration from west to east along the coastline in Jackson County and in the vicinity of Biloxi Bay. As a result, there have been several studies conducted to gain a better understanding of the problem and to delineate the areas of concern. The early reports of Brown (1944) and Harvey (1965) made note of the regionally high chloride concentrations, but both indicated that this increase was probably due either to connate water or saline water from shallow sands entering wells with damaged casings rather than saltwater intrusion. A 1978 report by B. E. Wasson stated that, with increased pumpage, the freshwater/saltwater contact would move updip and intrude into the Pascagoula area. The 1989 U.S. Geological Survey (USGS) Miocene Aquifer Model Report suggested that the saltwater interface had arrived or was near the southeastern edge of Pascagoula in the Upper Pascagoula Aquifer, as indicated by the increase in chloride concentration in the Q164 and Q181 wells. This report also predicted that the saltwater front would reach the southernmost Graham Ferry wells at Bayou Casotte before 1995 if pumping continued at the 1989 rate.

As a result of the model report, the Office of Land and Water Resources (OLWR), Mississippi Department of Environmental Quality, was concerned that the then current rate of pumpage could cause saltwater intrusion in the Pascagoula area. OLWR stated that permits to withdraw ground water from wells in the coastal areas of Jackson County would not be renewed for the 1985 permitted volumes in 1995.

In order to gain a better understanding of the anticipated intrusion of salt water, in early 1992, OLWR personnel reviewed all available historic water quality and water level data for Jackson County. In addition, in 1992 and 1993, OLWR staff sampled 133 wells in the county to evaluate water quality and to determine whether saltwater intrusion was occurring. OLWR concluded, as Harvey did in 1965, that there was no evidence of saltwater intrusion in the deeper aquifers. The data indicated only minor fluctuations in chloride concentrations in individual wells, with no trends either up or down.

PURPOSE AND COMPONENTS OF NETWORK

In spite of these findings, many citizens and public officials were still concerned that saltwater intrusion might occur at some time in the future. In response to these concerns, in 1995 OLWR established a monitoring well network along the Mississippi coast to detect any possible changes in chloride concentrations. This network consists of 34 wells, varying in depth from 330 to 2000 feet, in Jackson, Harrison, and Hancock Counties (Figure 3). Eighteen of these wells are located in Jackson County, nine in Harrison County, and seven in Hancock County. A sample is collected and/or the static water level is measured at each of these wells twice a year - - once in summer, when pumpage is heaviest, and once during winter, when pumpage is reduced.

Several criteria were used in selecting wells for this network. First, wells of varying depths were needed for each county, with adequate spacing between wells in the same layer. All wells had to be located near the coastline. Accessibility was an important factor. For example, it is difficult or time-consuming to gain entry to some wells. Reliability of the data was another consideration. We had to be certain of the screened interval of the well and relatively sure that the casing was intact. Wells to be sampled had to be in use. Lastly, preference was given to wells for which good historical data was available.

PROCEDURES

Collection and Analysis of Samples

When sampling a well, the pump is allowed to run for a reasonable period of time to avoid sampling water that has been in the well casing or the tank for a long period of time. Flowing wells and wells that are used on a regular basis, such as for public supply and industry, may only require minimal purging before being sampled. Home wells, conversely, may not be in continuous use, so a longer period of purging may be needed before sampling. Two samples are collected, one in a large plastic cup, to be tested in the field, and one in a 250-ml bottle, to be taken to the Pollution Control Laboratory. The field sample is analyzed for pH and conductance, using an Orion portable pH meter Model 230A and a YSI conductance meter, Model 32. This provides a preliminary indicator whether any change in water quality has occurred. Bottles for the lab samples are labeled with the county, well number, name, and date. The bottles are filled and placed in a cooler until being delivered to the lab. At the lab, samples are analyzed for chloride concentration. Conductance and pH are also measured for comparison to the field analysis. Results are normally received from the lab within three or four weeks.

Measurement of Water Levels

Prior to measuring the static water level, the pump is turned off for a sufficient length of time to allow the water level to recover. Water levels in non-flowing wells are measured with a steel tape. Several measurements may be taken to insure that the water level has recovered, and the measurement is compared to recent records. Flowing wells are measured, after closing any open valves, with a 30-pound pressure gauge.

Analysis and Organization of Data

All data is recorded in a field notebook for transfer to a computer database. Each new measurement is checked against the historic data for that well. If the measurement differs greatly from previous measurements, a check is made for errors in sample identification or data entry. If an error is found, it is corrected or discarded if not positively correctable.

If the data appears to be correct but differs greatly from previous measurements, the well is resampled as soon as possible. One such case occurred in a Gautier well, USGS No. 0300, in 1996-97. The chloride concentration dropped from a previous average of about 44 mg/1 to about 16 mg/1. A casing leak was suspected. The well was revisited and sampled twice, once after the usual amount of pumping and again after pumping a slightly longer period of time. The first had an abnormally low chloride measurement, while the second was comparable to the previous norm.

When the reliability of the water level measurement or sample analysis is established, it is entered into the computer database, which is organized by county and USGS well number. This database contains pertinent information on the well, such as owner, location, and depth, plus all historic records of water levels, pH, conductance, and chloride concentration. The data for individual wells is graphed periodically for visual comparison over time. Wells with adequate water level and chloride data are graphed to compare water quality to pumpage.

RESULTS

In Jackson County, the monitoring wells vary in depth from 330 feet to 1395 feet. Chloride concentrations in these wells range from 4 mg/1 to 500 mg/1 and, in general, increase from west to east. The lowest chloride concentration is found in Well N517, a 561-foot deep well in Ocean Springs with an average of 5 mg/1. The highest concentration, averaging about 500 mg/l, is found in Well 074, a 1395-foot deep private well southeast of Ocean Springs. The southernmost well, 0392, is about 12 miles south of Gautier on Horn Island. This well is 835 feet deep and has a chloride concentration of about 70mg/l. The Q180 well, a Pascagoula city well, is less than one block north of the well (Ql8l) that the 1989 USGS Miocene Aquifer Model Report suggested the saltwater interface was approaching. Historical data for this well goes back to 1977, and, as can be seen in Figure 4, the chloride concentration in 1998 is 266 mg/1, compared to 240 mg/l in 1977. This data does not indicate that a saltwater front has reached the well.

Well No. Q137 is located in Bayou Cassotte at the Chevron refinery. It is a 387 foot deep Graham Ferry well with water quality records dating from 1963 to the present. As can be seen on the chloride graph (Figure 5), the chloride concentration increased from 100 mg/l in 1963 to 140 mg/l in 1969. Values since then have fluctuated somewhat, with a high of 200 mg/l in 1981. The chloride concentration for this well in February 1998 was 144 mg/l about the same as in 1969. The records do not indicate that a saltwater front has reached this well either.

In Harrison County, the monitoring wells vary in depth from 380 feet to 1640 feet. Chloride concentrations range from three mg/l to 39 mg/l. There has been very little change in chlorides over time in any of these wells. A well on Keesler Air Force Base (M67) has the longest period of record in the monitoring well network, going back to 1942. As can be seen in Figure 6, the chloride concentration has ranged from 2.8 mg/l to 11.1 mg/l for over thirty years.

The deepest monitoring well in Harrison County is 0307, at 1640 feet. Figure 7 shows that the chloride concentration has ranged from 24 mg/l to 34 mg/1. The two southernmost wells are on Ship Island and are 436 feet and 480 feet deep. Chloride concentrations for both of these wells are in the 20-30 mg/l range.

Monitoring wells in Hancock County vary in depth from 520 feet to 2000 feet. Chloride concentrations range from 16 mg/l to 65 mg/I. The well with the longest period of record is K4, a Bay St. Louis public supply well. Chloride concentrations in this well have been very consistent since 1959, ranging from 33 mg/l to 40 mg/l (Figure 8).

At 2000 feet in depth, Well No. Ll in Port Bienville Industrial Park is both the deepest and the southernmost well in the county. Chloride concentrations in this well have ranged from 39 mg/l to 50 mg/l (Figure 9).

Despite increasing pumpage all along the coast, water levels in most wells have remained relatively stable over the past several years. The exception to this is in the Pascagoula area. Groundwater pumpage in Jackson County increased from 22.5 Mgal/d in 1985 to 25.2 Mgal/d in 1992. Since 1992, pumpage in Pascagoula has remained fairly constant, yet water levels in several wells have been rising, especially Wells P150 (785 feet in depth) and P372 (336 feet) in downtown Pascagoula.

Water levels in some wells fluctuate greatly in response to pumpage, due to poor sand quality or a locally restricted aquifer. Wells Q180 and Q181 in southeastern Pascagoula are producing from an apparently isolated sand of the Upper Pascagoula Aquifer. They are very responsive to pumpage. When any one of these wells is heavily pumped, its water level drops significantly. When pumpage decreases, the water level recovers rapidly.

When chloride concentration graphs were compared with hydrographs in wells for which adequate data was available, no relationship could be established between changes in chloride concentrations and fluctuations in water levels.

SUMMARY

The Miocene-Pliocene monitoring well network extends across the entire Mississippi Gulf Coast. This network includes appropriately spaced wells of various depths for adequate representation of the aquifer system. Although water from certain wells is high in chloride concentration, there have been no significant increases. To date, only minor fluctuations in chlorides have been observed in these wells. Water levels along the coast have also remained relatively stable for the past several years.

All too often, data from a single well or a few select wells is misinterpreted to represent a regional trend, rather than an anomaly. This study has emphasized the importance of collecting data from an adequate number of wells and of taking steps to insure the reliability of this data.

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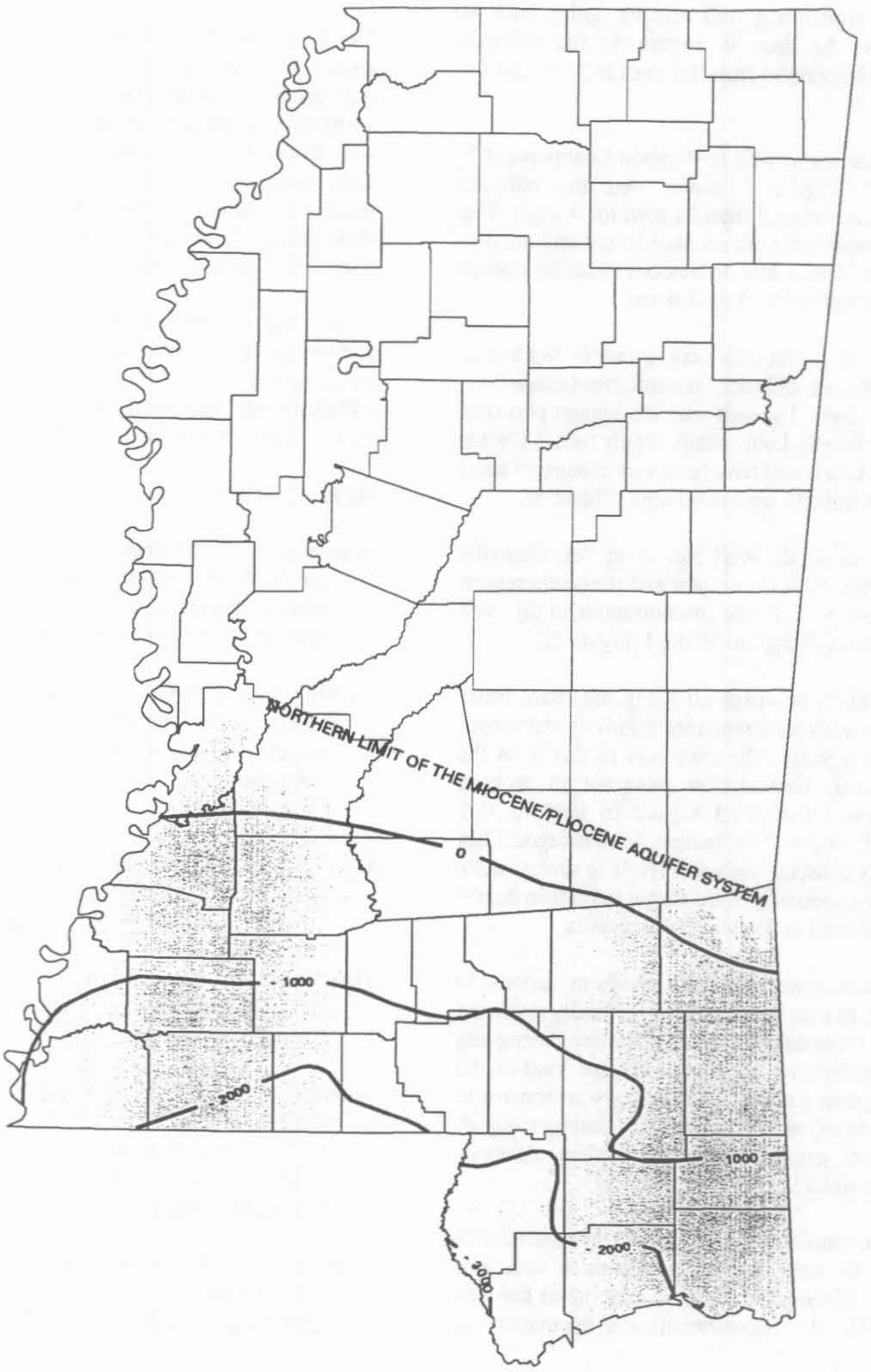
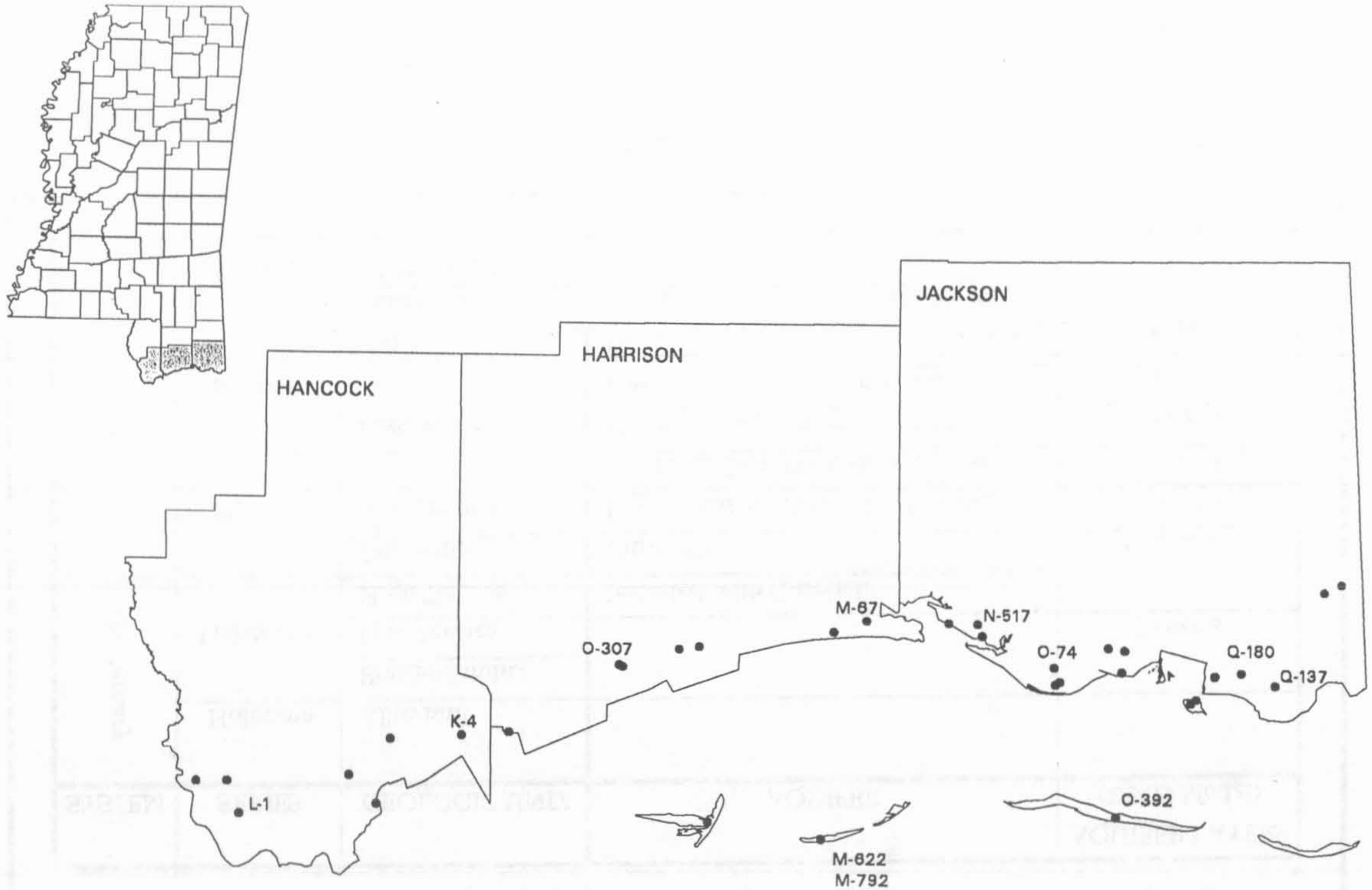


Configuration of the Base of Freshwater in the Miocene/Pliocene Aquifer System
Amended from Newcome 1965
Figure 1

Geohydrologic Units

SYSTEM	SERIES	GEOLOGIC UNIT	AQUIFER	AQUIFER LAYERS (USGS Model)
Quaternary	Holocene	Alluvium		
	Pleistocene	Prairie-Pamlico		
		Low Terrace		Layer 8
		High Terrace	Included with Citronelle	
Tertiary	Pliocene	Citronelle	Citronelle	Layer 7
		Graham Ferry	Upper Graham Ferry (400 ft. sand)	Layer 6
			Lower Graham Ferry (600 ft. sand)	Layer 5
	Miocene	Pascagoula	Upper Pascagoula (800 ft. sand)	Layer 4
			Lower Pascagoula (1200 ft. sand)	Layer 3
		Hattiesburg	Undif. On Coast - Major Aq. In Hancock	Layer 2
		Catahoula	Undif. On Coast - Not a Major Aquifer	Layer 1
	Oligocene	"Het" Limestone	Not an Aquifer	

Figure 2



Miocene/Pliocene Monitoring Well Network Study Area

Figure 3

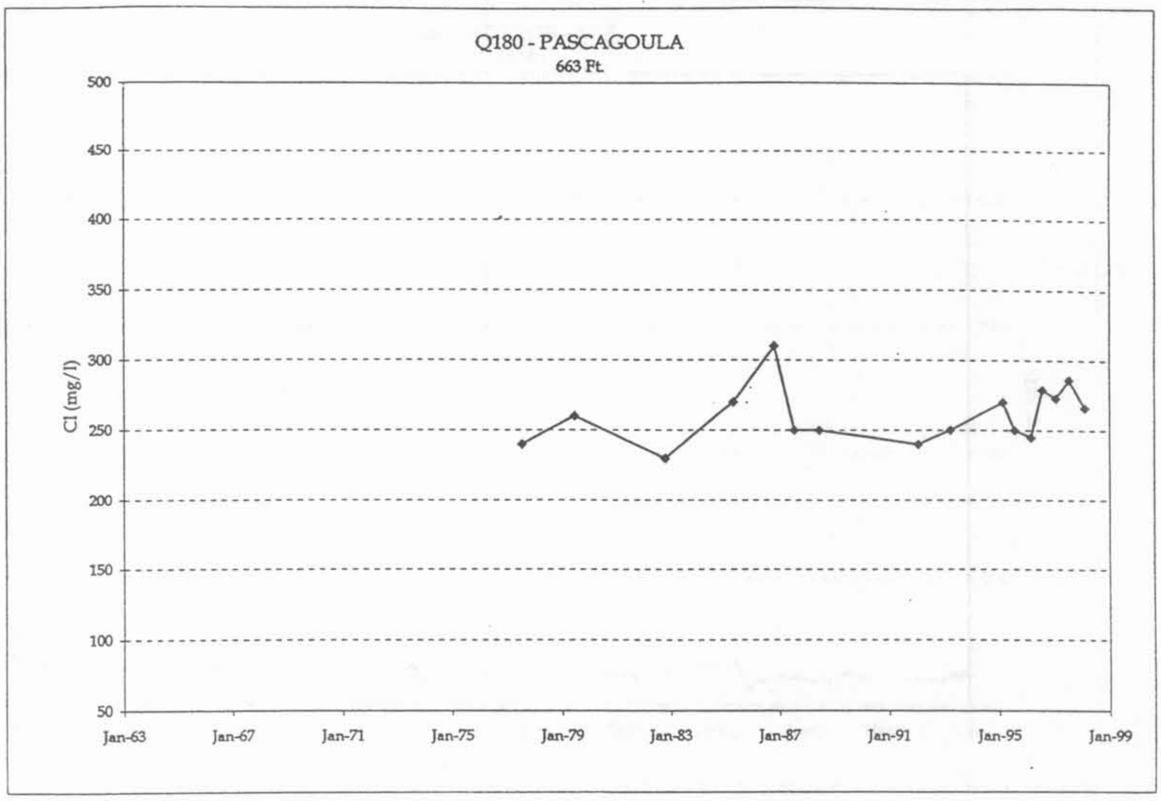


Figure 4

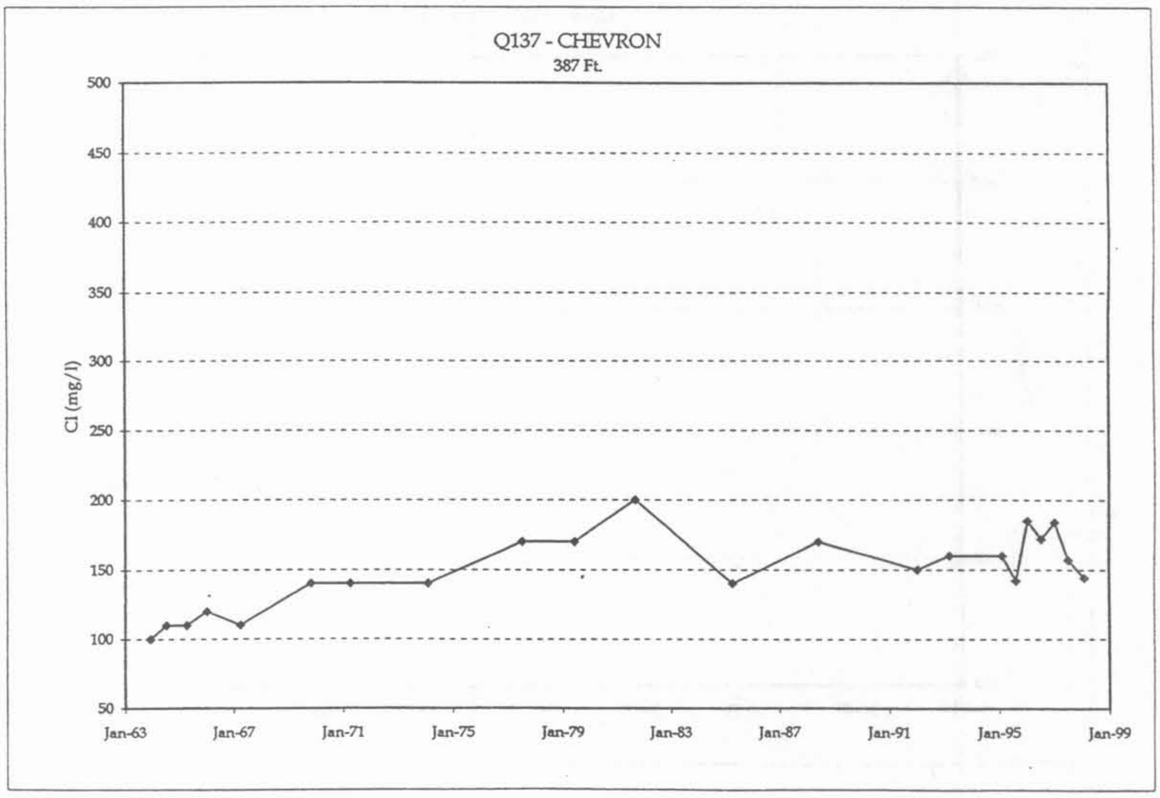


Figure 5

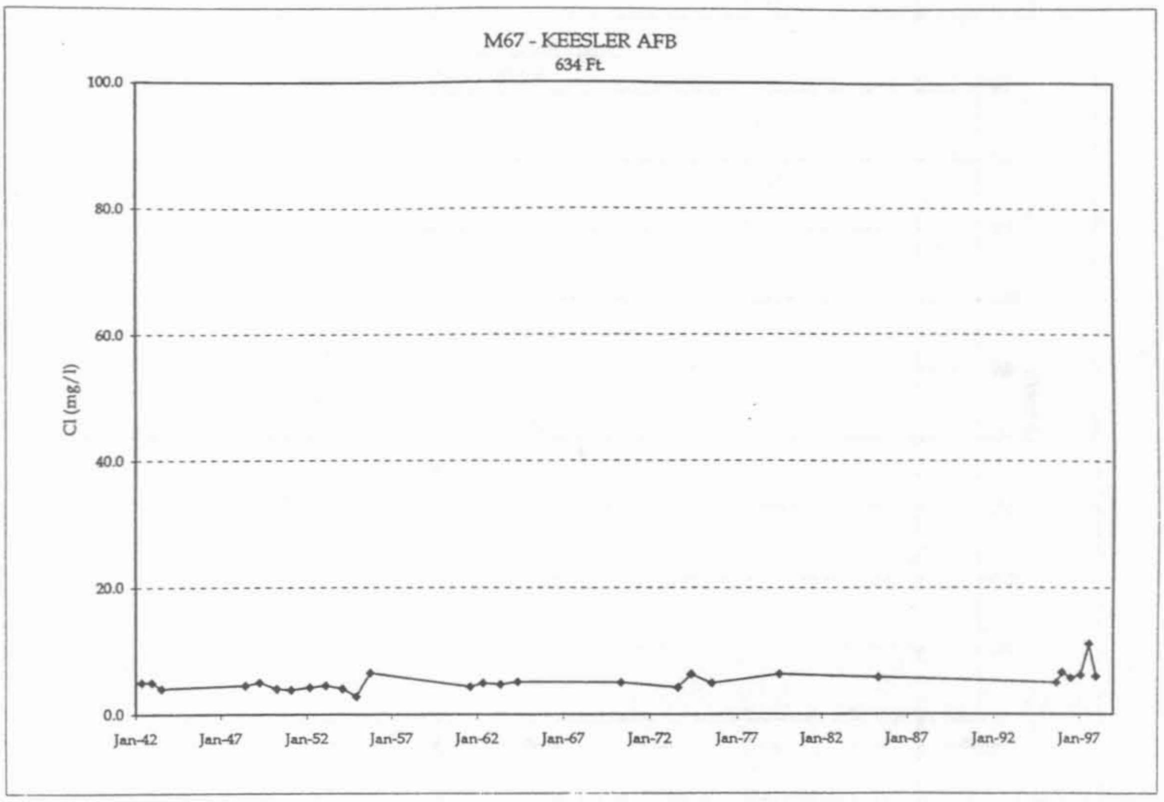


Figure 6

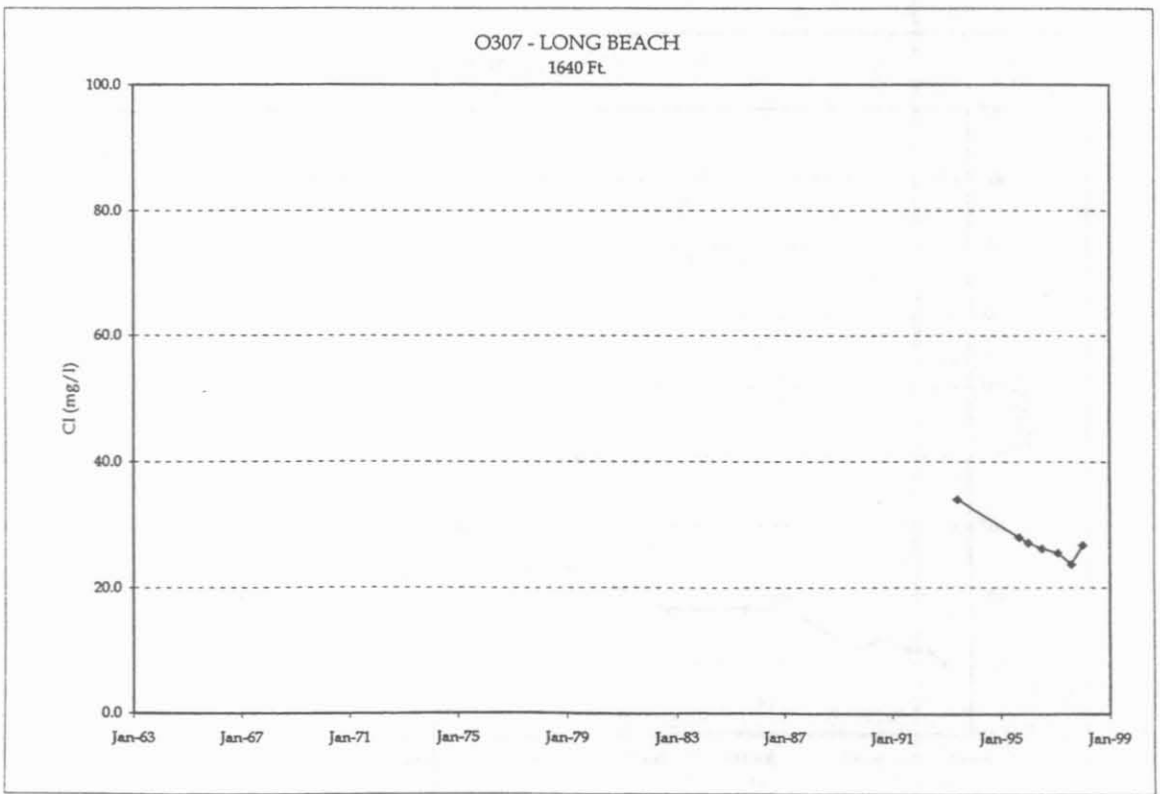


Figure 7

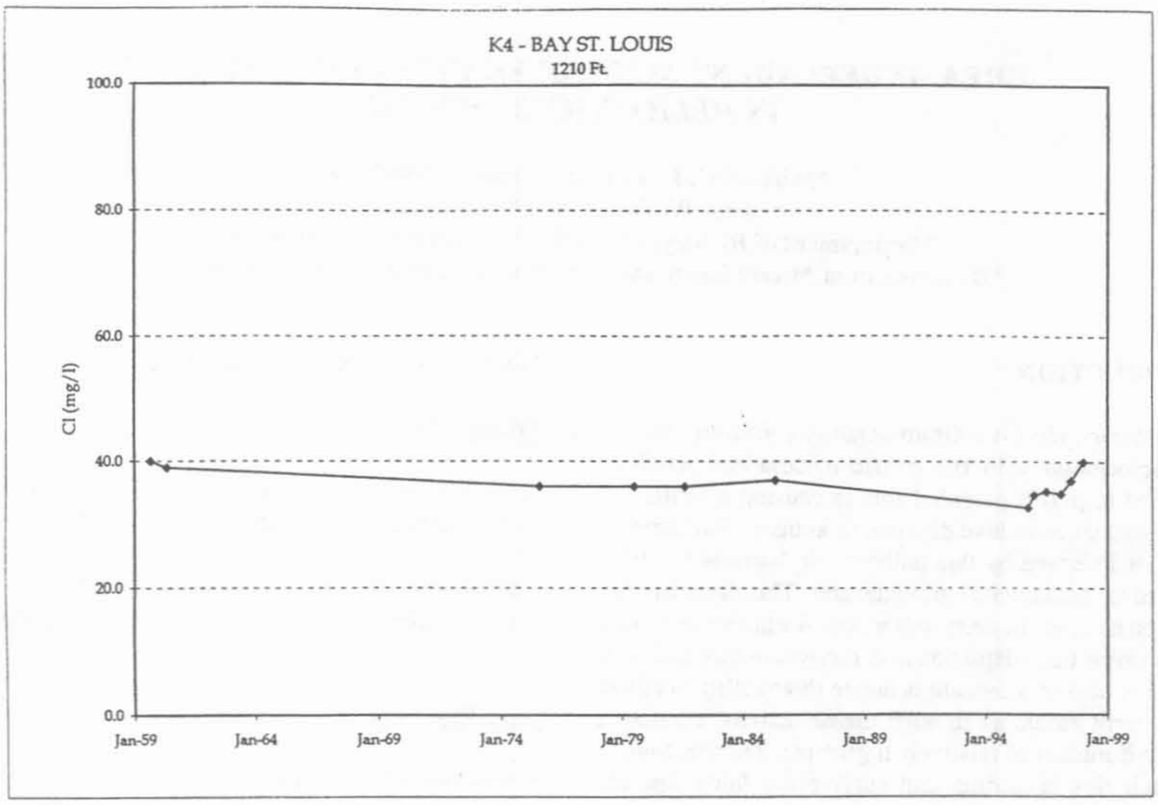


Figure 8

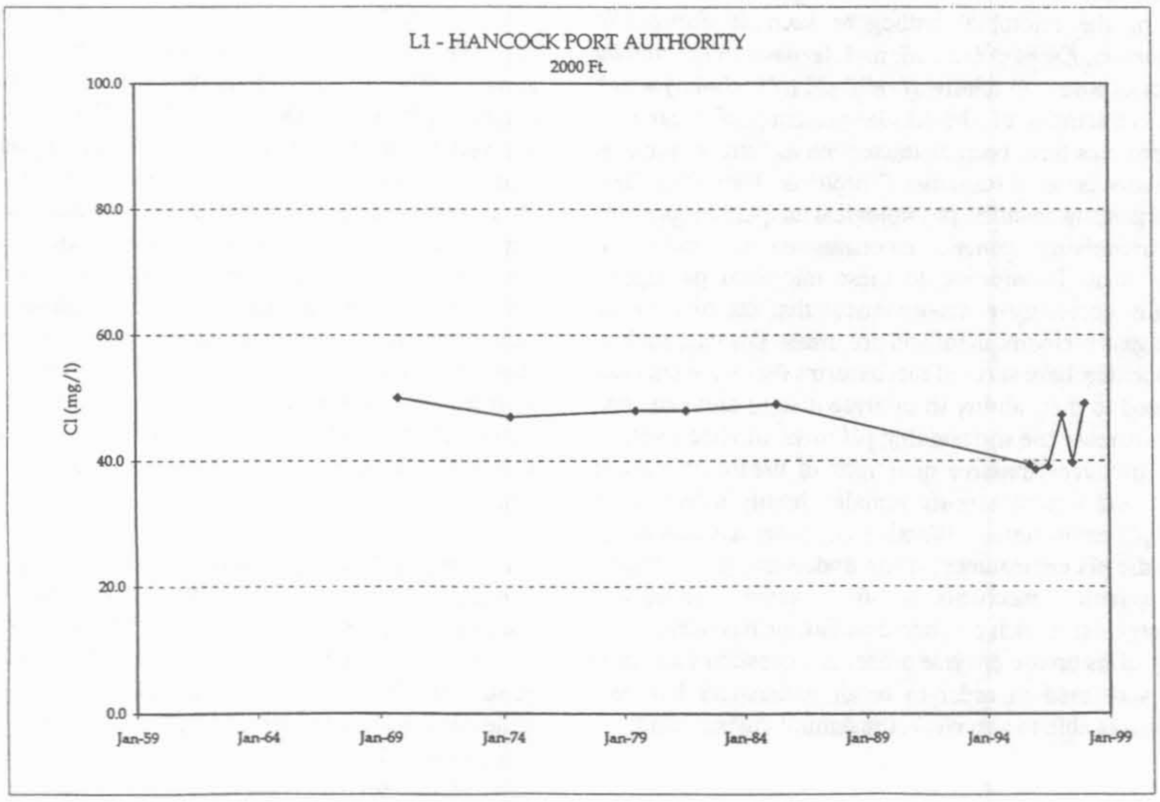


Figure 9