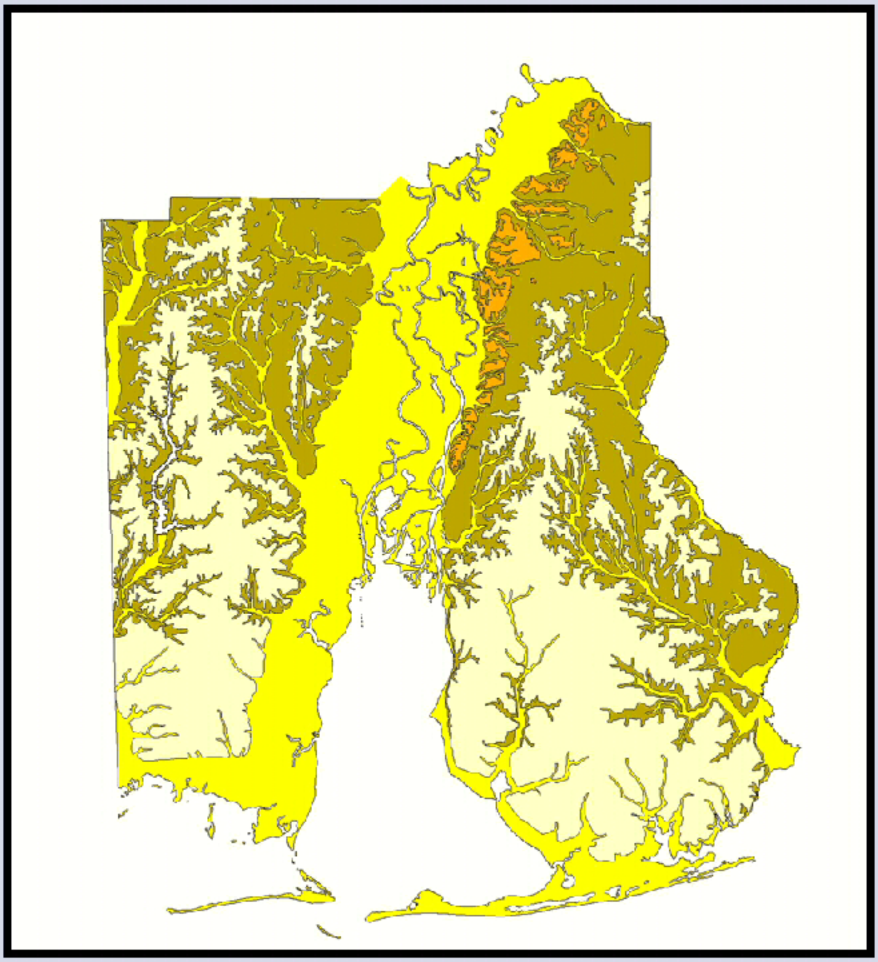
HYDROGEOLOGY AND VULNERABILITY TO CONTAMINATION OF MAJOR AQUIFERS IN ALABAMA: AREA 13



STATE OF ALABAMA
GEOLOGICAL SURVEY

ADEM

GEOLOGICAL SURVEY OF ALABAMA
COMPACT DISC 1

GEOLOGICAL SURVEY OF ALABAMA

Donald F. Oltz
State Geologist

HYDROGEOLOGY DIVISION

COMPACT DISC 1

HYDROGEOLOGY AND VULNERABILITY TO CONTAMINATION OF MAJOR AQUIFERS IN ALABAMA: AREA 13

By

Blakeney Gillett, Dorothy E. Raymond,
James D. Moore, and Berry H. Tew

Prepared by the Geological Survey of Alabama in cooperation with
the Alabama Department of Environmental Management

Tuscaloosa, Alabama
2000

GEOLOGICAL SURVEY OF ALABAMA

STATE OF ALABAMA
GEOLOGICAL SURVEY

DONALD F. OLTZ
State Geologist

420 Hackberry Lane
P.O. Box O
Tuscaloosa, Alabama 35486-9780
(205)349-2852
FAX (205)349-2861
gsa@ogb.gsa.tuscaloosa.al.us

GEOLOGICAL SURVEY OF ALABAMA 1848

February 15, 2000

The Honorable Don Siegelman
Governor of Alabama
Montgomery, Alabama

Dear Governor Siegelman:

It is with pleasure that I make available to you and the citizens of Alabama the publication "Hydrogeology and Vulnerability to Contamination of Major Aquifers in Alabama: Area 13," by Blakeney Gillett, Dorothy E. Raymond, James D. Moore, and Berry H. Tew. It is published as Compact Disc 1 of the Geological Survey of Alabama and is the result of a cooperative effort between the Survey and the Alabama Department of Environmental Management.

The publication contains information on the geology, the characteristics of the major aquifers, and public supply wells in Baldwin and Mobile Counties. This report is the first in a 13-part series which will ultimately cover the entire state and is the first publication that the Survey has released on compact disc. The information should be vital to engineers, resource managers, city planners, and others needing information on the ground water resources of Alabama.

Respectfully,

Donald F. Oltz
State Geologist

Table of Contents

ILLUSTRATIONS

ILLUSTRATIONS—Continued

FIGURES

TABLES

HYDROGEOLOGY AND VULNERABILITY TO CONTAMINATION OF MAJOR AQUIFERS IN ALABAMA : AREA 13

By

Blakeney Gillett, Dorothy E. Raymond, James D. Moore, and Berry H. Tew

ABSTRACT

The Geological Survey of Alabama (GSA), in cooperation with the Alabama Department of Environmental Management (ADEM), is revising and expanding a series of reports that delineates the major aquifers in Alabama and characterizes their vulnerability to contamination. The original reports were prepared by the U.S. Geological Survey in cooperation with ADEM. The state is divided into 13 areas that are addressed in separate reports. The hydrogeology and vulnerability to contamination of the major aquifers in Area 13, which includes Baldwin and Mobile Counties, are described in this report, which currently is available only in digital format.

The major aquifers in the study area are the Miocene-Pliocene aquifer and the watercourse aquifer (alluvial-coastal aquifer of Mooty, 1988). The Miocene-Pliocene aquifer consists of the Citronelle Formation and the undifferentiated deposits of the Miocene Series. No continuous confining unit exists between the Citronelle Formation and the shallow part of the Miocene Series undifferentiated, and as a result, the two units generally act as a single aquifer. The Miocene Series undifferentiated, however, does not appear to be a single aquifer. New deep well data available from central Mobile County and southern Baldwin County suggest that the Miocene deposits in both counties may be subdivided into at least two separate aquifers.

The recharge areas for these aquifers include all of Mobile and Baldwin Counties and parts of Washington County. The soils throughout most of the study area are highly permeable and allow rapid infiltration of surface water. Consequently, the shallow unconfined aquifers in the study area are considered highly vulnerable to surface sources of contamination. Aquifers become less vulnerable to contamination from the surface with an increasing degree of confinement by clay layers. However, even deep aquifers can be vulnerable to natural sources of contamination such as salt water from the Gulf of Mexico and mineralized ground water.

Pumping of public water supply wells and irrigation wells can increase the potential for contamination of aquifers if not properly planned, managed, and monitored. Pumping of large quantities of ground water creates cones of depression, increases

flow gradients, and draws ground water and any associated contamination toward pumping wells.

INTRODUCTION

The U.S. Geological Survey, in cooperation with the ADEM, conducted a series of hydrogeologic studies in Alabama to delineate the major aquifers and their recharge areas and to define areas susceptible to contamination from the surface. Each of the 13 areas of the state was studied by different authors. Mooty (1988) summarized the characteristics of the alluvial-coastal aquifer (the watercourse aquifer) and the Pliocene-Miocene aquifer in Area 13, which includes Baldwin and Mobile Counties. The present study is a cooperative effort between GSA and ADEM to update and supplement the results of the previous studies and to provide the hydrogeologic information in a digital format that can be easily accessed by computer.

ACKNOWLEDGMENTS

The authors thank the well drillers and managers and operators of water supply systems in Mobile and Baldwin Counties for information they provided about their wells. In addition, Sonja Massey, Fred Mason, and Enid Bittner of ADEM provided assistance and suggestions in the preparation of this report. Geographic Information Systems (GIS) support was provided by Ruth T. Collier and Douglas R. Taylor of the GSA. Lewis S. Dean and Ginger R. Blakney, also of the GSA, provided assistance with the manuscript. Their efforts are greatly appreciated.

PURPOSE AND SCOPE

The purposes of this report are to (1) describe the hydrogeology of the study area; (2) delineate, redefine, and describe the major aquifers and their recharge areas; (3) delineate areas that are vulnerable to contamination; (4) compile the Source Water Assessment Areas or Wellhead Protection Areas as defined under §335-7-5 and §335-7-12 of the ADEM's administrative code and as currently identified in the study area; (5) identify the locations of public supply wells in the study area; and (6) provide all hydrogeologic data in a digital geographic information systems (GIS) format that can be readily accessed by scientists and the public.

The Geologic Map of Alabama (Szabo and Copeland, 1988) at a scale of 1:250,000 provided geologic data used to update the previous aquifer susceptibility map by Mooty (1988). In the study by Mooty (1988), all wells used for municipal and rural public water supplies were inventoried. For the present study, water-level data from the GSA's regular monitoring program and historical water-level data were used to prepare a generalized potentiometric surface map of the uppermost aquifer. Areas vulnerable to surface contamination were delineated from topographic maps and geologic maps.

Delineations of Wellhead Protection Areas were derived from maps submitted to the ADEM by public water systems that have completed wellhead protection projects.

LOCATION AND EXTENT OF THE STUDY AREA

Area 13 is in southwestern Alabama on the northern coast of the Gulf of Mexico and comprises Mobile and Baldwin Counties (plate 1). The combined land area is about 2,828 square miles (Alabama Department of Economic and Community Affairs, 1984). The area includes the major cities of Mobile, Prichard, Bay Minette, and Gulf Shores and many smaller towns and communities. The total population of the area was about 476,923 in 1990. Much of the land in Baldwin and Mobile Counties is used for agricultural purposes. Large areas along the Mobile and Tensaw Rivers and along the coast are characterized by low-lying, swampy terrain and brackish water. In recent years, the city of Gulf Shores and most of coastal Baldwin County have become highly developed resort areas, whereas the Mobile area has experienced substantial industrial growth.

The city of Mobile and the town of Prichard use surface water as a source of public supply. Mobile's water system withdraws water from an impoundment on Big Creek. In 1995 the average withdrawal rate from Big Creek was 131.4 million gallons per day (Mgal/d). The town of Prichard uses surface water from Eight Mile Creek at a rate of about 4.0 Mgal/d. The remaining cities and towns in the study area use ground water for their public supply.

PREVIOUS INVESTIGATIONS

Numerous reports describe the geology and hydrology of the study area. A detailed description of the geology of Alabama and a geologic map were published by the Geological Survey of Alabama in 1926 (Adams and others, 1926). In 1988, the Geological Survey of Alabama published a new geologic map for the state which provides the most up-to-date mapping of the geology of Mobile and Baldwin Counties (Szabo and Copeland, 1988) (plate 2).

Reports that contain information on the geology and ground water resources of the area are *Ground-Water Investigations in the Mobile Area, Alabama* (Peterson, 1947); *Water Availability of Baldwin County, Alabama* (Reed and McCain, 1971); *Geology of Mobile County, Alabama* (Reed, 1971a); *Geology of Baldwin County, Alabama* (Reed, 1971b); *Water Availability in Mobile County, Alabama* (Reed and McCain, 1972); *Water Content and Potential Yield of Significant Aquifers in Alabama* (Barksdale and others, 1976); *Map of Fresh and Slightly Saline Ground-Water Resources in the Coastal Plain of Alabama* (Ellard, 1977); *Depositional Sequences in the Pensacola Clay (Miocene) of Southwest Alabama* (Raymond, 1985); *Ground-Water Chemistry and Salt-Water Encroachment, Southern Baldwin County, Alabama* (Chandler and others, 1985);

Configuration of the Base of the Miocene Series (Moore and Raymond, 1985); *Watercourse Aquifers in Alabama* (Moore and Hunter, 1991); *Post-Miocene Sediments of the Shallow Subsurface of Coastal Alabama* (Raymond and others, 1993); *Hydrologic and Water-Use Data for Southern Baldwin County, Alabama* (Chandler and others, 1996); and *Aquifers in Alabama* (Moore, 1998).

PHYSICAL FEATURES

Study Area 13 lies entirely within the East Gulf Coastal Plain section of the Coastal Plain physiographic province (fig. 1). Most of the land area of Mobile and Baldwin Counties lies in the Southern Pine Hills physiographic district (Sapp and Emplaincourt, 1975). This upland area is underlain by Pliocene-Pleistocene terrigenous sediments, whereas younger terrace deposits occur along major streams in the area. The terrain of the Southern Pine Hills District slopes gradually from 350 feet above mean sea level (msl) southward to about 30 feet above msl at the southern limit of the area.

Parts of the study area along the Mobile and Tensaw Rivers are in the Alluvial-Deltaic Plain physiographic district of the East Gulf Coastal Plain, which consists of alluvial and terrace deposits along the larger rivers. These areas have very little relief and range in elevation from sea level to about 100 feet above msl.

Coastal areas of Area 13 are in the Coastal Lowlands physiographic district of the East Gulf Coastal Plain. These areas are characterized by flat to gently undulating, locally swampy plains underlain by terrigenous deposits of Holocene and late Pleistocene age. They include the mainland plain indented by many tidal streams and fringed by tidal marshes and barrier islands. The landward edge of the district is defined by the base of the Pamlico marine scarp at 25 to 30 feet elevation. The barrier islands and tidal marshes in the area are continually being modified by erosion and deposition.

STRATIGRAPHY

Geologic units that crop out in the study area range in age from Tertiary to Quaternary (table 1; fig. 2; plate 2). The Tertiary sedimentary deposits are generally unconsolidated. Alluvial and terrace deposits of Quaternary age overlie Tertiary deposits in and adjacent to the flood plains of the larger streams and rivers, and along the coastal areas of Mobile Bay and the Gulf of Mexico. The geologic map provided on plate 2 was compiled at a scale of 1:250,000 by Szabo and Copeland (1988) and is the most accurate geologic mapping currently available for the area of study.

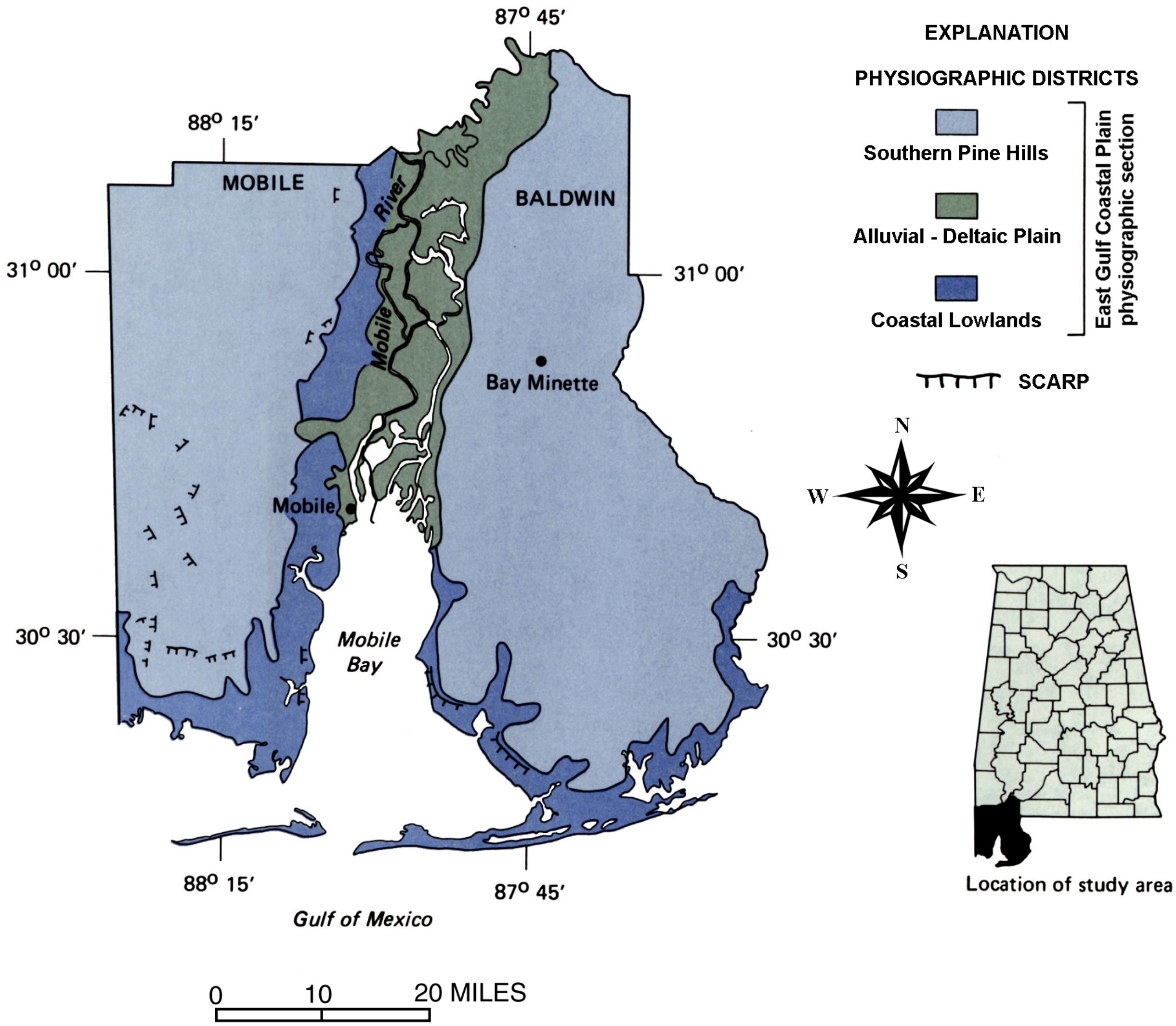


Figure 1.—Physiographic regions of Area 13 (modified from Sapp and Emplaincourt, 1975).

Table 1.—Geologic units and their water-bearing properties (modified from Reed and McCain, 1972)

System	Series	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water
Quaternary	Holocene and Pleistocene	Alluvium, low-terrace and coastal deposits	0-200	Sand, white, gray, orange, and red, very fine to coarse-grained, contains gravel in places; gray and orange sandy clay.	Watercourse	Will yield 10 gpm where saturated sands are of sufficient thickness. Potential source of 0.5 Mgal/d per well in the Mobile River basin.	Water generally suitable for most uses but commonly contains iron in excess of 0.3 mg/L and may be sufficiently acidic to be corrosive. Locally, in areas close to Mobile Bay and Mississippi Sound, water is very hard, has high chloride and dissolved solids contents, and contains iron in excess of 0.3 mg/L.
		High-terrace deposits				Will yield 10 gpm or more where saturated sands are of sufficient thickness.	Probably soft and low in dissolved solids. May contain iron in excess of 0.3 mg/L.
Tertiary	Pliocene	Citronelle Formation	0-200	Sand, brown, red, and orange, fine- to coarse-grained, gravelly in places, contains clay balls and partings; gray, orange, and brown lenticular sandy clay, ferruginous cemented sandstone.	Miocene/Pliocene	Will yield 2 Mgal/d or more per well	Water generally is soft and low in dissolved solids but may contain iron in excess of 0.3 mg/L and may be corrosive. In areas adjacent to Mobile River, Mobile Bay, and Mississippi Sound, water may have a dissolved solids content that exceeds 1,000 mg/L, a sulfurous odor, and a chloride content that exceeds 500 mg/L.
	Miocene	? Miocene Series undifferentiated	100-3,400	Sand, gray, orange, and red very fine to coarse-grained, contains gravel in places; gray thin-bedded to massive sandy silty clay.			

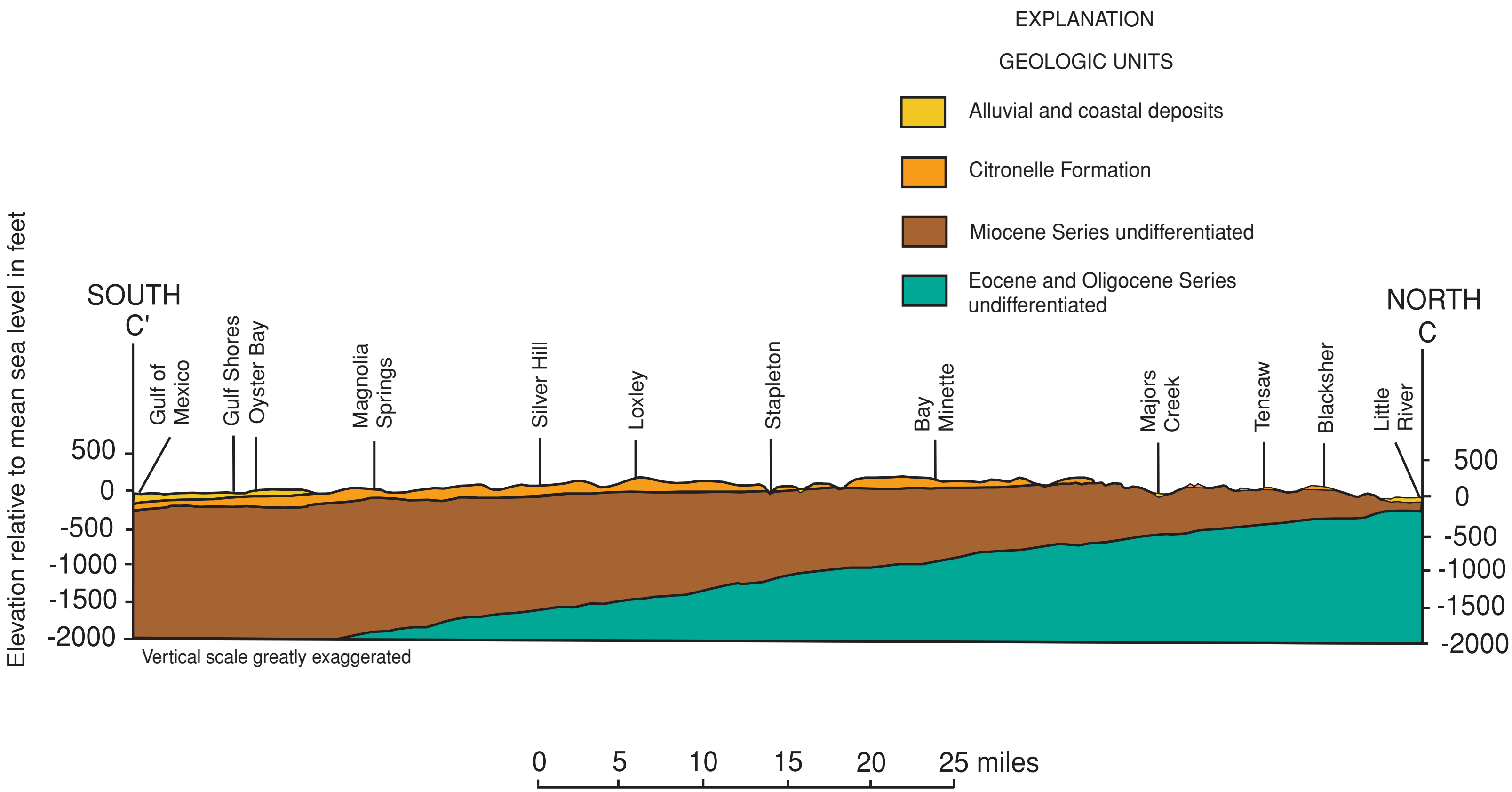


Figure 2.—Generalized geologic cross section from south to north in Baldwin County, Alabama (modified from Mooty, 1988). See plate 2 for line of cross section.

TERTIARY DEPOSITS

A thick sequence of Tertiary sediments underlies the study area. The geologic units currently used as sources of potable ground water are the Miocene Series undifferentiated and the Citronelle Formation. North-south hydrogeologic cross sections (plate 3) illustrate lithofacies in the Miocene and younger units in Mobile and Baldwin Counties.

EOCENE SERIES UNDIFFERENTIATED

In Alabama, the Eocene Series comprises the Hatchetigbee Formation, the Claiborne Group, and the Jackson Group. The Eocene Series, present only in the subsurface in the study area (fig. 2), includes interbedded sand, silt, clay, and some limestone. The Eocene sediments are not currently used as a source of water in the study area.

OLIGOCENE SERIES UNDIFFERENTIATED

The Oligocene Series is present only in the subsurface in the study area (fig. 2). The Oligocene is comprised of the Red Bluff Clay, Forest Hill Sand, Marianna Limestone, Byram Formation, and Chickasawhay Limestone. The Oligocene sediments are not currently used as sources of water in the study area.

The Red Bluff Clay consists of interbedded greenish-gray clay, limestone, and sand. The Forest Hill Sand is a thin carbonaceous clay with lenses of sand. The Marianna Limestone is white, soft fossiliferous limestone. The Byram Formation consists of interbedded marl, limestone, and clay. The Chickasawhay Limestone is sandy marl and limestone.

MIOCENE SERIES UNDIFFERENTIATED

Sediments of the Miocene Series crop out in central and northern Mobile and Baldwin Counties (plate 2) (Szabo and Copeland, 1988; Raymond and others, 1993). The unit ranges in thickness from 100 feet in northern Baldwin County to 3,400 feet in the subsurface in southern Mobile County (Reed, 1971a). Sediments of the Miocene Series undifferentiated are somewhat wedge-shaped, thickening and dipping southwestward toward the Gulf of Mexico (figs. 2, 3, 4). The dip of the sediments ranges from about 40 to 50 feet per mile (ft/mi) at the base of the series (fig. 4) to about 15 ft/mi at the contact with the Citronelle Formation (plate 3).

The Miocene Series undifferentiated consists of clastic sedimentary deposits of marine and estuarine origin. These Miocene sediments represent a transition from calcareous platform facies of Florida to the more fluvial siliciclastic facies of Mississippi and the subsiding Gulf basin. The sediments are primarily laminated to thinly bedded

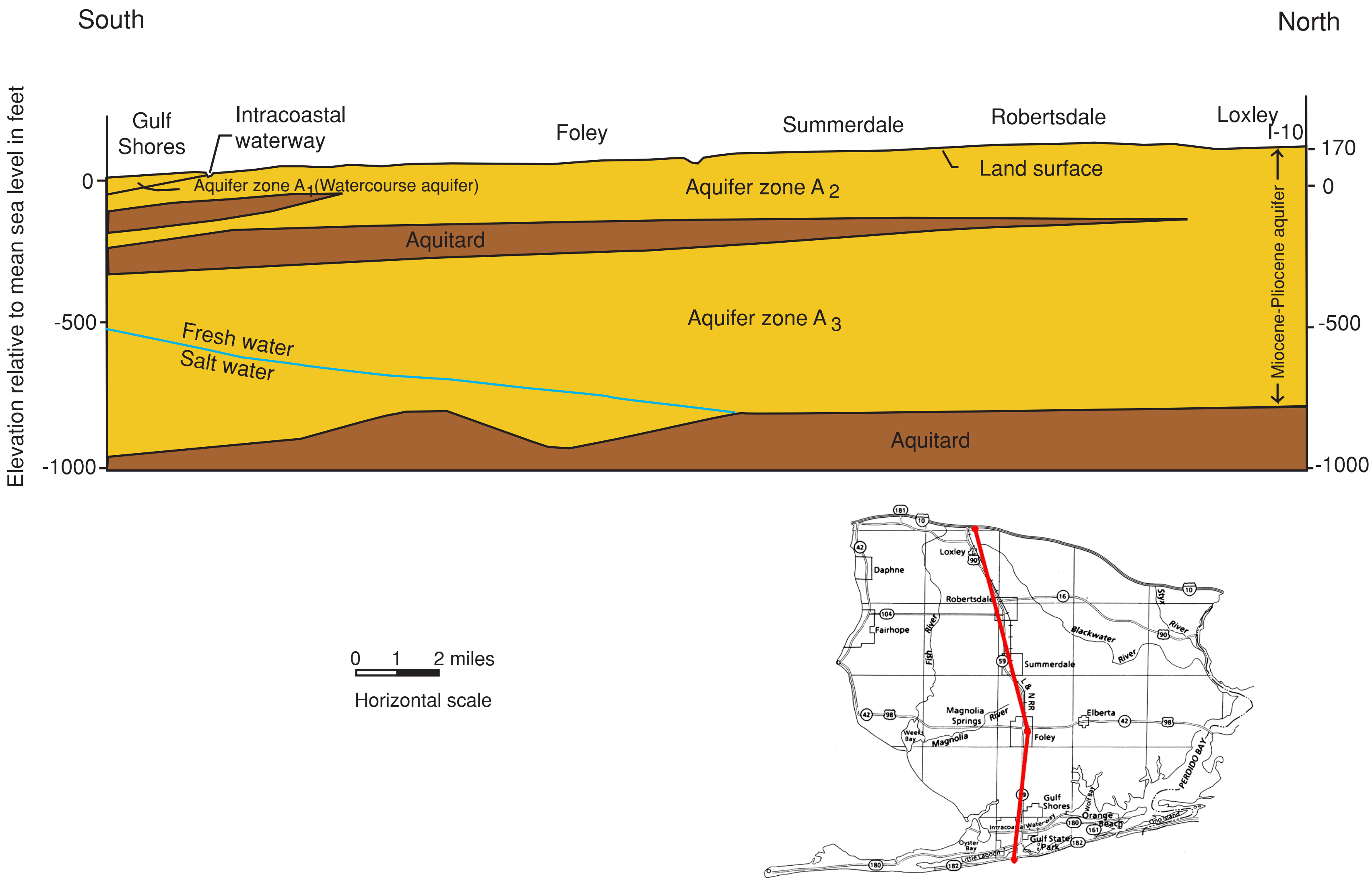
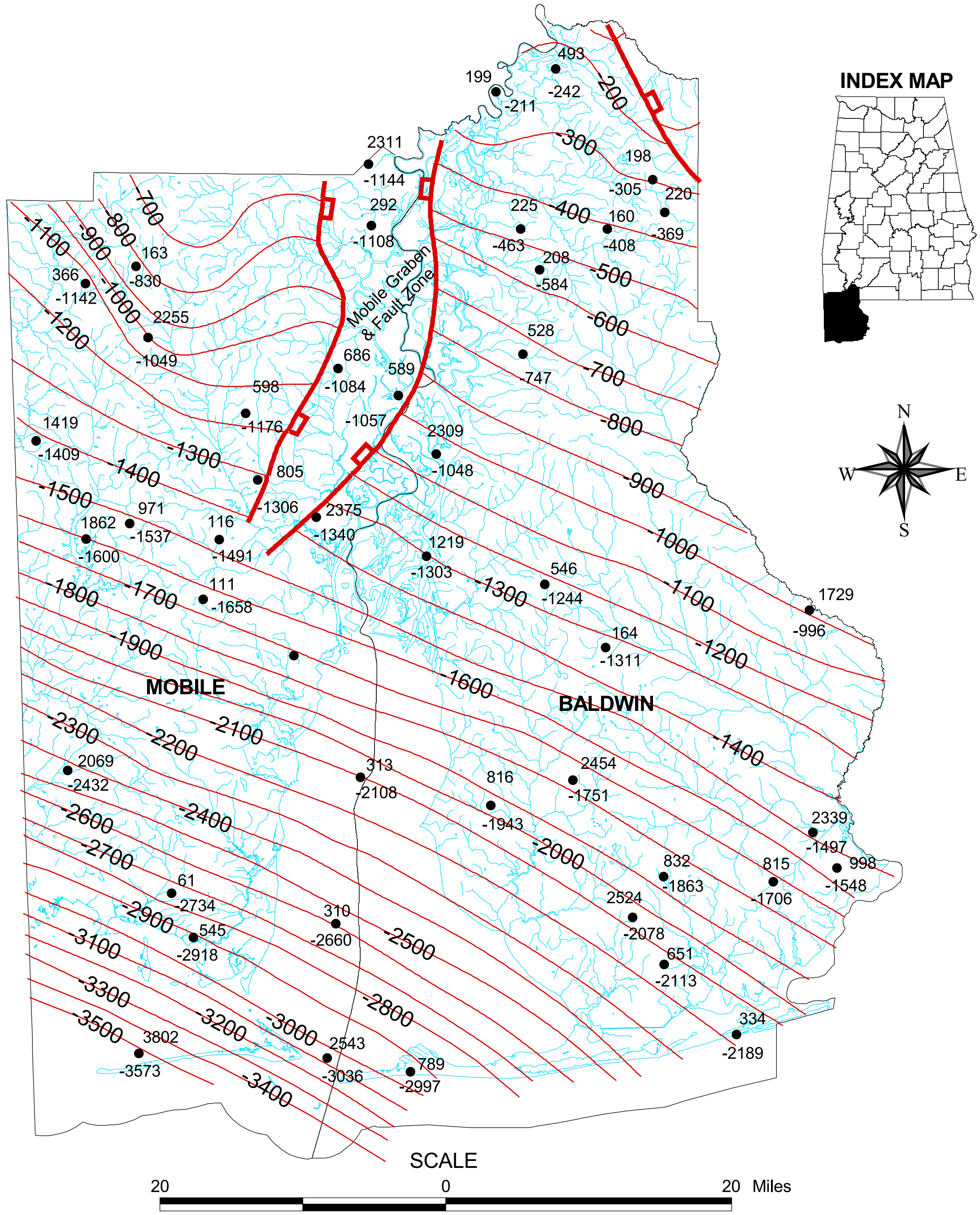


Figure 3.—Hydrogeologic cross section of southern Baldwin County, Alabama (modified from Chandler and others, 1985).



EXPLANATION

832 State Oil and Gas Board permit number (only selected wells used)

-1863 Elevation in feet relative to mean sea level of the base of the Miocene Series.

● Oil and gas test well

-500 Contour showing elevation of the base of the Miocene Series. Contour interval: 100 feet. Datum is mean sea level.

Normal fault, blocks on downthrown side

Note: Structural contours are not drawn within the Mobile Graben and Fault Zone because well control is sparse and the structure complex.

Figure 4.–Structure map of base of Miocene Series in Area 13 (modified from Moore and Raymond, 1985).

clays, sands, and sandy clays. Sands range from fine to coarse grained and are locally cross bedded. In outcrop, the sands weather to a variety of colors, some distinctly mottled. At some exposures, beds of sand contain gravel and plant fossils, and clays contain carbonized leaf remains. In the subsurface the Miocene sediments are divisible into two units, the lower Pensacola Clay (Marsh, 1966; Raymond, 1985) and the overlying coarse clastic unit informally referred to as the "Miocene coarse clastics" (Marsh, 1966; Raymond, 1985; Smith, 1991). The Miocene coarse clastics contain the deeper freshwater aquifers in Mobile and Baldwin Counties. The Pensacola Clay serves as a lower confining unit. Offshore, in the Gulf of Mexico, the coarse clastics of the Miocene interfinger with finer grained Miocene clays that serve as confining beds separating the interbedded sands.

PLIOCENE SERIES

CITRONELLE FORMATION

The Citronelle Formation of Pliocene age overlies the Miocene Series undifferentiated and crops out in the central and southern parts of the study area (plate 2). The formation is confined to the higher elevations in both Mobile and Baldwin Counties, having been eroded away along streams and the edges of Mobile Bay so that the Miocene undifferentiated is exposed along the bay and in stream channels. The Citronelle, which is relatively thin in northern parts of the study area, is about 200 feet thick in the subsurface in the southern part of the study area (plates 2, 3).

Citronelle sediments consist of nonfossiliferous moderate-reddish-brown fine to very coarse quartz sand; light-gray, orange, and brown sandy clay; and clayey gravel of nonmarine origin (Reed, 1971a, b; Szabo and Copeland, 1988). In many areas, lenses of sandy clay and clayey sand, which range in thickness from 5 to 15 feet, are interbedded with gravelly sand. Sediment type often changes abruptly over short distances. Sediments near the base of the Citronelle Formation have a high clay content, indicating that they were deposited in an estuarine environment, whereas overlying sediments were deposited by sediment-laden streams (Isphording and Lamb, 1971). Isphording (1977) reports the gravels of the Citronelle generally consist of quartzite and chert. Abundant highly polished limonite pebbles and granules from the underlying Miocene undifferentiated may also be present. Isphording and Lamb (1971) report that the Citronelle probably ranges from middle Pliocene to pre-Nebraskan Pleistocene in age.

QUATERNARY DEPOSITS

PLEISTOCENE SERIES

HIGH TERRACE DEPOSITS

High terrace deposits unconformably overlie Miocene sediments in the northeastern part of Mobile County and in many parts of Baldwin County that are adjacent to the Mobile River flood plain. The terrace deposits range in thickness from 0 to 50 feet with an average thickness of 15 to 30 feet. The altitude of the base of the terrace deposits ranges from 130 to 180 feet above msl in Mobile County, and from 60 to 210 feet above msl in Baldwin County. The deposits consist primarily of sandy clay, fine to coarse sand, and sand containing gravel in some places. These terrace deposits are considered part of the watercourse aquifer.

PLEISTOCENE AND HOLOCENE SERIES

ALLUVIAL, LOW TERRACE, AND COASTAL DEPOSITS

Alluvial, low terrace, and coastal deposits overlie Miocene and Pliocene sediments in many parts of Baldwin and Mobile Counties (plate 2). These deposits represent complex beach, dune, lagoonal, estuarine, and deltaic depositional environments. The deposits consist of very fine to coarse sand that is gravelly in many exposures. Clay and sandy clay are interbedded with the sand locally. Chandler and Moore (1983) estimated the thickness of the alluvial, low terrace, and coastal deposits to range from 0 to 200 feet, based on the first occurrence of coarse siliciclastic sediments.

The Quaternary sand and gravel beds represent buried channel deposits. Their widths and depths are similar to those of present river bed sediments. The length of individual sand and gravel beds probably ranges from a few hundred to a few thousand feet. These buried channel deposits are surrounded by silt and clay sediments similar to those being deposited on the present flood plain of the river.

Pleistocene sediments occur at a shallow depth; elevation is about -100 feet msl just off the east end of Dauphin Island (Raymond and others, 1993). Smith in Raymond and others (1993) reported a latest Pleistocene nannofossil flora from clay from well Permit No. 2543 in the mouth of Mobile Bay at a depth of 90 to 120 feet. The alluvial, low terrace, and coastal deposits are part of the watercourse aquifer.

HYDROGEOLOGY

Sediments cropping out at the surface have been divided into two major aquifers: the watercourse aquifer and the Miocene-Pliocene aquifer (plate 1), which are discussed in detail below.

MIOCENE-PLIOCENE AQUIFER

The Miocene-Pliocene succession, consisting of the Miocene Series undifferentiated and the Citronelle Formation, is about 3,400 feet thick in the coastal areas of southern Baldwin and Mobile Counties. In extreme northern Baldwin County, the unit is about 100 feet thick. The Miocene-Pliocene succession consists of beds of sand, gravel and clay (plate 3). Ground water flows through sand and gravel beds that are irregular in thickness and of limited lateral extent. The clay intervals between the sand units should be considered aquitards, not aquicludes, because the clays are not laterally extensive enough to prevent downward movement of ground water, but they do provide semi-confinement to many of the deeper sand and gravel intervals. Because of the discontinuous nature of these deposits, it is difficult to correlate one sand interval to another with confidence on the basis of available well data. In the northern part of the area, the principal water-bearing sands in the aquifer are at the base of the Miocene-Pliocene sequence. These sands interfinger or merge with relatively impermeable clays in central parts of the counties where the base of the aquifer appears to be in the middle of the Miocene-Pliocene strata (Reed and McCain, 1971). Individual beds of sand in the unit are 50 to 100 feet thick in many places, reaching 230 feet in thickness near Loxley. Lenticular clays separating the sands reach 80 feet in thickness. Sands in the lower part of the formation have yet to be extensively developed because good supplies of water are available at shallower depths.

Several different authors have developed schemes for subdividing the water-bearing sequence of sediments in Baldwin County (table 2). Walter and Kidd (1979) used clay units, which are more easily correlated than sand units, to divide the deposits in southern Baldwin County. Walter and Kidd (1979) identified four different aquifers: the Beach Sand aquifer, the Gulf Shores aquifer, the 350-foot aquifer, and the 500-foot aquifer (table 2). The Beach Sand aquifer in their study corresponds in part to the watercourse aquifer in this report. The wells used to construct the fence diagram of figure 5 are test wells drilled for Walter and Kidd's research and do not correspond to wells listed in this report. Chandler and others (1985) subdivided the same sequence of sediments in southern Baldwin County into aquifers A_1, A_2, and A_3 (fig. 3). Table 2 and plate 3 show how these various divisions correspond with each other and give the lithologic and hydrologic characteristics of the sedimentary sequence.

The cross sections shown on plate 3 demonstrate the difficulty in correlating individual sand units in Mobile and Baldwin Counties. However, relatively thick, predominantly clay sequences appear to be correlative from north to south in both counties, and possibly from east to west between counties. These clay sequences divide the shallow subsurface into several intervals dominated by beds of sand. The relationships between these aquifers and those named by Walter and Kidd (1979) and Chandler and others (1985) are indicated on cross section B-B' of plate 3.

Table 2.—Correlation and descriptions of previously recognized aquifers in Area 13

<table>
<tr><th rowspan="2">Hydrogeologic unit</th><th colspan="2">Unit character</th><th colspan="3">Aquifers</th></tr>
<tr><th>Lithologic</th><th>Hydrologic</th><th>Walter & Kidd, 1979</th><th>Chandler & others, 1985</th><th>This report</th></tr>
<tr><td>Pleistocene (?)-Holocene</td><td>Sand, white to pale-orange, fine- to coarse-grained; silt; clay; and sea-shell hash. Finer grained sediments predominant in lower part of unit as discontinuous layers.</td><td>Predominantly medium-grained sands in upper 20 to 60 feet of unit comprise principal aquifer. The aquifer is a water-table aquifer and is a potential source of more than 100 gpm of water per well.</td><td>Beach sand aquifer</td><td>A_1</td><td>Watercourse aquifer</td></tr>
<tr><td>Pleistocene-shallow Miocene</td><td>Sand, white to light-gray, fine- to very coarse-grained, gravelly and carbonaceous in places, interbedded with sandy silty clay.</td><td>Sand and gravel in unit comprise major aquifers. The lower aquifers are generally semiconfined. Potential source of 100 to more than 100 gpm of water per well.</td><td>Gulf Shores aquifer</td><td>A_2</td><td rowspan="2">Miocene-Pliocene aquifer</td></tr>
<tr><td>Deep Miocene</td><td>Same as A2, except sediments form more persistent and traceable layers in the subsurface. The siliciclastics immediately overlie the Pensacola Clay.</td><td>Major aquifers are semi-confined or confined and yield water to wells under low-head artesian pressure. Potential source of more than 1,500 gpm of water per well.</td><td>350- and 500-foot aquifers</td><td>A_3</td></tr>
</table>

In central Mobile County the Miocene-Pliocene aquifer (plate 3) appears to be at least two distinct aquifers. These aquifers have been identified on the cross section A-A' as the “middle sand” and “lower sand.” The lower sand has been further subdivided into the “A” and “B” sands. Whereas about 75 feet of clay separates the A and B sands in northern Mobile County, the clay thins to the south. Without additional aquifer test information the hydraulic relationship between these two sand sequences cannot be determined. Wells completed in lower sand intervals within the formation have significantly lower water levels than wells completed in the middle sand. The presence of two potentiometric surfaces suggests that in this area, the middle sand and the lower sand of the Miocene-Pliocene aquifer are hydraulically separate. In addition, electric and drillers’ logs of these deeper wells indicate a clay interval about 130 feet thick overlying the lower aquifer in north and central Mobile County. This 130-foot clay interval not only separates the aquifers, but also provides the lower sand a greater degree of protection from contamination from the surface. However, one should not assume that the protective clay layer extends laterally for a significant distance. The potentiometric surface shown on plate 1 corresponds to the middle sand aquifer in which the majority of the public supply wells are completed. Only 10 public supply wells are completed in the lower sand aquifer. These wells include 5 of Mobile County Water Authority’s wells, 1 of Kushla’s wells, 2 of Fairview’s wells, and 2 of South Alabama Water System’s wells. The depths of these wells range from 426 to 570 feet. Water levels in this unit are about 50 feet lower than water levels in the overlying unit. The deeper Eocene and Oligocene Series in the northeast corner of Baldwin County are potential sources of water supply that are not currently used by public water systems in the county (Reed and McCain, 1971).

Except in northernmost and easternmost parts of the outcrop area, properly constructed wells in the Miocene-Pliocene aquifer yield from 0.5 to 2.5 Mgal/d. Results of pump tests on individual wells are listed in the well data table (table 3). In this aquifer, the town of Robertsdale has completed one well which was tested at 1,823 gpm in 1987.

WATERCOURSE AQUIFER

Quaternary alluvial, coastal, and terrace deposits consisting of interbedded sand, gravel, and clay comprise the watercourse aquifer (figs. 3, 5). Properly constructed wells in the watercourse aquifer have the potential to yield from 0.5 to 1.0 Mgal/d where sand is sufficiently thick. Most high-yield wells are completed in sand and gravel coastal deposits and buried river sediments. These buried sand and gravel channels are surrounded by silty and clayey sediments that do not yield significant amounts of water, but do allow slow infiltration of water to recharge the sand and gravel beds. Individual buried channels may be directly connected to the present channels of the Mobile River. The watercourse aquifer is hydraulically connected to the underlying

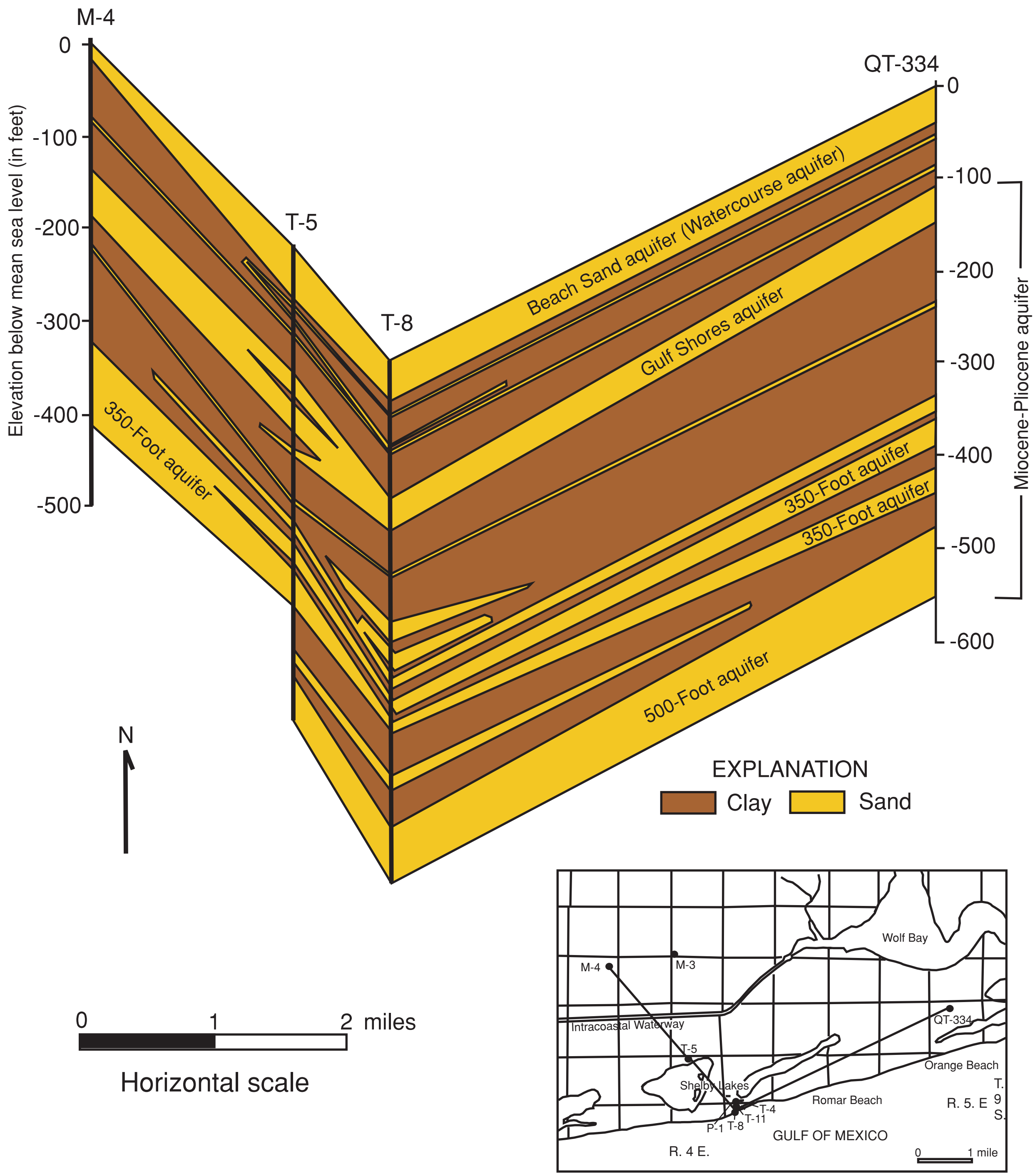


Figure 5.—Generalized fence diagram of the local named aquifer units comprising the watercourse and Miocene-Pliocene aquifers in southern Baldwin County, Alabama (modified from Walter and Kidd, 1979).

Miocene-Pliocene aquifer (fig. 3). In southern Baldwin County, the watercourse aquifer has been referred to as the “Beach Sand aquifer” (Walter and Kidd, 1979) (table 2).

The sand and gravel beds in the watercourse aquifer and those at shallow depths in the Miocene-Pliocene aquifer are hydraulically connected to the land surface; therefore, these aquifers are considered unconfined. Discontinuous lenses of clay retard the vertical movement of water but do not completely separate the sand units; therefore, the watercourse aquifer locally provides recharge for the underlying Miocene-Pliocene aquifer.

While the watercourse aquifer can provide large yields to wells, few public supply wells are completed in this aquifer because of its vulnerability to contamination from the land surface. Systems with wells completed in the watercourse aquifer include Mt. Vernon, Saraland, Satsuma, and Dauphin Island.

Dauphin Island’s hydrologic situation is unique in the state. Because it is an island, isolated from the rest of Mobile County by the brackish water of the Mississippi Sound, its primary source of fresh water is a freshwater lens which “floats” on top of more dense saline water (fig. 6). As with all shallow aquifers in the coastal regions, these sands are subject to contamination by storm tides and surges. The deeper sands underlying the watercourse aquifer also tend to be high in salt. Figure 7 shows logs of a test well, UU-25, drilled on Dauphin Island indicating that saline water was found in the shallow sands occurring from land surface to a depth of approximately 30 feet (630 mg/L Cl) and in the deeper sand between 260 and 350 feet (320 mg/L Cl). The level of chlorides in the shallow upper sands can be expected to vary significantly as rainfall flushes out the salty water resulting from overwash of storm surges. Dauphin Island uses a reverse-osmosis treatment system to reduce chloride levels in water from wells completed in the watercourse aquifer and from two deeper wells.

RECHARGE AND MOVEMENT OF GROUND WATER

The source of recharge to the aquifers is rainfall, which averages 64.0 inches per year (in/yr) in the study area (NOAA-CIRES/Climate Diagnostics Center, period 1961-1990). About 28 in/yr of rainfall runs off during and immediately after storms (Reed and McCain, 1971); a small percentage of rainfall infiltrates the subsurface as recharge to the aquifers and the remainder is returned to the atmosphere by evaporation and transpiration from trees and other plants.

The amount of water that infiltrates the soil depends on the hydraulic conductivity and permeability of the soil, the amount of water present in the soil during rainfall, and the slope of the land surface. Infiltration is greater in an area that is flat and underlain by gravel and coarse sand sediments rather than in an area with a sloping land surface that is underlain by dense clay.

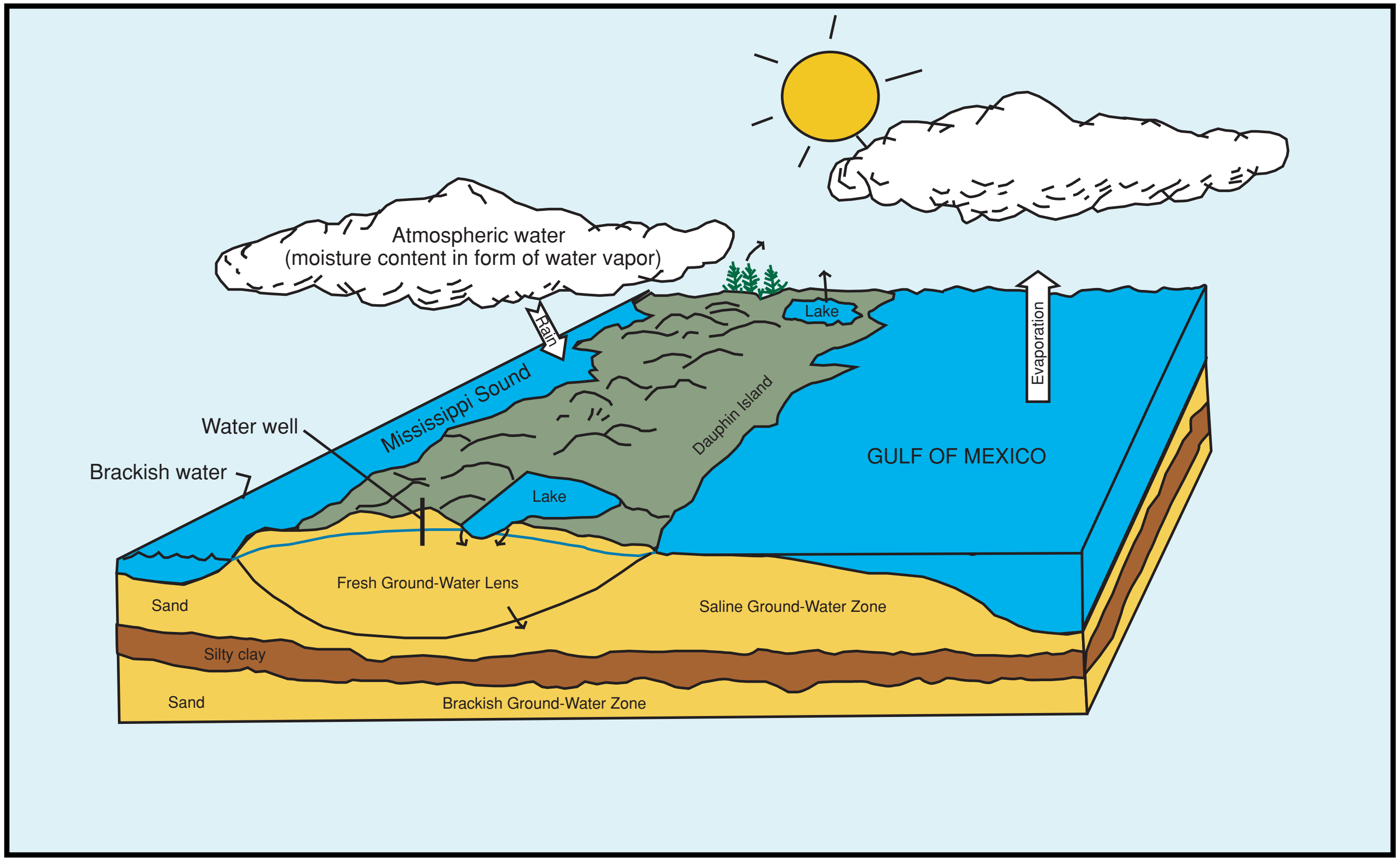


Figure 6.—Block diagram illustrating the hydrologic cycle at Dauphin Island, Alabama (modified from Chandler and Moore, 1983).

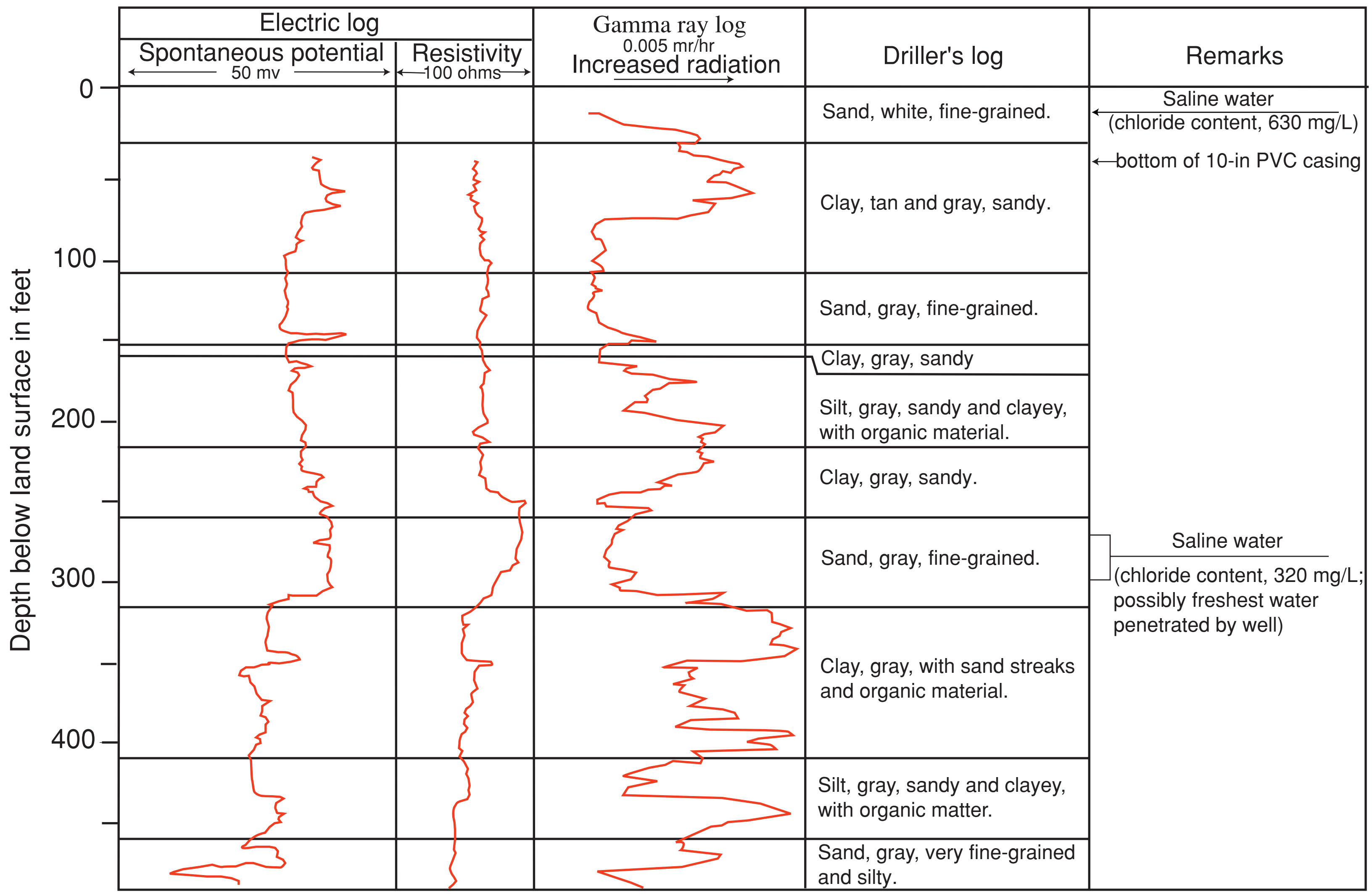


Figure 7.—Electric, gamma ray, and driller's logs for test well UU-25, mid-Dauphin Island, Alabama (modified from Chandler and Moore, 1983).

Most recharge to the major aquifers in Mobile and Baldwin Counties occurs within the boundaries of the study area (plate 1), and a small amount is contributed from Miocene outcrops to the north. The amount of recharge to aquifers may be estimated from the base (dry-weather) flow of streams, which is ground water discharge. The average baseflow (7-day Q_2) for streams in Area 13 is about 0.601 cubic feet per second per square mile of drainage area or about 8.1 in/yr (Walter, 1976; Bingham, 1982).

Water moves from areas of recharge to areas of natural discharge and areas of ground water withdrawal, along pathways generally perpendicular to the potentiometric contour lines shown on plate 1. Areas of artesian flow are present along major stream valleys and along the coast.

NATURAL DISCHARGE AND GROUND WATER WITHDRAWALS

Ground water discharges primarily into streams, water bodies, and wells. Some of the larger ground water pumping centers in the study area include the cities of Foley, Robertsdale, Bay Minette, Orange Beach, Gulf Shores, Fairhope, Daphne, Loxley, Silverhill, Perdido Bay, and Spanish Fort in Baldwin County; and Grand Bay, Fairview, Dauphin Island, Theodore, Turnerville, Kushla, LeMoyne, Citronelle, Mt. Vernon, Bayou LaBatre, Saraland, Satsuma, Semmes, and St. Elmo in Mobile County (table 3).

In addition to water withdrawn for public water supply, substantial quantities of ground water are used for irrigation in Baldwin and Mobile Counties. Mobile County has several chemical and paper factories and other industries that use large quantities of ground water. In 1995 average daily withdrawal of ground water in the study area was about 66 Mgal/d (Mooty and Richardson, 1998).

EFFECTS OF WITHDRAWALS FROM THE AQUIFERS

Large withdrawals of water from an aquifer cause a depression in the potentiometric surface of the aquifer. The extent of the depression depends on the amount of water withdrawn and the water-bearing characteristics of the sediments. Depressions occur in the vicinity of some industries along the Mobile River in northern Mobile County as well as around public supply wells. The effects of the depressions along the Mobile River in northern Mobile County are localized because of their proximity to the Mobile River, which is hydraulically connected to the aquifers in the area. The Mobile River has an average annual discharge of about 70,000 cubic feet per second (ft^3/s), which is adequate to recharge the aquifer in that area as withdrawals occur. However, in tidal reaches of the Mobile River, the induced recharge could draw salt water into the aquifer (fig. 8).

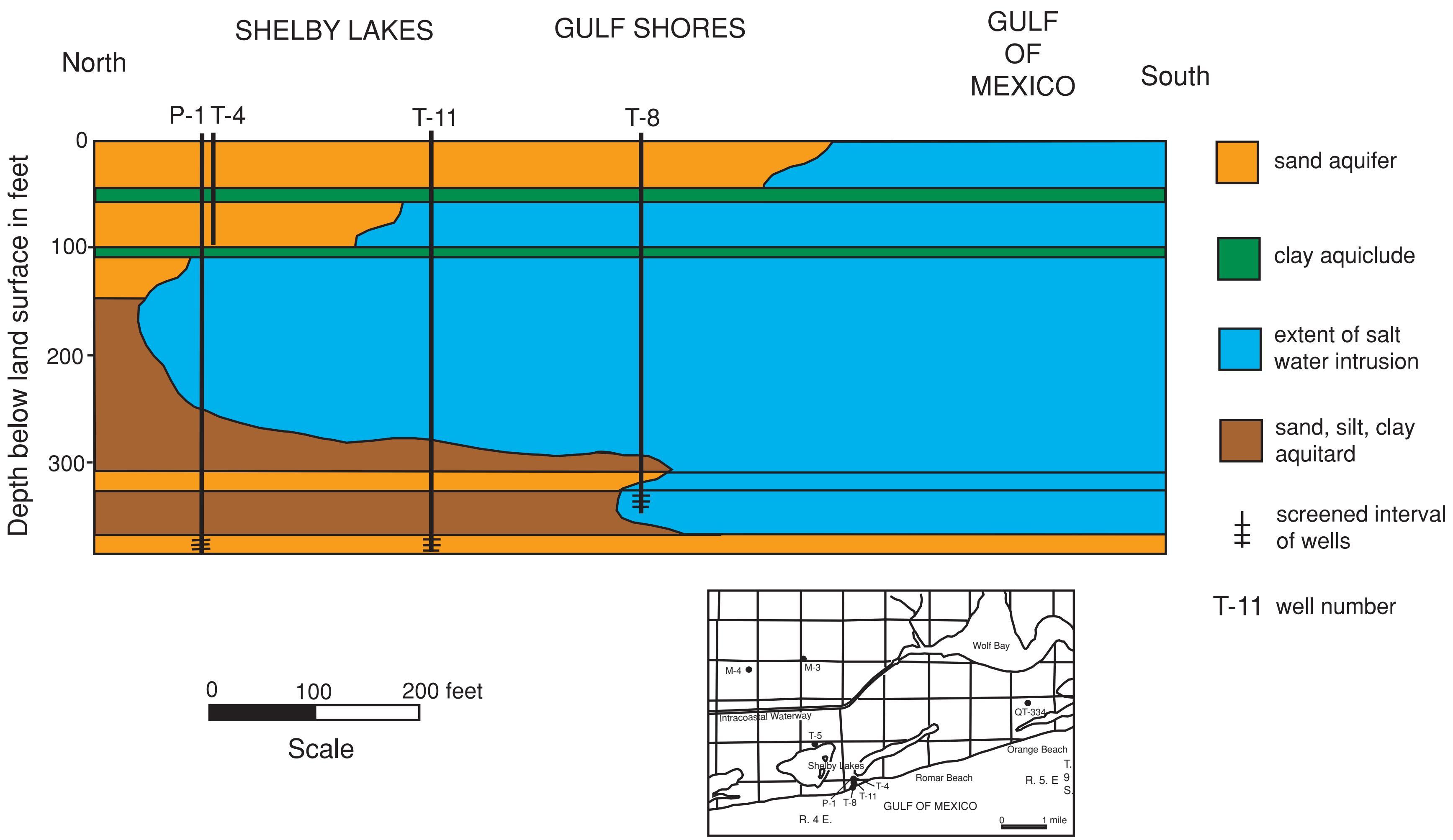


Figure 8.—Generalized cross section showing the extent of salt-water intrusion in the Miocene-Pliocene aquifer, southern Baldwin County, Alabama (modified from Walter and Kidd, 1979).

Declines in the potentiometric surface may eventually result in increased pumping costs due to the decline in the water levels in wells. In extreme cases, pump intake pipes may need to be lowered or wells deepened to maintain adequate supply. A depression in the potentiometric surface also creates a steepened hydraulic gradient in the vicinity of a pumping center and increases the rate of movement of water and any potential contaminant to points of ground water withdrawal.

GROUND WATER QUALITY

Wells in the Miocene-Pliocene aquifer, except those in areas adjacent to the Mobile River basin, Mobile Bay, the Gulf of Mexico, and Mississippi Sound, generally yield soft water that has a dissolved solids content of less than 250 mg/L. Objectionable amounts of iron are present locally but occur most commonly in areas adjacent to major waterways. Some wells also yield water that is sufficiently acidic to be corrosive. Acidity increases southward toward the Gulf of Mexico. At Dauphin Island and in areas adjacent to the major waterways, some sands in the aquifer contain water with a dissolved solids content that exceeds 1,000 mg/L, a sulfurous odor, and a chloride content that exceeds 500 mg/L. The depth at which ground water has total dissolved solids in excess of 10,000 mg/L in Area 13 is shown in figure 9. Generally, beneath this depth, water in aquifers is unsuitable for most uses.

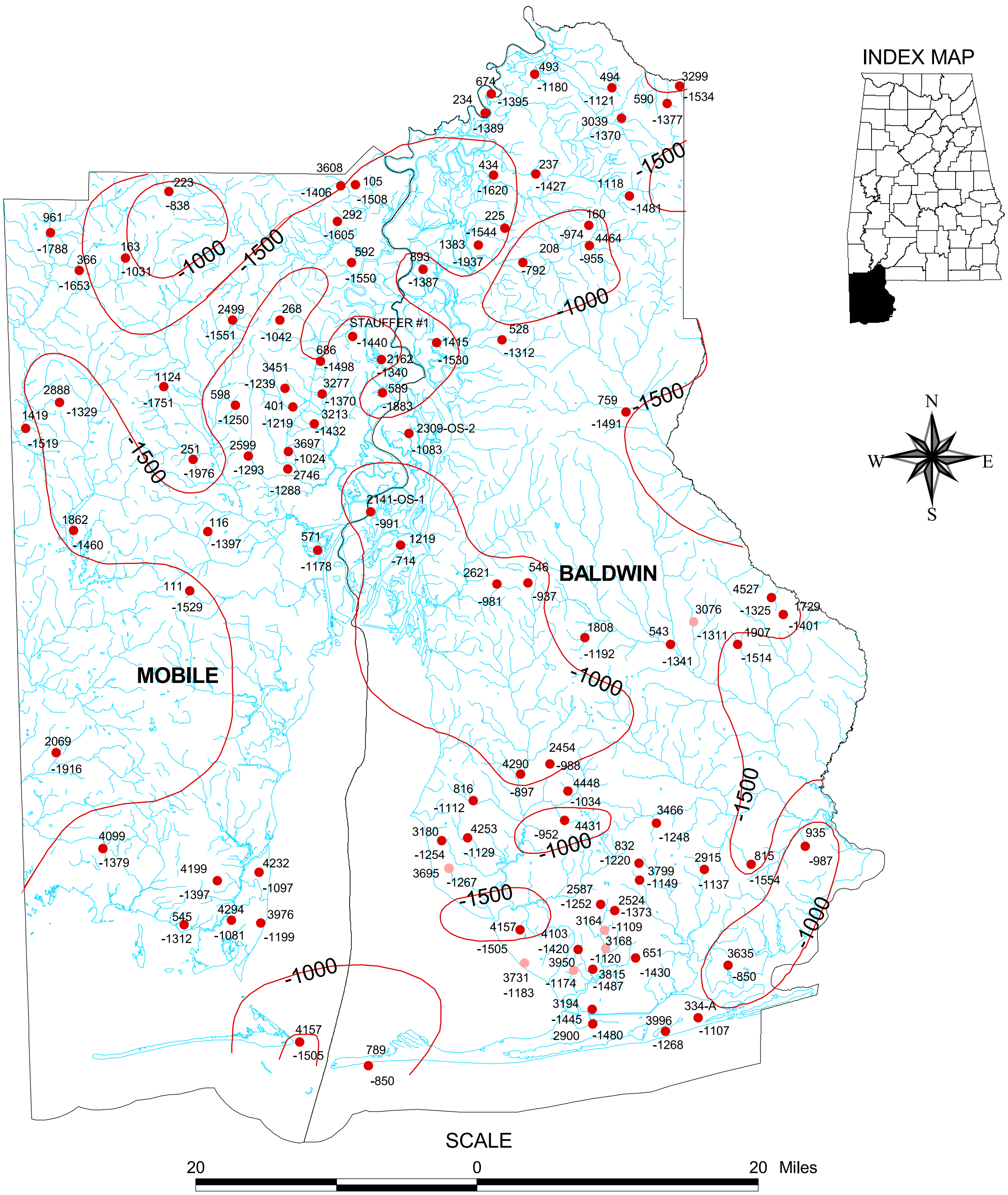
Salt-water encroachment is a significant problem along the coast in the watercourse and Miocene-Pliocene aquifers (Reed and McCain, 1972; Chandler and others, 1985). Because of the rapid population growth in the Gulf Shores area, pumpage from municipal wells has also increased. The rapid withdrawal of water from coastal aquifers may pull salt water northward into freshwater aquifers (fig. 8).

Water in alluvium and low terrace deposits generally is soft and has a dissolved solids content less than 100 mg/L, but commonly contains iron in excess of 0.3 mg/L and may be sufficiently acidic to be corrosive. Water in areas close to Mississippi Sound, the Gulf of Mexico, the Mobile River basin, and Mobile Bay commonly contains iron in excess of 0.3 mg/L; locally the water is very hard, the chloride content exceeds 250 mg/L, and the dissolved solids exceed 1,000 mg/L.

Ground water in high terrace deposits is soft and locally contains iron in excess of 0.3 mg/L.

VULNERABILITY OF AQUIFERS TO CONTAMINATION

Aquifer vulnerability is a difficult concept to evaluate owing to the complexity and variability of the geology and aquifers involved. Aquifers are vulnerable to contaminants from both surface and subsurface sources.



EXPLANATION

3299 State Oil and Gas Board Permit Number and other identifiers

-1534 Elevation, in feet below mean sea level, of ground water with approximately 10,000 milligrams per liter of total dissolved solids as NaCl at 25 °C (77 °F).

Elevation calculated from borehole geophysical logs.

Elevation interpolated from calculated values which were derived from borehole geophysical logs of permeable units above and below a thick (>100 ft) unit with low permeability.

-1500 Elevation in feet below mean sea level, of ground water with approximately 10,000 milligrams per liter of total dissolved solids as NaCl at 25 °C (77 °F). Contour interval 500 feet.

Figure 9.–Mean sea level elevations of ground water containing more than 10,000 mg/L of total dissolved solids in Area 13 (modified from Hinkle and Sexton, 1988).

Numerous surface sources of potential contamination include point sources such as gasoline tanks, chemical spills, pipeline and sewer leaks, treatment lagoons, and industrial sites. Potential nonpoint sources of pollution include chemicals applied to agricultural fields, on-site sewage system discharges, chemicals applied to lawns and gardens, and urban run-off.

Some types of contaminants such as petroleum products are lighter than water and float on the water table. These are referred to as light nonaqueous phased liquids (LNAPL's). Other chemicals such as chlorinated hydrocarbons are denser than water and can sink through the aquifer and accumulate and migrate on subsurface confining units. These chemical contaminants are referred to as dense nonaqueous phased liquids (DNAPL's). Some contaminants dissolve in or mix with water and neither float nor sink but move with the ground water. Also, naturally occurring contamination such as saline ground water may encroach into freshwater aquifers from downdip or from other water-bearing units.

Outcrops of all aquifers in Alabama are vulnerable to contamination from surface sources of pollution. The extent to which an aquifer can become contaminated is determined by the nature of the contaminant and the hydrogeologic characteristics of the aquifer. Hydrogeologic characteristics vary from aquifer to aquifer and even within individual aquifers and are largely controlled by the permeabilities of the units comprising an aquifer. Unconfined aquifers with high permeabilities have high recharge rates (typically more than 6 inches per year) and contaminants from the surface may not be filtered adequately as water moves towards the water table. The most vulnerable aquifers in Alabama are either unconsolidated sand and gravel or carbonate rocks that contain numerous solutionally enlarged joints and fractures. Aquifers least vulnerable to contamination are typically overlain by thick relatively impermeable units such as clay or chalk. These impermeable units are either aquicludes or aquitards.

Vulnerability may also vary within aquifers. Aquifers are most vulnerable in their outcrops where water-table conditions exist. Where aquifers become confined downdip, their vulnerability to surface contamination decreases as they are protected by aquicludes or aquitards that retard the vertical downward movement of contaminants (fig. 10). Although this confinement affords some protection to the aquifer, no aquifer is immune to contamination from poorly constructed wells and bad management practices. Pumping of large quantities of ground water by public supply wells, industrial supply wells, or irrigation wells creates cones of depression, increases flow gradients, and draws ground water and any associated contamination, where present, toward the pumping wells. In south Alabama and coastal areas some aquifers are especially vulnerable to natural sources of contamination such as salt water from the Gulf of Mexico and mineralized ground water in other parts of the aquifers (fig. 10).

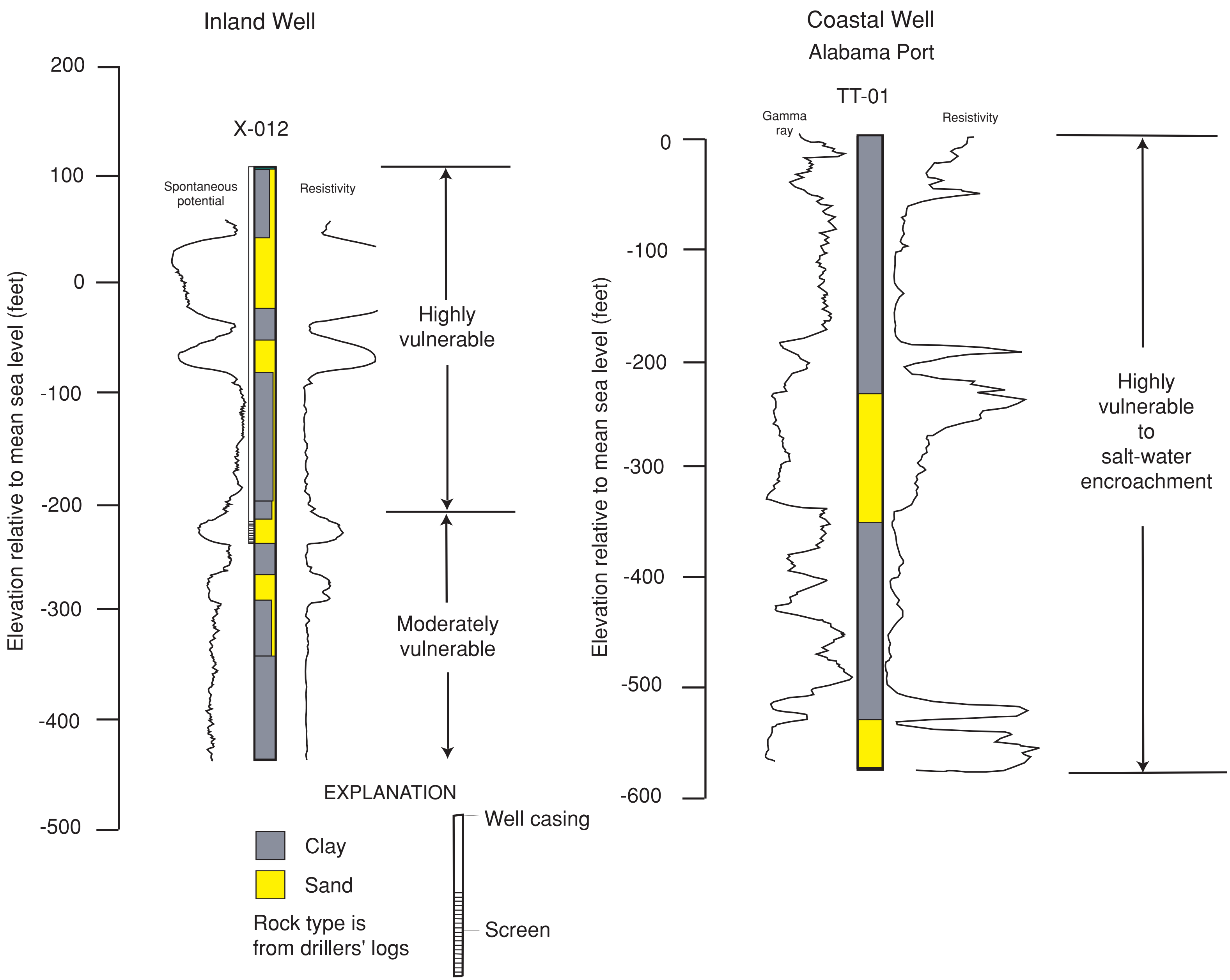


Figure 10.—Representative wells showing vulnerability to contamination with depth in Area 13.

General guidelines (shown below) have been established to assist in identifying aquifers as having either high, moderate, or low vulnerability to contamination. Most of the factors listed below apply particularly to the vulnerability of the aquifer in the outcrop area. Not all factors are required for any one aquifer to be assigned to a particular vulnerability category. A few factors pertain only to possible contamination from natural sources of contamination at depth or downdip.

High vulnerability to contamination

- Aquifer is unconfined, unconsolidated, highly permeable, and has high recharge rates (typically greater than 6 inches per year)
- Aquifer is not confined by thick homogeneous impermeable units or is semiconfined
- Aquifer is comprised of rocks that contain solution cavities and/or fractures that allow rapid ground water movement and high recharge rates
- Aquifer has a freshwater/salt-water interface in close proximity to the area of concern
- Aquifer is penetrated by faults that provide an avenue for entrance of contaminated water from the surface or from another aquifer

Moderate vulnerability to contamination

- Aquifer is unconfined, is consolidated rock, has low permeability, and has low to moderate recharge rates (typically 1 to 6 inches per year)
- Aquifer has no solution cavity development
- Aquifer is overlain by thick, cumulatively impermeable, or discontinuous impermeable units sufficient to provide some protection to the aquifer
- Aquifer is comprised of fractured rock, but fractures are of limited extent and connectivity and are not enlarged
- Aquifer is confined by aquitards that transmit water, but not in quantities sufficient for development

Low vulnerability to contamination

- Aquifer is well confined by aquicludes that are laterally continuous, are thick, lack connected fracture networks, have low recharge rates (less than 1 inch per year), and are incapable of transmitting significant quantities of water
- Area of concern is a significant distance from the freshwater/salt-water interface of the aquifer.

Detailed site-specific hydrogeologic investigations should be implemented to accurately determine an aquifer's vulnerability to contamination. Long-term aquifer testing is needed to determine the aquifer's hydrologic characteristics and the hydraulic properties of confining beds.

Outcrops of aquifers in Area 13 are classified as highly vulnerable to contamination from surface sources because of the unconsolidated nature of the aquifers, their exposure at the surface, and absence of continuous protective clay layers (plate 1). Downdip, individual water-bearing units in the Miocene-Pliocene aquifer become more confined by interbedded clay beds that are relatively impermeable when compared to the sands. Therefore, deeper parts of the aquifer may be moderately vulnerable to contamination from surface sources (fig. 10). Some contaminants, however, such as DNAPL's, could eventually migrate around and through discontinuous clay layers. Aquifers in the coastal areas are also subject to salt-water encroachment or salt-water intrusion if pumping rates of wells are excessive.

Much of Area 13 is rural and, particularly in Baldwin County, a large percentage of the land is agricultural. The topography is flat to low rolling hills. This type of terrain minimizes surface runoff and allows more time for water to infiltrate the soil. Areas of relatively flat terrain with very permeable soils are more vulnerable to contamination than areas with greater relief; however, relative to other areas in the state, all of Area 13 is considered highly vulnerable to contamination from the surface (plate 1).

Many of the low areas in Area 13 are used for intensive row-crop farming where pesticides are used extensively. Along the Mobile River in the northern part of Mobile County, chemical industries are potential sources of contamination to the ground water. Some of these industrial sites have been identified on the EPA's National Priorities List (Superfund sites) for cleanup. An industry located in this area, pumps process water from the Miocene-Pliocene aquifer at such a high rate that a significant depression in the potentiometric surface is evident in the area surrounding the plant. Declines in the potentiometric surface caused by such intensive ground water withdrawal can change the direction of ground water flow. In such a case, ground water could reverse flow direction and move away from the rivers and into the adjacent deposits. Since the topography adjacent to the Mobile River in northern Mobile County is relatively flat and is underlain by permeable sediments, this part of the aquifer becomes especially vulnerable to contamination from the surface.

Regions underlain by alluvial and coastal sediments generally discharge ground water to surface water bodies such as the adjacent rivers and streams. This flow direction decreases the likelihood of contamination from the rivers and streams. The shallower alluvial and coastal deposits themselves remain highly vulnerable to contamination from the surface.

Coastal areas are vulnerable to salt-water contamination from storm surges. The occasional hurricanes that strike the Gulf Coast can cause tides to rise 5 to 25 feet above normal. These storm surges allow salt water to infiltrate the shallow ground water system in coastal areas. Generally, storm-related salt-water contamination has not been a serious problem in the public water supply systems near coastal areas because wells in these systems generally tap deep sands.

Salt-water intrusion caused by excessive pumping of deep wells is a problem on Dauphin Island and a potential problem for southern Baldwin County. Because of salt-water encroachment, Dauphin Island installed a shallow well field on the island to produce water from the shallow unconfined parts of the aquifer. Eight shallow wells ranging from 30 to 40 feet in depth were drilled. Two existing deep wells were left in service; however, water from the northernmost well, MOBUU-2, must be treated by reverse osmosis to remove chlorides. Ground water is the only source of supply for private homes, municipalities, businesses, industries, golf courses, and large-scale agricultural enterprises. Therefore, salt-water intrusion resulting from excessive ground water withdrawals is becoming a threat elsewhere along the coast as the coastal area continues to be developed.

Results from a long-term aquifer test in the Gulf Shores area (Walter and Kidd, 1979) suggest that the clay units in the coastal area at more than 300 feet in depth are discontinuous and do not provide a high degree of confinement for sand aquifers. On the cross section of Mobile County shown on plate 3, well TT-01 at the Alabama Port (fig. 10) has a fairly homogeneous clay unit between 90 and 125 feet that provides some protection for the underlying sand intervals from contamination from the surface. However, well TT-01 is close enough to Mobile Bay that contamination from salt-water encroachment is a potential problem; therefore, the sand interval between 125 and 225 feet in depth may be considered highly vulnerable to contamination.

PUBLIC SUPPLY WELLS

In the study area, 113 public ground water supply wells provide water for 33 water systems (table 3; plate 1). Most of these wells derive water from the Miocene-Pliocene aquifer, although a few wells are completed in Quaternary alluvium of the watercourse aquifer. Maximum depth of wells completed in the watercourse aquifer is 135 feet. Wells completed in the Miocene-Pliocene aquifer vary in depth because there are several different water-bearing sand beds at different depths within the aquifer. The deepest well is 805 feet deep; however, most wells are less than 200 feet in depth.

WELLHEAD PROTECTION AREAS

Public water supply systems that use ground water provide water to about one-third of the population of Alabama (Mooty and Richardson, 1998). Programs that protect ground water sources from potential contamination are known as Wellhead Protection Programs (WHPP's). Alabama's WHPP is the result of 1986 amendments to the Safe Drinking Water Act originally enacted by Congress in 1974. The 1986 amendments directed the states to develop plans and programs to protect areas providing ground water to public water supply wells and springs. The 1996 amendments established Source Water Assessment requirements for public water supply systems using either ground water or surface water sources. Local wellhead protection plans (LWHPP) are not required. The Source Water Assessment Program (SWAP) requires a Source Water Assessment Area (SWAA) delineation, potential contaminant source inventory within each SWAA, a susceptibility analysis of each potential contaminant source in the inventory, and public notification of the condition of raw water supplies, including their susceptibility to contamination. The SWAA's are identified surface areas where potential contaminants are most likely to migrate into the ground resulting in contamination of public water supply wells or springs and are delineated by using hydrogeologic conditions or time of travel criteria. The revised WHPP is a voluntary program that builds on the SWAP by providing guidance for developing protection strategies in the delineated areas. Protection strategies include building a local team of concerned citizens, developing an educational and outreach program, and developing management and contingency strategies. The terms SWAA and WHPA can be used to identify the same area around a public water supply well or spring and are used synonymously in this report.

Eighteen public water supply systems currently have WHPA's or SWAA's delineated in Area 13 (plate 4). Ground water supply systems in Mobile County that have established WHPA's are Bayou LaBatre, LeMoyne, MCB (Movico, Chastang, and Bucks), Saraland, Satsuma, South Alabama/Citronelle, South Alabama/Semmes, Spanish Fort, Dauphin Island, Mobile County, Kushla, and Turnerville. Systems in Baldwin County with delineated WHPA's are Bay Minette, Fairhope, East Central Baldwin, Gulf Shores, Loxley, Orange Beach, and Perdido Bay. Public supply well locations and boundaries of the WHPA's are shown on plate 4.

SUMMARY AND CONCLUSIONS

The major aquifers in Area 13 are the Miocene-Pliocene aquifer and the watercourse aquifer. The recharge areas for these aquifers are primarily within or just north of the study area. The Miocene Series undifferentiated, the Citronelle Formation, and the alluvial, terrace and coastal deposits of Quaternary age that make up these aquifers are generally hydraulically connected and act as a single hydrologic unit. Discontinuous clay lenses within these deposits retard the vertical movement of ground water, but do not separate the sands completely over large areas; therefore, the study area is considered highly vulnerable to contamination from the surface. The deeper sands in the Miocene Series undifferentiated appear to be separated from the shallower unit by a significant clay interval and are considered moderately vulnerable to contamination.

The entire study area is considered to be highly vulnerable to contamination from the surface owing to the permeability of the underlying sediments. The soils are highly permeable, which allows rapid infiltration of water. Areas around some of the large pumping centers are more vulnerable to contamination, not only because of the permeable nature of the sediments and the slope of the land surface, but because of depressions created in the potentiometric surface by large withdrawals of water from the aquifers. These depressions act as funnels to direct ground water flow toward pumping centers and increase the rate at which a potential contaminant could migrate into the ground water system. Other areas of high vulnerability are regions characterized by flat terrain, which decreases the rate of surface runoff, and highly permeable soils, which increase the rate of infiltration from the surface. Many of these areas are farmed intensively and the potential exists for contamination of ground water by agricultural chemicals.

Public ground water supplies in the area are derived from 113 public supply wells in both aquifers. To date, WHPA's have been delineated for 18 of the public supply systems that rely on ground water as a source of supply.

SELECTED REFERENCES

Adams, G. I., Butts, Charles, Stevenson, L. W., and Cooke, C. W., 1926, Geologic map of Alabama: Alabama Geological Survey Special Map 7, scale 1:500,000, 1 sheet.

Alabama Department of Economic and Community Affairs, 1984, Alabama County Data Book: 92 p.

Baker, R. M., and Mooty, W. S., 1993, Use of water in Alabama, 1990: Alabama Geological Survey Information Series 59E, 49 p.

Barksdale, H. C., Moore, J. D., and contributors, 1976, Water content and potential yield of significant aquifers in Alabama: Alabama Geological Survey Open-File Report, 449 p.

Bingham, R. H., 1982, Low-flow characteristics of Alabama streams: U.S. Geological Survey Water-Supply Paper 2083, 27 p.

Brown, G. F., Foster, V. M., Adams, R. W., Reed, E. W., and Pudgett, H. D., Jr., 1944, Geology and ground-water resources of the coastal area in Mississippi: Mississippi Geological Survey Bulletin 60, 229 p.

Chandler, R. V., and Moore, J. D., 1983, Fresh ground-water resources of the Dauphin Island area, Alabama: Alabama Geological Survey Circular 109, 89 p.

Chandler, R. V., Moore, J. D., and Gillett, Blakeney, 1985, Ground-water chemistry and salt-water encroachment, southern Baldwin County, Alabama: Alabama Geological Survey Bulletin 126, 166 p.

Chandler, R. V., Gillett, Blakeney, and DeJarnette, S. S., 1996, Hydrologic and water-use data for southern Baldwin County, Alabama: Alabama Geological Survey

Circular 188, 124 p.

Davis, M. E., 1987, Stratigraphic and hydrogeologic framework of the Alabama Coastal Plain: U.S. Geological Survey Water-Resources Investigations Report 87-4112, 39 p.

Ellard, J. S., 1977, Map of fresh and slightly saline ground-water resources in the Coastal Plain of Alabama: Alabama Geological Survey Special Map 179.

Harvey, E. J., Golden, H. G., Jeffery, H. G., 1965, Water resources of the Pascagoula area, Mississippi: U.S. Geological Survey Water-Supply Paper 1763, 135 p.

Hinkle, Frank, and Sexton, Thomas, 1988, Depths to ground water in southwest Alabama with approximately 10,000 milligrams per liter of total dissolved solids: Alabama Geological Survey Special Map 214.

Isphording, W. C., 1977, Petrology and stratigraphy of the Alabama Miocene: Gulf Coast Association of Geological Societies Transactions, v. 27, p. 304-313.

Isphording, W. C., and Lamb, G. M., 1971, Age and origin of the Citronelle Formation in Alabama: Geological Society of America Bulletin, v. 82, no. 4, p. 775-780.

Marsh, O. T., 1966, Geology of Escambia and Santa Rosa Counties, western Florida panhandle: Florida Geological Survey Bulletin 46, 140 p.

Martin, A. M., Jr., and Whiteman, C. D., Jr., 1989, Geohydrology and regional ground-water flow of the coastal lowlands aquifer system in parts of Louisiana, Mississippi, Alabama, and Florida—a preliminary analysis: U.S. Geological Survey Water-Resources Investigations Report 88-4100, 88 p.

Moore, J. D., 1998, Aquifers in Alabama: Alabama Geological Survey Special Map 231 (revised).

Moore, J. D., and Hunter, J. A., 1991, Watercourse aquifers in Alabama: Alabama Geological Survey Circular 159, 26 p.

Moore, J. D., and Raymond, D. E., 1985, Configuration of the base of the Miocene Series: Alabama Geological Survey Special Map 199D.

Mooty, W. S., 1988, Geohydrology and susceptibility of major aquifers to surface contamination in Alabama; Area 13: U.S. Geological Survey Water-Resources Investigations Report 88-4080, 29 p.

Mooty, W. S., and Richardson, J. R., 1998, Water use in Alabama, 1995: U.S. Geological Survey Water-Resources Investigations Report 98-4154, 92 p.

Moser, P. H., and Chermock, R. L., 1978, Geologic and hydrologic environmental atlas of Mobile and Baldwin Counties, Alabama: Alabama Geological Survey Open-File Report, 210 p.

National Oceanic and Atmospheric Administration, 1985, Alabama precipitation yearly normals 1951-80: Birmingham, River Forecast Office.

Peterson, C. G., 1947, Ground-water investigations in the Mobile area, Alabama: Alabama Geological Survey Bulletin 58, 32 p.

Pettyjohn, W. A., Savoca, Mark, and Self, Dale, 1991, Regional assessment of aquifer vulnerability and sensitivity in conterminous United States: U.S. Environmental Protection Agency Report EPA/600/2-91/043, 319 p.

Pettyjohn, R. A., Busby, J. F., and Layman, T. B., 1993a, Properties and chemical constituents in ground water from permeable zone B (lower Pleistocene-upper Pliocene deposits), Coastal Lowlands aquifer system, south-central United States: U.S. Geological Survey Water-Resources Investigations Report 91-4152.

_____1993b, Properties and chemical constituents in ground water from permeable zone E (lower Miocene-Upper Oligocene deposits), Coastal Lowlands aquifer system, south-central United States: U.S. Geological Survey Water-Resources Investigations Report 92-4103.

Pettyjohn, R. A., Busby, J. F., and Cervantes, M. A., 1993, Properties and chemical constituents in ground water from permeable zone C (lower Pliocene-upper Miocene deposits), Coastal Lowlands aquifer system, south-central United States: U.S. Geological Survey Water-Resources Investigations Report 91-4151.

Raymond, D. E., 1985, Depositional sequences in the Pensacola Clay (Miocene) of southwest Alabama: Alabama Geological Survey Bulletin 114, 87 p.

Raymond, D. E., Copeland, C. W., and Rindsberg, A. K., 1993, Post-Miocene sediments of the shallow subsurface of coastal Alabama: Alabama Geological Survey Circular 168, 93 p.

Reed, P. C., 1971a, Geology of Mobile County, Alabama: Alabama Geological Survey Map 93, 8 p.

_____1971b, Geology of Baldwin County, Alabama: Alabama Geological Survey Map 94, 5 p.

Reed, P. C., and McCain, J. F., 1971, Water availability of Baldwin County, Alabama: Alabama Geological Survey Map 96, 55 p.

_____1972, Water availability in Mobile County, Alabama: Alabama Geological Survey Map 121, 45 p.

Riccio, J. F., Hardin, J. D., and Lamb, G. M., 1973, Development of a hydrologic concept for the greater Mobile metropolitan-urban environment: Alabama Geological Survey Bulletin 106, 171 p.

Robinson, J. L., Moreland, R. S., and Clark, A. E., 1996, Potentiometric surface of the Miocene-Pliocene aquifer system of Baldwin County, Alabama, 1995: U.S. Geological Survey WRD Open-File Report 96-590, 64 p.

Sapp, D. C., and Emplaincourt, Jacques, 1975, Physiographic regions of Alabama: Alabama Geological Survey Special Map 168, 1 sheet.

Smith, C. C., 1991, Foraminiferal biostratigraphy framework, paleoenvironments, rates of sedimentation, and geologic history of the subsurface Miocene of southern Alabama and adjacent State and Federal waters: Alabama Geological Survey Bulletin 138, 223 p.

Szabo, M. W., and Copeland, C. W., Jr., 1988, Geologic map of Alabama: southwest sheet: Alabama Geological Survey Special Map 220.

U.S. Department of Commerce, Bureau of Census, 1991, 1990 Estimated Alabama population: Special Tabulation, U.S. Department of Commerce, Bureau of Census.

U.S. Environmental Protection Agency, 1984, A ground-water protection strategy for the Environmental Protection Agency: U.S. Environmental Protection Agency, 56 p.

U.S. Geological Survey, 1986, Water resources data, Alabama water year 1985: U.S. Geological Survey Water Data Report AL-85-1, 286 p.

_____1997, Water resources data, Alabama water year 1996: U.S. Geological Survey Water Data Report AL-96-1, 456 p.

Walter, G. R., 1976, The Miocene-Pliocene aquifer and the alluvial aquifer, *in* Barksdale, H. C., and contributors, 1976, Water content and potential yield of significant aquifers in Alabama: Alabama Geological Survey Open-File Report, 449 p.

Walter, G. R., and Kidd, R. E., 1979, Ground-water management techniques for the control of salt-water encroachment in Gulf Coast aquifers, a summary report: Alabama Geological Survey Open-File Report, 84 p.

Williamson, A. K., Grubb, H. F., and Weiss, J. S., 1990, Ground-water flow in the Gulf Coast aquifer systems, south central United States—A preliminary analysis: U.S. Geological Survey Water-Resources Investigations Report 89-4071,124 p.

Whitmore, F. C., Jr., 1983, Hemphillian vertebrate fauna from Mobile County, Alabama, *in* Isphording, W. C., and Flowers, G. C., Differentiation of unfossiliferous clastic sediments: Solutions from the southern portion of the Alabama-Mississippi Coastal Plain: Tulane Studies in Geology and Paleontology, v. 17, no. 3, p. 71-72.

EXPLANATION FOR TABLE 3

SYSTEM, water system name.
PWS ID, Public water system identification number as assigned by the Alabama Department of Environmental Management.
SE ID, Source identification number as assigned by the Alabama Department of Environmental Management. New wells may not have SE ID's assigned at press time.
GSA ID, Well identification number assigned by the Geological Survey of Alabama (GSA).
DEPTH, total depth of well in feet. Number in parentheses denotes total depth of the test well drilled at the same location.
YEAR DRILLED, the year the well was completed and ready for operation.
DRILLING CONTRACTOR, name of driller.
ALTITUDE, elevation of land surface in feet above mean sea level.
AQUIFER: Qalt, alluvial and terrace deposits of Quaternary age;
Tmp, undifferentiated Pliocene and Miocene deposits of Tertiary age.
WATER LEVEL, water level in feet below land surface. The date the measurement was made is shown below the measurement.
WELL CONSTRUCTION, YIELD, REMARKS, gpm is gallons per minute.

Table 3.--Records of public water-supply wells in Area 13

BALDWIN COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Tensaw Water Authority	1679	1	BALG-02	963	1990	Griner Drilling Service, Inc.	68	Tmp	4.87 5/16/90	Casing: 8-in. from 0 to 320 ft, 4-in. from 268 to 328 ft and 377.67 to 387.67 ft. Screen: 4-in. from 328 to 377.67 ft and 387.67 to 410 ft. Drawdown 34 ft when pumped 72 hrs at 226 gpm in May, 1990.
Stockton Water System	71	1	BALK-01	207	1974	Acme Drilling Co.	115	Tmp	89 3/12/74	Casing: 12-in. from 0 to 169 ft, 8-in. from 128 to 168 ft, 6-in. from 188 to 196 ft. Screen: 6-in. from 168 to 188 ft and 196 to 207 ft. Drawdown 37 ft when pumped 8 hrs at 200 gpm in 1974.
North Baldwin Water Authority	1768	1	BALO-03	425	1996	Layne-Central Co.	308	Tmp	182 1996	Casing: 12-in. From 0 to 360 ft, 12-in. From 0 to 360 ft. Screen: 12-in. From 360 to 425 ft. Drawdown 37 ft when pumped at 450 gpm.
Bay Minette Utilities	23	1	BALU-5	229	1938	Layne-Central Co.	269	Tmp	90.4 7/20/66	Casing: 12-in. from 0 to 196 ft, 8-in. from 162 to 207 ft. Screen: 8-in. from 207 to 229 ft. Drawdown 41 ft when pumped 24 hrs at 320 gpm in 1938.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Bay Minette Utilities	23	2	BALU-9	204	1948	Layne-Central Co.	270	Tmp	88.88 7/20/66	Casing: 18-in. from 0 to 148 ft, 12-in. from 0 to 160 ft. Screen: 8-in. from 160 to 200 ft. Drawdown 23 ft when pumped 8 hrs at 361 gpm in 1948.
Bay Minette Utilities	23	3	BALU-11	187	1965	Layne-Central Co.	265	Tmp	66 1965	Casing: 24-in. from 0 to 130 ft, 12-in. from 80 to 135 ft. Screen: 10-in. from 135 to 175 ft. Drawdown 40 ft when pumped at 500 gpm in 1965.
Bay Minette Utilities	23	4	BALU-01	186	1975	Layne-Central Co.	255	Tmp	68 1/8/75	Casing: 24-in. from 0 to 130 ft, 12-in. from 80 to 135 ft. Screen: 10-in. from 135 to 175 ft. Drawdown 47 ft when pumped 8 hrs at 750 gpm in 1975.
Bay Minette Utilities	23	5	BALU-02	265	1983	Layne-Central Co.	269	Tmp	82 12/12/83	Casing: 24-in. from 0 to 165 ft, 16-in. from 112 to 170 and 190 to 205 ft, 6-in. from 255 to 265 ft. Screen: 16-in. from 170 to 190 ft and 205 to 255 ft. Drawdown 60 ft when pumped 16 hrs at 1,102 gpm in Dec. 1983.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Spanish Fort Water System	68	1	BALCC-5	326 (419)	1964	Layne-Central Co.	150	Tmp	109.6 3/15/66	Casing: 16-in. from 0 to 260 ft, 10-in. from 210 to 265 ft. Screen: 8-in. from 265 to 305 ft. Drawdown 13 ft when pumped at 200 gpm in 1966.
Spanish Fort Water System	68	2	BALCC-6	378 (414)	1959	Layne-Central Co.	160	Tmp	149.2 4/27/66	Casing: 18-in. from 0 to 289 ft, 12-in. from 239 to 294 ft and 8-in. from 319 to 348 ft. Screen: 8-in. from 294 to 319 ft and 348 to 368 ft. Drawdown 119 ft when pumped at 554 gpm in 1959.
Spanish Fort Water System	68	3	BALCC-07	374 (501)	1990	Griner Drilling Service, Inc.	197	Tmp	166.34 5/2/90	Casing: 16-in. from 0 to 324 ft, 8-in. from 264 to 324 ft. Screen: 8-in. from 324 to 364 ft. Drawdown 73 ft when pumped 25 hrs at 503 gpm in May 1990.
Spanish Fort Water System	68	4	BALCC-08	350 (502)	1995	Griner Drilling Service, Inc.	150	Tmp	136 9/25/93	Casing: 16-in. from 0 to 305 ft, 10-in. from 251 to 308.51 ft. Screen: 10-in. from 308.51 to 349 ft. Drawdown 22 ft when pumped 24 hrs at 42 gpm in Sept. 1993.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Spanish Fort Water System	68	5	BALCC-09	295 (504)	1998	Griner Drilling Service, Inc.	150	Tmp	127 1998	Casing: 16-in. from 0 to 305 ft, 10-in. from 251 to 308.51 ft. Screen: 10-in. from 308.51 to 349 ft. Drawdown 22 ft when pumped 24 hrs at 42 gpm in Sept. 1993.
Loxley Water Department	48	1	BALKK-3	184	1959	Layne Central	170	Tmp	40 5/26/59	Casing: 12-in. from 0 to 140 ft, 8-in. from 100 to 144 ft. Screen: 8-in. from 144 to 174 ft. Drawdown 30 ft when pumped 7 hrs at 305 gpm in 1959.
Loxley Water Department	48	2	BALKK-05	190	1984	Holland Well Co. Inc.	165	Tmp	55.41 5/30/91	Casing: 16-in. from 0 to 139 ft, 10-in. from 89 to 139 ft. Screen: 8-in. from 140 to 180 ft. Drawdown 61 ft when pumped 24 hrs at 1,125 gpm in 1984 .
Malbis Plantation	50	1	BALCC-06	260	1983	Holland Well Co. Inc.	197	Tmp	135 3/24/83	Casing: 16-in. from 0 to 208 ft, 8-in. from 190 to 208 ft. Screen: 8-in. from 208 to 258 ft. Drawdown 38 ft when pumped 24 hrs at 509 gpm on April 29, 1983.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Daphne Utilities Board	29	1	BALLL-04	430 (442)	1957 (re-worked in 1983)	Layne Central	157	Tmp	1321957	Casing: 12-in. from 0 to 397 ft, 6-in. from 337 to 402 ft. Screen: 6-in. from 380 to 430 ft. Drawdown 22 ft when pumped 16 hrs at 400 gpm in 1983.
Daphne Utilities Board	29	2	BALLL-6	452 (611)	1963	Layne Central	155	Tmp	144.72 11/13/82	Casing: 12-in. from 0 to 397 ft, 6-in. from 352 to 402 ft. Screen: 6-in. from 402 to 442 ft. Drawdown 31 ft when pumped at 250 gpm in 1965.
Daphne Utilities Board	29	3	BALLL-020	215 (314)	1992	Griner Drilling Service, Inc.	152	Tmp	63.89 12/19/91	Casing: 20-in. from 0 to 155 ft, 12-in. from 110 to 165 ft. Screen: 12-in. from 165 to 215 ft. Drawdown 36 ft when pumped 24 hrs at 503 gpm on Dec. 20, 1991.
Daphne Utilities Board	29	4	BALLL-011	198 (610)	1984	Powell Drilling Co., Inc.	143	Tmp	56 10/23/84	Casing: 18-in. from 0 to 151 ft, 12-in. from 95 to 152 ft. Screen: 10-in. from 152 to 193 ft. Drawdown 23 ft when pumped 8 hrs at 125 gpm on Oct. 23, 1984.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Daphne Utilities Board	29	5	BALLL-09	315 (399)	1959	Powell Drilling Co., Inc.	140	Tmp	48.5 1959	Casing: 12-in. from 0 to 270 ft, 8-in. from 220 to 275 ft. Screen: 6-in. from 275 to 305 ft. Drawdown 48 ft when pumped 8 hrs at 319 gpm n 1959.
Daphne Utilities Board	29	6	BALLL-02	155	1977	Graves Well Drilling Co.	142	Tmp	79.5 8/2/77	Casing: 6-in. from 0 to 140 ft. Screen: 6-in. from 140 to 155 ft. Drawdown 24.5 ft when pumped 8 hrs at 300 gpm on Aug. 8, 1977.
Daphne Utilities Board	29	7	BALLL-03	176 (204)	1982	Powell Drilling Co., Inc.	115	Tmp	63 9/3/82	Casing: 16-in. from 0 to 131 ft, 10-in. from 101 to 131 ft. Screen: 8-in. from 131 to 171 ft. Drawdown 34 ft when pumped 16 hrs at 608 gpm on Sept. 3, 1982. Formerly owned by Lake Forest Utilities.
Daphne Utilities Board	29	8	BALLL-06	300 (608)	1991	Griner Drilling Service, Inc.	152	Tmp	97.35 3/7/83	Casing: 20-in. from 0 to 155 ft. Screen: 12-in. from 165 to 210 ft.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Belforest Water System	25	1	BALLL-01	184	1974	Acme Drilling Co.	147	Tmp	53 1/30/84	Casing: 12-in. from 0 to 141 ft, 8-in. from 79.5 to 139.5 ft, 6-in. from 159.8 to 161.2 ft. Screen: 6-in. from 139.5 to 159.8 ft and from 161.2 to 181.5 ft. Drawdown 39 ft when pumped 8 hrs at 510 gpm on Nov. 4, 1974.
Robertsdale Utilities	61	1	BALPP-6	260	1958	Layne-Central Co.	148	Tmp	32.0 9/15/49 51.9 10/23/68 35.9 3/23/87	Casing: 16-in. from 0 to 99 ft, 10-in. from 77.5 to 220 ft. Screen: 10-in. from 220 to 260 ft. Drawdown 16 ft when pumped 4 hrs at 349 gpm in 1977. GSA observation well.
Robertsdale Utilities	61	2	BALPP-1	203	1959	Layne-Central Co.	138	Tmp	37.66 5/9/66	Casing: 18-in. from 0 to 150 ft, 12-in. from 110 to 153 ft. Screen: 10-in. from 153 to 193 ft. Drawdown 41 ft when pumped 3 hrs at 503 gpm in 1959.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Robertsdale Utilities	61	3	BALPP-09	250	1987	Weldon Drilling Co.	140	Tmp	39.46 6/3/87	Casing: 18-in. from 0 to 148 ft, 12-in. from 98 to 150 ft. Screen: 10-in. from 150 to 210 ft. Drawdown 68.8 ft when pumped 24 hrs at 1,823 gpm in June 1987.
Silverhill Water Works	65	1	BALOO-1	198	1962	Acme Drilling Co.	145	Tmp	50 1962 47.0 7/10/87	Casing: 10-in. from 0 to 153 ft, 4-in. from 112 to 155 ft. Screen: 4-in. from 155 to 195 ft. Drawdown 8 ft when pumped 7 hrs at 157 gpm in 1962.
Silverhill Water Works	65	2	BALOO-06	186	1973	Acme Drilling Co.	144	Tmp	7 1973 50.3 7/10/87	Casing: 12-in. from 0 to 153 ft, 8-in. from 111 to 153 ft. Screen: 6-in. from 153 to 184 ft.
Fairhope Water Department	35	1	BALNN-02	223	1974	Carloss Well Supply Co.	115	Tmp	71.5 1975 70.8 3/10/87	Casing: 20-in. from 0 to 158 ft. Screen: 12-in. from 158 to 218 ft. Drawdown 50 ft when pumped 24 hrs at 750 gpm in 1975.
Fairhope Water Department	35	2	BALNN-01	265	1974	Carloss Well Supply Co.	95	Tmp	51 1975 43.0 3/10/87	Casing: 20-in. from 0 to 192 ft. Screen: 12-in. from 201 to 261 ft. Drawdown 50 ft when pumped 24 hrs at 750 gpm in 1975.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Fairhope Water Department	35	3	BALOO-02	196 (511)	1981	Layne-Central Co.	105	Tmp	81 1981	Casing: 14-in. from 0 to 126 ft. Screen: 12-in. from 131 to 186 ft. Drawdown 19 ft when pumped 26 hrs at 750 gpm in 1981.
Fairhope Water Department	35	4	BALNN-04	230 (383)	1981	Layne-Central Co.	85	Tmp	61 1981	Casing: 14-in. from 0 to 105 ft, 12-in. from 120 to 129 ft, 154 to 195 ft and 220 to 230 ft. Screen: 12-in. from 110 to 120 ft, 129 to 154 ft and 195 to 220 ft. Drawdown 13 ft when pumped 28 hrs at 750 gpm in 1981.
Fairhope Water Department	35	5	BALWW-016	335 (501)	1990	Griner Drilling Service, Inc.	80	Tmp	50.50 7/25/90	Casing: 24-in. from 0 to 234 ft, 16-in. from 174 to 244 ft, 12-in. from 266 to 290 ft. Screen: 12-in. from 24 to 266 ft and 290 to 330 ft. Drawdown 166 ft when pumped 24 hrs at 752 gpm in July, 1990.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Fairhope Water Department	35		BALNN-017	260 (501)	1998	Griner Drilling Service, Inc.	105	Tmp	59 3/30/98	Casing: 24-in. from 0 to 234 ft, 16-in. from 174 to 244 ft, 12-in. from 266 to 290 ft. Screen: 12-in. from 24 to 266 ft and 290 to 330 ft. Drawdown 166 ft when pumped 24 hrs at 752 gpm in July, 1990.
Summerdale Water Works	73	1	BALPP-5	146	1955	Layne-Central Co.	115	Tmp	20 1955	Casing: 16-in. from 0 to 71 ft, 10-in. from 0 to 75 ft and 95 to 120 ft. Screen:10-in. from 75 to 95 ft and 120 to 140 ft. Drawdown 20 ft when pumped 8 hrs at 503 gpm in 1955.
East Central Baldwin Water & Fire Protection Authority			BALQQ-03	550 (600)	1998	Griner Drilling Service, Inc.	105	Tmp	56 3/27/97	Casing: 24-in. from 0 to 460 ft, 16-in. from 390 to 470 ft, 14-in. from 470 to 510 ft. Screen: 14-in. from 510 to 550 ft. Drawdown 135 ft when pumped 6 hrs at 1,051 gpm on 03/27/98.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Elberta Water Works	33	1	BALTT-6	103 (110)	1964	Spillers Well & Pump Co.	75	Tmp	29 3/28/84	Casing: 8-in. from 0 to 72 ft, 6-in. from 70 to 73 ft. Screen: 6-in. from 73 to 103 ft. Drawdown 30 ft when pumped 3 hrs at 335 gpm in 1964.
Riviera Utilities	36	1	BALUU-6	155	1962	Layne-Central Co.	75	Tmp	24 8/30/83	Casing: 24-in. from 0 to 103 ft, 16-in. from 0 to 108 ft, 12-in. from 133 to 137 ft. Screen: 12-in. from 108 to 133 ft and 137 to 147 ft. Drawdown 48 ft when pumped 8 hrs at 578 gpm in 1962.
Riviera Utilities	36	2	BALUU-9	148	1954	Layne-Central Co.	148	Tmp	29 8/30/83	Casing: 16-in. from 0 to 94 ft, 10-in. from 64 to 98 ft. Screen: 10-in. from 98 to 138 ft. Drawdown 32 ft when pumped 8 hrs at 503 gpm in 1954.
Riviera Utilities	36	3	BALUU-17	138	1971	Carloss Well Supply Co.	76	Tmp	25 8/30/83	Casing: 24-in. from 0 to 98 ft, 16-in. from 0 to 95 ft. Screen: 12-in. from 98 to 138 ft. Drawdown 44 ft when pumped 12 hrs at 625 gpm.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Riviera Utilities	36	4	BALZZ-046	210 (241)	1991	Layne-Central Co.	60	Tmp	29 11/4/91	Casing:20-in. from 0 to 155 ft, 12-in. from 105 to 160 ft. Screen:12-in. from 160 to 200 ft. Drawdown 83 ft when pumped 13 hrs at 1,050 gpm on 11/4/91.
Riviera Utilities	36		BALUU-021	131	1997	Layne Christensen Company	77	Tmp	18 6/25/97	Casing: 20-in. from 0 to 100 ft, 12-in. from 40 to 102 ft. Screen: 10-in. from 102 to 127 ft. Drawdown 46 ft when pumped 24 hrs at 704 gpm in 1997.
Riviera Utilities	36		BALUU-022	218 (310)	1997	Layne Christensen Company	72	Tmp	24 6/25/97	Casing: 20-in. from 0 to 185 ft, 12-in. from 130 to 190 ft. Screen: 10-in. from 190 to 215 ft. Drawdown 112 ft when pumped 6 hrs at 1,050 gpm in 1997.
Perdido Bay Water, Sewer and Fire Protection District	1490	1	BALBBB-04	300 (330)	1977	Layne-Central Co.	67	Tmp	42 3/28/84	Casing: 18-in. from 0 to 255 ft, 10-in. from 205 to 260 ft. Screen: 10-in. from 260 to 300 ft. Drawdown 38 ft when pumped 8 hrs at 500 gpm in 1977.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Perdido Bay Water, Sewer and Fire Protection District	1490	3	BALSS-03	280 (318)	1974	Layne-Central Co.	66	Tmp	27.5 3/28/84	Casing: 18-in. from 0 to 235 ft, 10-in. from 185 to 240 ft. Screen: 10-in. from 240 to 270 ft. Drawdown 37 ft when pumped 5 hrs at 457 gpm in 1976.
Perdido Bay Water, Sewer and Fire Protection District	1490	4	BALAAA-010	480 (500)	1995	Griner Drilling Service, Inc.	65	Tmp	41 2/1/95	Casing: 6-in. from 0 to 280 ft. Screen: 6-in. from 280 to 320 ft. Drawdown 43 ft when pumped 24 hrs at 250 gpm in 1995.
Gulf Shores Water System	38	1	BALDDD-3	98	1955	Layne-Central Co.	16	Tmp	7.5 3/26/84	Casing: 16-in. from 0 to 70 ft, 10-in. from 0 to 72 ft. Screen: 10-in. from 72 to 93 ft. Drawdown 15 ft when pumped 8 hrs at 150 gpm in 1955.
Gulf Shores Water System	38	2	BALDDD-21	138	1967	Layne-Central Co.	11	Tmp	11.10 3/26/84	Casing: 20-in. from 0 to 100 ft, 12-in. from 100 to 103 ft. Screen: 10-in. from 103 to 128 ft. Drawdown 11 ft when pumped 8 hrs at 503 gpm in 1967.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Gulf Shores Water System	38	3	BALDDD-010	225	1975	Layne-Central Co.	16	Tmp	11 1975 15.3 7/15/87	Casing: 20-in. from 0 to 170 ft, 12-in. from 185 to 183 ft. Screen: 10-in. from 185 to 215 ft. Drawdown 58 ft when pumped 11 hrs at 754 gpm in 1976.
Gulf Shores Water System	38	4	BALZZ-02	215	1979	Layne-Central Co.	36	Tmp	19.2 3/26/84	Casing: 20-in. from 0 to 205 ft, 12-in. from 120 to 175 ft. Screen: 10-in. from 175 to 205 ft. Drawdown 132 ft when pumped 24 hrs at 750 gpm in 1979.
Gulf Shores Water System	38		BALZZ-023	345	1984	Alsay-Pippin Corporation	39	Tmp	13.83 5/8/84	Casing: 20-in. from 0 to 265 ft, 10-in. from 216 to 270 ft. Screen: 10-in. from 270 to 320 ft. Drawdown 106 ft when pumped 72 hrs at 1,499 gpm in 1984.
Gulf Shores Water System	38	6	BALZZ-034	203	1986	Alsay, Inc.	11	Tmp	18.91 3/16/87	Casing: 16-in. from 0 to 145 ft, 10-in. from 108 to 148 ft. Screen: 8-in. from 148 to 198 ft. Drawdown 82 ft when pumped 89 hrs at 820 gpm in 1986.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Gulf Shores Water System	38	7	BALZZ-041	200 (421)	1987	Layne-Western Company, Inc.	30	Tmp	16 12/6/88	Casing: 20-in. from 0 to 112 ft, 12-in. from 72 to 112 ft, 10-in. from 112 to 117 ft, 132 to 152 ft and 172 to 183 ft. Screen: 10-in. from 117 to 132 ft, 152 to 172 ft and 183 to 193 ft. Reported yield 500 gpm.
Gulf Shores Water System	38	5	BALZZ-025	205 (528)	1984	Alsay-Pippin Corporation	34	Tmp	9.95 4/11/84	Casing: 20-in. from 0 to 160 ft, 12-in. from 103 to 163 ft. Screen: 10-in. from 163 to 203 ft. Drawdown 20 ft when pumped 24 hrs at 781 gpm in April 1984.
Gulf Shores Water System	38	8	BALZZ-045	370	1997	J. Patrick Scott		Tmp	26 1997	Casing: 16-in. from 0 to 265 ft, 12-in. from 260 to 270 ft and 330 to 340 ft. Screen: 12-in. from 270 to 330 ft and 340 to 360 ft. Drawdown 75 ft when pumped 19 hrs at 1,125 gpm in 1997.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Orange Beach Water Authority	53	1	BALDDD-04	144	1975	Carloss Well Supply Co.	26.2	Tmp	9.8 12/2/76 14.5 6/22/84	Casing: 12-in. from 0 to 100 ft, 8-in. from 60 to 120 ft. Screen: 8-in. from 120 to 140 ft. Drawdown 36 ft when pumped 24 hrs at 350 gpm in 1975. Also known as the Carloss well.
Orange Beach Water Authority	53	2	BALDDD-02	120	1981	Graves Well Drilling	9.8	Tmp	6 1981 0.8 3/29/88 6.5 10/1/90	Casing: 18-in. from 0 to 100 ft, 10-in. from 0 to 100 ft. Screen: 10-in. from 100 to 120 ft. Drawdown 25 ft when pumped 29 hrs at 503 gpm in 1981. Also known as the shallow Stuckey well.
Orange Beach Water Authority	53	3	BALDDD-03	408	1983	Acme Drilling Co.	9.8	Tmp	10 1981	Casing: 16-in. from 0 to 330 ft, 10-in. from 292 to 331 ft. Screen: 8-in. from 331 to 407 ft. Drawdown 66.5 ft when pumped 24 hrs at 830 gpm in 1983. Also known as deep Stuckey well.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Orange Beach Water Authority	53	4	BALDDD-017	140	1983	Acme Drilling Co.	9.8	Tmp	8 1983	Casing: 16-in. from 0 to 100., 10-in. from 43 to 100 ft. Screen: 8-in. from 100 to 140 ft. Drawdown 50 ft when pumped 12 hrs at 1,000 gpm in 1986. Also known as the Craft well.
Orange Beach Water Authority	53		BALZZ-043	197	1989	Layne-Central Co.	16.4	Tmp	7 1989	Casing: 24-in. from 0 to 105 ft, 16-in. from 60 to 109 ft and 129 to 157 ft. Screen: 16-in. from 109 to 129 ft and 157 to 182 ft. Drawdown 78 ft when pumped 53 hrs at 1,514 gpm in May, 1989. Also known as the Fodor well.
Orange Beach Water Authority	53		BALCCC-011	376	1990	Graves Well Service Co., Inc.	11	Tmp	9 1990	Casing: 14-in. from 0 to 246 ft. Screen: 8-in. from 246 to 371 ft. Also known as the Cox well.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

MOBILE COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
South Alabama Utilities/ Citronelle	967	1	MOBD-2	762 (770)	1959	Layne-Central Co.	339	Tmp		Casing: 16-in. from 0 to 687 ft, 8-in. from 608 to 692 ft. Screen: 8-in. from 692 to 752 ft. Drawdown 10 ft when pumped 3 hrs at 400 gpm in 1959.
South Alabama Utilities/ Citronelle	967	2	MOBD-3	745	1954	Layne-Central Co.	309	Tmp	203 5/1953	Casing: 16-in. from 0 to 650 ft, 8-in. from 570 to 655 ft. Screen: 8-in. from 655 to 735 ft. Drawdown 18 ft when pumped 8 hrs at 412 gpm in 1954.
South Alabama Utilities/ Citronelle	967	3	MOBG-1	805	1965	Layne-Central Co.	334	Tmp	252 1965	Casing: 16-in. from 0 to 700 ft, 8-in. from 640 to 705 ft, 725 to 745 ft and 760 to 770 ft. Screen: 8-in. from 705 to 725 ft, 745 to 760 ft and 770 to 795 ft. Drawdown 18 ft when pumped 8 hrs at 402 gpm in 1965.
South Alabama Utilities/ Citronelle	967	4	MOBD-01	760	1969	Carloss Well Service		Tmp	260 1969	Casing: 16-in. from 0 to 685 ft, 8-in. from 634 to 696 ft. Screen: 8-in. from 696 to 760 ft. Drawdown 30 ft when pumped 8 hrs at 554 gpm in 1969.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Mt. Vernon Water Department	1006	1	MOBA-4	95	1967	Carloss Well Service	56	Qal	29.1 2/27/67	Casing: 6-in. from 0 to 75 ft. Screen: 6-in. from 75 to 95 ft. Drawdown 14 ft when pumped 24 hrs at 406 gpm in 1967.
Mt. Vernon Water Department	1006	2	MOBA-3	95	1962	Carloss Well Service	51	Qal	27 1962	Casing: 20-in. from 0 to 60 ft, 12-in. from 0 to 75 ft. Screen: 12-in. from 75 to 95 ft. Drawdown 10 ft when pumped 8 hrs at 305 gpm in 1963.
Searcy Hospital	1024	1	MOBB-3	728	1946	Layne-Central Co.	185	Tmp	109 1/3/50 133 7/23/65	Casing: 16-in. from 0 to 242 ft, 12-in. from 200 to 660 ft, 8-in. from 585 to 665 ft. Screen: 8-in. from 665 to 710 ft. Drawdown 19 ft when pumped 12 hrs at 560 gpm in 1965.
MCB Water & Fire Protection	1004	1	MOBI-03	200	1996	Griner Drilling Service, Inc.	10	Tmp	flowing 1996	Casing: 16-in. from 0 to 150 ft, 10-in. from 90 to 160 ft. Screen: 10-in. from 160 to 200 ft. Drawdown 93 ft when pumped 24 hrs at 305 gpm on 12/19/95.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
LeMoyne Water System, Inc.	994	1	MOBL-013	165	1973	Holland Well Co.	25	Tmp	12 1973 13.10 1995	Casing: 8-in. from 0 to 102 ft, 4-in. from 90 to 105 ft. Screen: 4-in. from 105 to 135 ft. Drawdown 17 ft when pumped 4 hrs at 330 gpm in 1972.
LeMoyne Water System, Inc.	994	2	MOBL-04	160	1982	Holland Well Co.	30	Tmp	20 1981	Casing: 20-in. from 0 to 107 ft, 12-in. from 0 to 110 ft. Screen: 12-in. from 110 to 130 ft. Drawdown 30 ft when pumped 24 hrs at 600 gpm in 1981.
LeMoyne Water System, Inc.	994	3	MOBL-014	125 (140)	1992	Donald Smith Co.	32	Tmp	18 1992	Casing: 20-in. from 0 to 85 ft. Screen: 10-in. from 85 to 115 ft. Drawdown 10 ft when pumped 24 hrs at 600 gpm in 1992.
Turnerville Water & Fire Protection District	1510	1	MOBR-01	522	1979	Layne-Central Co.	240	Tmp	191 1979	Casing: 12-in. from 0 to 480 ft, 6-in. from 405 to 482 ft. Screen: 6-in. from 482 to 512 ft. Drawdown 52 ft when pumped 24 hrs at 517 gpm in 1979.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Turnerville Water & Fire Protection District	1510	2	MOBM-022	494 (594)	1995	Griner Drilling Service, Inc.	256	Tmp	182 1995	Casing: 16-in. from 0 to 447 ft, 10-in. from 386 to 450 ft. Screen: 10-in. from 450 to 494 ft. Drawdown 38 ft when pumped 24 hrs at 457 gpm in 1995.
Satsuma Water Works	1022	1	MOBS-3	117	1964	Acme Drilling	20	Tmp	22 7/1964	Casing: 12-in. from 0 to 90 ft, 8-in. from 50 to 90 ft. Screen: 6-in. from 90 to 115 ft. Drawdown 11.5 ft when pumped 3 hrs at 302 gpm in 1964.
Satsuma Water Works	1022	2	MOBS-08	127	1979	Acme Drilling	21	Qalt	10 1979	Casing: 14-in. from 0 to 95 ft. Screen: 8-in. from 94 to 125 ft. Drawdown 11 ft when pumped 12 hrs at 572 gpm in 1979.
Satsuma Water Works	1022	3	MOBS-4	124	1964	Acme Drilling	18	Qalt	20 7/1964	Casing: 12-in. from 0 to 99 ft, 8-in. from 58 to 98.5 ft. Screen: 6-in. from 98.5 to 128.5 ft. Drawdown 13.5 ft when pumped 3 hrs at 302 gpm in 1964.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Saraland Water Service	1021	1	MOBS-5	132	1963	Layne-Central Co.	34	Qalt	16 1964	Casing: 24-in. from 0 to 95 ft, 12-in. from 0 to 100 ft. Screen: 12-in. from 100 to 125 ft. Drawdown 19 ft when pumped 8 hrs at 500 gpm in 1964.
Saraland Water Service	1021	2	MOBV-1	148	1959	Layne-Central Co.	19	Qalt	17.1 8/1/67 15.26 4/21/86	Casing: 18-in. from 0 to 105 ft, 12-in. from 0 to 108 ft. Screen: 10-in. from 108 to 138 ft. Drawdown 38 ft when pumped 8 hrs at 632 gpm in 1959.
Saraland Water Service	1021	3	MOBS-015	126	1980	Layne-Central Co.	18	Qalt	8 7/15/80	Casing: 24-in. from 0 to 82 ft, 12-in. from 0 to 86 ft. Screen: 10-in. from 86 to 116 ft. Drawdown 62 ft when pumped 72 hrs at 650 gpm in 1980.
Kushla Water & Fire Protection District	993	1	MOBR-06	257	1976	Holland Well Co		Tmp		Casing: 10-in. from 0 to 227 ft. Screen: 6-in. from 227 to 257 ft. Drawdown 18 ft when pumped at 240 gpm in 1976.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Kushla Water & Fire Protection District	993	2	MOBR-02	540	1978	Holland Well Co	140	Tmp	66 1/26/78	Casing: 12-in. from 0 to 444 ft, 6-in. from 425 to 465 ft. Screen: 6-in. from 490 to 530 ft. Drawdown 29.5 ft when pumped 24 hrs at 605 gpm on Jan. 26, 1978.
Fairview Water & Fire Protection Authority	977	1	MOBX-9	442 (527)	1971	Carloss Well Supply Co.	228	Tmp	112 1/28/71	Casing: 10-in. from 0 to 390 ft, 6-in. from 328 to 397 ft. Screen: 6-in. from 397 to 437 ft. Drawdown 32 ft when pumped 8 hrs at 208 gpm on Jan. 28, 1971.
Fairview Water & Fire Protection Authority	977	2	MOBX-01	426	1978	Layne Central	208	Tmp	96 1978	Casing: 12-in. from 0 to 385 ft, 6-in. from 325 to 386 ft. Screen: 6-in. from 386 to 416 ft. Drawdown 68 ft when pumped 24 hrs at 510 gpm in 1978.
South Alabama Utilities/ Semmes	965	2	MOBQ-01	250 (380)	1983	Holland Well Company, Inc.	250	Tmp	59.0 2/4/83	Casing: 16-in. from 0 to 140 ft, 8-in. from 120 to 140 ft, 155 to 215 ft and 220 to 230 ft. Screen: 8-in. from 140 to 155 ft, 215 to 220 ft and 230 to 250 ft. Drawdown 49 ft when pumped 8 hrs at 510 gpm in 1983.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
South Alabama Utilities/ Semmes	965	3	MOBAA-07	470 (491)	1986	Layne-Central Co.	200	Tmp	163 1986	Casing: 20-in. from 0 to 414 ft, 12-in. from 370 to 420 ft. Screen: from 420 to 470 ft. Drawdown 35 ft when pumped 24 hrs at 751 gpm on Aug. 12, 1986.
South Alabama Utilities/ Semmes	965	5	MOBGG-03	484 (765)	1996	Griner Drilling Service, Inc.	185	Tmp	169 1996	Casing: 16-in. from 0 to 416 ft, 10-in. from 356 to 426 ft and 454 to 460 ft. Screen: 10-in. from 426 to 454 ft and 460 to 484 ft. Drawdown 47 ft when pumped 24 hrs at 752 gpm on 5/6/96.
South Alabama Utilities/ Semmes	965		MOBY-07	384 (507)	1998	Griner Drilling Service, Inc.	235	Tmp	139 5/14/98	Casing: 16-in. from 0 to 344 ft, 10-in. from 280 to 344 ft. Screen: 10-in. from 344 to 384 ft. Drawdown 147 ft when pumped 10 hrs at 750 gpm on 5/14/98.
Mobile County Water & Fire Protection Authority	1002	1	MOBFF-04	505	1960 deep ened 1986	Layne-Central Co. Graves Well Drilling	162	Tmp	166 4/24/86	Casing: 24-in. from 0 to 463 ft, 16-in. from 400 to 460 ft. Screen: 16-in. from 460 to 505 ft. Drawdown 166 ft when pumped 24 hrs at 900 gpm in 1986.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Mobile County Water & Fire Protection Authority	1002	2	MOBFF-4	480	1959	Layne-Central Co.	123	Tmp	91.34 6/19/67	Casing: 12-in. from 0 to 445 ft, 8-in. from 385 to 450 ft. Screen: 8-in. from 450 to 480 ft. Drawdown 35 ft when pumped 8 hrs at 470 gpm in 1960.
Mobile County Water & Fire Protection Authority	1002	3	MOBKK-05	493 (536)	1968	Layne-Central Co.	67	Tmp	31.31 6/26/67	Casing: 16-in. from 0 to 438 ft, 8-in. from 386 to 443 ft. Screen: 8-in. from 443 to 483 ft. Drawdown 15 ft when pumped 1 hr at 227 gpm in 1967.
Mobile County Water & Fire Protection Authority	1002	4	MOBKK-3	544 (714)	1968	Layne-Central Co.	87	Tmp	61.5 1967	Casing: 16-in. from 0 to 489 ft, 8-in. from 439 to 489 ft. Screen: 8-in. from 494 to 544 ft. Drawdown 24 ft when pumped 4 hrs at 302 gpm in 1967.
Mobile County Water & Fire Protection Authority	1002	5	MOBFF-05	330 (661)	1984	Layne-Central Co.	175	Tmp	105 1984	Casing: 16-in. from 0 to 225 ft, 8-in. from 175 to 230 ft and 250 to 285 ft. Screen: 8-in. from 230 to 250 ft and 285 to 320 ft. Drawdown 24 ft when pumped 8 hrs at 610 gpm on Jan. 17, 1984.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Mobile County Water & Fire Protection Authority	1002	6	MOBGG-04	570 (800)	1990	Layne-Central Co.	177	Tmp	167 1990	Casing: 20-in. from 0 to 455 ft, 10-in. from 395 to 460 ft and 520 to 535 ft. Screen: 10-in. from 460 to 520 and 535 to 560 ft. Drawdown 76 ft when pumped 24 hrs at 1,050 gpm in March 1990.
Mobile County Water & Fire Protection Authority	1002	7	MOBTT-01	390	1984	Holland Well Co., Inc.	5	Tmp	4 1984	Casing: 16-in. from 0 to 360 ft, 8-in. from 325 to 365 ft. Screen: 8-in. from 365 to 390 ft. Drawdown 56 ft when pumped 24 hrs at 300 gpm in 1984.
St. Elmo-Irvington Water System	1034	1	MOBJJ-01	143	1976	Holland Well Co., Inc.	115	Tmp	38 1977	Casing: 10-in. from 0 to 101 ft, 6-in. from 91 to 103 ft. Screen: 6-in. from 103 to 143 ft. Drawdown 31 ft when pumped 0.5 hr at 490 gpm in 1976.
St. Elmo-Irvington Water System	1034	2	MOBKK-01	266 (592)	1980	Powell Drilling Co.	75	Tmp	30 1981	Casing: 16-in. from 0 to 216 ft, 8-in. from 196 to 217 ft. Screen: 8-in. from 217 to 258 ft. Drawdown 10.8 ft when pumped 24 hrs at 495 gpm in 1980.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Grand Bay Water Works Board	983	1	MOBII-4	155	1964	Acme Drilling	102	Tmp	57 1964	Casing: 12-in. from 0 to 115 ft, 8-in. from 74 to 115 ft. Screen: 6-in. from 115 to 155 ft. Drawdown 13 ft when pumped 5 hrs at 406 gpm in 1964.
Grand Bay Water Works Board	983	2	MOBII-03	143	1974	Holland Well Co., Inc.	100	Tmp	38 1974	Casing: 10-in. from 0 to 103 ft. Screen: 8-in. from 103 to 143 ft. Drawdown 22 ft when pumped 8 hrs at 1,200 gpm in 1974.
Grand Bay Water Works Board	983	3	MOBJJ-08	170	1981	Powell Drilling Co.	125	Tmp	33 1981	Casing: 16-in. from 0 to 105 ft, 8-in. from 59 to 109 ft. Screen: 8-in. from 109 to 134 ft. Drawdown 34 ft when pumped 24 hrs at 307 gpm in 1981.
Bayou LaBatre Utilities	957	1	MOBOO-05	335	1980	Layne-Central Co.	75	Tmp	71 9/1/80	Casing: 24-in. from 0 to 280 ft, 16-in. from 220 to 285 ft. Screen: 16-in. from 285 to 325 ft. Drawdown 103 ft when pumped 3 hrs at 708 gpm in 1980.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Bayou LaBatre Utilities	957	2	MOBNN-02	379 (496)	1969	Layne-Central Co.	72	Tmp	48 9/14/67	Casing: 16-in. from 0 to 325 ft, 8-in. from 286 to 329 ft. Screen: 8-in. from 329 to 369 ft. Drawdown 64 ft when pumped 8 hrs at 500 gpm in 1969.
Dauphin Island Water & Sewer Board	971	1	MOBUU-2	305	1962	Layne-Central Co.	5.6	Tmp	4 1962	Casing: 16-in. from 0 to 230 ft, 8-in. from 180 to 235 ft and 250 to 285 ft. Screen: 8-in. from 235 to 250 ft and 285 to 295 ft. Drawdown 56 ft when pumped 24 hrs at 250 gpm in 1962.
Dauphin Island Water & Sewer Board	971	3	MOBUU-1	253 (333)	1967	Layne-Central Co.	6.5	Tmp	9 1967	Casing: 16-in. from 0 to 200 ft, 8-in. from 150 to 205 ft and 225 to 233 ft. Screen: 8-in. from 205 to 225 ft and 233 to 243 ft. Drawdown 46 ft when pumped 24 hrs at 201 gpm in 1967.
Dauphin Island Water & Sewer Board	971	4	MOBUU-01	30	1989	Donald Smith Co., Inc.	6	Qalt	8 1989	Casing: 24-in. from 0 to 17 ft, 12-in. from 0 to 18 ft. Screen: 12-in. from 18 to 28 ft. Drawdown 13 ft when pumped 24 hrs at 85 gpm in 1988.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Dauphin Island Water & Sewer Board	971	5	MOBUU-02	32.5	1989	Donald Smith Co., Inc	6	Qalt	6.5 1988	Casing: 20-in. from 0 to 19.5 ft, 12-in. from 0 to 20.5 ft. Screen: 12-in. from 20.5 to 30.5 ft. Drawdown 15 ft when pumped 48 hrs at 75 gpm in 1988.
Dauphin Island Water & Sewer Board	971	6	MOBUU-03	34.5	1988	Donald Smith Co., Inc	6	Qalt	5.8 1988	Casing: 20-in. from 0 to 21.5 ft, 12-in. from 0 to 22.5 ft. Screen: 12-in. from 22.5 to 32.5 ft. Drawdown 17.7 ft when pumped 48 hrs at 44 gpm in 1988.
Dauphin Island Water & Sewer Board	971	7	MOBUU-04	33	1988	Donald Smith Co., Inc	7	Qalt	6 1988	Casing: 20-in. from 0 to 20 ft, 12-in. from 0 to 21 ft. Screen: 12-in. from 21 to 31 ft. Drawdown 16 ft when pumped 48 hrs at 63 gpm in 1988.
Dauphin Island Water & Sewer Board	971	8	MOBUU-05	40	1992	Griner Drilling Service, Inc.	7	Qalt	7.22 1992	Casing: 24-in. from 0 to 22.65 ft, 12-in. from 0 to 23.65 ft. Screen: 12-in. from 23.65 to 33.65 ft. Drawdown 8.68 ft when pumped 24 hrs at 55 gpm in 1992.

EXPLANATION

Table 3.--Records of public water-supply wells in Area 13–Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level Date measured	Well construction, yield, remarks
Dauphin Island Water & Sewer Board	971	9	MOBUU-06	40	1992	Griner Drilling Service, Inc	7	Qalt	6.50 1992	Casing: 24-in. from 0 to 23.75 ft, 12-in. from 0 to 24.75 ft. Screen: 12-in. from 24.75 to 34.75 ft. Drawdown 6.30 ft when pumped 24 hrs at 55 gpm in 1992.
Dauphin Island Water & Sewer Board	971	10	MOBUU-07	40	1992	Griner Drilling Service, Inc	7	Qalt	6.75 1992	Casing: 24-in. from 0 to 25.10 ft, 12-in. from 0 to 26.10 ft. Screen: 12-in. from 26.10 to 36.10 ft. Drawdown 10.88 ft when pumped 24 hrs at 55 gpm in 1992.
Dauphin Island Water & Sewer Board	971	11	MOBUU-08	40	1992	Griner Drilling Service, Inc	8	Qalt	6.15 1992	Casing: 24-in. from 0 to 25.65 ft, 12-in. from 0 to 26.65 ft. Screen: 12-in. from 26.65 to 36.65 ft. Drawdown 10.83 ft when pumped 24 hrs at 55 gpm in 1992.

EXPLANATION

RELATED LINKS

http://www.adem.state.al.us/
Alabama Department of Environmental Management (ADEM)
ADEM administers all major federal environmental laws, including the Clean Air, Clean Water and Safe Drinking Water acts and federal solid and hazardous waste laws. Information regarding ADEM news, regulations, funded programs, and status of filings are available on this site.

http://www.epa.gov/OW
United States Environmental Protection Agency (EPA)
This is the home page of the EPA Office of Water. Information includes America's water resources, environmental programs and partnerships, monitoring, data, and tools, you and clean water, regulations and legislation, information resources, etc. Pages for EPA Water are maintained as well: Wetlands, Oceans, and Watersheds, Science and Technology, Wastewater Management, Groundwater and Drinking Water, etc. The various regional programs are also covered as well as EMAP Estuaries.

http://www.ga.nrcs.usda.gov/al/
United States Department of Agriculture (USDA)
The Natural Resources Conservation Service (NRCS) is the USDA agency that works at the local level to help people conserve all natural resources on private lands. USDA provides soil information and other agricultural information, including maps of soil types.

http://www.ngwa.org/
National Ground Water Association (NGWA)
NGWA operates the National Ground Water Information Center ®, the largest non-governmental clearinghouse on ground water science and well technology in the world, with more than 40,000 volumes. Ground Water On-Line ®, a nearly 80,000 citation bibliographic database of ground water literature is available at no cost to NGWA members. A database of standards, guidelines, criteria, practices and procedures is also available at the Web site.

http://www.gsa.state.al.us
Geological Survey of Alabama (GSA)
The Geological Survey of Alabama, established in 1848, is a data gathering and research agency that explores and evaluates the mineral, water, energy, biological, and other natural resources of the State of Alabama and conducts basic and applied research in these fields as a public service to citizens of the State.

http://water.usgs.gov/
United States Geological Survey (USGS)
This site is the http server Water Division home page. It contains links to information from the water, geologic, and mapping divisions. USGS fact sheets, information releases, publications, data products, etc. are available. Information on GIS and the National Spatial Data Infrastructure is also included. Contact information for USGS resources (maps, etc.) Is given as well as the USGS telephone book. Links to other USGS sites on-line are available.

http://www.uwin.siu.edu:80/dir_search/index.html
Universities Water Information Network (UWIN)
UWIN maintains several databases for providing water information. Over 100 different water related links are listed by categories.

http://gwpc.site.net/
Ground Water Protection Council (GWPC)
The Ground Water Protection Council is a nonprofit (501(c)3) organization whose members consist of state and federal ground water agencies, industry representatives, environmentalists and concerned citizens, all of whom come together within the GWPC organization to mutually work toward the protection of the nation's ground water supplies.

http://www.gwrtac.org
Ground-Water Remediation Technologies Analysis Center (GWRTAC)
The Ground-Water Remediation Technologies Analysis Center compiles, analyzes, and disseminates information on innovative ground-water remediation technologies. GWRTAC prepares reports by technical teams selectively chosen from Concurrent Technologies Corporation (CTC), the University of Pittsburgh, and other supporting institutions, and also maintains an active outreach program.

http://www.fws.gov/
U.S. Fish & Wildlife Service (FWS)
This site has general information, news releases, and employment information for the Fish and Wildlife Services. Pages on FWS activities such as Conservation Programs, Endangered Species, Contaminants, Federal Aid to States, Fire Management, Fisheries, Migratory Birds and Waterfowl, National Wildlife Refuge System, Wetlands, Wildlife Law, and Wildlife Species are included. Pages for the various FWS Regions are also incorporated.

http://hermes.ecn.purdue.edu:8001/server/water/water.html
National Extension Water Quality Database
This site allows for searches in a database that has 2,500 abstracts and 1,500 documents on all aspects of water quality. The documents are full text and list available contacts. Also available are Quick Time Movies.

http://www.TheHydrogeologist.com/
This page is a collection of hundreds of links to hydrogeological organizations, software and data repositories, publications, and other resources of potential use to hydrogeologists.

http://www.nws.noaa.gov/oh/

The Office of Hydrology serves as a primary link between the National Weather Service Headquarters and the hydrologic field service programs. Activities include development of hydrologic models, hydrologic data for rivers and flood forecasts, warnings, and water supply forecasts. Current and Historical Data include floods, hydrologic conditions, and water supply outlooks. Data systems available online are HADS (a real time hydrological and meteorological data acquisition and distribution system) and INFLOWS (Integrated Flood Observing and Warning System). Full text handbooks, reports, and user manuals are available. Information on forecast systems are also available.

Published by

GEOLOGICAL SURVEY OF ALABAMA

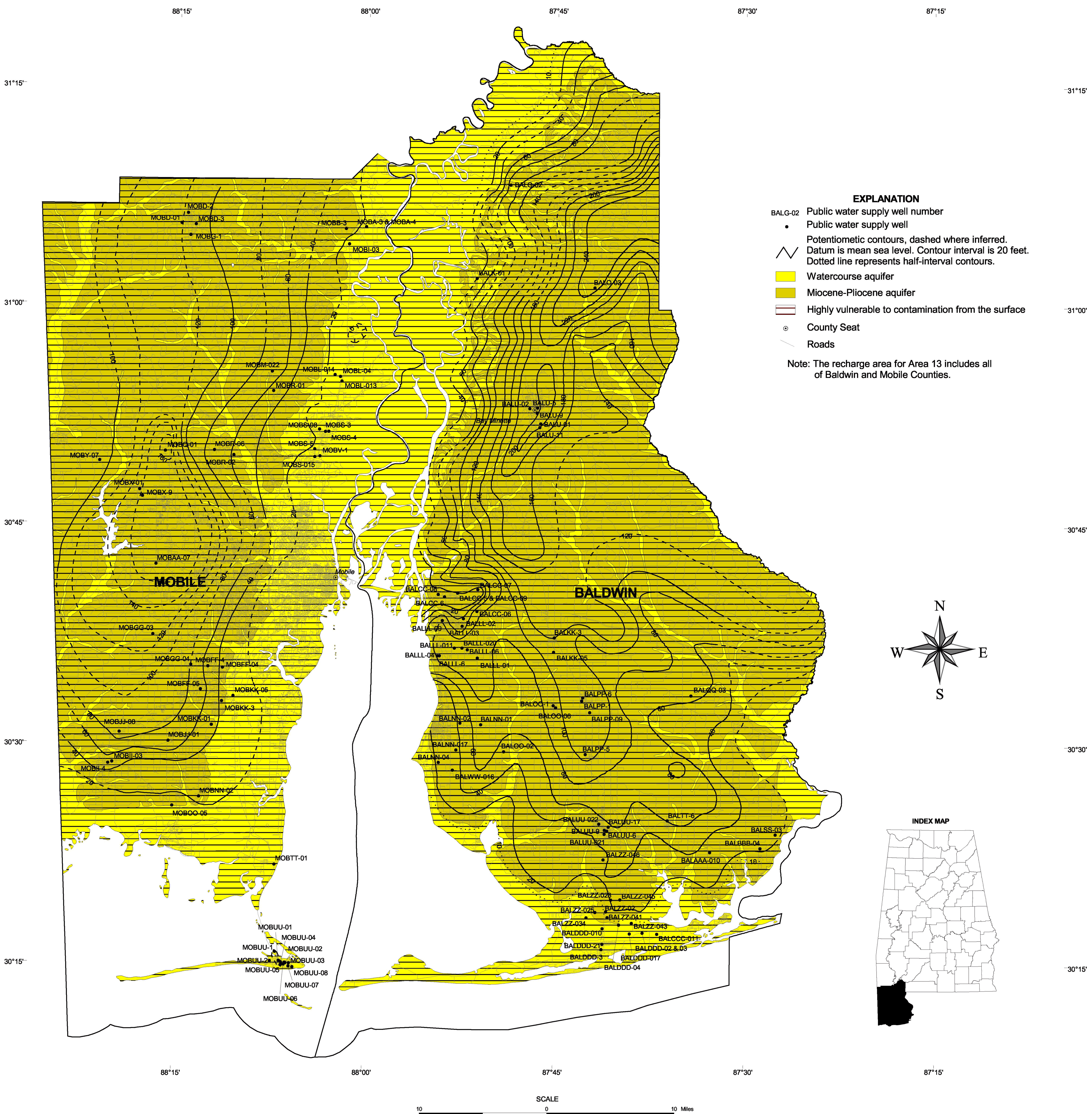
Serving Alabama since 1848

Donald F. Oltz, State Geologist

For additional copies write:
Publication Sales Office
P.O. Box 869999
Tuscaloosa, Alabama 35486-6999

Telephone 205/349-2852

A complete list of Geological Survey of Alabama and Oil and Gas Board publications can be obtained at the Publication Sales Office or through our web page at http://www.gsa.state.al.us/



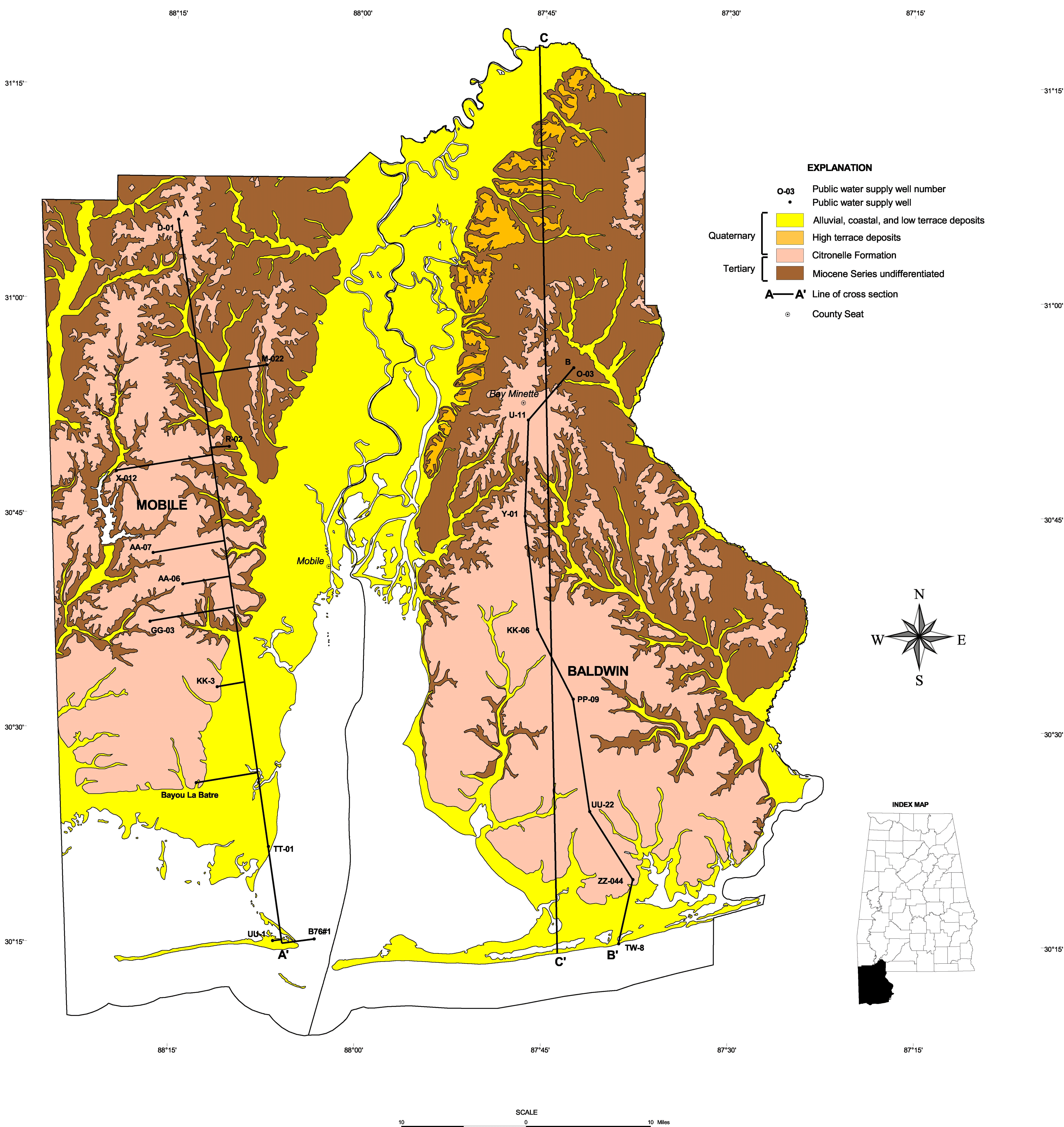
AQUIFER RECHARGE AREAS, AREA OF VULNERABILITY, POTENTIOMETRIC SURFACE OF MAJOR AQUIFERS, AND LOCATIONS OF PUBLIC WATER SUPPLY WELLS IN AREA 13

By Blakeney Gillett and Dorothy E. Raymond
(modified in part from Robinson and others, 1996)

2000

STATE OF ALABAMA
GEOLOGICAL SURVEY
DONALD F. OLTZ
State Geologist

GIS by Douglas R. Taylor and Ruth T. Collier



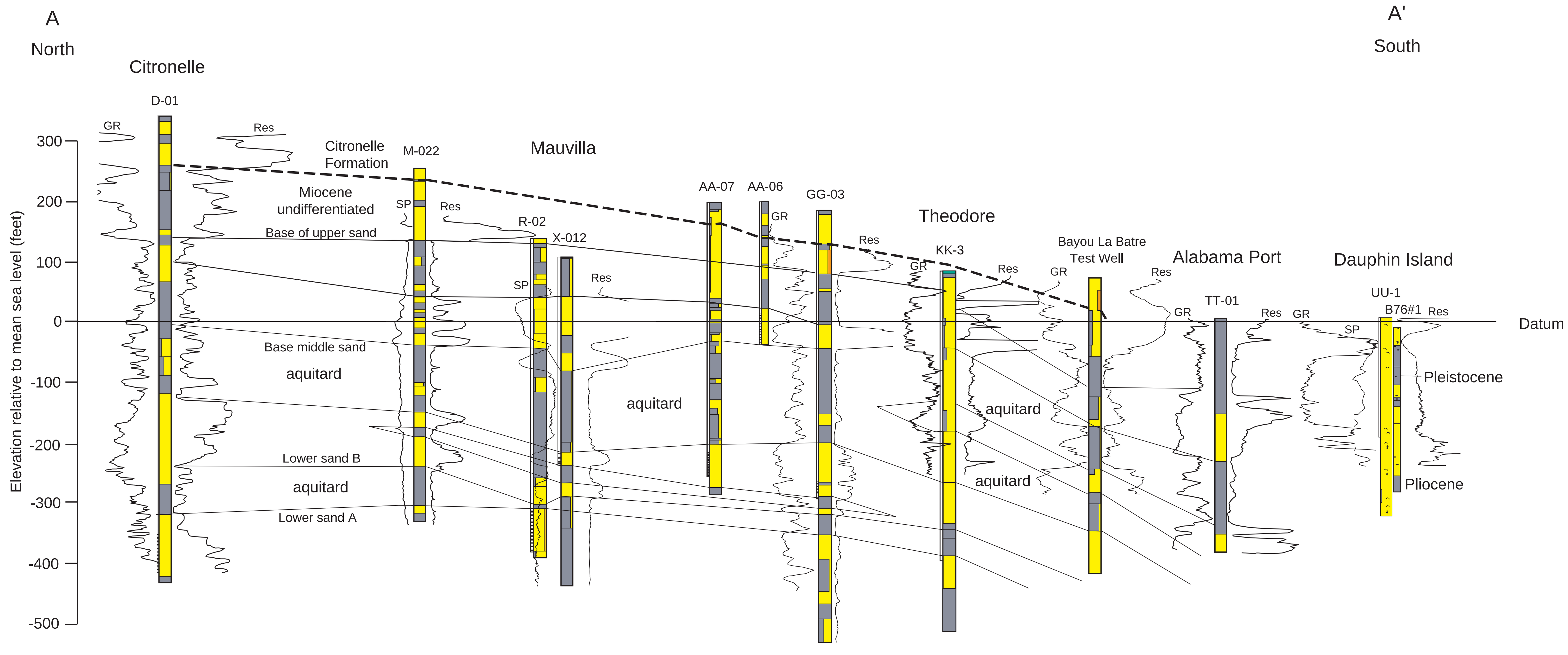
GEOLOGY AND LOCATIONS OF GEOLOGIC CROSS SECTIONS IN AREA 13

Geology from Szabo and Copeland (1988)

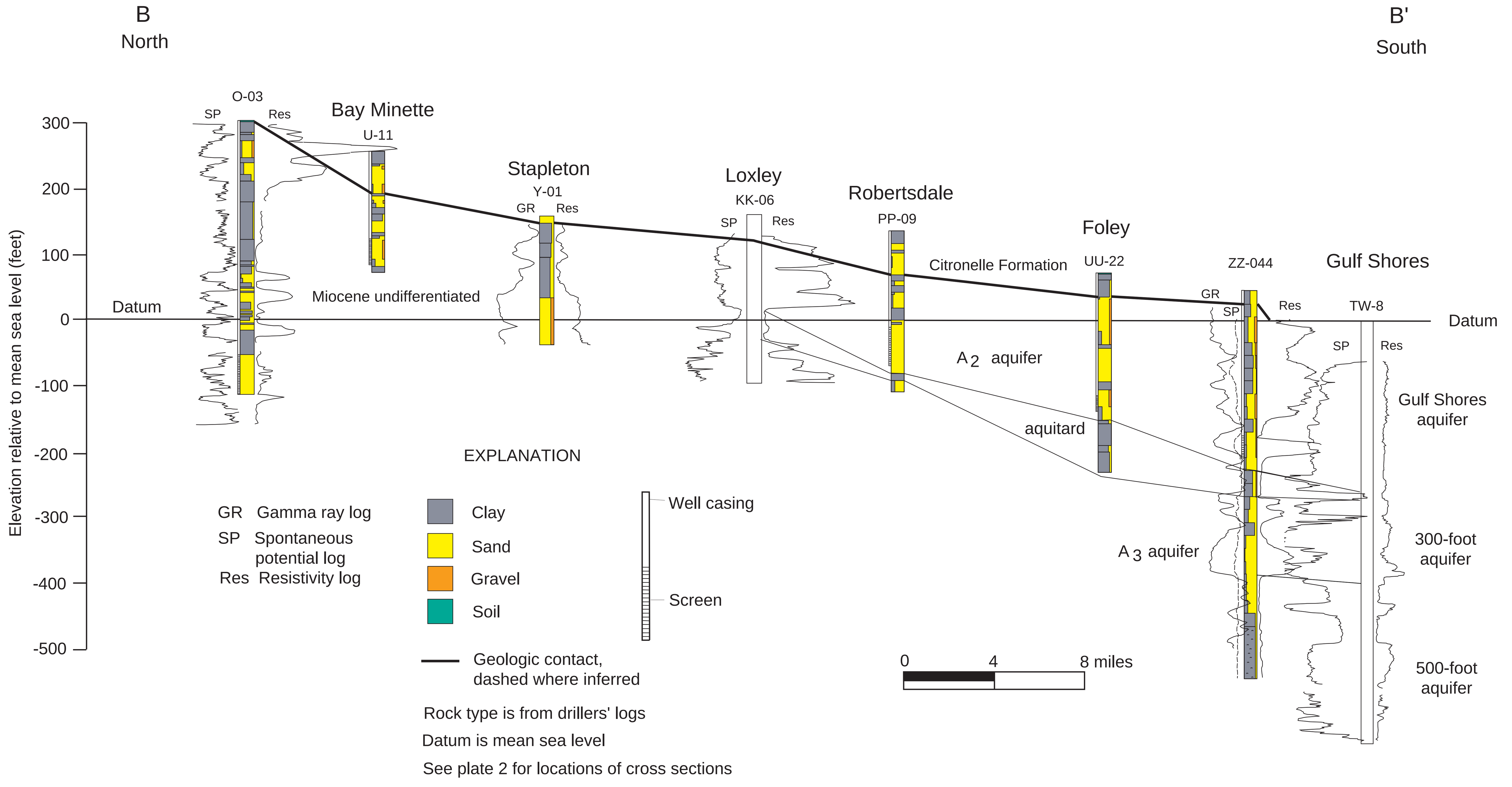
2000

STATE OF ALABAMA
GEOLOGICAL SURVEY
DONALD F. OLTZ
State Geologist

GIS by Douglas R. Taylor and Ruth T. Collier



Hydrogeologic Cross Section of Mobile County, Alabama

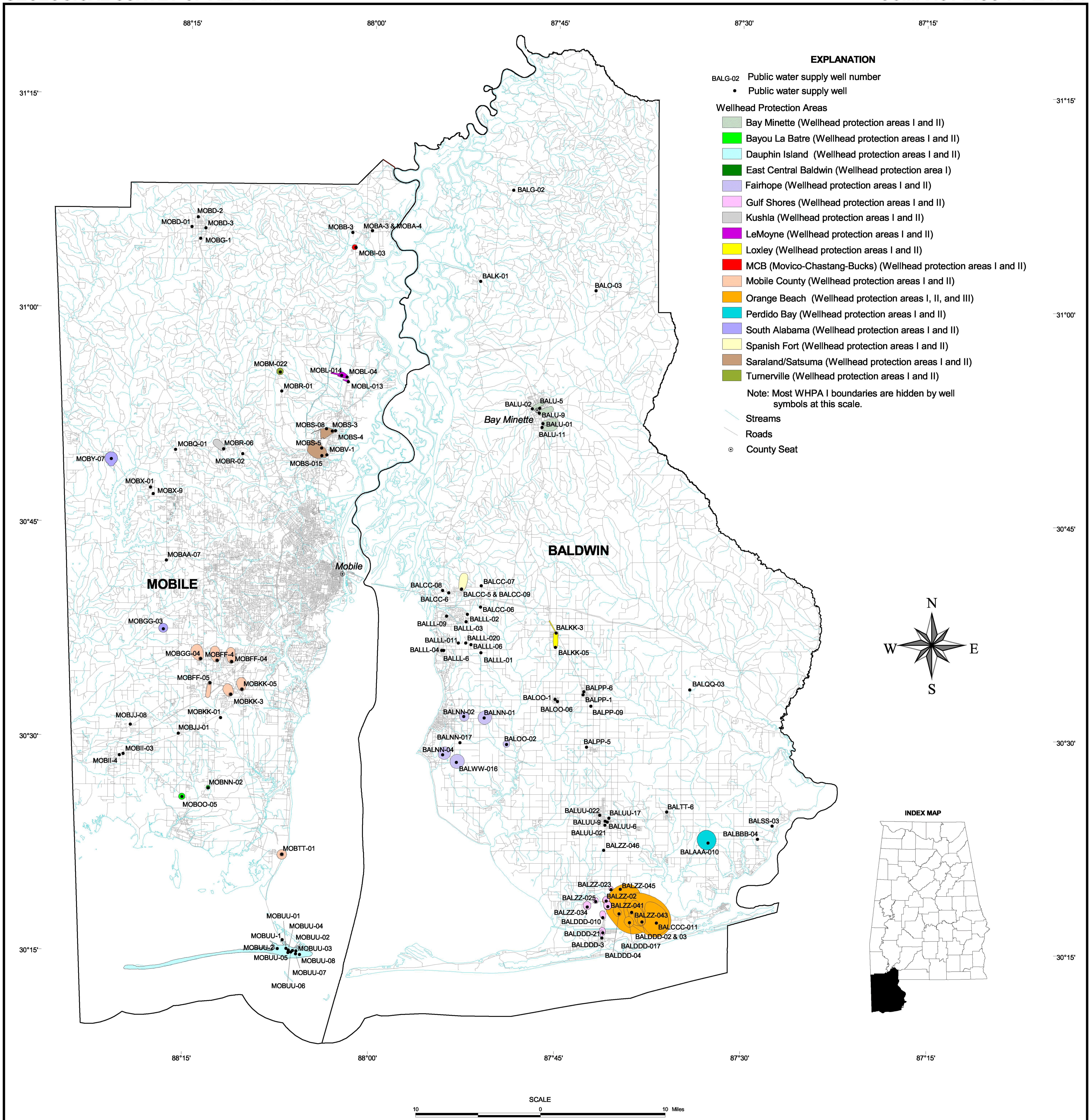


Hydrogeologic Cross Section of Baldwin County, Alabama

HYDROGEOLOGIC CROSS SECTIONS OF THE MIOCENE-PLIOCENE AQUIFER FOR BALDWIN AND MOBILE COUNTIES, ALABAMA

By
Dorothy E. Raymond and Blakeney Gillett
2000

STATE OF ALABAMA
GEOLOGICAL SURVEY
Donald F. Oltz
State Geologist



LOCATIONS OF PUBLIC WATER SUPPLY WELLS AND WELLHEAD PROTECTION AREAS DELINEATED IN AREA 13

By Blakeney Gillett

2000

STATE OF ALABAMA
GEOLOGICAL SURVEY
DONALD F. OLTZ
State Geologist

GIS by Ruth T. Collier