

STATUS OF SALINE WATER OCCURRENCE WITHIN THE COCKFIELD AND SPARTA AQUIFERS, WASHINGTON COUNTY, MISSISSIPPI, 1991

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Introduction

The Mississippi Department of Environmental Quality, Office of Land and Water Resources, is currently conducting a water-quality survey of the Eocene Cockfield and Sparta aquifers of Washington County, Mississippi. The primary objective of this study is to determine the amount of change in the salinity of the Cockfield and Sparta aquifers since a 1987 study by David Bockelmann.

The current study consisted of sampling 102 wells (86 Cockfield, 16 Sparta) for five chemical parameters. These parameters include specific conductance, total dissolved solids, chlorides, color, and dissolved nitrogen. Fifty-three of the 102 wells sampled had been used in the 1987 study by Bockelmann.

Automatic digital recorders (ADR) are being used to track fluctuations in the potentiometric surface of the aquifers. To date, three recorders have been installed in the Cockfield aquifer and plans are currently being made to install recorders in the Sparta aquifer. The recorders will track changes in the cone of depression in the Greenville area and possibly allow correlation of any changes in water quality with changes in the hydraulic gradient of the Cockfield aquifer. ADR data will be supplemented by biannual measurements of approximately 25 wells.

Data collected in this study are being organized and stored in a statewide GIS data base administered by the Office of Land and Water Resources. Future sampling programs will be added to this data base to expedite retrieval and complement data interpretation.

Purpose and Scope

High chloride levels in the aquifers of Washington County have been recognized since the early 1900's. High chloride occurrence was first documented in a report by G.F. Brown (1947) and later in a report by Taylor and Thomson (1971). In 1987 Bockelmann mapped lateral variations in chloride concentrations (Bockelmann 1987).

The primary objective of this study is to determine if there has been a significant increase in the chloride levels in the Cockfield and Sparta aquifers of Washington County since the 1986 water-quality study. Secondary objectives include establishing both a basis for future water quality studies and a network of wells to monitor local groundwater levels. Methods of study include interpretation of E-Logs, water-level measurements, and water-sample collection.

Geologic Structure and Stratigraphy

The geology of the Washington County area was summarized by Taylor and Thomson (1971). The following discussion of structure and stratigraphy has been summarized from that report.

Structure

Geologic structures that have had a direct influence on the depositional environment of Washington County include the Monroe Uplift, the Desha Basin, and the Mississippi Embayment. Washington County is underlain by the axis of the Mississippi Embayment Syncline, a plunging syncline of pre-Jurassic origin. This structurally low feature is basically aligned with the course of the Mississippi River and was diverted eastward during the late Cretaceous by the Monroe Uplift to coincide with the axis of the Desha Basin (Figure 1). The presence of these structures had a significant impact on the depositional environment, thickness, and physical characteristics of all subsequently deposited sediments. The net effect in the Cockfield and Sparta Formations was a thickening of deposits along the axis of the basin and a reduction in fresh water flushing of sediments after deposition.

Stratigraphy

The Sparta Sand overlies the Zilpha Clay which is a confining layer between the Sparta and the older Winona Sand (Figure 2). Thickness of the Sparta in Washington County ranges from 450 to 700 feet and it generally consists of two thick sand units. These units

are lenticular and are discontinuous. The Sparta sands are heterogenous and are of nonmarine origin.

Overlying the Sparta Sand is the Cook Mountain Formation. The Cook Mountain ranges in thickness from 90 to 210 feet and is a confining layer between the Sparta Sand and the Cockfield Formation. The Cook Mountain is a marine clay with some interbedded sand.

The Cockfield Formation overlies the Cook Mountain and consists of a complex series of interfingering lenticular fluvial sand beds. Overlying the Cockfield Formation in some parts of the county is the Jackson Group. The Jackson Group consists of the Moodys Branch Formation and the Yazoo Clay. The top of the Jackson Group is an erosional feature and is not present throughout the county. In areas where the Jackson Group is absent, the Cockfield is overlain by the Mississippi River Alluvium.

The Mississippi River Alluvium underlies the entire county and consists of sand, gravel, silt, and clay. The alluvium is very irregular in thickness and composition.

Geohydrologic Setting

The Cockfield Formation, the Sparta Sand, and the Mississippi River Alluvial Aquifer are the principal aquifers in Washington County. The alluvial aquifer is used mostly for small diameter domestic wells and large diameter irrigation wells. Well depths generally range from 20 to about 120 feet. Owing to the high level of iron in the water, the alluvium, without extensive treatment, is not an acceptable source for public supply wells.

The Cockfield is the source for most public and domestic supply wells in Washington County. Well depths generally range from 250 to 600 feet. Water quality is generally good; however, there are problems with color and with zones of high chlorides.

The Sparta Sand is a good source of public supply in the southern part of the county; however, there are some Sparta wells in the northeast. Sparta wells range in depth from 650 to 1,300 feet.

1986 Chloride Study

In 1986 areas of high chlorides in the Cockfield and Sparta aquifers of Washington County were mapped. During the year, 230 samples were obtained from 135 wells. One hundred ten wells were producing from the Cockfield Formation and 25 from the Sparta Sand. This study was the basis for the 1991 chloride study.

1991 Chloride Study

In the Spring of 1991 a network of wells was established to monitor the potentiometric surface of the Cockfield Aquifer. A network of approximately 25 wells, 3 with continuous recorders, was established for monitoring on a semi-annual basis. Emphasis was placed on the Cockfield Aquifer during this stage owing to the abundance of sites, ease of access, and equipment limitations.

A network of wells to be sampled was established with wells having a water quality history given priority. One hundred two wells were sampled during the summer of 1991. Fifty-three of the wells were sampled during the 1986 study. Of the 102 wells sampled, 86 were producing from the Cockfield (Figure 3) and 16 from the Sparta Sand (Figure 4). Forty-one of the wells had no testing history, 34 had lower chloride values, and 27 had higher chloride values. The maximum chloride concentration in water from the Cockfield was 1400 mg/l and the minimum was 5.6 mg/l. The maximum chloride concentration in water from the Sparta was 380 mg/l and the minimum was 2.4 mg/l.

Observations

To date no significant interaction between the Cockfield and alluvial aquifers has been observed in the Greenville area. This interpretation is based upon a comparison of head values of the alluvial and Cockfield aquifers and the interpretation of geophysical well logs. Also, there has been some speculation that upward movement of high chloride water through old casings or annular spaces might result in the contamination of freshwater zones. However, after comparing oil test locations with areas of high chloride concentrations there does not appear to be any correlation between the oil test and high chlorides. There are several oil test sites west of Swiftwater, but the abundance of sites in the southern half of the county and the lack of high chloride occurrence suggests a natural origin for the chlorides.

As suggested in earlier reports, there is a lateral distribution of chlorides in the Cockfield and Sparta aquifers; however, there is also a significant vertical distribution. This was demonstrated very clearly in samples taken from three wells at Red Leaf Plantation, about 8 miles south-south-east of Greenville (Figure 4). The wells, which vary in depth from 359 to 443 feet, have chloride values from 580 to 1400 mg/l.

Chloride concentrations in Washington County fluctuate with time. This is evident in samples from almost all the Greenville city wells (Figure 5) and also in samples from the wells in the Swiftwater area. One possible

factor in the chloride fluctuations is aquifer stress. When aquifer stress reaches a certain level, a process known as upconing may begin to occur (Figure 6). This is the process where a layer of more dense, lower quality water (higher chlorides) is pulled up into the capture zone of a pumping well, resulting in a deterioration of water quality. If stress on the aquifer is reduced, the effect of upconing may decrease or cease temporarily and resume during times of increased stress.

Recommendations

A continued water quality sampling program should be initiated to continue monitoring fluctuations in chloride levels. These data should be collected along with detailed water use records. This may prove correlation between water use and chloride concentration fluctuations.

Second, the groundwater recorder network should be expanded. This would provide a better gage of aquifer stress and establish a dependable database of historical water levels.

Third, a detailed geologic investigation should be initiated to better define the aquifer characteristics and areas of elevated chlorides. This would lead to an overall better understanding of hydrologic conditions and possibly increase the efficiency of water use from the aquifers.

References

- Bockelmann, D.J., 1987. Saline Water Occurrence Within the Tertiary Sparta Sand and Cockfield Aquifers of Washington County, Mississippi: Proceedings Mississippi Water Resources Conference 1987, pp. 101-107.
- Brown, G.F., 1947. Geology and Artesian Water of the Alluvial Plain in Northwestern Mississippi: Mississippi State Geological Survey, Bulletin 65, 424 p.
- Taylor, R.E. and Thomson, F.H., 1971. Water For Industry and Agriculture In Washington County, Mississippi: U.S. Geological Survey, WRD, 64 p.

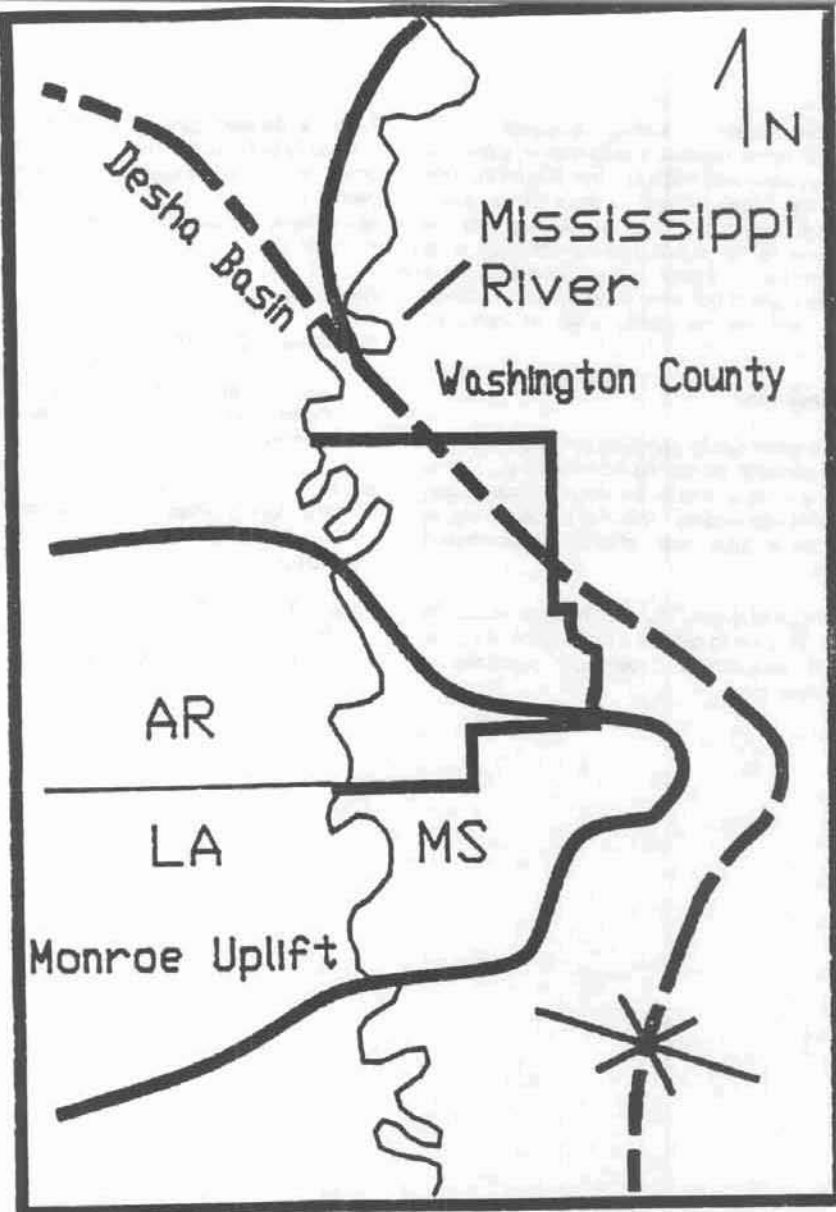


Figure 1

(Taylor & Thomson, 1971)

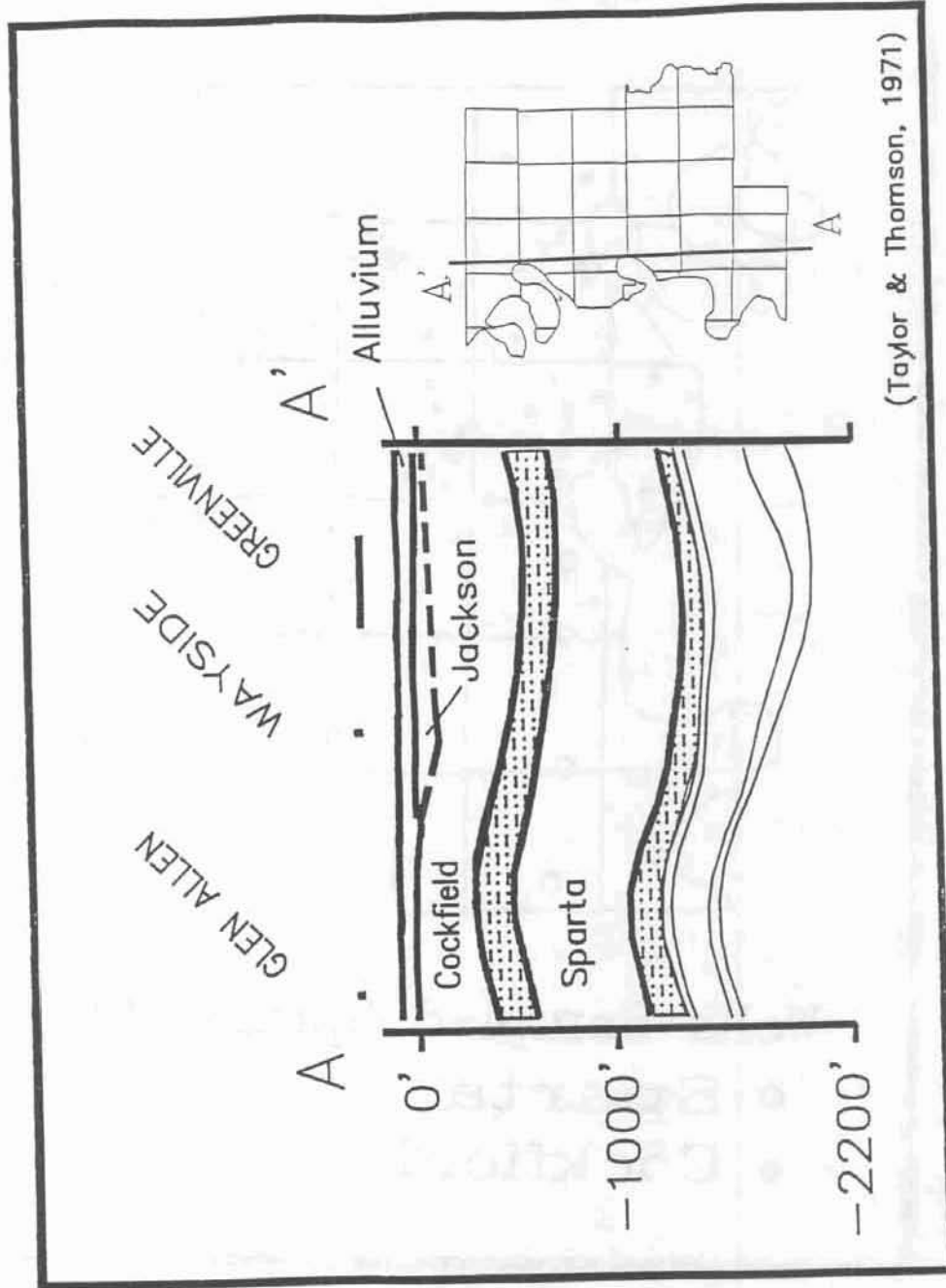
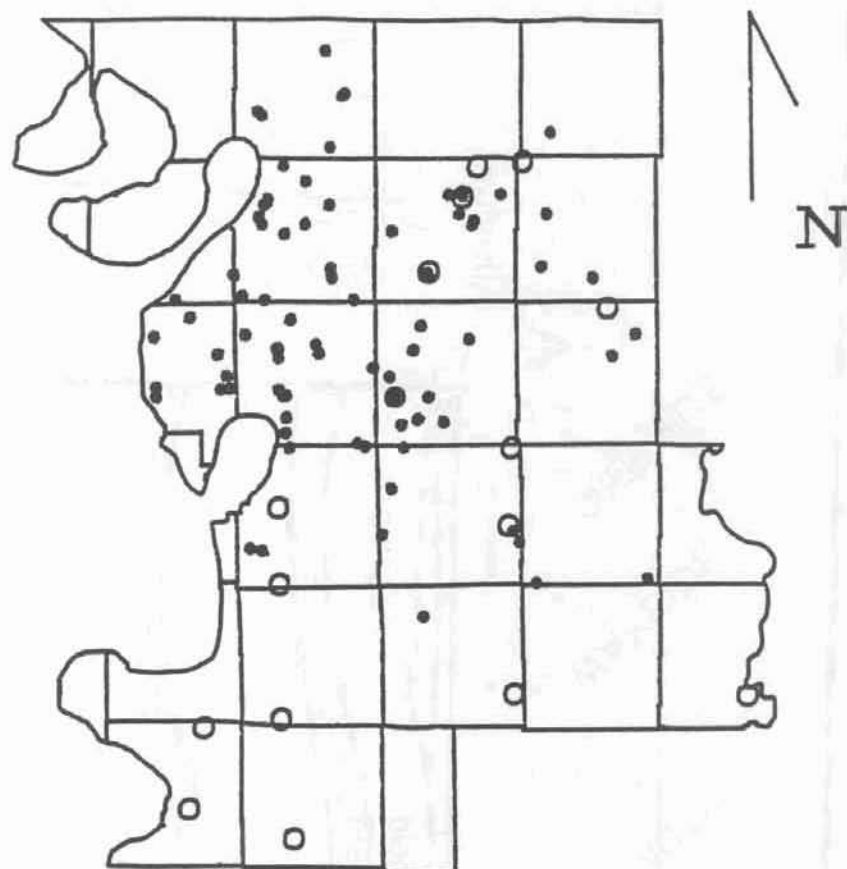


Figure 2



Wells Sampled Spring 1991

- Sparta
- Cockfield

Figure 3

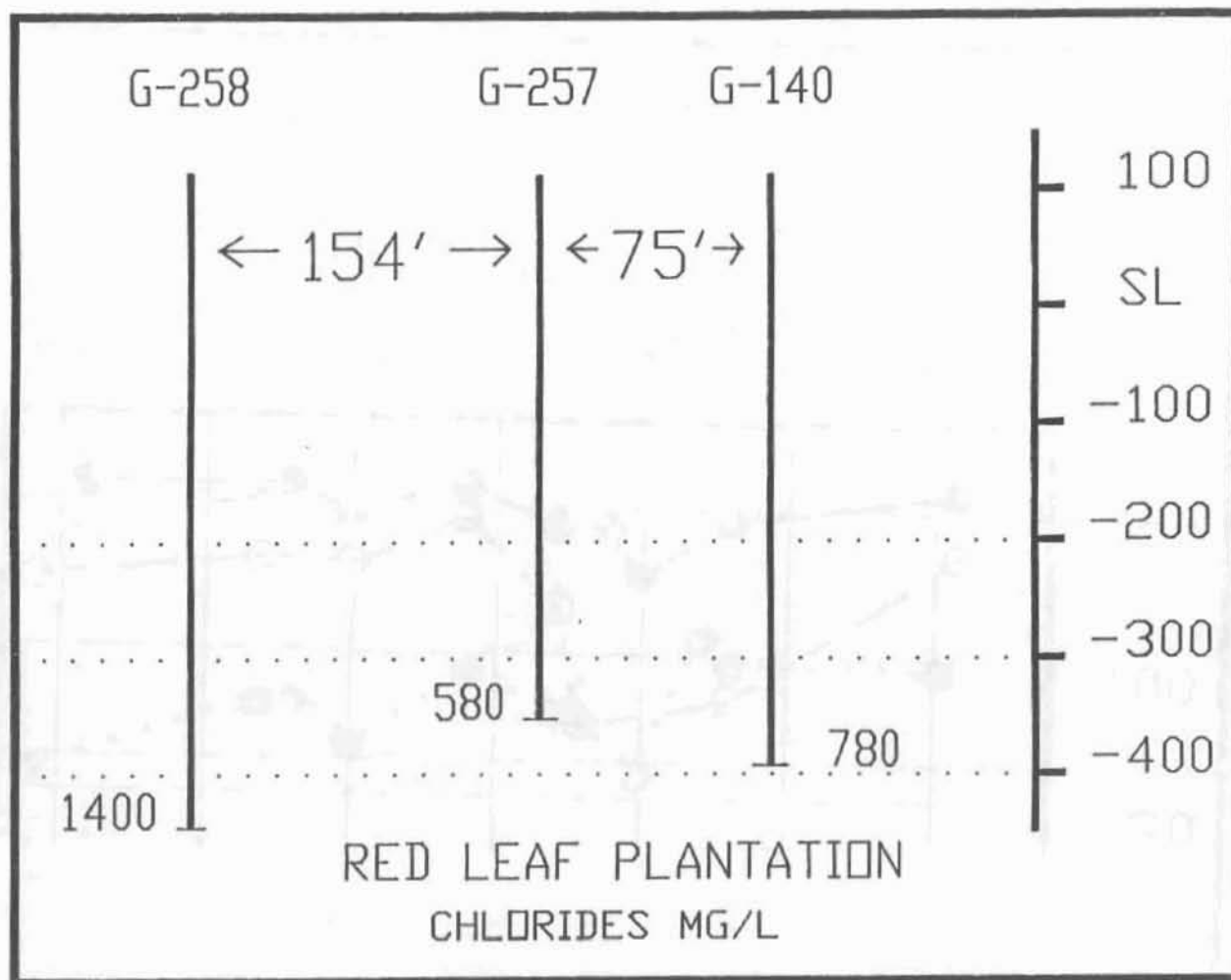


Figure 4

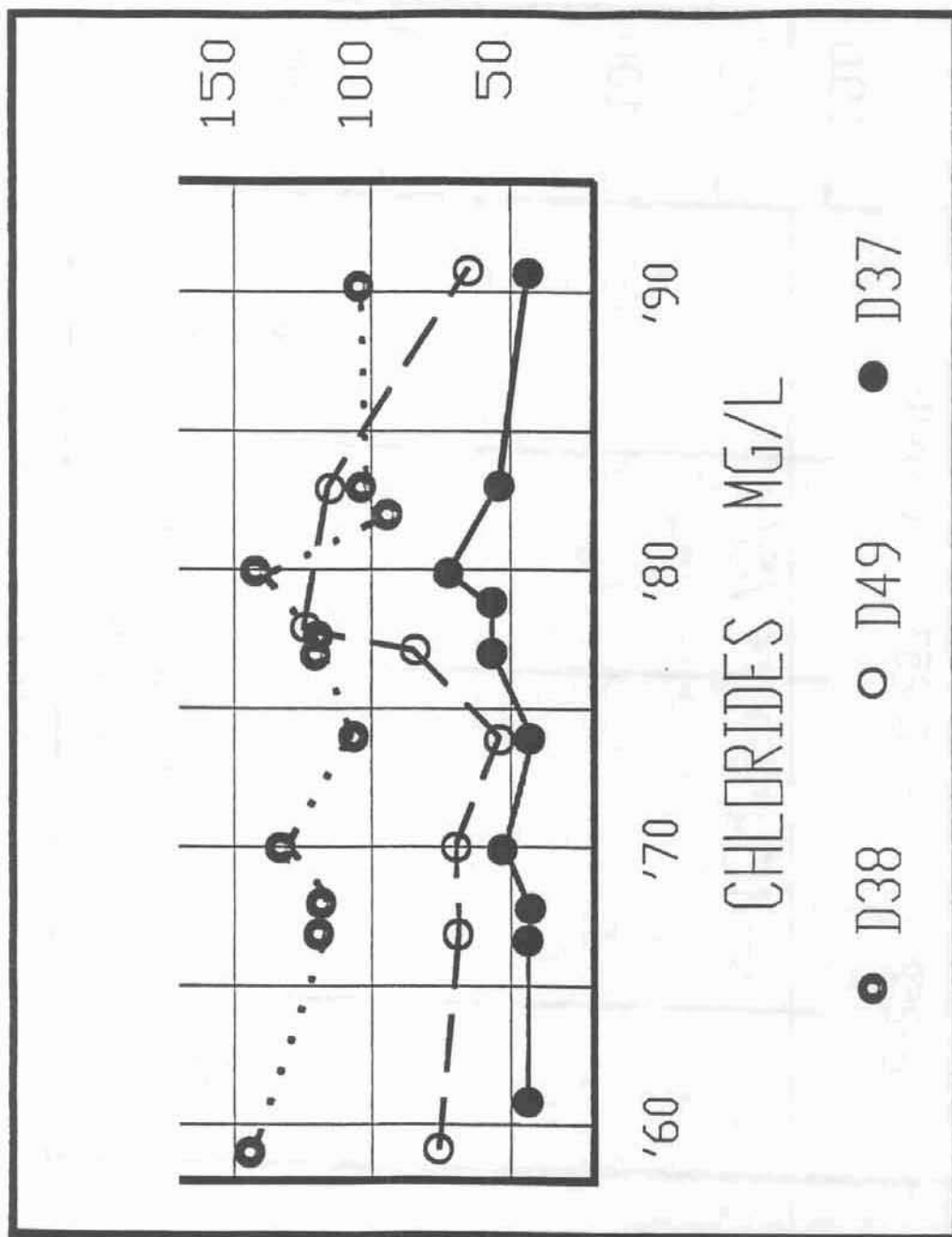
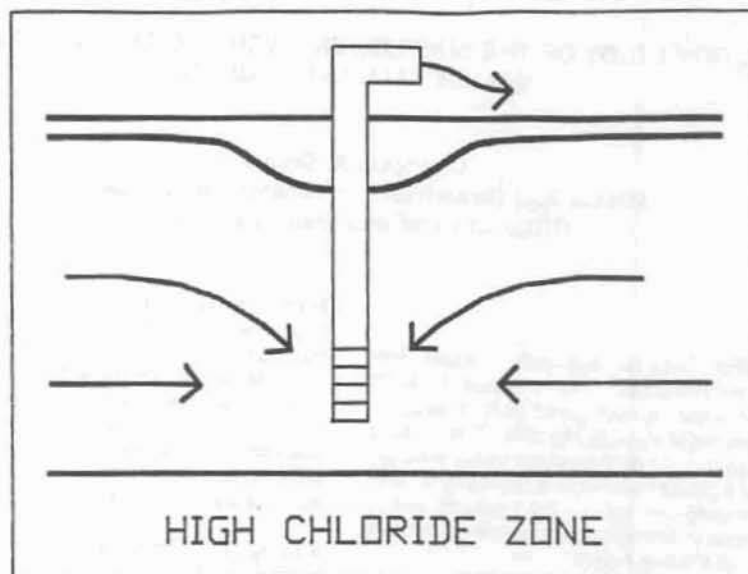
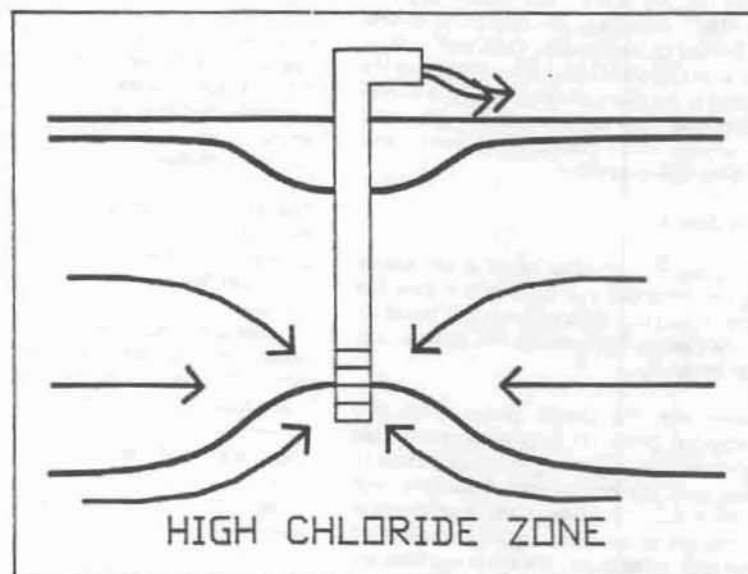


Figure 5



Normal Flow



Upconing
Figure 6