STATE OF MISSISSIPPI

GROUND WATER QUALITY ASSESSMENT

April 2015

Pursuant to Section 305(b) of the

Clean Water Act

Prepared by the

Mississippi Department of Environmental Quality

Office of Land and Water Resources

P. O. Box 2309

Jackson, Mississippi 39225

TABLE OF CONTENTS

INTRODUCTION

Section 106(e) of the Clean Water Act requires that each state monitor the quality of its surface and groundwater resources and report the status to Congress every two years in its State 305(b) Report. This section of the 305(b) Report addresses the groundwater quality in Mississippi. Groundwater resources provide over 90% of Mississippi's drinking water supply (MSU Coop Ext. Jason Barrett 2015). The 1,213 public water systems operating in the state use 3,892 wells and four surface water intakes. Because of this reliance on groundwater, the State has a vested interest in its protection as evidenced in this report.

Over the years, the Environmental Protection Agency (EPA) has revised the reporting requirements associated with the groundwater section of the 305(b) Report. These changes signaled an attempt by the EPA to not only address relevant groundwater issues of concern or interest but also to obtain aquifer-specific data that can be used for comparison sake. There are 16 major aquifers and numerous minor aquifers distributed throughout Mississippi. Unfortunately, this large number of aquifers makes providing aquifer-specific data in the report cumbersome.

The overall quality of the groundwater resources in Mississippi remains very good. Natural coloration associated with certain aquifers is the most notable groundwater quality issue in the state. Extensive contamination of aquifers in the state or incidents of public water systems being impacted by groundwater contamination are uncommon. The sporadic "boil water" notices periodically issued in the state are usually the result of system maintenance issues or unforeseen natural disasters. Another issue is the relatively large number of small rural water associations operating in the state that are often plagued with compliance issues.

ASSESSMENT OF GROUNDWATER QUALITY

EPA guidelines for the 305(b) Report encourage the use of the best available data in reflecting the quality of the groundwater resources. To provide as accurate and representative assessment of the groundwater quality in Mississippi as possible, the information in this report contains data compiled from the Mississippi Department of Environmental Quality (MDEQ), the Mississippi State Department of Health (MSDH), and the U. S. Geological Survey (USGS).

Groundwater Quality Standards

In November 1991, MDEQ adopted groundwater quality standards equivalent to the EPA established drinking water standards or Maximum Contaminant Levels (MCLs). These standards apply to all of the groundwater in Mississippi that meets the EPA's definition of underground sources of drinking water (USDW), which is defined as water that "contains fewer than 10,000 mg/l total dissolved solids." However, the State standard did allow for an exemption of certain water-bearing geologic units capable of yielding only extremely low volumes of water.

The standards also establish a procedure to calculate groundwater quality standards for types of constituents that may not be included on the EPA list of MCLs.

Mississippi Agricultural Chemical Groundwater Monitoring Program

The Mississippi Agricultural Chemical Groundwater Monitoring (AgChem) Program was initiated in March 1989 for the purpose of determining if the use of agricultural chemicals is impacting groundwater quality in Mississippi. Thus far, the sampling of over 2,042 wells (Figure 1) throughout the state does not indicate any significant impacts directly attributable to agricultural practices.

During 2014, the AgChem Program collected samples from a total of 46 wells across the state, including 23 private water wells and 23 large-capacity irrigation and fish culture wells located in the Mississippi Delta.

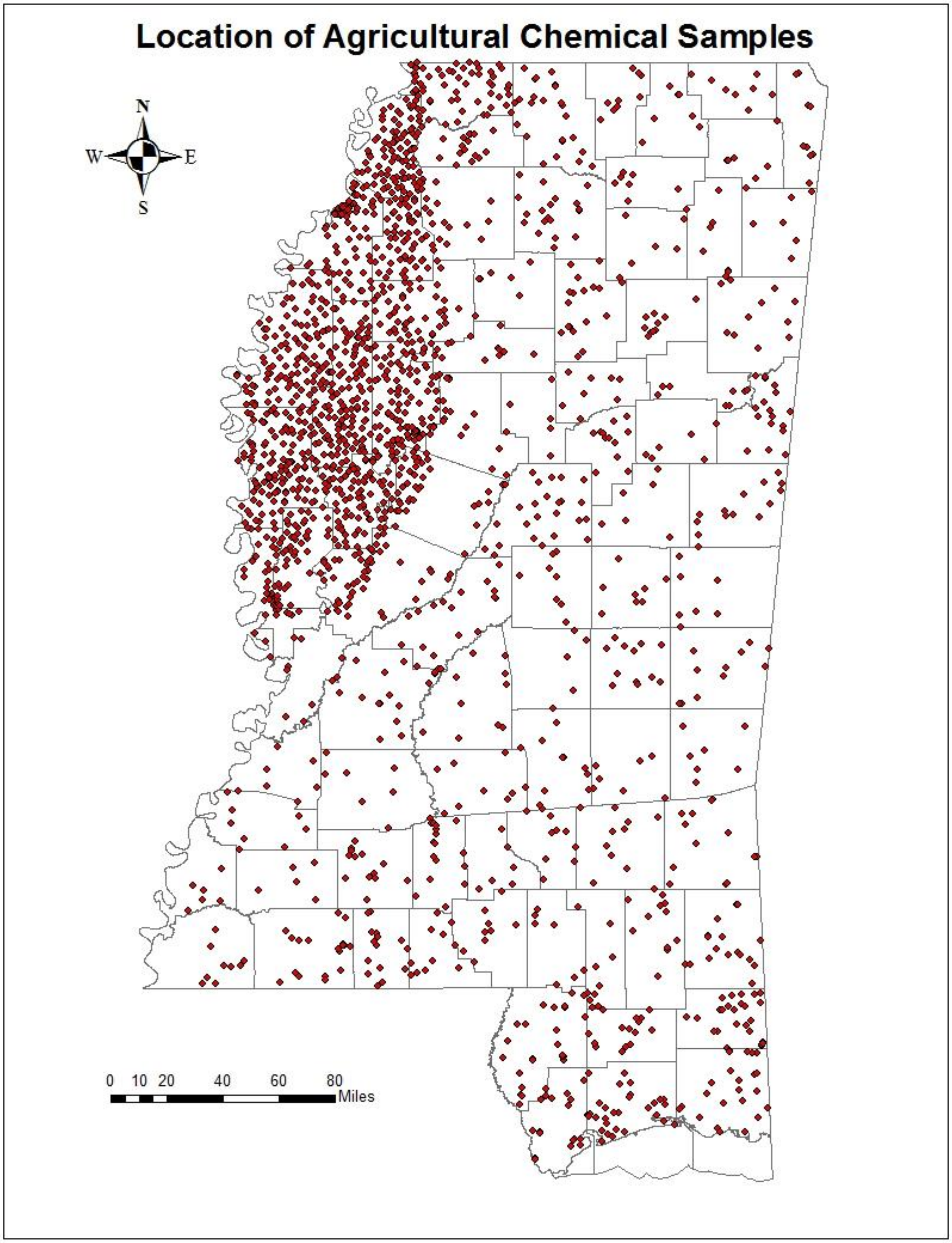

Location of Agricultural Chemical Samples
N
W
E
S
0 10 20 40 60 80
Miles

Figure 1

U. S. Geological Survey

The USGS has sampled water wells in Mississippi since the early 1900's. Most of the USGS sampling has involved analysis of inorganic parameters to characterize the basic types of groundwater found in the various aquifers across the state. These sampling efforts helped establish that most of the groundwater in Mississippi can be characterized as a soft sodium or calcium bicarbonate type. Although the USGS has been involved in previous surface water investigations to identify pesticides in surface water bodies in the state, the agency has not actively pursued similar groundwater studies until fairly recently.

National Water Quality Assessment (NAWQA) Program – Congressional funding in the late 1980s enabled the USGS to initiate the NAWQA Program, designed to investigate the status and trends of the water quality in the streams, rivers, and groundwater supplies found throughout the nation. After dividing the country into 60 study areas or units, the USGS began phasing in this project in 1991. Initially, 15 NAWQA study units across the nation were designated for investigation by the USGS, including one that encompassed parts of six states in the Mississippi Embayment. A significant area of northern Mississippi was contained in this investigation, including the Mississippi Delta region, the preeminent agricultural area in the state. The study involved the sampling of 14 wells pumping from the shallow MRVA, widely used for irrigation and fish culture in the Delta, or various deeper Tertiary aquifers that provide drinking-water supply throughout northern Mississippi. The results reported by the USGS indicate no exceedances of MCLs on any samples obtained from the Tertiary aquifers in the state. The study also concluded that even the shallow alluvial aquifer underlying the Mississippi Delta had not been adversely impacted by the application of significant amounts of pesticides in the region. The reported results from the Mississippi Embayment study closely mimic those reported for MDEQ's AgChem Program. Cycle II of the NAWQA program began in 2001 and focuses on regional assessments of water-quality conditions and trends.

During Cycle II, three new groundwater investigations began in Mississippi. Three sites were established in the Mississippi Delta region to investigate the fate and transport of agricultural chemicals in surface and groundwater. Two wells were sampled in northwestern Bolivar County in an area used for corn and cotton production. A groundwater infiltration study was conducted in a soybean field in Bolivar County, and a groundwater/surface-water interaction study was conducted in northeastern Washington County adjacent to the Bogue Phalia at US Highway 82.

A 30-well network was established over the coastal portions of MS, AL, and FL to monitor the quality of water in domestic supply wells screened in aquifers of the Coastal Lowlands aquifer system. Sixteen of the sampled wells were located in Hancock, Pearl River, Lamar, Stone, Harrison, Jackson, George, and Perry Counties.

A 30-well network was established in MS and TN to investigate the quality of water in the out-crop areas of the middle Claiborne aquifer. Thirteen wells used for drinking water were sampled in the Sparta aquifer in MS.

The 60 designated study units in the NAWQA investigation cover other parts of Mississippi as well. The ongoing Acadian-Pontchartrain investigation is centered primarily in Louisiana but covers parts of five counties in southwestern Mississippi. Another study underway focuses on the Mobile River Basin and encompasses a large area along the eastern side of the state associated with the Tombigbee River Basin. Seven wells in Mississippi are scheduled for sampling during the Mobile River Basin investigation. Reports on the two studies are available online at pubs.er.usgs.gov.

During Cycle III, several new public supply well networks will be sampled in Mississippi as part of a Principal Aquifer Survey (PAS) Study, a new groundwater quality study designed to assess the quality of groundwater used for public supply. The goal of these new networks is to provide nationally consistent data and information on the quality of the Nation's water. Studies such as this provide information on current water-quality conditions, a baseline for trend evaluation, and an understanding of what factors affect water quality. To date, three Principal Aquifers have been sampled in MS, the Coastal Lowlands and Southeastern Coastal Plain in FY 2013 and the Mississippi Embayment in FY 2014. Well selection was determined using an equal area grid and random well selection process. The focus of this study is on the quality of raw water. Results of the sampling will be will be made publicly available through USGS databases and publications. Owner information and specific well locations are not released to the public. This is not compliance sampling; however well owners will be informed of concentrations exceeding Maximum Contaminant Levels (MCLs). Although many of the constituents sampled do not have MCLs, this information may help to better understand the occurrence of natural and (or) human-related constituents in public supply wells screened within the aquifer systems. In addition, samples will be evaluated for the age of groundwater from your supply well. This information has proven valuable to other purveyors for understanding the groundwater system from which they withdraw supplies. The constituents to be analyzed in each well are listed below (table 1).

Table 1. Constituents that are being sampled as part of the Principal Aquifer Survey Networks

Field Measurements	*Dissolved Oxygen, pH, Specific conductance, temperature, alkalinity, turbidity and water levels*
Basic Suite	*Major Inorganics, Nutrients, Dissolved organic carbon, Trace Elements*
Pesticides	*(200+)Pesticides and metabolites*

VOCs	*(90+) Volatile organic compounds*
Pharmaceuticals	*Human Health Pharmaceuticals, Hormones*
Radionuclides	*Radon, Radium isotopes (224, 226, 228), Polonium-210, Lead-210, Gross alpha and beta*
Microbial Indicators	*Total coliform, E. coli bacteria, Enterococci bacteria, Somatic and F-specific coliphage*
Age-Dating	*Tritium, Helium, SF6, Dissolved Gases,14C and 13C, Oxygen & Deuterium stable isotope ratios*

Mississippi State Department of Health

The Safe Drinking Water Act (SDWA) allows States to seek EPA approval or primacy to administer their own Public Water System Supervision (PWSS) Programs, often referred to as the drinking water program. To receive program primacy, the EPA must determine that a State meets certain requirements laid out in the SDWA and complementary regulations. Some of these requirements include the adoption of State drinking water regulations that are at least as stringent as the Federal regulations and a demonstration that a State can enforce the program requirements. Mississippi assumed administration of its PWSS Program in 1974 when the Mississippi State Department of Health's (MSDH) Bureau of Public Water Supply became the primacy agency. This agency is responsible for ensuring that safe drinking water is provided to the 96% of the state's population who rely on the 1,213 public water systems (PWSs) and their corresponding 3,892 wells operating in Mississippi (Figures II and III).

The EPA also regulates the frequency with which PWSs monitor their water supply for contaminants and report the corresponding analytical results. PWSs are required to monitor and verify that the levels of contaminants present in their drinking water supply do not exceed established MCLs. In Mississippi, most PWSs submit all of their samples to the MSDH for analysis at the state laboratory. The laboratory annually processes and analyzes over 50,000 water samples submitted for microbiological analysis as well as hundreds of samples for lead and copper, nitrate/nitrite, various inorganic constituents, volatile organic compounds (VOCs), total trihalomethanes (TTHMs), haloacetic acids, and bromates. The overall compliance rate of PWSs

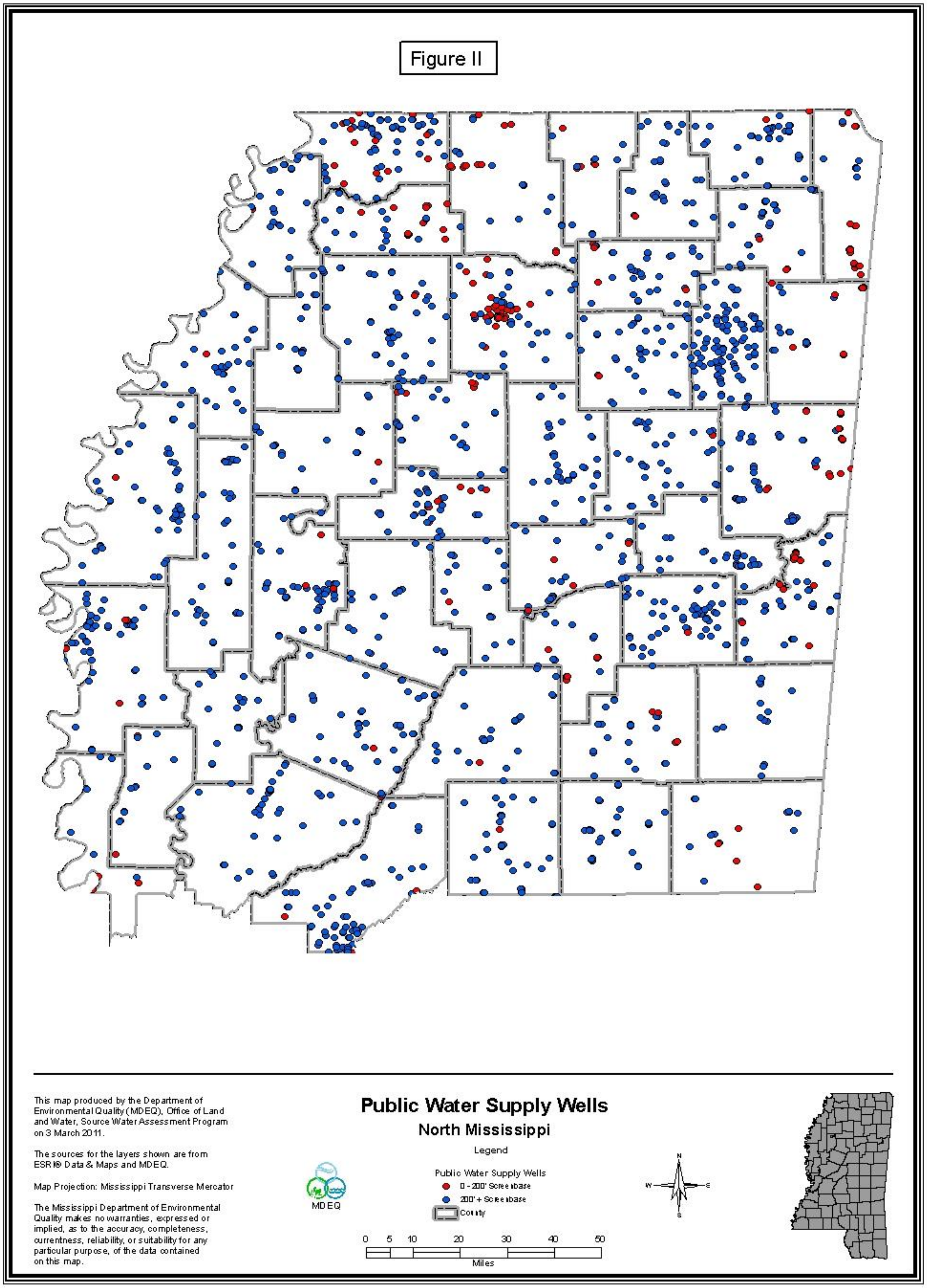


Figure II
Public Water Supply Wells
North Mississippi
Legend
Public Water Supply Wells
0 - 200' Screenbase
200' + Screenbase
County
0 5 10 20 30 40 50
Miles
MDEQ
N
W
E
S
This map produced by the Department of Environmental Quality (MDEQ), Office of Land and Water, Source Water Assessment Program on 3 March 2011.
The sources for the layers shown are from ESRI® Data & Maps and MDEQ.
Map Projection: Mississippi Transverse Mercator
The Mississippi Department of Environmental Quality makes no warranties, expressed or implied, as to the accuracy, completeness, currentness, reliability, or suitability for any particular purpose, of the data contained on this map.

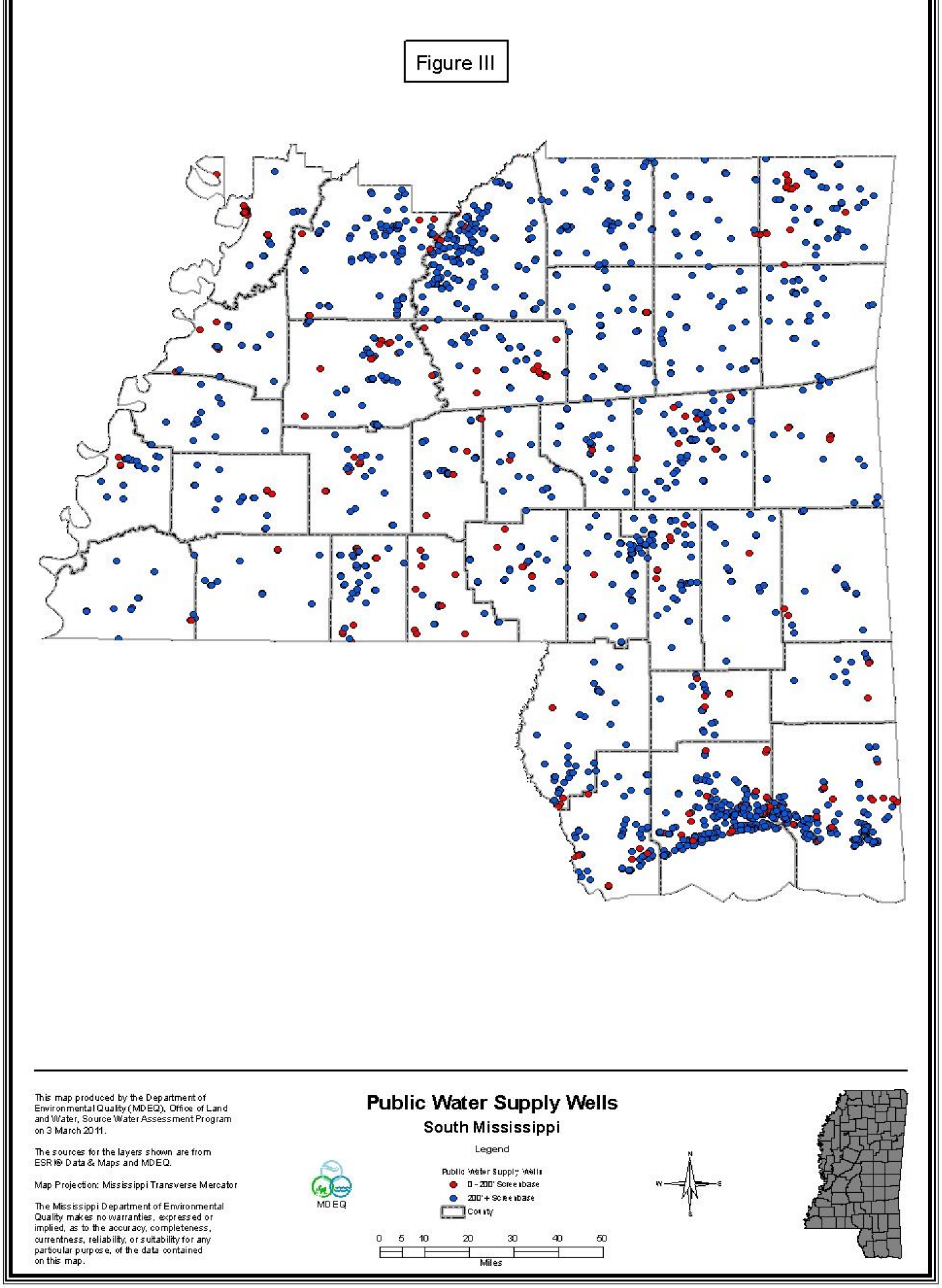


Figure III
Public Water Supply Wells
South Mississippi
This map produced by the Department of Environmental Quality (MDEQ), Office of Land and Water, Source Water Assessment Program on 3 March 2011.
The sources for the layers shown are from ESRI® Data & Maps and MDEQ.
Map Projection: Mississippi Transverse Mercator
The Mississippi Department of Environmental Quality makes no warranties, expressed or implied, as to the accuracy, completeness, currentness, reliability, or suitability for any particular purpose, of the data contained on this map.
MDEQ
Legend
Public Water Supply Wells
0 - 200' Screenbase
200' + Screenbase
County
0 5 10 20 30 40 50
Miles
N
W
E
S

in Mississippi is generally very high because of the predominant use of confined aquifers for drinking water supplies. Most of the PWSs have been granted a waiver from monitoring for the synthetic organic compounds (pesticides) based on previous studies, vulnerability assessments, and chemical use data.

Primacy States are required to submit data quarterly to the EPA via the Safe Drinking Water Information System (SDWIS), an automated database maintained by the Federal agency. Some of the data submitted include PWS inventory information, monitoring/compliance information, and enforcement activity related to any system violations. The SDWA also requires States to provide the EPA with an annual report detailing violations of established MCLs by operating PWSs.

The 1996 Amendments to the SDWA require that every community water system provide its customers with a brief annual water quality report. A system's Consumer Confidence Report (CCR) should explain the nature of any violation, its potential health effects, and the steps being taken to correct the violation. The CCRs often include educational material and also provide information related to the Source Water Assessment Program.

Summary of Groundwater Quality

The information included in Table I summarizes the groundwater quality data compiled by the MDEQ. The reporting period for the MDEQ data is 1990 through 2014. The reported parameters include those specifically requested by the EPA for the 305(b) Report. The only MCL violation for a public water system was for thallium and it is being monitored quarterly.

Table I. MDEQ Analytical Results

Aquifer	# Wells Sampled	NO3 0-5 mg/l	NO3 5-10 mg/l	NO3 >10 mg/l	VOCs >MCL	SOCs >MCL
Miss. River alluvium	1020	1019	1	0	0	0
Citronelle	104	101	2	1	0	0
Miocene	224	118	4	2	0	0
Oligocene	17	14	3	0	0	0
Cockfield	52	50	1	1	0	0
Sparta	108	108	0	0	0	0

Winona-Tallahatta	34	34	0	0	0	0
Meridian-Upper Wilcox	54	54	0	0	0	0
Wilcox	79	79	0	0	0	0
Ripley	25	25	0	0	0	0
Coffee Sand	9	9	0	0	0	0
Eutaw-McShan	49	47	2	0	0	0
Gordo	20	20	0	0	0	0
Coker	0	0	0	0	0	0
Paleozoic	5	5	0	0	0	0

GROUNDWATER CONTAMINATION IN MISSISSIPPI

The aquifers used for drinking water supply in Mississippi generally are confined to some extent by layers of clay that prevent widespread instances of groundwater contamination. Most of the documented cases of groundwater contamination in Mississippi have involved shallow unconfined aquifers that remain widely used in some areas of the state as domestic drinking water sources.

Potential Sources of Contamination

The primary sources of groundwater contamination in Mississippi typically can be traced to leaking underground storage tanks (USTs) holding petroleum-based products and faulty septic systems. Another problem of note in areas of the state where petroleum exploration and production have been prevalent is localized brine (saltwater) contamination of shallow aquifers. Many of the past problems associated with the oil and gas industry have been corrected with the adoption of more stringent state regulations. Groundwater contamination involving hazardous waste has been detected at various commercial and industrial facilities across the state as well. These facilities often cover such relatively large tracts of land that the associated contamination plumes are contained within their property boundaries. Table II lists the major sources of groundwater contamination and also other perceived sources of contamination in Mississippi. The location of selected potential contaminant sources, Brownfields sites, and groundwater remediation sites involving the Comprehensive Environmental Response and Compensation, and Liability Act (CERCLA) Program are identified in Figures IV and V.

Table II. Major Sources of Ground Water Contamination

Contaminant Source	Ten Highest Priority Sources	Factors Considered in Selecting a Contaminant Source	Contaminants
Agricultural Activities			
Agricultural chemical facilities			
Animal feedlots			
Drainage wells			
Fertilizer applications	X		Nitrates
Irrigation practices			
Pesticide applications	X		Various pesticides
Storage and Treatment Activities			
Land application			
Material stockpiles			
Storage tanks (above ground)	X		Petroleum products
Storage tanks (underground)	X		Petroleum products
Surface impoundments			
Waste piles			
Waste tailings			
Disposal Activities			
Deep injection wells			
Landfills	X		Various constituents
Septic systems	X		Nitrates, pathogens
Shallow injection wells			
Other			
Hazardous waste generators	X		Various constituents
Hazardous waste sites	X		Various constituents
Industrial facilities	X		Various constituents
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines			
Salt storage and road salting			
Salt water intrusion			
Spills			
Transportation of materials			
Urban runoff			
Oil and Gas Production Exploration/Production sources (please specify)	X		Chlorides
Other sources (please specify)			

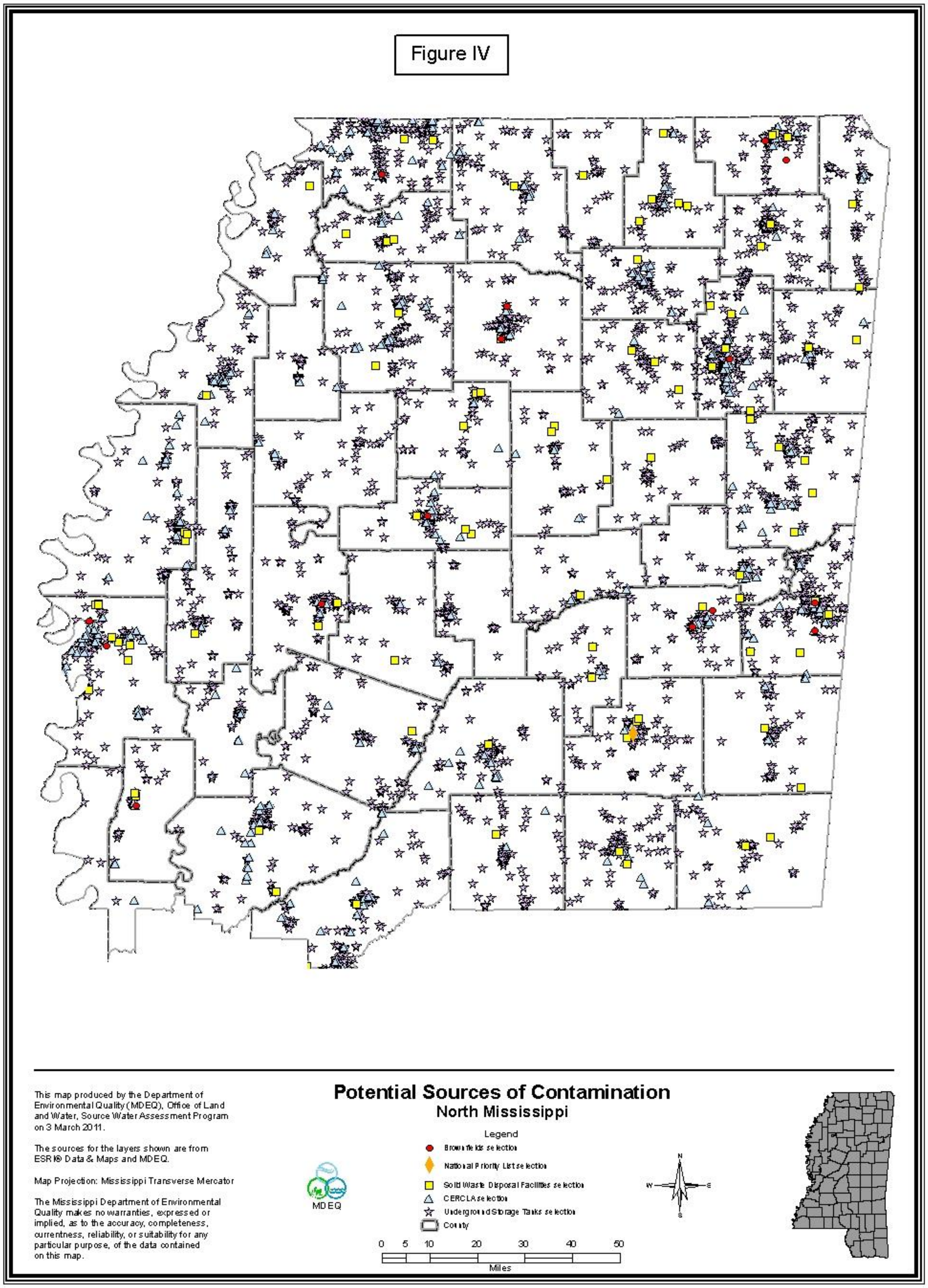
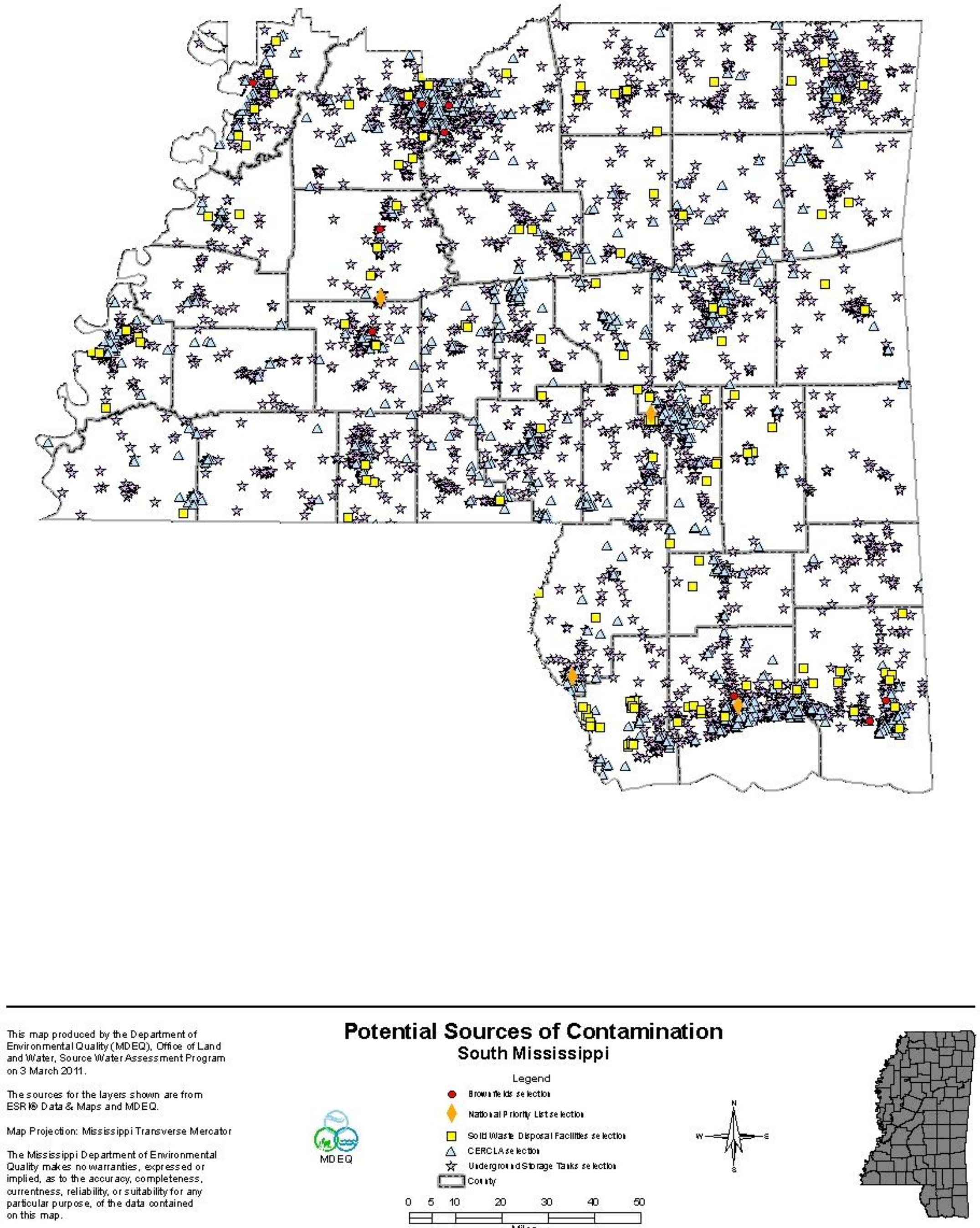


Figure IV
Potential Sources of Contamination
North Mississippi
This map produced by the Department of Environmental Quality (MDEQ), Office of Land and Water, Source Water Assessment Program on 3 March 2011.
The sources for the layers shown are from ESRI® Data & Maps and MDEQ.
Map Projection: Mississippi Transverse Mercator
The Mississippi Department of Environmental Quality makes no warranties, expressed or implied, as to the accuracy, completeness, currentness, reliability, or suitability for any particular purpose, of the data contained on this map.
MDEQ
Legend
Brownfields selection
National Priority List selection
Solid Waste Disposal Facilities selection
CERCLA selection
Underground Storage Tanks selection
County
0 5 10 20 30 40 50
Miles
N
W
E
S

Figure V


Potential Sources of Contamination
South Mississippi
This map produced by the Department of Environmental Quality (MDEQ), Office of Land and Water, Source Water Assessment Program on 3 March 2011.
The sources for the layers shown are from ESRI® Data & Maps and MDEQ.
Map Projection: Mississippi Transverse Mercator
The Mississippi Department of Environmental Quality makes no warranties, expressed or implied, as to the accuracy, completeness, currentness, reliability, or suitability for any particular purpose, of the data contained on this map.
MDEQ
Legend
Brownfields selection
National Priority List selection
Solid Waste Disposal Facilities selection
CERCLA selection
Underground Storage Tanks selection
County
0 5 10 20 30 40 50
Miles
N
W
E
S

Groundwater Assessments and Remediation Efforts

MDEQ learns about contaminated land or water from facility inspections, site investigations, complaints, or emergency response activities. Contamination can result from a variety of activities such as improper practices at existing facilities, accidental spills, or leaks from UST systems. MDEQ also gathers information about suspected contamination due to old landfills, illegal dumps, and abandoned facilities called uncontrolled sites. MDEQ oversees the investigation and remediation of sites that have been or are suspected to have been contaminated by toxic metals, chemicals, petroleum, or other pollutants or contaminants. MDEQ also maintains a database inventory of identified contaminated sites. MDEQ regulates coal and non-coal surface mining activities so as to minimize injurious effects by requiring proper reclamation of surface-mined lands, while balancing the economic necessities of developing our natural resources with protection of the natural environment.

Brownfields

The Mill at MSU Brownfield Project Breaks Ground In February 2014, the Commission approved a Brownfield Agreement for the redevelopment of the Cooley Center, an old textile mill that sits on the National Register of Historic Places and will serve as the development's centerpiece. The mixed-use development, which sits on the edge of Mississippi State University's campus, will be constructed in phases and includes a hotel, parking garage, infrastructure and the development of outparcels. The brownfield agreement included provisions for addressing asbestos abatement and the removal of several underground storage tanks and solid waste. The parking garage – which will have three bays and four levels – will have a parking capacity of 650 vehicles, and is being paid for by an $8 million community development block grant issued by the Mississippi Development Authority. The City of Starkville is managing that part of the project. The design for the Cooley Building received in early January preliminary approval from the Mississippi Department of Archives and History followed by MDEQ's approval of the cleanup in February. It then moved to the National Park Service, which had the final say whether the design meets the standards for historic buildings. The Park Service signing off on the design was crucial, because it makes the project eligible for historic and new market tax credits. The Cooley Building will be remade into a conference center and office space. To go with the parking garage and the hotel, the developer would ideally like to include two to three restaurants in the final version of the development. The demolition of everything on the site that is not on the Historic Register and the removal of the underground storage tanks and solid waste was part of the first phase which is now complete. Work on the Cooley Building has begun with asbestos removal and makes up the second phase which is currently taking place.

Underground Storage Tanks

The primary goal of the Underground Storage Tanks (UST) Program is to protect groundwater from leaking underground storage tanks. A two-pronged strategy is used to achieve this goal. First, a compliance program inspects UST facilities in order to ensure the systems do not leak. In Mississippi, the UST compliance personnel are responsible for ensuring approximately 8,300 tanks at nearly 3,100 facilities have the appropriately maintained equipment in order to protect the groundwater. Secondly, in the event of a release, the Mississippi Groundwater Protection fund is used by MDEQ to assess and cleanup any contamination resulting from leaking USTs. The Mississippi Groundwater Protection fund began in 1987 and has committed $169 million to eligible tank owners for the assessment and cleanup of sites contaminated from leaking underground storage tanks. The average fund commitment per site is nearly $155,000. At the end of this fiscal year, the Mississippi Groundwater Protection Trust Fund had assessed 1121 sites, completed assessment and/or remediation of 908 sites. During the reporting period, MDEQ UST staff actively oversaw 213 sites. This past fiscal year $8.0 million were used to assess and remediate leaking underground storage tanks in Mississippi. Also, this year 26 new sites were assessed and 36 sites were closed.

Uncontrolled Sites & Voluntary Evaluation Program

Over the past 12 months, MDEQ Groundwater Assessment and Remediation (GARD) staff actively oversaw 174 assessments and/or cleanups. During that same timeframe, the number of sites brought to GARD's attention was 20, bringing the total number of sites in MDEQ's public record to 1,912 sites. Also, MDEQ issued "State No Further Action" letters for seven of these sites that were evaluated and remediated to levels protective of human health and the environment. MDEQ issued no Restrictive Use Agreed Orders/Environmental Covenants during their reporting period, thereby allowing these sites to be reused with certain activity and use limitations. Through MDEQ's efforts, 32 acres were put back into productive use in FY 2014. The staff continues to respond expeditiously to requests from MDOT and other governmental agencies for the review of environmental assessments and remediation of contaminated sites and those sites with economic development potential. The Voluntary Evaluation Program (VEP) offers an opportunity to receive an expedited review of site characterization and remediation plans and reports for parties that are voluntarily cleaning up uncontrolled sites that they have an interest in. The VEP is funded entirely by these participants who pay for MDEQ's oversight costs.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

Oversight of the site assessment and restoration of hazardous waste sites at federal facilities continues to be a large portion of the work involving the CERCLA Branch of MDEQ. Oversight is conducted at seven Department of Defense (DoD) Sites, a Department of Energy Site (Salmon Test Site), a NASA facility (Stennis Space Center), and several formerly used defense sites. MDEQ is funded for this oversight work through agreements with the Department of Defense, Department of Energy, and NASA. Through the grants from the Environmental Protection Agency, CERCLA staff performed preliminary assessments, site investigations and site inspections at hazardous waste sites for National Priority List (NPL) consideration, coordinated with EPA on emergency/removal projects at the Copiah County Manufacturing Co. (Hazlehurst) and the Southeastern Wood Preserving Site (Canton), and assisted the Environmental Protection Agency with the oversight of the assessment and future remediation of four Superfund Sites in the state— Sonford Products (Flowood), Davis Timber (Hattiesburg), American Creosote (Louisville), and Wood Treating (Picayune). At the present time it is estimated that the remediation costs for these four sites is approximately $80 million. The state will pay 10 percent of these remediation costs or $7.3 million. In addition, remedial investigations have begun at Red Panther Chemical (Clarksdale), Kerr-McGee (Tronox) (Columbus), and Southeastern Wood (Canton). Estimations of remedial costs for these sites will be developed after the remedial investigations have been completed by EPA. The Red Panther Chemical site is a potential responsible party (PRP) site and the responsible party(s) will be paying for the further assessment and remediation of this site. The Kerr-McGee (Tronox), site went into bankruptcy and further legal proceedings. The bankruptcy proceeding resulted in a trust being set up that will provide as much as $68 million toward the further assessment and remediation of the site. The Southeastern Wood site does not have a potentially responsible party and will require a 10 percent state match for the remediation costs.

RCRA Corrective Action

EPA Region 4 is responsible for 33 sites in the state that are under the jurisdiction of the Resource Conservation and Recovery Act (RCRA) Corrective Action Program. This program covers the cleanup of hazardous waste and hazardous constituents released from Solid Waste Management Units or Areas of Concern at regulated facilities. More than half of these facilities have achieved control of current human exposures and control of the migration of contaminated groundwater according to the EPA website.

Table III is a statewide summary of groundwater contamination source types and the number of sites for each source. The format of the table was established by the EPA, specifically for inclusion in the 305(b) Reports.

Table III. Ground Water Contamination Summary
Hydrogeologic Setting: Statewide
Spatial Description:

Map Available:

Data Reporting Period: 2013-2014

Source Type	Number of Sites	Number of Sites that are listed and/or have confirmed releases	Number with confirmed ground water contamination	Contaminants	Number of Site Investigations (optional)	Number of sites that have been stabilized or have had the source removed	Number of sites with corrective action plans (optional)	Number of sites with active remediation (optional)	Number of sites with cleanup completed (optional)
NPL	12	12	7	Pentachlorophe nol Creosote	12	4	11	6	5
CERCLIS (non-NPL)	534								
DOD/ DOE	10			VOCs					
LUST	476	362	188	BETX,PAH		236	236	47	6934
RCRA Corrective Action	33	33	22	VOCs, SVOCs, Metals	33	7	20	18	6
Underground Injection	5-CL I 576-CL II	0	0						
State Sites	1912		352	Metals, VOCs, SVOCs, Pesticides, Herbicides		673			590
Non-point Sources									
Totals	**3558**	**407**	**569**		**45**	**920**	**267**	**71**	**7535**

GROUNDWATER PROTECTION EFFORTS

The Mississippi Department of Environmental Quality (MDEQ) has received primacy from the EPA to administer the related Federal programs dealing with groundwater and surface water quality in the state. The Source Water Assessment Branch (SWAB) in MDEQ's Office of Land and Water Resources (OLWR) has the primary responsibility of coordinating groundwater (quality) protection efforts in Mississippi. Activities to prevent the contamination of drinking-water aquifers in the state have focused mainly on the implementation of the Wellhead Protection Program, completion of Source Water Assessment Program requirements, and addressing Source Water Protection Program related measures.

Wellhead Protection Program

Initial groundwater protection efforts by the Groundwater Planning Branch focused on the State Wellhead Protection Program (WHPP). This program conceptually was designed to identify and properly manage potential contaminant sources in Wellhead Protection Areas from which public water system (PWS) wells capture their water over a specific period of time. Demonstration projects for several high-priority PWSs in Mississippi resulted in the first local management plans being completed in the state by the mid-1990s. MDEQ used the success of these projects to spearhead interest in cross-program coordination of groundwater protection activities in Mississippi.

Since the mid-1990s, the Mississippi Rural Water Association has utilized a national EPA grant to fund a technician who has assisted MDEQ in the development and implementation of local Wellhead Protection management plans. Most of the WHPP activities over the past eight years have centered around Rural Water's efforts to develop management plans for at least 12 rural PWSs per year.

Source Water Assessment Program

The 1996 amendments to the Safe Drinking Water Act mandated states to develop and implement a Source Water Assessment Program (SWAP). The purpose of this program was to notify PWSs and customers regarding the relative susceptibility of their drinking-water supplies to contamination. Congress intended for these susceptibility assessments to encourage efforts that would enhance the protection of PWSs by managing identified potential contaminant sources of concern. In 1998, the Mississippi State Department of Health (MSDH) contracted with MDEQ to develop and administer the SWAP in Mississippi. Required elements of assessments include the following: (1) delineating Source Water Protection Areas around PWS wells; (2) inventorying potential contaminant sources in the protection areas; (3) assigning susceptibility rankings to wells; and (4) notifying the public regarding the availability of SWAP information.

Assessments in Mississippi use the following rankings to notify PWSs of their relative susceptibility: (1) Higher, (2) Moderate, and (3) Lower. Some of the criteria considered when assigning these rankings to public groundwater systems include aquifer confinement; MSDH minimum well design criteria; potential contaminant sources identified within the delineated Source Water Protection Area; and abandoned wells within the protection area.

The size of a Source Water Protection Area is based on eight delineation scenarios that were developed using EPA's Wellhead Protection Area (WHPA code) computer program. The different scenarios are a result of countless computer modeling runs and an extensive data review of aquifer characteristics and well data from the USGS and MDEQ's Office of Geology and OLWR. The eight developed delineation scenarios incorporate differing model input parameters, including well discharge, aquifer porosity and transmissivity, aquifer thickness, and time. The approved pumping scenarios are arranged according to well discharge ranges with larger pump rates corresponding to larger Source Water Protection Areas.

Assessments of all public groundwater systems and the four public surface water systems operating in the state have been completed. After MDEQ mailed the prepared assessment reports to the systems, it became their responsibility to notify their customers that a SWAP report was available for review upon request. As another reminder, the EPA required the annual Consumer Confidence Report (CCR) prepared by systems to include a reference regarding the SWAP report and a brief summary of the assessment findings.

The SWAP reports and corresponding maps of delineated Source Water Protection Areas are available online at the MDEQ website: http://landandwater.deq.ms.gov/swap. All new PWS wells now require that preliminary assessments be performed by MDEQ prior to the issuance of groundwater withdrawal permits. These preliminary assessments allow the suitability of proposed well sites to be screened prior to the drilling and completion of PWS wells.

Source Water Protection

The OLWR staff continued its efforts to protect the drinking water supplies of the 1,213 public water systems operating in the state as part of activities related to the Source Water Assessment/Protection Program. This program focuses on the proper siting of new wells and addressing potential sources of contamination identified in the vicinity of drinking water supplies. MDEQ worked closely with the Mississippi State Department of Health's Water Supply Division to assist in the implementation of the EPA's new Groundwater Rule. MDEQ is also working to identify abandoned public water supply wells so they can be properly plugged by a licensed well driller. Improperly abandoned water wells can serve as potential conduits for the introduction of contaminants into drinking water aquifers. As of March 2015, 94 wells have been properly plugged and abandoned. This coordinated plugging effort is being funded by the Mississippi State Department of Health.

Source Water Protection Strategy

Mississippi's Source Water Protection Strategy for PWS wells using unconfined aquifers involves the integration/coordination of protection efforts with various environmental regulatory programs within MDEQ, such as UST, RCRA, CERCLA, and Brownfields/Uncontrolled Sites, as well as the MSDH. The implementation of this strategy is initiated when the corresponding regulatory programs are provided a Source Water Assessment analysis of a PWS well from the Source Water Assessment Branch. This direct cross-program involvement should help to ensure contaminant plumes do not degrade shallow groundwater sources used for public water supply.

The protection strategy for public groundwater systems using deeper confined wells focuses on the hydrogeolologic confinement (vulnerability) of their production aquifers. Adequate aquifer confinement is generally assumed if an overlying confining unit of clay is at least 30 feet in thickness and/or the corresponding potentiometric surface (head) extends at least 10 feet above the screened aquifer. The implementation of this strategy is considered complete when the confinement is verified and a system is notified of any abandoned (unplugged) wells that may pose public health issues.

The Source Water Protection Strategy for the four surface water intakes used in the state involves the integration of public drinking-water protection into MDEQ's Basin Management Approach that is designed to protect and restore the quality of Mississippi's surface water resources. This integration component was well received by the Basin Management Managers which incorporated extra protection measures into their management plans to complete the strategy.

Source Water Assessment Summary for Public Drinking Surface Water Intakes

The Safe Drinking Water Act (SDWA) Amendments of 1996 (Public Law 104-182) required the state to develop and implement a Source Water Assessment Program (SWAP) and to prepare a Source Water Assessment (SWA) for each of the 4 surface water intakes in the state and the 3,892 water well groundwater intakes. All have been completed except the City of Corinth surface water intake. This summary of Source Water Assessment activities just addresses the surface water assessments. In 1998, the MS Department of Health (MSDH) who has federal primacy for the Safe Drinking Water Act (SDWA) contracted with MDEQ to develop and administer the MS Source Water Assessment Program. EPA approved the MDEQ state plan in November 1999. Tennessee Valley Authority (TVA) was contracted to complete the assessment for the City of Jackson intakes at the Ross Barnett Reservoir and the Pearl River (2004) and it was updated by FTN Associates in 2010 , the City of Tupelo intake at the Old Tombigbee River intake at Fulton (2004) and the Short Coleman water intake at Yellow Creek Pickwick Lake (2004) and was updated by TVA in 2008 and 2011. The following is a summary of assessment and protection efforts at the aforementioned intakes. In addition to the SWAP federal requirement the MSDH administers the federal Vulnerability Assessment and the Emergency Response Plan for public water systems in the state which is the first line of defense against terrorism and natural disasters. The SWAP susceptibility analysis for these surface water intakes is based on the following criteria: 1. MSDH water quality analysis, 2. Intake located in stream versus a lake or reservoir, 3. Intake located in Clean Water Act 303(d) list of impaired waters, 4. Intake located in transportation corridors such as barge traffic, railroads, highways and pipelines, 5. Potential contaminant sources located within 1000 foot buffer area of the primary protection area, 6. Potential contaminant source storage or operating concerns and 7. Non-point sources of pollution in the 250 foot buffer of the secondary protection area. All of the surface water intakes for public water consumption are ranked higher due to being located in transportation corridors. The susceptibility rankings which are lower, moderate or higher do not indicate the water supply is safe or un-safe but allows the state to focus resources on protection efforts. The primary protection area is based on a 24 hour time of travel and the entire surface area of the lake or reservoir with a 1000 foot buffer from the water's edge. The secondary protection area, consist of the upstream sub-watersheds and have a 250 foot buffer. MDEQ administers Section 314 of the Clean Water Act which dictates surface water quality standards based on designated uses such as drinking water, contact recreation (swimming) or aquatic life support (fishing). MSDH administers the SDWA to insure national health based standards are met for public consumption. The numeric value standards can differ between these programs because the toxicity is so different between humans and aquatic species. Some common denominators are nutrients (nitrogen and phosphorous) which lead to algal blooms causing water treatment problems, pathogens from human or animal feces (cryptosporidium, fecal coliform-E. coli, giardia lamblia, legionella and viruses). Nitrates, some pesticides/herbicides and endocrine disrupting chemicals are not removed by conventional water treatment and have to be removed with expensive reverse osmosis treatment. USGS testing of all three of the surface water systems, before and after treatment, for 137 pesticide and pesticide metabolites indicated that none were in violation of the SDWA standards (if a standard was available).

Only nineteen of these compounds are regulated under the SDWA. The Clean Water Act and the Safe Drinking Water Act must act synergistically to meet drinking water health based standards. The Basin Management Coordinators have provided oversight for the SWAP updates, financial resources for projects and have integrated SWAP into the Basin Management Approach. EPA has supported workshops and approved projects for Source Water Protection and on a national level is working on integrating some aspects of the SDWA and CWA. There are over 90 SDWA primary enforceable standards and 15 non-enforceable secondary standards that must be tested for and reported to the water consumer each year in the form of a Consumer Confidence Report.

Source Water Protection Plan for the O.B. Curtis Drinking Water Intake FTN 2011 Ross Barnett Reservoir

The Ross Barnett Reservoir is a 33,000 acre impoundment and the upstream drainage area is approximately 3,050 square miles. This is the source of the public water intake for the City of Jackson which serves a population of 175,938. The Primary Protection Area (PPA) includes the surface area of the Reservoir at flood stage (299 ft.) and the 24 hour travel zone in the reservoir upstream from the intake. A 1000 foot protection buffer around the reservoir is also part of the (PPA). The Secondary Protection Area (SPA) consist of the upstream subwatersheds and a 250 foot protection buffer exist from the tributary channel. Some water bodies in the watershed are impaired and 29 TMDLs have been calculated for these and recommend reductions in pollutant loads. Although TMDL reports exist for tributaries of the Reservoir, they are not considered a significant threat to water quality. In many cases, the presence of pollutants in these tributaries has not been substantiated with monitoring data. Pollutants are potentially present based on anecdotal evidence or biological monitoring. Attenuation occurs in these upper reaches and ongoing monitoring by the water treatment plant confirms that upstream pollutants are not present in the treated water in amounts exceeding the National Primary Drinking Water Regulations. Three of these tributaries are located in the Primary Protection Area and are addressed in the 2011 FTN report. The Reservoir is not included on the 303(d) list as impaired and is meeting water quality standards for aquatic life support. The drinking water goals of the Water Quality Monitoring Plan are to track water quality constituents related to drinking water treatment issues identified by the City of Jackson and to assess the status and trends of suspended sediments, dissolved oxygen, algae, and total organic carbon (TOC). When TOC is high the chlorination process can cause four disinfection byproducts to form that are regulated. Lab test are performed on intake water (source water), raw water at the treatment plant and finished water after treatment. Required water quality monitoring is as follows: continuous monitoring for turbidity, monthly for chlorite, total organic carbon (TOC) and bacteria, quarterly for disinfection by-products, yearly for cyanide, inorganic chemicals, and nitrate, every three years for lead, copper and synthetic organic chemicals, and every six years for volatile organic chemicals and radionuclides. The treatment process consist of pre-oxidation (to address taste, odor, manganese removal and pH adjustments), flocculation, ultraviolet disinfection and ultrafiltration to achieve a 99.99% reduction in biological contaminants. The ultrafiltration process also reduces the risk for cryptosporidium in the finished water. Samples of raw water and finished water were tested for 137 pesticide and pesticide metabolites and all were below EPA standards (if a standard was available). The current issues identified for the Reservoir water quality are: turbidity, pathogens, nutrients, pesticides, trash and invasive aquatic plant species. Naturally occurring manganese and iron can cause metallic tasting water and colored water which the treatment plant has to deal with. In the Primary Protection Area the following potential contaminant sites exist: 1. Six sites with aboveground gasoline storage tanks, 2. Six sites with aboveground oil storage tanks, 3. Twenty-one boat launches, 4. Forty-three bridge crossings, 5. Five car washes, 6. One natural gas well, 7. Five CO2 wells, 8. Two CO2 pipelines, 9. Two natural gas pipelines, 10. Nine marinas, 11. Two non-sewered subdivisions, 12. One surface mining pit, 13. Eight storm water outfalls, 14. Twelve underground gasoline storage sites, and 15. Three wastewater treatment plant discharges. Land use in the Primary Protection Area consist of: Open water 56.6%, Forest 14.5 %, Wetland 13%, Developed 9.0%, Shrubland 3.6%, Pasture 2.9% and Agriculture .3%.

Source Water Assessment Northeast MS Regional Water Supply District-Fulton Intake for Tupelo and Fulton

The NE MS Regional Water Supply District's water intake is located on the Tombigbee River in Fulton, within the Upper Tombigbee Watershed. The drainage area upstream of the intake to the upstream boundary of the Upper Tombigbee Watershed covers 594 square miles. This intake serves Tupelo with a population of 38,439 and Fulton with a population of 8,550. Maintenance and operation of the Tenn-Tom Waterway is the joint responsibility of the U.S. Army Corps of Engineers and the U.S. Coast Guard. In 2008 it carried 6.5 million tons of cargo and three-quarters of the freight consisted of coal, wood products, crude materials (chemicals) and petroleum. The watershed is approximately 48 percent forested, 26 percent cropland/pasture, 11 percent wetland, and the remainder open water, residential, rangeland, right of way, commercial, industrial and disturbed land. The Source Water Protection Area (SWPA), extends 15 miles upstream of the intake and ¼ mile downstream, with a 1000 foot buffer from the water's edge, and where a known or suspected contaminant exist within 1500 feet of the water's edge, the buffer shall be extended to include these areas. Where a significant tributary enters the SWPA the protection area is extended up this tributary for 1 mile and a 1000 foot buffer is also applied to this area. A one –dimensional model of the Tombigbee River was developed to assist in determining travel times along the rivers channel in the event of a contaminant spill. The model extends from Mackeys's creek outflow from the Tennessee-Tombigbee Waterway to the water intake at Fulton. Water system operators or Emergency coordinators can use the charts developed to estimate when a contaminant plume will enter the intake area if a transportation accident occurred. The main causes of water quality issues are believed to be nutrients, siltation, pathogens and organic enrichment derived from nonpoint sources. Nonpoint source pollutants can contribute as much as five times more DO-consuming waste than point sources and result from agricultural activities (runoff from fertilizer and pesticide applications, erosion and animal waste), land development and urbanization (storm sewers, combined storm and sanitary overflows, and septic systems). According to the 2012 Consumer Confidence Reports for Tupelo and Fulton the water meets all federal drinking water standards. In the protection area the following potential contaminant sites exist: 1. Three wastewater treatment plant discharges, 2. Two gasoline storage sites, 3. Ten bridge crossings, and 4. Five boat ramps.

Source Water Assessment and Protection Plan Short Coleman Surface Water Intake Yellow Creek

The Short Coleman surface water intake is located on the Yellow Creek embayment within the Pickwick Lake watershed. The water system serves 1,623 customers some of which may be drinking groundwater and according to the 2012 Consumer Confidence Report meets all federal drinking water standards. The Yellow Creek embayment of the Tennessee River, located in northeastern MS has a drainage area of approximately 44.7 square miles. The Tennessee River basin lies in a seven state area in the southeastern U.S. and its drainage area covers 40,900 square miles, most of which is in the state of Tennessee. The Tennessee River drainage is one of nine major drainage groups in MS and it drains 181 of 48,434 square miles of MS area. The average daily flow past MS is 3,715 cfs. The TVA manages the Tennessee River for navigation, flood control, electric power generation, recreation, and minimum flows for the maintenance of water quality and aquatic habitat. The Tennessee River flowing through MS is impounded by Pickwick Reservoir and has a total surface area of 42,790 acres at elevation 414 feet which is normal maximum pool. Dams and reservoirs control the flow through the system. Barge traffic is about 54 million tons every year and cargo consist of sand and gravel, coal, chemicals, petroleum, timber products and ores and minerals. Maintenance and operation of the Tennessee River Waterway is the joint responsibility of TVA, U.S. Coast Guard and the Corps of Engineers. According to TVA the overall condition of Pickwick Reservoir was fair in 2002. All assessed monitor stations rated good for fish (number and variety) and sediment quality (amount of PCB's, pesticides and metals in the bottom sediment). The Bear Creek embayment and transitional zone rated good for DO levels, while the forebay was rated as fair. The chlorophyll level was rated poor at three monitored stations which is typical for low flow years such as 2002. In developing the Source Water Protection Area (SWPA) TVA and MDEQ elected to define the SWPA with a unique set of boundaries. Since the intake is in the northeast corner of the state, going 15 miles upstream would have placed the SWPA in the states of MS, TN and AL. Instead, the SWPA was limited to a region in MS. The study area includes part of the Yellow Creek embayment, as well as the MS shoreline on the TN River.

The SWPA includes the entire Pickwick Lake/Yellow Creek embayment and the area downstream of the mouth of Yellow Creek embayment on the MS and TN shoreline of the TN River. The non-aquatic land cover in this area is forest, pasture, wetlands, and small percentages of other land uses. Travel times of a hypothetical chemical spill to travel through Pickwick Reservoir and/or the upper Tenn.-Tom Waterway were evaluated and charts were developed to assist the water system and emergency responders on plume travel time to intake from a given location. Potential contaminant sources identified within the protection area include: 1. One petroleum bulk storage facility, 2. Twelve wastewater treatment facilities, 3. Seven gasoline storage sites, 4. Eleven bridges, and 5. Six boat ramps.

Summary of State Ground Water Protection Programs

Table IV summarizes the different groundwater protection programs and activities in Mississippi. The following abbreviations listed in the table correspond to the state agencies responsible for the various ground water protection programs:

1. MEMA - Mississippi Emergency Management Agency
2. MDEQ - Mississippi Department of Environmental Quality
3. MDAC - Mississippi Department of Agriculture and Commerce
4. MSDH - Mississippi State Department of Health
5. MSOGB- Mississippi State Oil and Gas Board

Table IV. Summary of State Ground Water Protection Programs

Programs or Activities	Check (□)	Implementation Status	Responsible State Agency
Active SARA Title III Program	□	established	MEMA
Ambient groundwater monitoring system	□	established	MDEQ
Aquifer vulnerability assessment	□	developing	MDEQ
Aquifer mapping			
Aquifer characterization	□	considering	MDEQ
Comprehensive data management system	□	developing	MDEQ
EPA-endorsed Core Comprehensive State Ground Water Protection Program (CSGWPP)	□	reevaluating participation	MDEQ
Groundwater discharge permits	□	established	MDEQ
Groundwater Best Management Practices	□	developing	MDEQ
Groundwater legislation	□	established	MDEQ
Groundwater classification			
Groundwater quality standards	□	established	MDEQ
Interagency coordination for ground water protection initiatives	□	established	MDEQ
Nonpoint source controls	□	developing	MDEQ
Pesticide State Management Plan	□	established	MDAC

Pollution Prevention Program	□	established	MDEQ
Resource Conservation and Recovery Act (RCRA) Primary	□	established	MDEQ
State Response Program	□	established	MDEQ
State RCRA Program incorporating more stringent requirements than RCRA Primary	N/A	N/A	MDEQ
State septic system regulations	□	established	MSDH
Underground storage tank installation Requirements	□	established	MDEQ
Underground Storage Tank Remediation Fund	□	established	MDEQ
Underground Storage Tank Permit Program	□	established	MDEQ
Underground Injection Control Program	□	established	MDEQ-MSOGB
Vulnerability assessment for drinking water/wellhead protection	□	established	MDEQ
Well abandonment regulations	□	established	MDEQ
Wellhead Protection Program (EPA-approved)	□	established	MDEQ
Well installation regulations	□	established	MSDH

Investigations Supporting Groundwater Protection

Because Mississippians are so reliant on the groundwater resources in the state, a great deal of time and effort has been devoted to developing a working knowledge of the related hydrogeology. Agencies that have been involved in groundwater investigations and publications in the past include the U.S. Geological Survey and MDEQ's Office of Land and Water Resources (OLWR) and Office of Geology (OG).

Office of Land and Water Resources

The abundant water supplies in Mississippi constitute one of the most important and valuable natural resources in the state. These resources attribute directly to the quality of life and economic prosperity of the state. However, the water resources available in areas of the state can vary significantly depending on various hydrogeologic conditions that may affect base flow in streams, water quality and quantity, as well as the prolificacy of local aquifers. The highly variable nature of these resources means that a concerted effort must be maintained to collect related groundwater and surface water data that will allow proper decisions to be made regarding the management and development of the state's water resources.

In 2014, work continued on a project to evaluate the availability of groundwater resources in Lafayette County. Water levels were collected in the summer of 2012, and a subsequent set of water levels was measured in early 2013. Proprietary data were obtained from private sources, in an effort to supplement the geophysical logs being utilized. A preliminary set of cross-sections has been developed illustrating the subsurface hydrogeology of the county, which, along with hydrologic data and the use of geographic information systems, will result in a more complete understanding of the water resources available in Lafayette County.

In the spring of 2010, Office of Land and Water Resources staff completed work on the development of a numerical groundwater flow model of the Mississippi River Valley Alluvial Aquifer (MRVA) of the Mississippi Delta. The model is used to better understand the groundwater flow system, the potential effects of variations in pumping patterns, and to evaluate various water resources management scenarios. The model will eventually be refined to incorporate information developed through the MRVA top stratum and infiltration studies to improve its use as a management tool. Additionally, OLWR staff is expanding its information base on the Tertiary aquifers that also provide recharge to the MRVA. During 2014, significant effort and resources have also gone into enhancing the design and capabilities of the Delta Groundwater Model to support implementation of the Delta Conjunctive Water Management Strategies. A more comprehensive network of observation wells screened in the Cockfield and Sparta aquifers just below the alluvial aquifer is needed. OLWR staff are assessing which existing wells can be incorporated into a network for this purpose and determining the areas in which new monitoring wells should be constructed. This information will also be incorporated into the model.

In the southern third of Mississippi, sand beds of the Catahoula, Hattiesburg, Pascagoula, and Graham Ferry Formations form the main aquifers that are primary sources of water supplies. These formations contain numerous interbedded layers of sand and clay. The complexity of these sediments has made it difficult to map the surface geology and delineate the aquifers in the subsurface. The MDEQ Office of Geology and OLWR continued their work in this area to map the surficial geology and construct geologic cross-sections across the area. The objectives of this effort are to identify and protect the recharge areas of the aquifers that are sources of water in this region and to correlate and determine the extent of the sand intervals that form these aquifers in the subsurface.

In anticipation of an increase in demand for water resources due to recent exploration activities by oil and gas companies, OLWR initiated a study to evaluate groundwater resources in Wilkinson and Amite Counties to determine the availability of groundwater for use in an oil and gas well completion method known as hydraulic fracturing, and to assess the susceptibility of the fresh water sands to contamination. This work was performed in conjunction with the above-mentioned study of the aquifers of southern Mississippi which provided the foundation for the present work. Maps of the structural elevation of the tops of the Glendon and Moody’s Branch Formations and geohydrologic cross-sections detailing the fresh water section in the subsurface have been completed. A map depicting the elevation of the base of fresh water relative to mean sea level is being prepared.

Water Resource Issues in the Mississippi Delta

Developing and Implementing Conjunctive Water Management Strategies

The future of the Mississippi Delta's economic and environmental viability depends on abundant, accessible water of sufficient quality. Water needs in the region are broad and include personal consumption, irrigation, aquaculture, fisheries and aquatic habitat, wetland function, wildlife, and waste water assimilation. Over 17,000 permitted irrigation wells screened in the shallow Mississippi River Valley Alluvial Aquifer (MRVA) are used for irrigation and aquaculture and pump approximately 1.5 billion gallons of groundwater each day. However, this pumpage demand has exceeded the recharge to the MRVA resulting in continuing overbalances of groundwater withdrawals versus aquifer recharge, and notable water-level declines in the aquifer. Because of increased yields and profitability that irrigation provides over dry land farming, the level of water withdrawal permit applications continues to increase which further complicates this issue. Fortunately, these challenges are in a region that experiences historically around 53-55 inches of rainfall each year, is adjacent to the 1-1.5 MM cubic feet/second flow of the Mississippi River, and is downstream from four adjacent major flood control reservoirs. So, although the challenges are significant, opportunities exist for the development of conjunctive water management options and alternative surface water supplies.

Conjunctive water management is the foundation for sustainable Delta water resources. In its simplest context, conjunctive water management is managing the coordinated use of surface and groundwater to satisfy desired water needs such that the total benefits exceed the sum of the benefits that would result from independent management of each water resource. During December 2011, MDEQ formed the executive level, multi-agency and organization Delta Sustainable Water Resources Task Force. The Task Force's mission is to develop and implement approaches that will result in sustainable water resources for agriculture, fisheries, and wildlife in the Mississippi Delta. Office of Land and Water Resources (OLWR) staff lead a multi-agency Task Force work group designed to develop and implement conjunctive water management strategies in the Delta. Core strategies include identification and evaluation of alternative surface water supplies; advancement of irrigation efficiency and conservation practices; understanding historical trends, current status, water use, and water budgets as a management tool; modeling future scenarios for planning and implementation purposes; monitoring and assessing water resources information; and identifying and developing economic incentives and funding sources. Other supporting strategies are also being developed. OLWR staff also leads a Task Force work group that is addressing how to implement a program for producers to measure water used for irrigation and waterfowl management to foster conservation at the farm level. This activity will also provide needed water use information for regional modeling and management uses. OLWR staff also support a third Task Force work group led by a Delta stakeholder organization that is addressing stakeholder awareness, outreach, education, and training needs. Over the past year, three functional teams and eight alternative water supply teams were created to implement various plans developed to further the goal of conjunctive water management. OLWR staff is lead or co-lead of two of the functional teams and three of the alternative water supply teams.

Office of Geology

MDEQ's Office of Geology (OG) plays a critical role in supporting the various groundwater investigations in Mississippi. This agency has specialized in the collection of geologic and hydrologic data and provides field support to other divisions of MDEQ. These functions revolve around the OG's drilling rig, coring equipment, and geophysical well-logging units. Water wells and engineering test holes drilled across the state are logged by the staff to collect valuable hydrogeologic information. These logs are maintained in the OG's log library of water wells and test holes. The work normally associated with a traditional state geological survey is performed by this office. Among the other functions of the agency are surface geologic mapping and research involving the geology, paleontology, and mineral resources of the state.

The preparation of surficial geologic maps by the OG is an important groundwater protection tool that cannot be over emphasized. These maps provide basic information required to assess the availability of energy and mineral resources, locations of geologic hazards, the occurrence and availability of water resources, and the suitability of land for various uses. Geologic maps also are used to characterize sites for waste disposal facilities and to identify aquifer recharge areas.

U. S. Geological Survey

Harrison County Study – The USGS is involved in a project that includes monitoring groundwater changes in the region and analyzing water samples collected from 25 wells in Harrison County annually. Analyses of temperature, pH, specific conductance, color, and concentrations of chloride and manganese are performed as part of this project. Over a 4-year period, the entire network of about 100 wells in Harrison County is sampled and monitored. This project, designed to help protect the local groundwater resources by monitoring for occurrences of saltwater encroachment in the area, is funded via a cooperative agreement with the Harrison County Board of Development.

Real-Time Monitoring of Water Levels – Water levels are being monitored continuously at three well sites located in Bolivar, Wayne, and Grenada Counties. The wells in Wayne and Grenada Counties are part of the Federal Collection of Basic Record (CBR) Program; the Bolivar County well is part of the USGS's NAWQA Program. The related data are transmitted via satellite and are available real-time (updated every 4 hours) at URL: http://waterdata.usgs.gov/ms/nwis/current/?type=gw

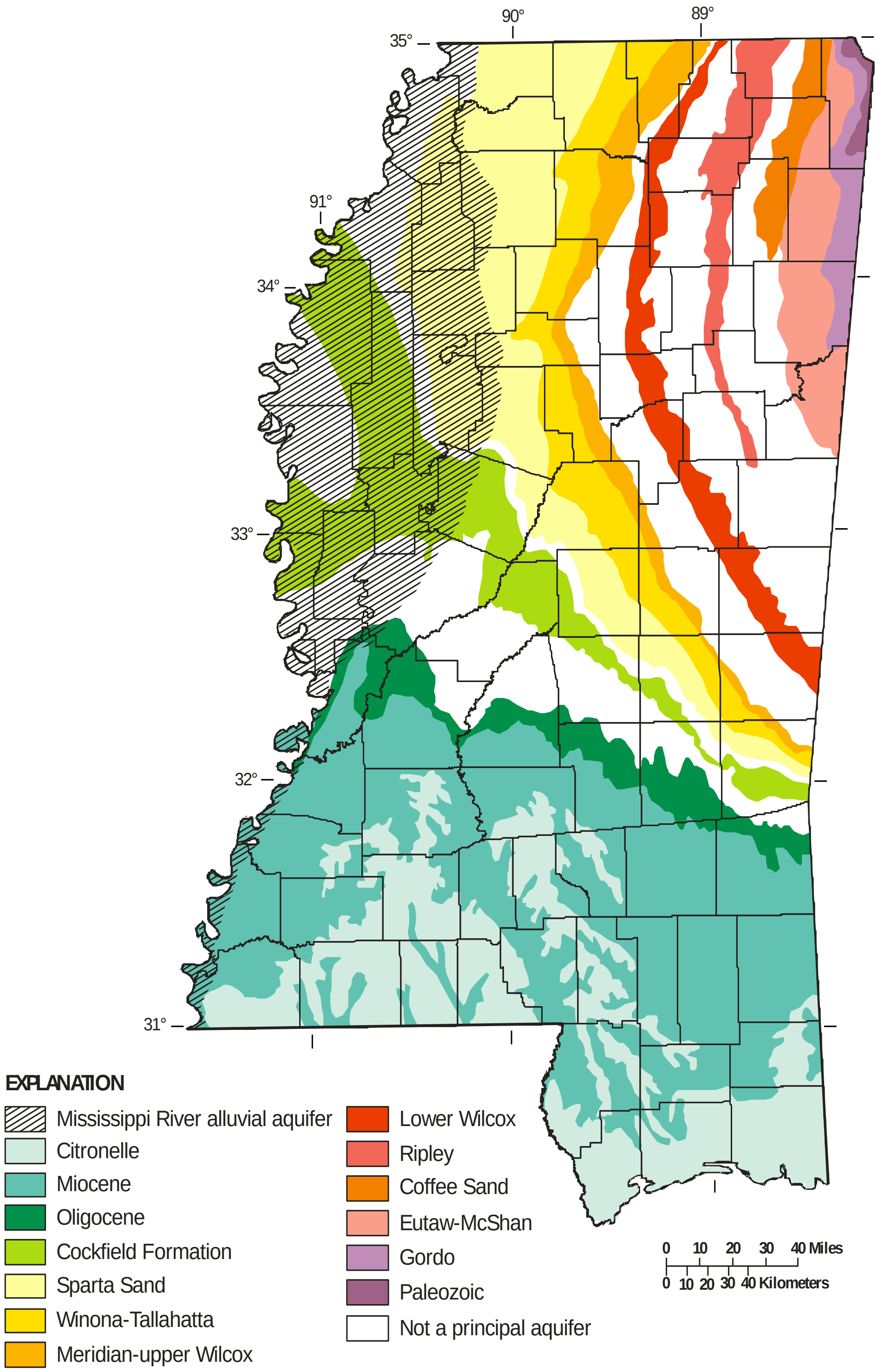
Groundwater Data and Maps Database – The USGS is entering electric log card header information into its GWSI database. This effort includes the scanning of approximately 13,000 E-logs using a Neuralog scanner. A web interface that will allow users to view all pertinent information for a well by "pointing and clicking" on a well-location map is in the final stages of development. Combining the water-quality data with the hydrogeological data will hopefully aid in providing a better understanding of the significance of water-quality changes in individual aquifers and also the differences in water quality among the various aquifers. This correlation should enhance the making of better planning and management decisions.

Computer Groundwater Models **–** Another important function of the USGS is the development, maintenance, and support of various regional groundwater flow models. These USGS models typically are developed to assist in providing MDEQ and Mississippi's water management districts with enough information that informed decisions can be made in managing and protecting the groundwater resources of the state. For example, model output can be used by water resource planners as a tool in evaluating well-field development. The Mississippi Embayment Regional Aquifer Study (MERAS) produced a model to assist the groundwater availability of the Mississippi Embayment aquifer system. The study area covers portions of eight states including AL, AR, IL, LA, MS, MO, and TN. For more information on the MERAS project, please visit the project's web page at the following URL:
http://waterdata.usgs.gov/PROJECTS/MerasModel.html

Phosphorus in the Mississippi River Alluvial Aquifer **–** Previous groundwater studies show that phosphorus in Mississippi River alluvial groundwater is higher than the natural background concentration of 0.03 mg/l in groundwater, and higher than the USEPA desired goal of 0.1 mg/L for phosphorus in streams for the prevention of nuisance plant growth. Groundwater from the aquifer could be contributing to high phosphorus concentration in Mississippi Delta streams during the irrigation season. From June to October 2010, the USGS sampled 42 irrigation wells, 1 abandoned irrigation well, and 3 MDEQ monitoring wells. Phosphorus was detected in all 46 wells at concentrations ranging from 0.12 to 1.2 mg/l with a median concentration of 0.62 mg/l.

AQUIFER SPECIFIC INFORMATION

The following aquifer descriptions were revised in 2005 by the USGS, Jackson, MS, from "Sources For Water Supplies In Mississippi", which was a cooperative study initially sponsored by the USGS and the Mississippi Research and Development Center.



Note: The Coker aquifer is included in this summary but is not listed here because it does not crop out in Mississippi

Figure 1. Location of outcrop areas for principal aquifers in Mississippi (from Wasson, 1986).

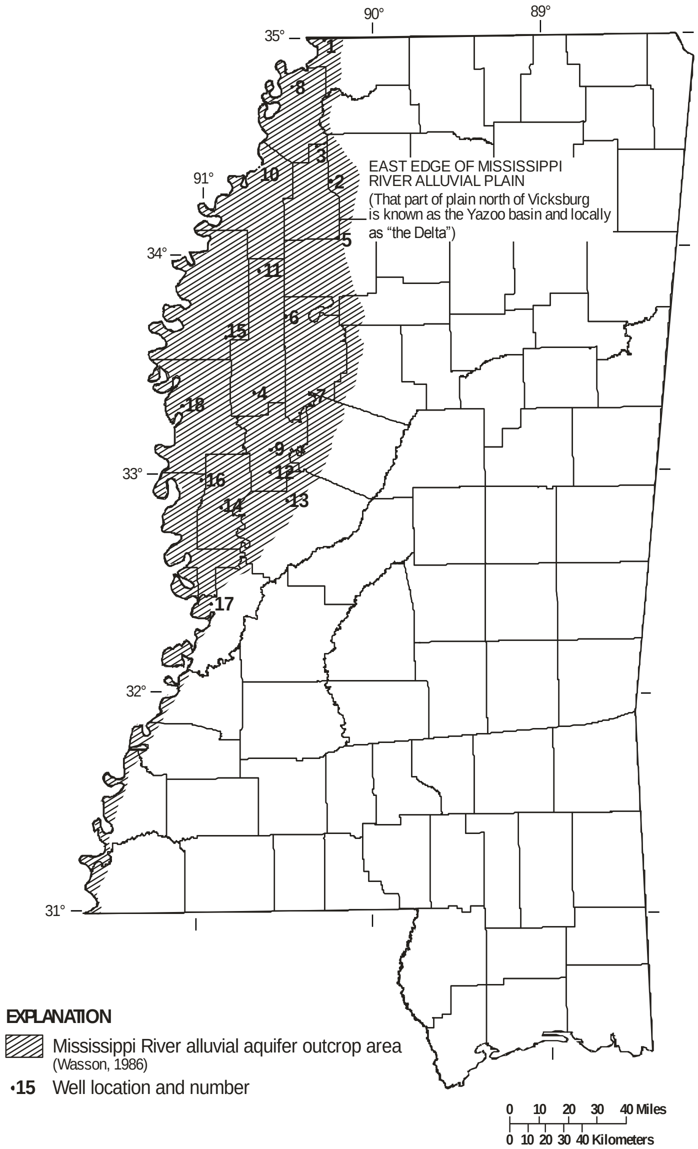


Figure 2. Location of the Mississippi River alluvial aquifer outcrop area and selected wells.

Mississippi River Alluvial Aquifer – Dissolved-solids concentrations generally increase from north to south and from east to west in the Mississippi River alluvial aquifer (Wasson, 1986[a]). Chemical analyses from selected freshwater wells (fig. 2) representative of the range of dissolved-solids concentrations found in the Mississippi River alluvial aquifer are listed in table 1.

For all wells screened in the Mississippi River alluvial aquifer, dissolved-solids concentrations ranged from 95 to 949 mg/L (milligrams per liter) with a median value of 344 mg/L (fig. 17); hardness ranged from 2 to 690 mg/L with a median value of 290 mg/L (fig. 18); specific conductance ranged from 104 to 1,790 µS/cm (microsiemens per centimeter) with a median value of 580 µS/cm (fig. 18); pH ranged from 6.0 to 8.9 standard units with a median value of 7.2 standard units (fig. 19); color ranged from 0 to 55 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 15 mg/L with a median value of 5.4 mg/L (fig. 20); and nitrate ranged from 0.08 to 12 mg/L with a median value of 0.2 mg/L (fig. 20).

---

[a]Wasson, B.E., 1986 (revised), Sources for water supplies in Mississippi: Jackson, MS, Mississippi Research and Development Center, 113 p.

Table 1. Typical water-quality data for freshwater wells completed in the Mississippi River alluvial aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	A0010	De Soto	36	19600411	197	100	288	6.5	0	30	11	12	2.9	121	29	10	0.3	37	1.9	NA
2	P0026	Panola	105	19730607	NA	130	290	7.2	NA	40	6.6	6.2	1.2	161	2.2	5.9	0.2	27	3.8	NA
3	A0040	Quitman	30	19801022	200	130	310	6.8	2	31	12	9.1	1.0	NA	0.1	4.8	0.2	38	7.0	NA
4	T0001	Sunflower	115	19650722	229	180	361	7.9	2	52	11	7.9	NA	224	5.4	4.6	0.2	32	NA	NA
5	F0002	Tallahatchie	124	19650723	272	220	444	8.0	5	62	17	8.8	NA	280	0.4	9.5	0.4	29	NA	NA
6	C0002	Leflore	95	19540623	274	230	457	7.7	6	64	16	9.3	1.8	290	64	4.0	NA	NA	5.0	NA
7	A0013	Holmes	100	19760730	294	220	460	7.7	5	62	17	12	0.4	496	0.4	8.8	0.5	33	10	NA
8	D0003	Tunica	115	19650729	297	260	498	8.3	0	68	22	9.5	0.7	328	NA	3.1	0.1	31	NA	NA
9	J0001	Humphreys	118	19650730	300	260	516	7.0	5	71	19	15	NA	348	0.2	3.9	0.5	38	6.9	NA
10	B0001	Coahoma	120	19650729	344	300	575	7.2	5	89	20	7.2	NA	392	20	1.5	0.3	28	13	NA
11	C0030	Sunflower	137	19650722	388	310	610	8.3	2	79	27	16	0.6	334	49	8.4	NA	30	NA	NA
12	L0018	Humphreys	113	19760121	400	360	605	7.0	30	97	28	21	3.0	461	2.4	10	0.2	32	3.8	NA
13	G0070	Yazoo	131	19771215	438	360	732	7.4	38	93	32	19	3.9	470	9.8	9.8	0.2	42	NA	NA
14	H0004	Sharkey	103	19671116	501	360	825	7.1	5	90	33	47	2.3	513	37	9.1	NA	27	NA	NA
15	T0080	Bolivar	160	19190902	503	380	NA	NA	NA	106	29	28	NA	415	80	15	NA	39	NA	NA
16	A0074	Issaquena	110	19820827	NA	470	944	7.0	5	130	36	25	1.3	NA	78	9.8	0.2	37	7.5	NA
17	J0021	Warren	181	19740227	641	500	1000	7.1	30	120	48	29	5.5	598	8.8	46	0.2	39	NA	NA
18	G0024	Washington	58	19110821	883	460	NA	NA	NA	174	6.1	NA	NA	879	46	11	NA	50	NA	1.0

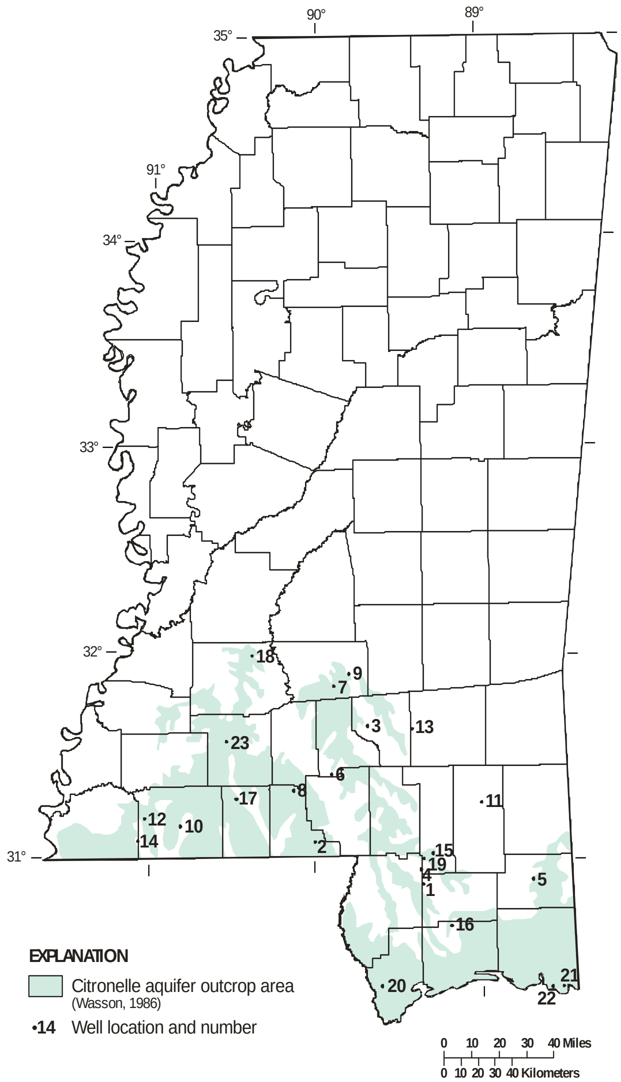


Figure 3. Location of the Citronelle aquifers outcrop area and selected wells.

Citronelle Aquifers – Dissolved-solids concentrations generally increase from north to south in the Citronelle aquifers toward the Gulf of Mexico (Wasson, 1986), except for locations contaminated with brine from oil wells. Chemical analyses from selected freshwater wells (fig. 3) representative of the range of dissolved-solids concentrations found in the Citronelle aquifers are listed in table 2. The downdip limit of freshwater in the Citronelle aquifers is not shown in figure 3, as it may extend several miles beyond the coast line.

For all wells screened in the Citronelle aquifers, dissolved-solids concentrations ranged from 12 to 1,690 mg/L with a median value of 50 mg/L (fig. 17); hardness ranged from 1 to 530 with a median value of 9 mg/L (fig. 18); specific conductance ranged from 13 to 7,200 µS/cm with a median value of 40 µS/cm (fig. 18); pH ranged from 4.1 to 10.3 with a median value of 5.4 standard units (fig. 19); color ranged from 0 to 140 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 2.5 mg/L with a median value of 0.020 mg/L (fig. 20); and nitrate ranged from 0.01 to 37 mg/L with a median value of 1.5 mg/L (fig. 20).

Table 2. Typical water-quality data for freshwater wells completed in the Citronelle aquifers

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	A0003	Stone	60	19750806	17	2	50	5.3	0	0.2	0.4	1.7	0.1	1	0.1	2.5	0.1	9.0	<0.010	NA
2	K0001	Walthall	115	19660427	18	5	19	5.9	5	1.3	0.3	2.4	0.6	5	0.6	2.2	NA	9.8	NA	0.7
3	E0003	Covington	74	19660819	20	5	22	5.6	5	1.0	0.6	2.3	0.4	9	NA	2.9	NA	9.6	NA	NA
4	D0048	Pearl River	80	19850828	23	7	32	5.1	NA	1.4	0.7	2.2	0.7	NA	<.2	3.1	NA	8.7	0.010	NA
5	F0014	George	63	19590422	26	4	29	5.4	1	1.2	0.4	2.2	0.2	5	0.8	3.5	NA	2.3	NA	0.6
6	H0002	Jefferson Davis	80	19660819	29	10	38	6.0	5	2.8	0.7	3.7	1.3	16	NA	4.4	0.2	14	NA	NA
7	O0007	Simpson	204	19690624	31	4	25	5.9	0	1.5	0.1	3.2	0.4	7	0.8	2.9	0.1	8.5	NA	1.3
8	B0001	Walthall	110	19660817	31	6	32	6.1	5	1.9	0.3	3.3	0.5	12	NA	2.4	NA	10	NA	1.5
9	K0005	Simpson	130	19780712	36	7	34	5.2	5	1.3	0.9	3.1	0.8	10	2.0	3.8	<1	9.6	<0.010	NA
10	N0003	Amite	163	19780804	38	8	37	5.6	1	2.2	0.7	4.8	1.0	15	0.2	4.1	<.1	15	0.34	NA
11	H0025	Perry	122	19790606	40	3	34	5.3	20	0.7	0.3	3.6	1.1	10	1.6	2.9	<.1	17	0.060	0.2
12	F0020	Amite	80	19680311	47	8	59	5.6	10	1.9	0.8	6.8	0.3	9	1.2	9.9	NA	13	NA	2.7
13	E0048	Jones	86	19910731	48	19	74	5.0	5	2.9	2.9	3.2	1.7	NA	<.2	6.7	<1	9.2	0.010	NA
14	O0023	Wilkinson	208	19780804	60	8	83	5.6	1	1.2	1.2	11	1.4	15	3.4	12	<.1	16	<0.010	NA
15	K0026	Forrest	125	19850828	62	8	43	5.9	NA	2.1	0.6	4.8	1.9	NA	0.5	3.0	NA	33	0.011	NA
16	B0002	Harrison	70	19650209	66	24	90	6.0	5	4.0	3.4	3.9	1.0	22	0.4	5.3	0.2	10	NA	12
17	A0001	Pike	100	19680307	98	15	142	5.2	0	4.0	1.2	18	0.3	8	0.2	22	NA	10	NA	19
18	D0003	Copiah	108	19641102	135	52	221	6.0	5	11	6.0	18	2.9	22	17	30	0.1	14	NA	17
19	M0084	Forrest	70	19850619	149	24	210	5.0	NA	7.7	1.2	28	0.6	NA	4.5	57	NA	9.4	0.098	NA
20	H0010	Hancock	140	19650225	232	6	366	6.9	30	1.5	0.5	83	0.9	198	4.6	14	0.5	22	NA	0.3
21	Q0448	Jackson	180	19930324	395	NA	733	NA	70	NA	NA	NA	NA	NA	NA	130	NA	NA	NA	NA
22	P0130	Jackson	200	19600415	1020	190	1780	7.5	10	26	30	284	14	256	18	415	0.6	14	NA	0.6
23	G0065	Lincoln	187	19831130	1690	330	3010	4.7	NA	97	20	460	5.9	NA	0.3	940	NA	NA	NA	NA

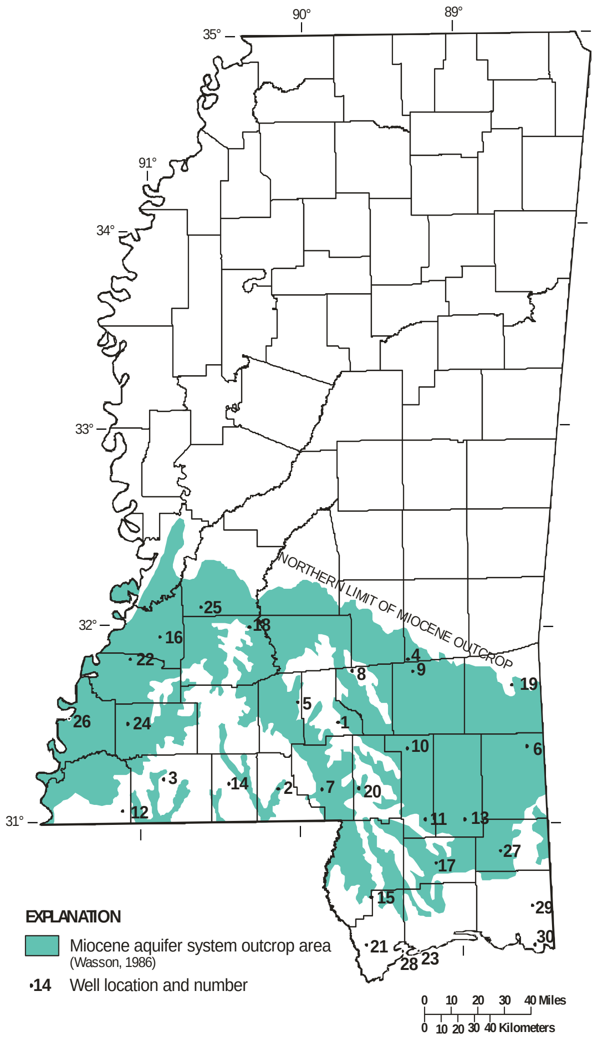


Figure 4. Location of the Miocene aquifer system outcrop area and selected wells.

Miocene Aquifer System – Generally, dissolved-solids concentrations increase with depth in water-bearing units in the Miocene aquifer system and increase downdip from areas of outcrop and recharge (Wasson, 1986). Wells less than 200 feet deep generally yield water with dissolved solids less than 100 mg/L, except where contaminated with brine from oil wells (Kalkhoff, 1982[a]). Also, the freshwater section of the Miocene aquifer system is more than 1,000 feet thick, and in some cases, more than 3,000 feet (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 4) representative of the range of dissolved-solids concentrations (but less than 1,000 mg/L) found in the Miocene aquifer system are listed in table 3.

For all wells screened in the Miocene aquifer system, dissolved-solids concentrations ranged from 8 to 130,000 mg/L with a median value of 192 mg/L (fig. 17); hardness ranged from 1 to 3,200 with a median value of 11 mg/L (fig. 18); specific conductance ranged from 16 to 150,000 µS/cm with a median value of 340 µS/cm (fig. 18); pH ranged from 4.2 to 9.9 standard units with a median value of 8.0 standard units (fig. 19); color ranged from 0 to 300 platinum-cobalt units with a median value of 7 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 5.1 mg/L with a median value of 0.03 mg/L (fig. 20); and nitrate ranged from 0.04 to 52 with a median value of 0.3 mg/L (fig. 20).

Table 3. Typical water-quality data for freshwater wells completed in the Miocene aquifer system

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to toal dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentratons in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate. M, Miocene; NA, no data; P, Pascagoula; C, Catahoula; H, Hattiesburg]

Map	Well	County	Formation	Depth	Date	ROE	Hardness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	K0001	Jefferson-Davis	M	425	19660426	23	5	22	5.7	5	1.3	0.3	1.7	0.7	6	0.4	1.8	NA	9.8	NA	1.2
2	F0011	Walthall	P	300	19660818	34	8	33	6.2	5	2.0	0.7	3.0	1.3	14	1.2	3.0	NA	17	NA	NA
3	H0002	Amite	M	279	19680403	62	12	62	6.4	0	3.5	0.8	5.5	2.2	32	0.2	1.6	0.1	30	NA	NA
4	R0002	Jasper	C	160	19680903	63	12	48	5.6	15	3.1	1.0	2.1	1.1	9	10	2.0	0.1	34	NA	0.1
5	H0008	Lawrence	C	500	19650720	96	10	121	6.6	0	4.0	NA	22	1.4	54	11	2.7	NA	25	NA	0.1
6	C0001	Greene	C	170	19650401	97	29	162	6.7	10	7.5	2.5	21	2.3	80	6.2	5.3	NA	12	NA	0.1
7	N0002	Marion	H	650	19660818	100	12	90	6.6	60	4.0	0.5	12	2.9	37	8.8	3.0	0.1	24	NA	0.1
8	B0002	Covington	C	400	19660426	112	15	114	6.6	0	4.7	0.9	18	4.3	52	9.0	2.8	0.1	52	NA	NA
9	A0003	Jones	C	470	19650826	115	4	104	6.3	0	1.6	NA	19	1.5	37	12	1.8	NA	56	NA	0.2
10	B0069	Forrest	M	654	19740206	129	44	206	7.6	3	11	4.0	28	4.9	115	9.6	2.6	0.2	12	0.35	NA
11	N0002	Forrest	H	529	19650614	148	16	205	6.9	5	5.0	0.9	39	1.1	113	1.2	3.6	0.2	41	NA	0.1
12	T0001	Wilkinson	M	875	19680814	154	31	173	6.7	20	8.7	2.2	25	1.6	88	8.0	4.9	0.1	56	NA	NA
13	R0001	Perry	M	194	19650615	157	16	249	7.2	5	4.9	0.9	51	0.9	144	NA	6.0	0.2	13	NA	0.2
14	E010B	Pike	M	710	19700217	159	20	156	7.8	0	7.1	0.6	27	1.5	88	4.8	3.0	0.1	63	NA	0.1
15	V0094	Pearl River	M	1,142	19740222	164	5	243	9.0	3	2.0	0.1	54	0.7	131	12	2.0	0.2	19	0.050	NA
16	N0001	Claiborne	M	100	19611020	167	55	199	6.9	10	13	5.5	17	1.4	52	21	20	0.1	41	NA	NA
17	F0001	Stone	M	951	19650716	174	2	231	7.3	NA	0.5	0.2	51	1.2	124	11	1.7	0.2	36	NA	NA
18	E0018	Copiah	C	310	19701021	178	9	224	7.1	0	2.8	0.5	49	2.9	126	12	0.4	0.1	42	NA	NA
19	N0003	Wayne	C	110	19550526	198	130	334	7.4	4	36	9.6	21	2.9	180	16	6.2	NA	9.4	NA	0.3
20	J0059	Lamar	M	196	19640805	223	100	275	7.2	30	28	7.8	19	2.4	157	0.2	8.9	0.1	58	NA	0.1
21	H0007	Hancock	M	1,434	19651029	270	5	412	7.4	10	1.0	0.6	95	1.0	224	11	14	0.3	20	NA	1.2
22	D0002	Jefferson	M	200	19621024	276	190	407	7.9	5	47	18	12	3.6	244	12	5.5	0.2	36	NA	NA
23	N0199d	Harrison	M	1,745	19660119	282	10	439	8.8	30	2.1	1.2	94	1.6	167	11	29	0.3	18	NA	0.2
24	F0001	Franklin	M	250	19600511	325	92	485	6.4	10	24	11	55	3.9	112	31	74	0.3	21	NA	4.2
25	S0002	Hinds	C	307	19580130	359	7	544	7.2	10	2.2	0.4	149	5.2	238	63	16	0.3	41	NA	0.1
26	C0020	Adams	M	142	19610601	482	420	794	7.8	5	94	46	12	1.6	540	0.8	7.1	0.3	32	NA	NA
27	E0055	George	M	380	19790621	501	5	720	8.6	60	1.4	0.3	200	0.5	410	2.8	42	1.4	15	<0.010	NA
28	K0473	Hancock	H	1,800	19960214	528	9	900	8.6	40	3.0	0.3	200	1.2	NA	<2	120	0.5	19	0.010	NA
29	L0078	Jackson	M	1,081	19700407	643	3	991	8.9	70	0.7	0.3	255	1.5	564	NA	26	1.4	16	NA	0.7
30	Q0164	Jackson	P	682	19770712	967	9	1650	8.4	30	3.2	0.3	380	1.9	340	2.6	380	0.8	25	0.050	NA

[a] Kalkolff, S.J., 1982, Specific conductance and dissolved chloride concentrations of freshwater aquifers and streams in petroleum producing areas in Mississippi: U.S. Geological Survey Open-File Report 82-353, 33 p.

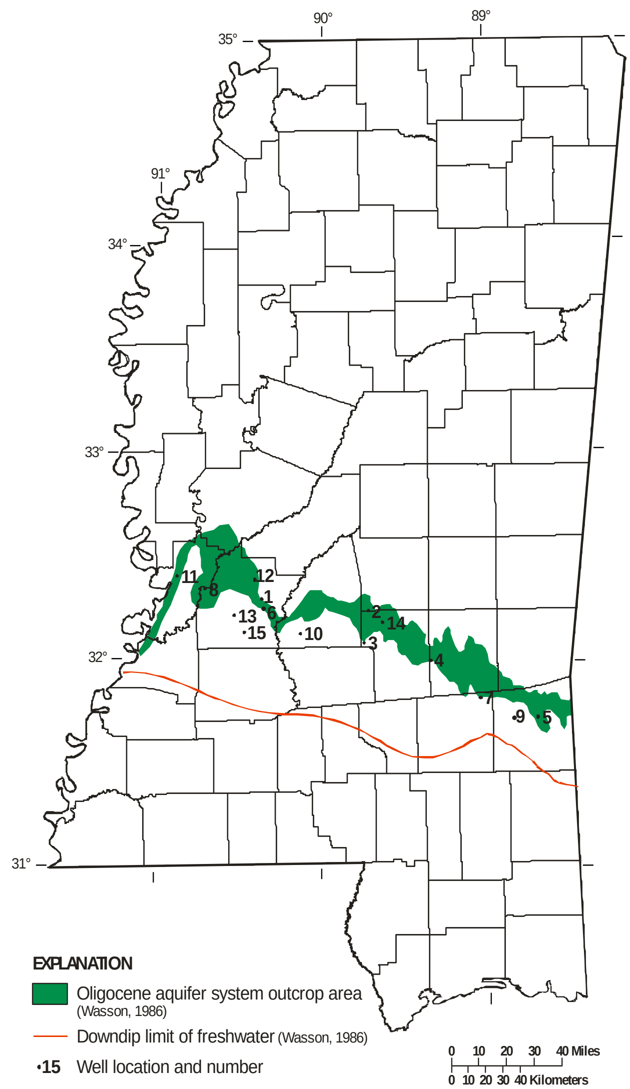


Figure 5. Location of the Oligocene aquifer system outcrop area and selected wells.

Oligocene Aquifer System – Dissolved-solids concentrations generally increase from north to south in the Oligocene aquifer system. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 5) ranges from about 15 miles near the Mississippi-Alabama boundary to about 35 miles in west-central Mississippi (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 5) representative of the range of dissolved-solids concentrations (but less than 1,000 mg/L) found in the Oligocene aquifer system are listed in table 4.

For all wells screened in the Oligocene aquifer system, dissolved-solids concentrations ranged from 40 to 1,480 mg/L with a median value of 323 mg/L (fig. 17); hardness ranged from 3 to 470 mg/L with a median value of 27 mg/L (fig. 18); specific conductance ranged from 46 to 2,430 µS/cm with a median value of 429 µS/cm (fig. 18); pH ranged from 5.3 to 8.8 standard units with a median value of 7.9 standard units (fig. 19); color ranged from 0 to 320 platinum-cobalt units with a median value of 10 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 9 mg/L with a median value of 0.14 mg/L (fig. 20); and nitrate ranged from 0.1 to 7.5 mg/L with a median value of 0.2 mg/L (fig. 20).

Table 4. Typical water-quality data for freshwater wells completed in the Oligocene aquifer system

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, FH, Forest Hill; V, Vicksburg; no data]

Map	Well	County	Form-ation	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	M0119	Hinds	FH	115	19841107	40	6	46	5.5	1	1.4	0.5	6	1.0	NA	0.9	5.3	<.1	17	0.25	NA
2	A0009	Smith	FH	55	19680905	86	20	149	6.3	10	4.5	2.1	21	0.4	50	0.6	14	NA	18	NA	4.6
3	E0004	Smith	FH	312	19680905	209	15	333	7.9	30	4.4	1.0	74	1.3	200	12	4.0	0.3	14	NA	0.1
4	J0014	Jasper	FH	225	19690507	216	180	348	7.9	0	43	18	5.6	1.3	218	11	3.9	0.1	18	NA	0.1
5	H0002	Wayne	V	120	19650401	261	15	428	7.4	15	3.9	13	95	2.3	258	9.6	1.8	0.6	11	NA	0.1
6	M0048	Hinds	FH	376	19590909	270	11	297	7.0	80	1.6	1.7	65	4.0	154	19	7.0	0.3	35	9.0	NA
7	D0007	Jones	FH	210	19550527	296	14	467	8.5	23	3.3	1.3	110	3.8	250	19	4.2	NA	NA	NA	1.2
8	D0008	Hinds	V	55	19590415	308	220	439	8.5	NA	50	24	16	1.2	244	22	10	0.3	15	0.040	NA
9	M0003	Wayne	V	377	19650616	323	29	521	7.3	5	5.6	3.6	114	2.7	319	6.8	3.2	1.2	10	NA	0.2
10	U0016	Rankin	FH	492	19720623	326	6	515	7.7	0	2.0	0.2	120	2.0	260	46	7.4	0.2	16	0.70	NA
11	F0008	Warren	FH	260	19620316	332	150	463	8.2	0	38	15	47	2.6	306	0.2	5.1	0.1	17	NA	0.1
12	F0005	Hinds	FH	233	19590909	342	22	483	8.1	NA	3.2	3.5	111	4.0	298	21	3.5	0.3	9.3	0.11	NA
13	P0026	Hinds	FH	313	19590909	456	4	657	8.5	110	1.1	0.3	173	3.6	408	4.6	9.5	1.7	7	0.19	NA
14	B0003	Smith	FH	135	19680905	641	470	921	7.5	NA	171	11	17	1.8	308	217	26	0.1	24	NA	NA
15	U0016	Hinds	FH	553	19590909	741	3	1060	8.4	320	NA	0.5	279	3.7	692	3.8	12	4.0	7.7	0.14	NA

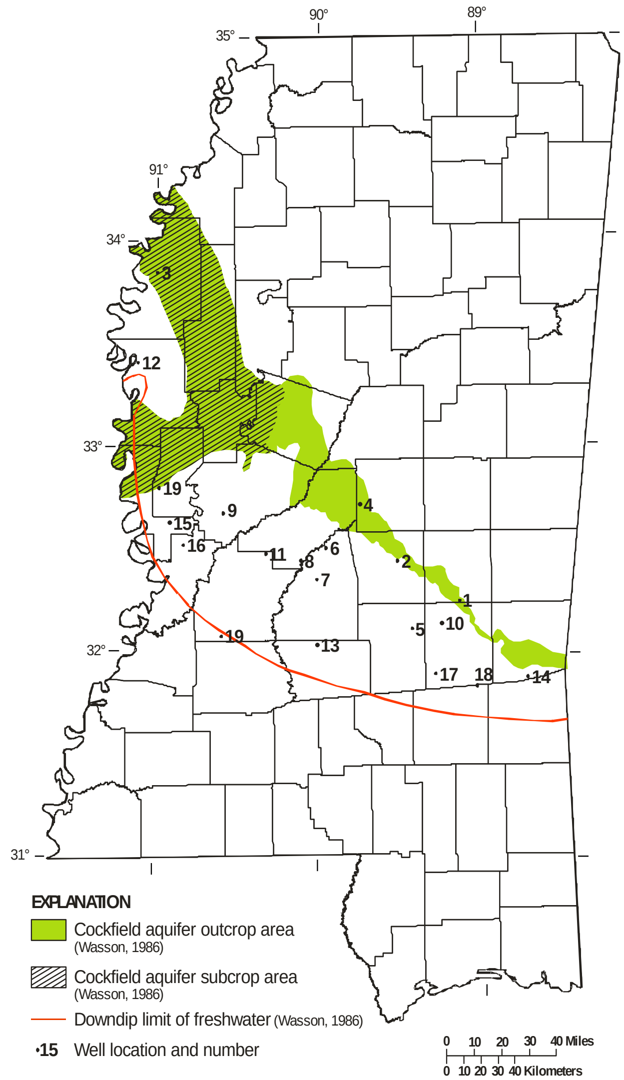


Figure 6. Location of the Cockfield aquifer outcrop area and selected wells.

Cockfield Aquifer – Dissolved-solids concentrations generally increase from northeast to southwest in the Cockfield aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 6) ranges from about 20 miles near the Mississippi-Alabama boundary to about 60 miles in west-central Mississippi (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 6) representative of the range of dissolved-solids concentrations found in the Cockfield aquifer are listed in table 5.

For all wells screened in the Cockfield aquifer, dissolved-solids concentrations ranged from 39 to 2,800 mg/L with a median value of 415 mg/L (fig. 17); hardness ranged from 1 to 430 mg/L with a median value of 10 mg/L (fig. 18); specific conductance ranged from 39 to 5,120 µS/cm with a median value of 700 µS/cm (fig. 18); pH ranged from 5.7 to 9.0 standard units with a median value of 8.0 standard units (fig. 19); color ranged from 0 to 1,000 platinum-cobalt units with a median value of 40 platinum-cobalt units (fig. 19); iron ranged from 0.010 to 14 mg/L with a median value of 0.16 mg/L (fig. 20); and nitrate ranged from 0.1 to 5.6 mg/L with a median value of 0.6 mg/L (fig. 20).

Table 5. Typical water-quality data for freshwater wells completed in the Cockfield aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hardness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	P0003	Newton	110	19680912	39	12	39	7.1	5	3.9	0.5	1.5	0.8	14	0.6	2.8	NA	19	NA	0.4
2	G0027	Scott	175	19680926	69	21	79	7.0	10	6.5	1.2	6.1	0.5	33	0.2	6.4	0.1	21	NA	NA
3	F0048	Bolivar	303	19710309	188	8	293	7.3	5	3.0	0.1	68	1.6	154	0.6	21	0.1	13	NA	1.2
4	J0004	Leake	77	19700707	190	44	236	6.8	10	11	4.0	26	0.5	32	0.6	51	NA	15	NA	5.6
5	H0007	Smith	486	19680911	224	36	370	7.9	5	7.5	4.2	66	3.4	141	39	20	0.2	19	NA	1.2
6	A0021	Rankin	500	19810819	249	61	308	6.7	40	17	4.5	45	3.2	130	37	10	0.1	57	14	NA
7	G0008	Rankin	772	19820701	258	7	361	7.4	4	1.6	0.7	89	1.7	NA	26	9.6	0.2	30	0.1	NA
8	W0021	Madison	600	19561001	299	5	549	7.5	25	1.6	0.2	113	0.7	258	30	15	0.4	13	1.6	NA
9	Q0008	Yazoo	560	19760123	310	NA	430	8.3	10	<.1	0.1	120	1.3	250	27	18	0.2	15	0.090	NA
10	F0001	Jasper	372	19680903	314	250	512	7.9	5	82	11	9.0	3.7	286	31	7.9	0.2	28	NA	0.8
11	C0011	Hinds	890	19561001	368	4	640	8.3	5	1.0	0.4	146	3.1	271	50	30	0.2	NA	NA	NA
12	D0015	Washington	527	19510524	398	5	654	8.5	55	1.2	0.5	156	9.9	293	2.3	68	0.2	17	NA	0.8
13	C0002	Simpson	1111	19700520	425	1	695	8.2	90	0.4	NA	165	1.8	346	44	22	0.6	15	NA	0.5
14	R0002	Clarke	211	19550526	451	17	796	8.2	45	4.6	1.3	182	5.0	436	33	22	1.0	3.6	NA	1.5
15	F0040	Issaquena	920	19950627	490	1	829	8.6	120	0.4	0.1	180	1.1	NA	35	29	0.8	14	0.016	NA
16	B0001	Warren	857	19610523	514	3	788	7.5	70	0.7	0.3	187	1.6	386	41	33	0.9	13	NA	NA
17	N0002	Jasper	913	19671128	546	11	899	7.8	10	2.4	1.2	202	2.2	361	82	53	0.2	12	NA	0.5
18	D0003	Jones	640	19550427	556	1	880	8.6	70	2.7	1.1	218	5.6	429	49	28	2.0	NA	NA	2.6
19	G0004	Sharkey	365	19620208	572	350	1250	7.3	5	82	36	79	2.7	538	63	22	0.3	17	NA	1.6
20	S0034	Hinds	1280	19751007	1320	8	1910	8.3	1000	2.5	0.4	550	2.6	1350	8.3	60	5.1	15	0.80	NA

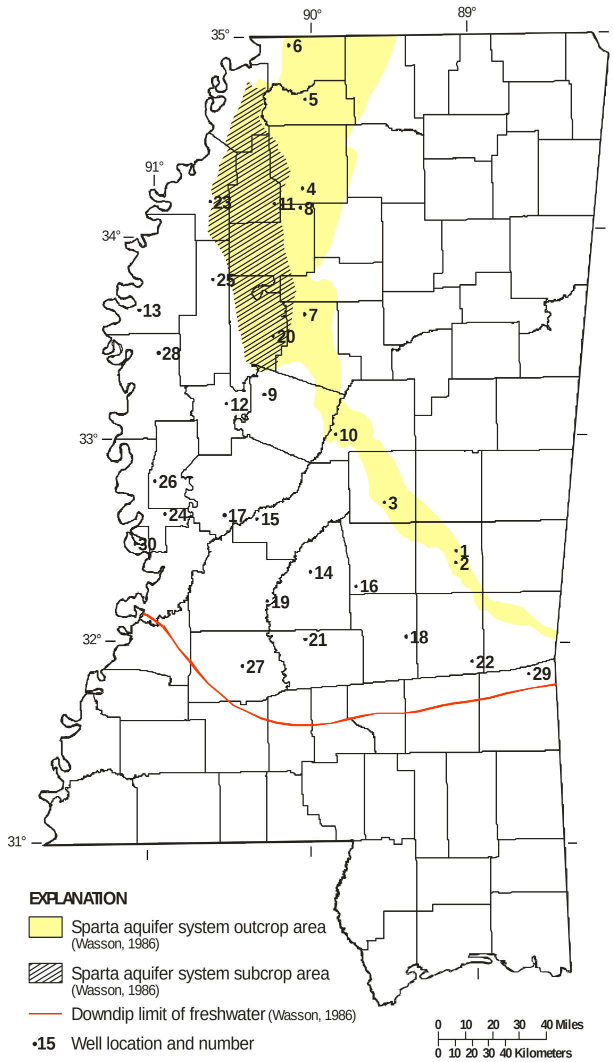


Figure 7. Location of the Sparta aquifer system outcrop area and selected wells.

Sparta Aquifer System – Dissolved-solids concentrations generally increase from northeast to southwest in the Sparta aquifer system. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 7) ranges from about 20 miles near the Mississippi-Alabama boundary to about 90 miles in west-central Mississippi (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 7) representative of the range of dissolved-solids concentrations found in the Sparta aquifer system are listed in table 6.

For all wells screened in the Sparta aquifer system, dissolved-solids concentrations ranged from 23 to 1,510 mg/L with a median value of 253 mg/L (fig. 17); hardness ranged from 1 to 290 mg/L with a median value of 9 mg/L (fig. 18); specific conductance ranged from 25 to 3,420 µS/cm with a median value of 385 µS/cm (fig. 18); pH ranged from 5.1 to 9.3 standard units with a median value of 8.0 standard units (fig. 19); color ranged from 0 to 200 platinum-cobalt units with a median value of 15 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 8.1 mg/L with a median value of 0.080 mg/L (fig. 20); and nitrate ranged from 0.04 to 14 with a median value of 0.4 mg/L (fig. 20).

Table 6. Typical water-quality data for freshwater wells completed in the Sparta aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	G0016	Newton	81	19680912	25	5	25	6.7	5	1.2	0.5	3.0	0.4	10	0.2	2.9	NA	7.9	NA	0.4
2	L0091	Newton	125	19900328	32	8	<50	5.4	<5	2.4	0.6	1.8	1.0	NA	6.9	2.4	<.1	21	0.66	NA
3	L0034	Leake	254	19700312	35	6	29	6.4	5	1.2	0.7	4.0	1.0	12	0.2	3.0	NA	16	NA	0.1
4	U0001	Panola	240	19710311	54	14	55	6.3	0	3.7	1.2	6.4	0.8	27	1.2	2.3	0.1	26	NA	1.3
5	B0006	Tate	158	19870713	66	21	100	6.2	<5	5.0	2.1	11	0.5	NA	0.4	9.8	<.1	16	0.030	NA
6	B0011	De Soto	388	19740710	68	35	80	5.7	3	8.6	3.2	7.2	1.3	53	3.8	3.1	0.1	13	0.66	NA
7	B0007	Carroll	195	19760709	78	17	75	6.1	0	5.0	1.1	8.5	0.9	37	2.8	3.4	0.1	29	0.17	NA
8	B0009	Tallahatchie	231	19761103	123	79	170	7.6	0	18	8.2	5.5	2.3	100	2.8	3.1	<.1	39	3.10	NA
9	G0051	Holmes	472	19920424	144	40	197	6.8	5	11	3.1	23	4.5	NA	7.2	4.3	0.1	43	0.03	NA
10	K0012	Attala	126	19570228	170	40	170	8.1	NA	10	3.5	21	3.6	88	7.0	6.5	0.2	NA	NA	0.7
11	J0003	Quitman	571	19570523	173	41	210	7.1	8	9.8	4.0	29	5.1	120	11	1.8	NA	NA	NA	0.1
12	C0015	Humphreys	791	19960410	198	3	289	7.6	NA	0.9	0.1	67	1.4	NA	8.5	1.6	0.1	37	0.078	NA
13	N0051	Bolivar	650	19960411	202	NA	359	8.9	NA	0.3	0.1	81	0.7	NA	0.3	20	0.3	11	0.014	NA
14	G0051	Rankin	1325	19880224	223	3	340	8.1	5	1.1	0.1	84	0.8	NA	6.7	2.0	0.1	22	0.15	NA
15	K0020	Madison	1380	19850730	236	28	300	7.2	10	9.9	0.7	59	1.6	NA	10	3.3	<.1	58	0.60	NA
16	N0004	Scott	1322	19870722	243	35	320	7.1	5	11	1.8	59	2.8	NA	13	4.0	0.1	56	0.64	NA
17	V0044	Yazoo	1582	19771102	247	2	380	8.5	16	0.8	0.1	100	0.5	250	5.5	2.2	0.1	18	0.030	NA
18	L0012	Smith	1086	19870722	288	1	440	8.8	5	0.4	0.1	100	1.1	NA	11	2.8	0.2	20	0.020	NA
19	R0176	Hinds	1232	19910529	295	NA	479	9.0	35	1.0	<.1	120	1.0	NA	8.0	1.9	0.3	16	0.12	0.04
20	L0154	Leflore	220	19720323	308	250	491	7.2	10	69	19	11	2.4	323	11	4.9	0.3	37	6.3	NA
21	C0043	Simpson	1910	19770325	337	6	480	8.6	200	2.1	0.2	130	1.2	315	3.4	4.8	0.5	20	0.090	NA
22	Q0049	Jasper	720	19850228	359	3	590	9.0	100	0.8	0.3	150	2.0	NA	8.2	3.6	0.4	16	0.040	NA
23	J0030	Coahoma	148	19740904	379	290	540	6.5	4	75	24	12	2.3	356	19	7.5	0.4	33	6.40	NA
24	F0007	Issaquena	1448	19950627	436	3	728	8.9	100	0.9	0.1	170	1.0	NA	2.1	9.1	0.5	16	0.11	NA
25	E0011	Sunflower	639	19761104	474	31	650	7.5	0	8.8	2.3	180	2.9	471	2.6	25	0.1	25	0.35	NA
26	G0028	Sharkey	800	19980520	497	1	813	8.9	NA	0.3	0.1	191	1.0	NA	0.3	26	0.6	11	0.022	NA
27	J0028	Copiah	2577	19641105	505	3	753	7.8	200	1.0	0.1	195	0.9	497	2.4	8.0	0.6	20	NA	0.3
28	E0120	Washington	1080	19871020	711	4	1200	8.8	60	1.2	0.2	280	2.0	NA	0.2	160	0.6	14	0.16	NA
29	D0004	Wayne	527	19640902	849	12	1240	7.9	NA	3.5	0.8	322	3.9	838	NA	12	2.3	22	NA	0.7
30	A0002	Warren	1741	19620712	1510	8	2620	8.7	200	3.0	0.1	598	3.9	699	0.4	440	1.8	11	NA	0.6

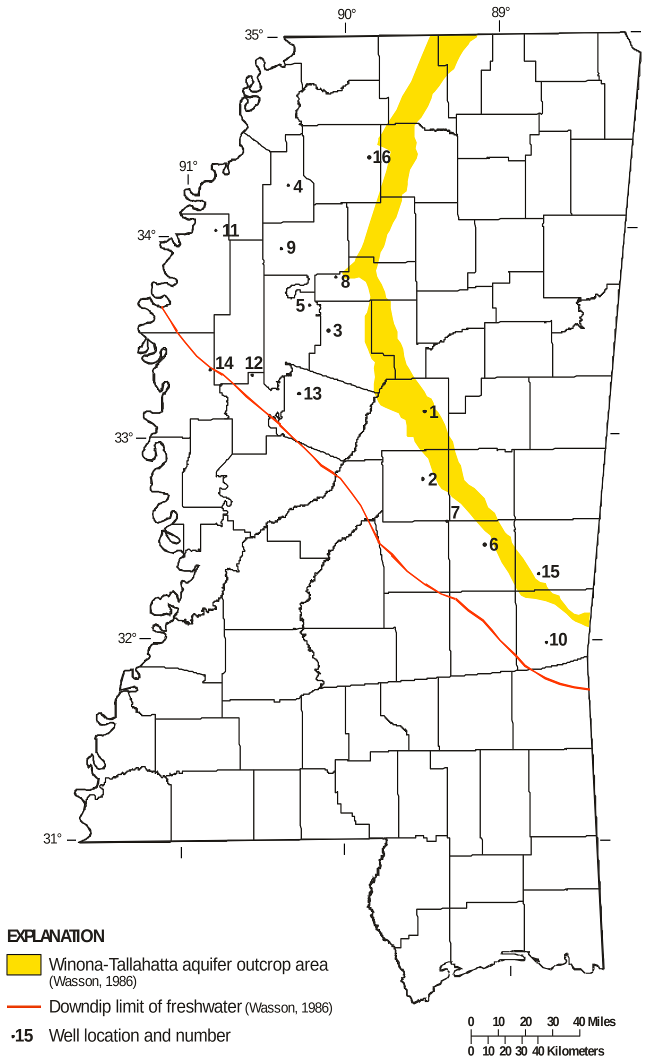


Figure 8. Location of the Winona-Tallahatta aquifer outcrop area and selected wells.

Winona-Tallahatta Aquifer– Dissolved-solids concentrations generally increase from northeast to southwest in the Winona-Tallahatta aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 8) ranges from about 20 miles near the Mississippi-Alabama boundary to about 70 miles in west-central Mississippi (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 8) representative of the range of dissolved-solids concentrations found in the Winona-Tallahatta aquifer are listed in table 7.

For all wells screened in the Winona-Tallahatta aquifer, dissolved-solids concentrations ranged from 70 to 1,030 mg/L with a median value of 281 mg/L (fig. 17); hardness ranged from 2 to 170 mg/L with a median value of 10 mg/L (fig. 18); specific conductance ranged from 28 to 2,150 µS/cm with a median value of 391 µS/cm (fig. 18); pH ranged from 5.6 to 8.8 standard units with a median value of 7.7 standard units (fig. 19); color ranged from 0 to 240 platinum-cobalt units with a median value of 16 platinum-cobalt units (fig. 19); iron ranged from 0.010 to 11 mg/L with a median value of 0.12 mg/L (fig. 20); and nitrate ranged from 0.1 to 2.7 mg/L with a median value of 0.5 mg/L (fig. 20).

Table 7. Typical water-quality data for freshwater wells completed in the Winona-Tallahatta aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter: Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	H0023	Attala	210	19870810	94	26	70	5.9	<5	6.7	2.2	3.1	2.6	NA	7.6	2.0	0.1	49	0.68	NA
2	G0007	Leake	225	19700707	127	8	105	6.9	30	2.4	0.5	19	2.7	52	7.0	1.9	0.1	58	NA	0.2
3	D0058	Carroll	238	19970409	142	81	214	7.4	40	21	7.0	9.2	6.0	NA	8.0	1.7	<.1	33	0.080	NA
4	E0031	Quitman	655	19721017	150	2	179	7.3	5	0.8	<.1	44	0.3	113	0.4	1.0	0.1	39	NA	NA
5	E0010	Leflore	382	19760722	184	14	260	7.6	5	4.0	0.9	58	2.8	168	2.3	2.3	0.2	35	0.41	NA
6	G0026	Newton	110	19690515	242	170	386	7.7	5	50	11	12	5.8	228	12	3.1	0.1	32	NA	1.5
7	D0001	Scott	270	19670214	259	39	389	7.4	10	11	2.8	76	3.8	207	27	1.9	1.3	35	NA	0.5
8	F0020	Grenada	478	19720209	264	8	424	7.4	5	2.0	0.7	110	5.0	272	NA	13	0.2	13	NA	0.1
9	J0020	Tallahatchie	816	19960417	298	2	471	7.8	NA	0.4	0.2	110	1.9	NA	0.3	15	0.2	41	0.13	NA
10	M0001	Clarke	472	19671130	328	10	510	7.7	10	4.0	NA	120	2.1	288	30	6.2	0.1	20	NA	0.1
11	B0112	Bolivar	1284	19960415	422	NA	686	8.5	NA	0.2	0.1	160	1.0	NA	1.0	39	0.4	30	0.044	NA
12	A0021	Humphreys	1310	19900605	464	2	700	8.1	240	0.5	0.2	180	1.3	NA	6.8	6.3	0.9	29	0.180	NA
13	G0050	Holmes	819	19920424	576	6	900	NA	150	1.8	0.4	230	2.5	NA	0.2	2.3	0.5	25	0.050	NA
14	J0005	Washington	1792	19620104	1030	NA	1590	8.2	100	NA	NA	419	2.0	1100	2.0	2.3	1.7	17	NA	NA
15	R0008	Lauderdale	100	19610901	NA	39	NA	8.2	NA	9.9	3.4	NA	NA	NA	8.8	4.0	0.1	2.4	NA	NA
16	N0046	Panola	325	19920528	NA	7	32	6.2	NA	1.9	0.7	3.2	NA	NA	NA	NA	NA	14	0.012	NA

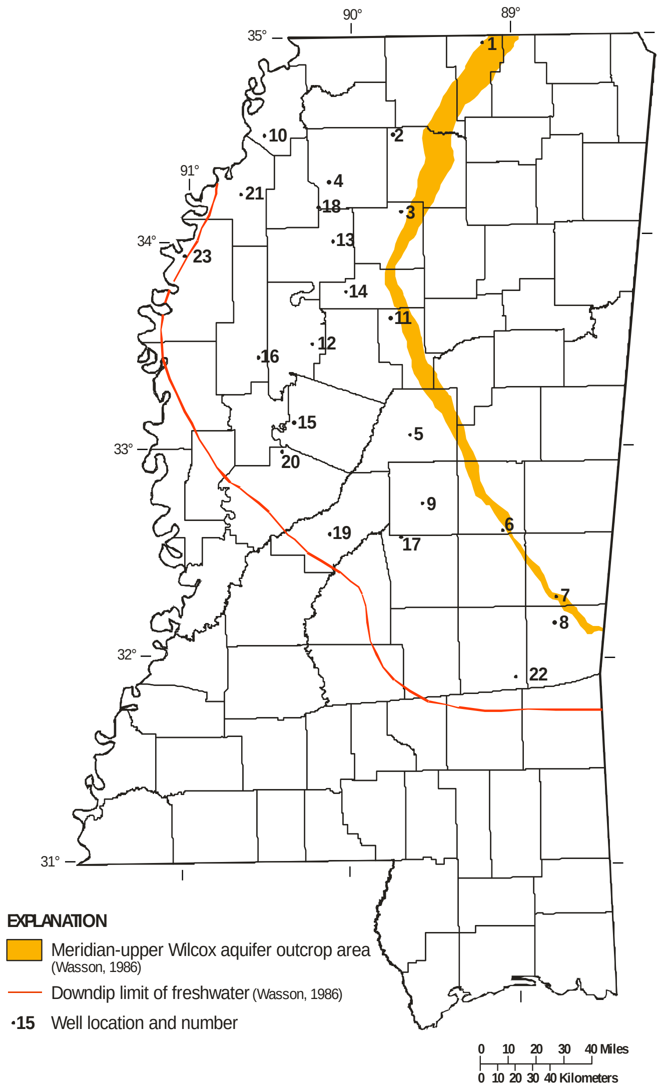


Figure 9. Location of the Meridian-upper Wilcox aquifer outcrop area and selected wells.

Meridian-upper Wilcox Aquifer– Dissolved-solids concentrations generally increase from northeast to southwest in the Meridian-upper Wilcox aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 9) ranges from about 30 miles near the Mississippi-Alabama boundary to about 90 miles in west-central Mississippi (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 9) representative of the range of dissolved-solids concentrations found in the Meridian-upper Wilcox aquifer are listed in table 8.

For all wells screened in the Meridian-upper Wilcox aquifer, dissolved-solids concentrations ranged from 26 to 1,530 mg/L with a median value of 212 mg/L (fig. 17); hardness ranged from 1 to 1,000 mg/L with a median value of 8 mg/L (fig. 18); specific conductance ranged from 23 to 3,250 µS/cm with a median value of 307 µS/cm (fig. 18); pH ranged from 5.2 to 9.0 standard units with a median value of 7.7 standard units (fig. 19); color ranged from 0 to 200 platinum-cobalt with a median value of 10 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 5.0 mg/L with a median value of 0.12 mg/L (fig. 20); and nitrate ranged from 0.1 to 41 mg/L with a median value of 0.3 mg/L (fig. 20).

Table 8. Typical water-quality data for freshwater wells completed in the Meridian-Upper Wilcox aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; K, potassium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hardness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	B0020	Benton	155	19740208	26	6	23	5.6	3	1.7	0.5	1.5	0.7	8	5.3	1.8	0.1	13	0.040	NA
2	A0001	Lafayette	366	19720614	37	5	25	6.3	0	1.8	0.1	3.0	0.8	13	0.2	0.9	NA	13	NA	0.1
3	C0081	Yalobusha	30	19931013	40	8	40	5.6	<5	1.8	0.8	3.3	0.8	NA	1.8	2.9	<.1	16	0.020	NA
4	Q0006	Panola	650	19631113	80	15	104	7.1	0	2.8	1.9	14	4.0	53	4.4	1.8	NA	21	NA	0.1
5	M0061	Attala	436	19760120	106	39	110	6.2	10	9.0	4.0	3.8	4.0	47	7.8	1.7	<.1	59	0.64	NA
6	P0021	Neshoba	169	19670214	132	44	140	6.3	20	9.8	4.7	4.6	2.6	75	3.6	3.7	0.1	59	NA	0.1
7	R0017	Lauderdale	292	19680919	155	50	251	7.3	5	18	1.2	36	1.2	150	6.0	1.4	NA	16	NA	0.8
8	B0084	Clarke	374	19791107	159	11	205	6.8	5	3.2	0.7	45	3.0	110	12	2.7	0.1	42	0.26	NA
9	K0001	Leake	612	19720329	167	1	253	7.7	20	0.4	NA	63	1.0	156	8.4	1.7	0.1	9.6	NA	0.1
10	J0010	Tunica	1004	19740831	179	3	210	7.7	6	1.0	<.1	55	1.2	143	2.5	1.6	0.3	30	0.15	NA
11	D0026	Montgomery	477	19710216	188	9	289	7.5	10	3.0	0.4	68	1.2	186	3.6	2.9	0.1	12	NA	0.2
12	L0252	Leflore	830	19960416	190	2	320	8.4	NA	0.4	0.1	79	1.3	NA	6.3	1.9	0.2	15	<.10	NA
13	F0025	Tallahatchie	560	19720524	219	18	306	7.0	10	4.6	1.6	62	3.7	172	0.2	8.3	0.1	27	NA	0.1
14	F0002	Grenada	440	19700923	234	5	384	8.1	5	1.2	0.5	90	5.6	237	NA	10	0.2	14	NA	NA
15	J0019	Holmes	1488	19790830	242	2	365	8.3	5	0.5	0.1	87	0.8	240	5.2	2.1	0.1	14	0.030	NA
16	R0031	Sunflower	1485	19761104	277	2	400	8.0	5	1.0	<.1	110	1.0	306	2.0	2.7	0.1	13	0.050	NA
17	A0023	Scott	1230	19870722	349	7	600	8.8	40	2.0	0.5	140	1.2	NA	0.8	2.1	0.3	8.6	0.60	NA
18	J0056	Quitman	926	19960418	362	4	619	8.8	NA	1.1	0.3	150	1.5	NA	0.4	17	0.3	12	0.025	NA
19	M0049	Madison	1951	19880823	459	5	750	8.6	40	1.4	0.3	190	1.4	NA	0.2	1.9	0.3	17	0.23	NA
20	A0059	Yazoo	1760	19900605	461	5	700	8.0	20	1.4	0.3	190	1.5	NA	0.3	5.3	0.7	16	0.060	NA
21	J0134	Coahoma	1206	19920122	557	3	NA	8.5	10	0.7	0.2	220	1.6	NA	<.2	120	0.4	26	0.14	NA
22	Q0048	Jasper	1210	19850223	713	5	1160	8.7	<1	1.2	0.4	300	2.2	NA	4.9	4.7	1.5	13	0.17	NA
23	C0118	Bolivar	1738	19720405	1340	14	2330	7.9	20	3.7	1.2	540	18	737	NA	420	1.0	13	NA	0.2

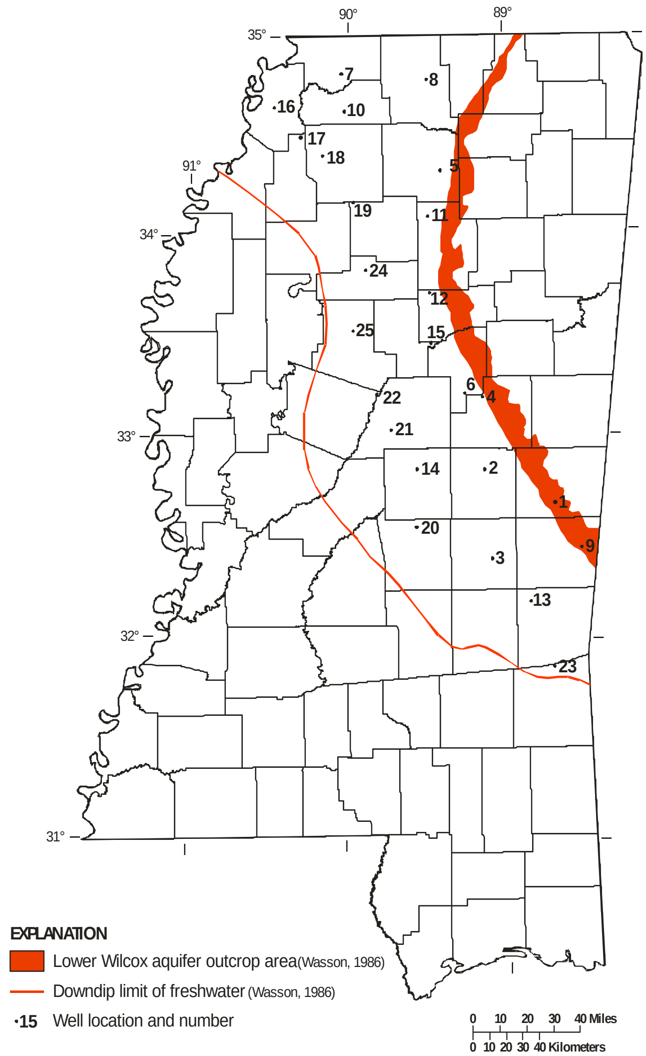


Figure 10. Location of the Lower Wilcox aquifer outcrop area and selected wells.

Lower Wilcox Aquifer – Dissolved-solids concentrations generally increase from northeast to southwest in the Lower Wilcox aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 10) ranges from about 50 to 80 miles. Dissolved-solids concentrations are high in the central part of the aquifer where transmissivity values are low (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 10) representative of the range of dissolved-solids concentrations found in the Lower Wilcox aquifer are listed in table 9.

For all wells screened in the Lower Wilcox aquifer, dissolved-solids concentrations ranged from 13 to 4,310 mg/L with a median value of 165 mg/L (fig. 17); hardness ranged from 1 to 130 mg/L with a median value of 16 mg/L (fig. 18); specific conductance ranged from 19 to 7,500 µS/cm with a median value of 269 µS/cm (fig. 18); pH ranged from 5.1 to 8.9 standard units with a median value of 7.5 standard units (fig. 19); color ranged from 0 to 250 platinum-cobalt units with a median value of 7 platinum-cobalt units (fig. 19); iron ranged from 0.010 to 10 mg/L with a median value of 0.14 mg/L (fig. 20); and nitrate ranged from 0.1 to 17 mg/L with a median value of 0.3 mg/L (fig. 20).

Table 9. Typical water-quality data for freshwater wells completed in the Lower Wilcox aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	S0003	Kemper	118	19561025	13	4	19	6.1	7	1.2	0.3	1.5	0.6	6	0.8	2.5	NA	NA	NA	0.4
2	G0003	Neshoba	650	19850709	64	32	84	NA	3	6.0	4.0	8.0	3.0	NA	3.3	3.7	0.1	15	10	NA
3	L0092	Newton	1661	19900328	109	24	188	7.0	<5	7.0	1.6	30	4.6	NA	6.0	4.9	<.1	16	7.9	NA
4	D0013	Winston	406	19850722	112	42	185	5.7	NA	11	3.4	22	3.0	NA	3.2	4.1	<.1	24	3.4	NA
5	L0013	Lafayette	230	19780711	128	22	200	7.3	5	4.7	2.5	40	2.1	120	2.9	2.2	0.1	9.8	0.40	NA
6	J0042	Choctaw	500	19940824	143	27	220	7.9	<5	7.8	1.8	40	1.9	NA	<.2	4.0	<.1	21	0.16	NA
7	L0055	De Soto	1397	19780713	152	9	220	7.4	1	2.8	0.5	55	1.3	140	2.4	2.2	0.1	12	0.14	NA
8	P0003	Marshall	344	19581125	158	19	212	6.8	0	14	4.7	15	4.1	24	20	26	0.1	5.6	NA	17
9	J0109	Lauderdale	280	19850726	168	63	270	7.0	3	20	3.0	32	3.2	NA	11	6.1	0.1	29	0.19	NA
10	G0061	Tate	1167	19750115	171	9	260	8.2	4	2.2	0.9	58	1.2	163	0.4	5.0	0.1	14	0.030	NA
11	A0003	Calhoun	286	19701203	172	9	251	7.5	5	2.4	0.7	57	2.8	158	2.6	3.0	0.1	23	NA	0.3
12	A0010	Webster	280	19850728	184	11	322	NA	3	3.2	0.8	74	1.4	NA	1.2	6.3	0.1	11	0.039	NA
13	A0110	Clarke	1336	19780713	187	4	298	8.0	3	1.0	0.3	70	1.7	160	4.4	12	0.1	17	0.14	NA
14	F0006	Leake	1659	19850711	190	15	328	NA	5	4.5	0.8	72	1.1	NA	6.7	5.6	<.1	16	0.014	NA
15	L0002	Montgomery	580	19850728	194	2	335	NA	5	0.5	0.1	79	0.7	NA	1.7	11	0.1	13	0.015	NA
16	G0027	Tunica	1680	19780609	247	3	416	8.3	20	1.0	0.2	95	1.1	230	2.0	17	0.2	14	0.040	NA
17	A0013	Quitman	1490	19710311	281	2	459	7.8	5	0.8	NA	108	1.0	232	NA	35	0.2	11	NA	0.1
18	K0022	Panola	1127	19921007	286	4	444	8.2	5	1.3	0.2	100	1.6	NA	<.2	23	0.2	13	0.078	NA
19	A0001	Yalobusha	998	19710310	292	10	477	8.3	15	3.0	0.6	115	1.4	287	NA	12	0.2	15	NA	1.3
20	B0023	Scott	2140	19891012	326	3	520	8.4	10	0.9	0.2	130	1.1	NA	<.1	16	0.3	16	0.16	NA
21	L0042	Attala	1379	19860731	336	NA	500	8.4	40	0.1	0.1	135	0.9	NA	0.1	12	0.2	14	0.27	NA
22	F0017	Holmes	1339	19850724	434	3	735	NA	NA	1.0	0.2	170	1.1	NA	3.6	47	0.3	14	0.045	NA
23	C0058	Wayne	2402	19820908	571	6	1060	8.6	15	1.9	0.3	240	1.1	NA	7.0	150	0.7	17	NA	NA
24	A0022	Grenada	650	19780714	686	11	1150	8.3	1	3.3	0.7	270	2.0	170	3.4	190	0.4	11	0.070	NA
25	F0001	Carroll	1274	19760716	729	7	1300	8.3	20	2.5	0.2	380	1.7	402	2.8	350	0.5	15	0.18	NA

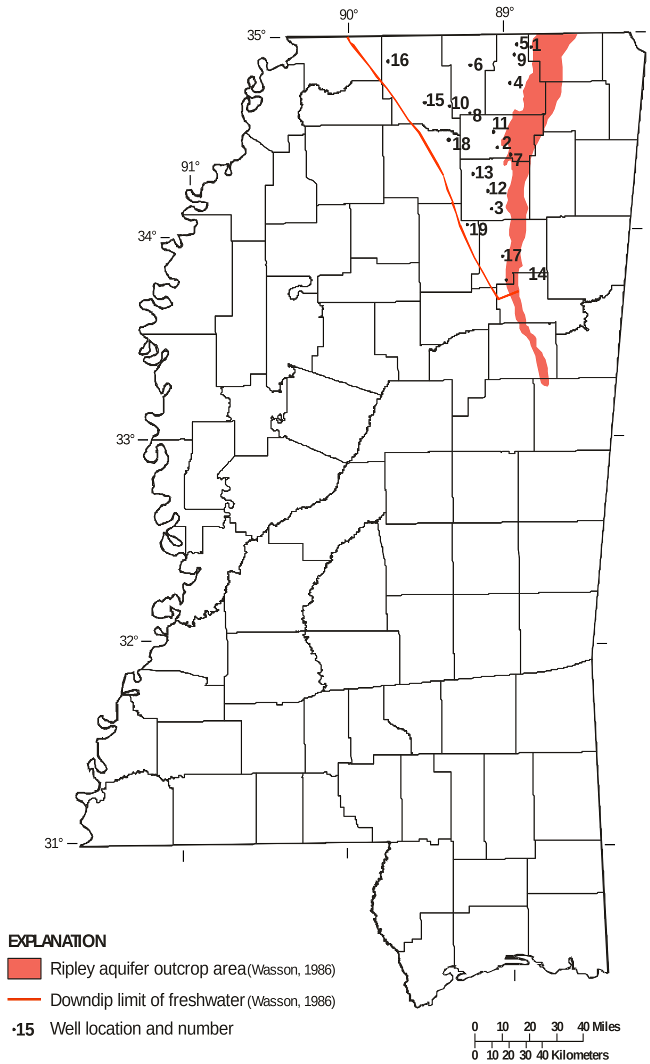


Figure 11. Location of the Ripley aquifer outcrop area and selected wells.

Ripley Aquifer – Dissolved-solids concentrations generally increase from northeast to southwest in the Ripley aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 11) ranges from about 15 to 70 miles (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 11) representative of the range of dissolved-solids concentrations found in the Ripley aquifer are listed in table 10.

For all wells screened in the Ripley aquifer, dissolved-solids concentrations ranged from 34 to 587 mg/L with a median value of 247 mg/L (fig. 17); hardness ranged from 5 to 250 mg/L with a median value of 45 mg/L (fig. 18); specific conductance ranged from 40 to 900 µS/cm with a median value of 377 µS/cm (fig. 18); pH ranged from 5.0 to 8.9 standard units with a median value of 8.1 standard units (fig. 19); color ranged from 0 to 200 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from <0.010 to 5.4 mg/L with a median value of 0.12 mg/L (fig. 20); and nitrate ranged from 0.04 to 4.4 mg/L with a median value of 1.3 mg/L (fig. 20).

Table 10. Typical water-quality data for freshwater wells completed in the Ripley aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hardness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	E0003	Alcorn	125	19810108	34	6	40	5.0	NA	1.3	0.6	2.0	0.5	6	<.1	1.9	<.1	16	0.010	NA
2	H0028	Union	187	19570725	120	98	212	7.9	NA	33	3.9	5.6	1.0	122	6.8	3.5	0.5	NA	NA	0.4
3	K0001	Pontotoc	148	19571004	184	150	329	7.8	5	38	13	13	7.0	202	16	2.0	0.9	NA	NA	1.3
4	J0043	Tippah	265	19780712	185	160	310	7.3	1	54	6.0	2.3	1.0	190	6.9	1.3	0.1	12	0.99	NA
5	B0008	Tippah	150	19541202	190	160	342	8.0	10	50	8.8	3.4	1.9	186	6.8	5.0	0.4	19	NA	NA
6	H0010	Benton	920	19730131	191	140	306	8.3	5	45	6.7	13	2.1	196	9.4	1.3	0.1	18	NA	NA
7	M0007	Union	245	19670322	191	150	304	7.3	5	50	6.1	4.3	1.4	185	5.2	4.1	0.2	28	NA	0.1
8	O0009	Benton	612	19581125	192	39	270	8.1	1	9.9	3.5	52	4.7	180	10	1.2	0.3	4.9	NA	2.0
9	D0014	Tippah	190	19780712	222	180	374	7.4	1	64	5.5	3.4	1.4	230	7.4	1.0	0.1	19	0.74	NA
10	U0002	Marshall	730	19581125	255	20	363	8.3	0	5.6	1.4	84	3.4	232	7.8	1.5	0.5	5.5	NA	2.3
11	B0004	Union	326	19570725	284	20	454	8.5	NA	5.7	1.3	106	4.8	288	4.8	2.5	1.6	NA	NA	1.2
12	F0014	Pontotoc	208	19780711	308	180	500	7.7	1	39	20	38	6.5	230	74	4.5	0.2	12	0.32	NA
13	A0046	Pontotoc	440	19780524	311	33	495	8.1	5	8.3	3.0	110	3.6	290	23	6.4	0.8	11	0.060	NA
14	O0003	Chickasaw	135	19591001	356	250	541	8.4	0	69	18	29	6.7	290	38	12	0.4	13	NA	2.4
15	S0036	Marshall	1060	19780713	360	11	540	8.1	1	3.3	0.7	140	2.3	370	7.3	0.9	0.5	14	0.090	NA
16	D0005	Marshall	1620	19700415	457	6	757	8.9	0	1.2	0.7	187	2.0	440	0.2	2.0	0.8	14	NA	NA
17	F0018	Chickasaw	115	19580718	489	110	711	7.5	6	23	12	130	6.9	308	132	9.0	0.9	9.5	NA	4.4
18	D0001	Lafayette	950	19570729	507	23	785	8.6	NA	6.7	1.6	192	6.8	503	1	7.5	2.8	NA	NA	1.7
19	E0007	Calhoun	630	19560806	587	40	900	8.2	5	9.2	4.1	214	7.8	566	2.4	33	4.0	NA	NA	NA

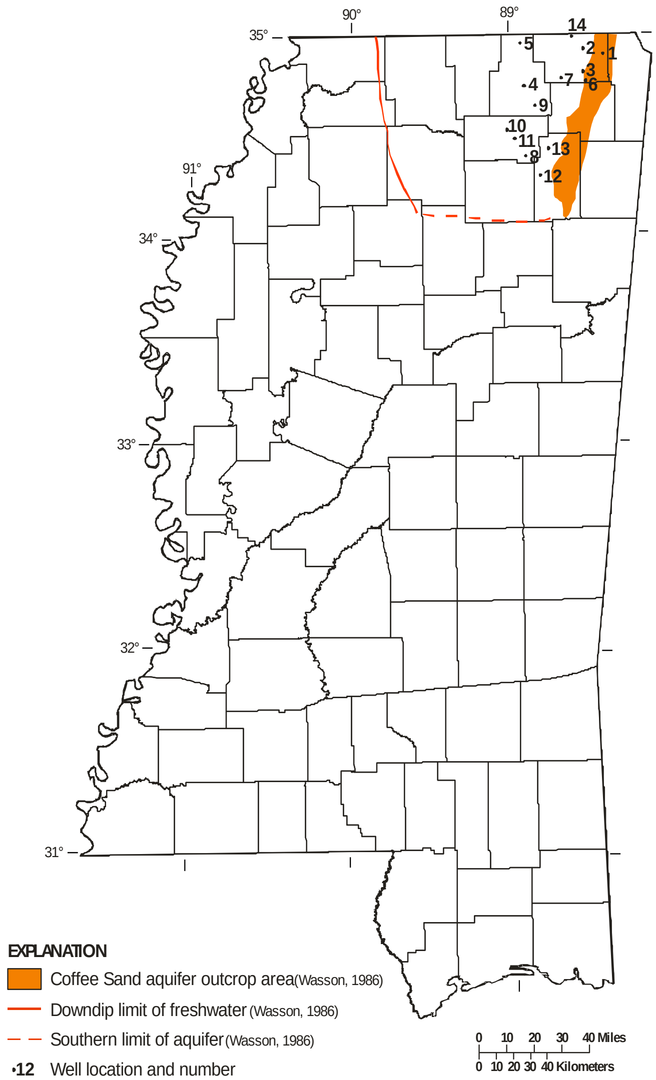


Figure 12. Location of the Coffee Sand aquifer outcrop area and selected wells.

Coffee Sand Aquifer – Dissolved-solids concentrations generally increase downdip in the Coffee Sand aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 12) is about 70 miles (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 12) representative of the range of dissolved-solids concentrations found in the Coffee Sand aquifer are listed in table 11.

For all wells screened in the Coffee Sand aquifer, dissolved-solids concentrations ranged from 48 to 495 mg/L with a median value of 190 mg/L (fig. 17); hardness ranged from 5 to 300 mg/L with a median value of 100 mg/L (fig. 18); specific conductance ranged from 40 to 761 µS/cm with a median value of 280 µS/cm (fig. 18); pH ranged from 5.4 to 8.8 standard units with a median value of 7.7 standard units (fig. 19); color ranged from 0 to 15 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from 0.030 to 1.7 mg/L with a median value of 0.080 mg/L (fig. 20); and nitrate ranged from 0.1 to 27 mg/L with a median value of 0.4 mg/L (fig. 20).

Table 11. Typical water-quality data for freshwater wells completed in the Coffee Sand aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	H0012	Alcorn	90	19560929	48	18	65	6.1	5	5.8	1.8	1.7	1.6	22	6.6	1.5	0.4	NA	NA	0.2
2	G0003	Alcorn	245	19540623	70	31	89	6.4	5	8.6	2.4	2.2	4.7	38	8.4	1.0	NA	9.7	NA	NA
3	K0006	Alcorn	156	19560929	110	66	151	7.0	5	21	3.3	2.3	1.7	82	1.8	2.5	0.3	NA	NA	0.2
4	K0001	Tippah	720	19600224	164	120	254	8.0	5	44	3.6	6.0	2.7	163	5.0	1.5	0.2	9.1	NA	0.2
5	B0011	Tippah	961	19810106	165	92	270	8.2	NA	25	6.9	18	4.8	150	18	2.3	0.1	13	0.050	NA
6	L0007	Alcorn	34	19560928	176	5	297	5.4	5	6.7	4.4	36	3.0	6	4.4	62	0.2	NA	NA	19
7	J0075	Alcorn	546	19731212	202	150	323	7.4	NA	48	8.1	3.3	4.2	196	7.8	2.6	0.1	22	0.56	NA
8	N0012	Union	512	19870810	209	35	352	8.8	<5	10	2.4	67	3.1	NA	4.0	12	1.4	10	0.030	NA
9	P0008	Tippah	720	19720613	225	120	350	7.7	0	31	9.4	24	5.2	146	37	7.4	0.2	13	NA	0.2
10	C0009	Union	612	19780712	225	15	380	8.2	10	4.3	1.1	85	2.6	200	20	4.9	1.3	9.6	0.14	NA
11	H0029	Union	900	19780712	287	99	530	7.3	3	29	6.5	75	4.2	150	5.2	82	0.2	11	0.070	NA
12	G0005	Lee	147	19190905	324	47	NA	NA	NA	9.4	5.6	NA	NA	202	38	13	NA	25	NA	0.9
13	A0016	Lee	200	19670216	412	180	650	7.0	10	51	12	62	5.5	108	162	42	0.4	12	NA	0.8
14	C0004	Alcorn	300	19561001	495	300	761	7.7	7	152	7.5	13	2.6	384	75	38	0.3	NA	NA	0.4

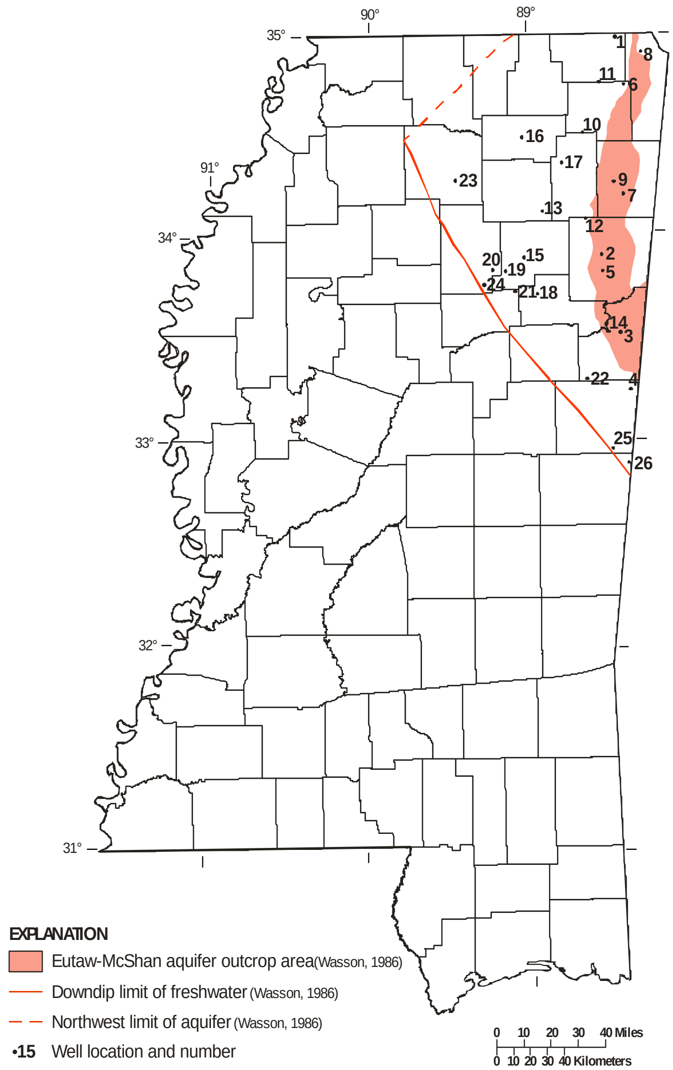


Figure 13. Location of the Eutaw-McShan aquifer outcrop area and selected wells.

Eutaw-McShan Aquifer – Dissolved-solids concentrations generally increase downdip in the Eutaw-McShan aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 13) ranges from about 20 miles near the Mississippi-Alabama boundary to about 80 miles in north-central Mississippi (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 13) representative of the range of dissolved-solids concentrations found in the Eutaw-McShan aquifer are listed in table 12.

For all wells screened in the Eutaw-McShan aquifer, dissolved-solids concentrations ranged from 21 to 8,970 mg/L with a median value of 210 mg/L (fig. 17); hardness ranged from 1 to 490 mg/L with a median value of 42 mg/L (fig. 18); specific conductance ranged from 20 to 12,700 µS/cm with a median value of 260 µS/cm (fig. 18); pH ranged from 4.1 to 9.2 standard units with a median value of 7.3 standard units (fig. 19); color ranged from 0 to 400 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from 0.010 to 200 mg/L with a median value of 2.5 mg/L (fig. 20); and nitrate ranged from 0.04 to 17 mg/L with a median value of 0.3 mg/L (fig. 20).

Table 12. Typical water-quality data for freshwater wells completed in the Eutaw-McShan aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	D0003	Alcorn	350	19631003	81	28	86	6.1	0	8.0	1.9	3.9	1.8	32	7.6	3.6	0.1	20	NA	0.1
2	G0062	Monroe	90	19800423	85	46	108	7.3	0	14	2.7	1.9	1.9	56	4.2	1.1	0.2	22	0.86	NA
3	G0201	Lowndes	270	19911002	89	42	162	7.4	5	12	2.8	15	6.0	NA	<.2	1.6	<.1	13	0.070	NA
4	E0004	Noxubee	460	19561025	107	1	194	8.0	5	0.4	0.1	40	1.8	104	1.0	3.0	0.5	NA	NA	0.6
5	L0079	Monroe	130	19770928	127	61	195	7.7	0	18	3.8	20	5.0	120	<1.0	4.9	0.1	13	0.020	NA
6	D0037	Prentiss	280	19800714	130	69	187	7.7	3	24	2.3	10	3.9	NA	15	2.3	0.3	26	0.010	NA
7	L0018	Itawamba	26	19770913	145	51	250	6.4	120	15	3.3	13	1.8	100	0.4	5.0	0.1	22	34*	0.3
8	B0032	Tishomingo	34	19800507	159	100	326	5.4	2	31	6.5	3.8	2.8	170	9	3.4	0.1	11	39*	<.3
9	G0066	Itawamba	71	19800422	170	120	248	6.6	5	39	5.0	1.4	7.6	150	1.1	2.0	NA	16	67*	0.3
10	J0068	Prentiss	420	19720613	174	110	306	7.3	0	35	5.5	19	3.6	136	9.6	21	0.1	13	NA	NA
11	K0052	Alcorn	285	19671204	196	160	323	7.6	0	53	7.0	2.3	2.6	196	10	2.4	NA	18	NA	NA
12	O0015	Lee	282	19580618	217	150	362	7.4	0	50	6.8	13	6.0	176	34	4.0	NA	20	NA	NA
13	M0003	Pontatoc	792	19571004	225	16	397	7.9	5	4.8	1.0	80	3.5	153	4.4	46	0.9	NA	NA	1.1
14	J0098	Clay	58	19780830	246	120	396	6.9	10	35	8.9	30	7.5	230	11	6.6	0.1	17	0.090	0.5
15	F0016	Chiclasaw	1076	19540625	316	26	565	7.5	5	8.3	1.5	109	4.0	167	3.8	90	0.1	8.9	NA	1.2
16	H0008	Union	1030	19541202	358	110	716	7.7	5	27	11	85	5.2	150	6	130	0.4	14	NA	0.1
17	D0025	Lee	606	19720405	406	170	790	7.3	0	49	12	81	4.3	140	3.2	170	0.2	11	NA	NA
18	D0017	Clay	800	19601025	419	14	688	8.1	5	2.6	1.7	151	4.2	302	NA	20	1.4	6.3	NA	NA
19	J0018	Chickasaw	1341	19710311	423	16	761	8.0	5	5.8	0.4	165	3.0	262	NA	115	0.6	17	NA	1.4
20	L0008	Calhoun	1445	19701202	510	12	835	8.3	5	4.9	NA	185	2.3	278	NA	120	0.7	14	NA	1
21	E0002	Webster	1120	19600610	520	14	836	8.0	6	4.6	0.7	182	4.4	348	1.4	95	0.8	5.0	NA	1.3
22	N0001	Lowndes	757	19640410	622	24	1060	7.8	5	9.0	0.4	244	3.9	452	0.4	130	0.3	11	NA	NA
23	L0005	Lafayette	1692	19720614	754	52	1400	7.8	0	NA	29	260	5.0	189	0.2	320	0.5	14	NA	0.2
24	O0003	Calhoun	1550	19610720	769	10	1320	7.7	5	3.0	0.6	285	29	456	1.6	201	2.0	12	NA	0.3
25	T0003	Noxubee	961	19550922	796	10	1470	8.0	7	3.3	0.6	315	6.3	278	2.6	330	1.0	NA	NA	0.4
26	E0035	Kemper	945	19871211	869	11	1590	8.9	<5	3.1	0.7	340	3.8	NA	<.1	350	0.7	13	0.050	NA

*__NOTE:__ High values of iron presented in this figure were closely associated with samples from wells that were shallow (less than 100 foot depth) and that had low pH values (less than 6 standard pH units)

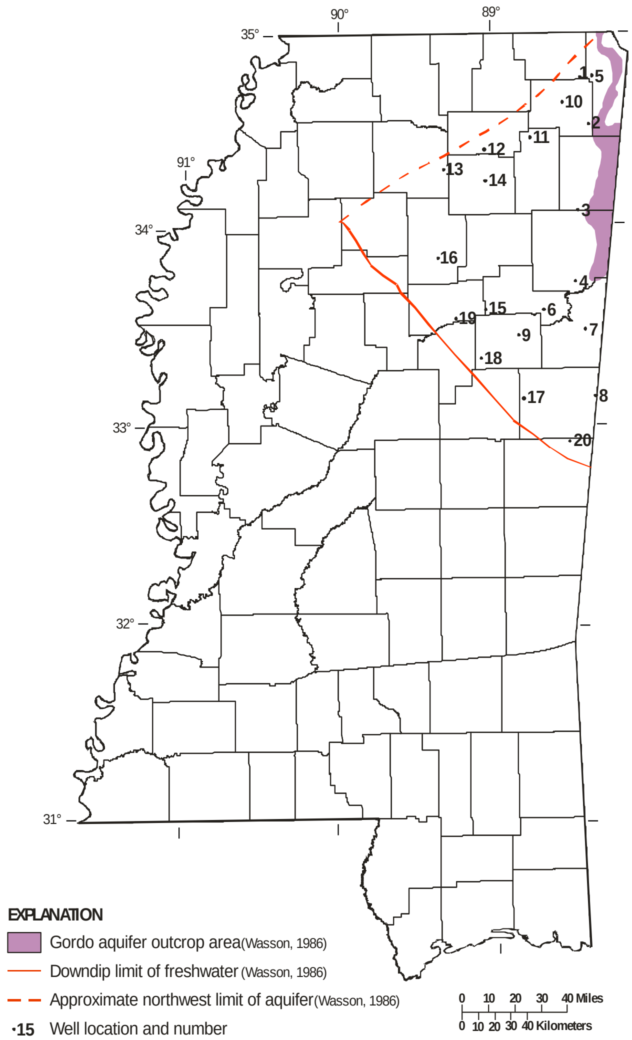


Figure 14. Location of the Gordo aquifer outcrop area and selected wells.

Gordo Aquifer – Dissolved-solids concentrations generally increase downdip in the Gordo aquifer. The distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 14) ranges from 50 to 80 miles (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 14) representative of the range of dissolved-solids concentrations found in the Gordo aquifer are listed in table 13.

For all wells screened in the Gordo aquifer, dissolved-solids concentrations ranged from 21 to 1,380 mg/L with a median value of 104 mg/L (fig. 17); hardness ranged from 3 to 220 mg/L with a median value of 30 mg/L (fig. 18); specific conductance ranged from 24 to 2,390 µS/cm with a median value of 118 µS/cm (fig. 18); pH ranged from 5.0 to 9.6 standard units with a median value of 6.8 standard units (fig. 19); color ranged from 0 to 200 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from 0.010 to 83 mg/L with a median value of 2.9 mg/L (fig. 20); and nitrate ranged from 0.04 to 8.4 mg/L with a median value of 0.2 mg/L (fig. 20).

Table 13. Typical water-quality data for freshwater wells completed in the Gordo aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hardness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	L0042	Alcorn	389	19800715	42	14	43	6.9	35	4.5	0.6	2.1	1.9	NA	2.8	2.5	0.1	13	0.97	NA
2	M0021	Prentiss	226	19900410	44	25	66	6.7	5	7.1	1.8	1.4	2.1	NA	5.6	1.5	0.1	13	12	NA
3	N0028	Itawamba	180	19760525	48	23	100	5.0	90	6.6	1.6	2.4	3.0	34	2.9	2.0	0.1	9.0	15	NA
4	Q0003	Monroe	422	19621016	52	21	78	6.6	0	6.1	1.4	5.1	4.4	36	2.0	5.0	0.1	8.0	NA	NA
5	D0040	Tishomingo	192	19770914	70	35	110	6.8	20	14	0.1	6.4	2.4	30	19	2.6	0.1	0.9	0.020	NA
6	H0009	Clay	760	19620529	72	35	116	6.2	5	11	1.8	5.8	5.2	60	0.2	2.9	0.1	7.9	NA	0.2
7	G0076	Lowndes	490	19720404	82	43	137	7.0	10	12	3.2	9.0	6.0	74	9.4	1.2	0.2	11	NA	NA
8	K0003	Noxubee	781	19551118	91	5	160	8.0	3	1.5	0.4	34	2.1	89	0.8	4.5	NA	NA	NA	0.2
9	G0021	Oktibbeha	1460	19510821	124	25	194	7.6	6	6.6	2.0	33	2.4	106	1.6	9.8	0.1	24	NA	0.8
10	F0044	Prentiss	503	19730117	174	130	274	8.0	15	38	8.5	6.5	4.9	164	10	22	0.1	15	NA	NA
11	A0022	Lee	669	19670918	229	140	414	7.8	0	42	8.5	25	2.9	141	6.2	54	0.1	10	NA	NA
12	M0031	Union	1180	19870811	248	110	438	8.2	<5	32	7.5	45	3.8	NA	5.2	71	0.2	11	0.040	NA
13	M0004	Lafayette	1646	19720614	341	91	670	7.6	0	26	6.3	95	4.3	144	4.2	120	0.1	13	NA	0.2
14	G0028	Pontotoc	1239	19610925	396	80	707	6.8	5	18	8.4	97	14	140	NA	145	NA	6.7	NA	NA
15	F0030	Clay	1692	19770606	481	39	790	8.5	0	12	2.1	180	4.1	140	<1.0	210	0.2	13	0.19	NA
16	K0001	Calhoun	1935	19591002	667	51	1150	7.5	5	18	1.5	202	7.4	156	NA	270	0.4	6.3	NA	0.9
17	F0003	Noxubee	1734	19600311	729	34	1300	8.1	5	8.8	1.8	257	7.2	210	NA	295	0.5	5.5	NA	0.3
18	J0005	Oktibbeha	2072	19541103	772	26	1390	7.7	5	7.9	1.6	292	4.4	248	2.5	315	0.9	9.9	NA	1.9
19	H0012	Webster	2194	19661130	780	53	1430	7.2	5	16	3.2	285	3.2	175	0.8	378	0.4	16	NA	0.1
20	E0006	Kemper	1450	19550622	865	34	1610	7.9	6	8.7	3.1	321	NA	258	1.4	370	NA	NA	NA	0.2

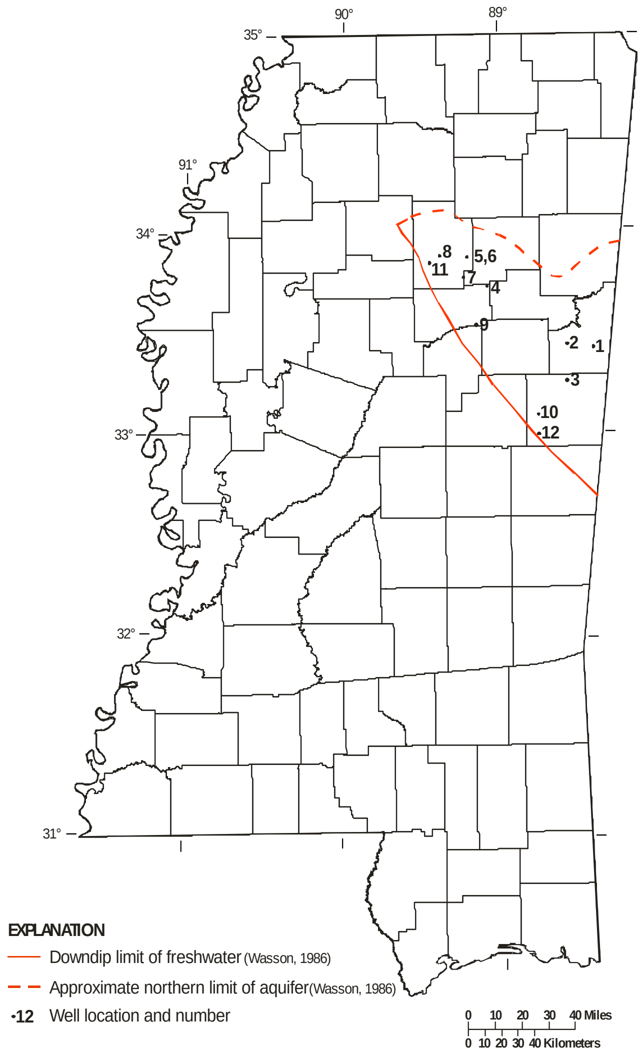


Figure 15. Location of the selected wells in the Coker aquifer.

Coker Aquifer – Dissolved-solids concentrations generally increase downdip in the Coker aquifer. The outcrop of the aquifer is to the east in Alabama, and the distance from the outcrop area to the downdip limit of freshwater (1,000 mg/L dissolved solids, fig. 15) is about 50 miles in the southeastern part of the aquifer (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 15) representative of the range of dissolved-solids concentrations found in the Coker aquifer are listed in table 14.

For all wells screened in the Coker aquifer, dissolved-solids concentrations ranged from 55 to 1,100 mg/L with a median value of 500 mg/L (fig. 17); hardness ranged from 14 to 91 mg/L with a median value of 51 mg/L (fig. 18); specific conductance ranged from 82 to 2,000 µS/cm with a median value of 905 µS/cm (fig. 18); pH ranged from 6.0 to 8.5 standard units with a median value of 7.8 standard units (fig. 19); color ranged from 0 to 10 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from 0.16 to 16 mg/L with a median value of 0.97 mg/L (fig. 20); and nitrate ranged from 0.2 to 5.1 mg/L with a median value of 0.8 mg/L (fig. 20).

Table 14. Typical water-quality data for freshwater wells completed in the Coker aquifer

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hard-ness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO_4	Cl	F	SiO_2	Fe	NO_3
1	L0031	Lowndes	948	19720404	55	31	82	6.4	0	8.6	2.3	2.8	3.0	38	8.0	1.3	0.1	9.7	NA	NA
2	K0033	Lowndes	1289	19790705	95	51	160	7.3	10	15	3.3	10	5.5	74	5.2	9.9	0.1	11	0.98	NA
3	C0018	Noxubee	1288	19810112	95	16	205	7.7	NA	4.6	1.0	26	3.3	80	3.7	3.4	<.1	13	0.16	NA
4	E0009	Webster	1698	19701118	393	42	741	7.3	0	13	2.3	136	5.3	133	NA	165	0.3	13	NA	0.3
5	L0004	Calhoun	1911	19620816	488	73	NA	7.8	NA	23	4.0	157	6.0	NA	NA	217	NA	NA	NA	NA
6	L0002	Calhoun	1975	19540625	500	68	934	8.5	4	20	4.3	165	5.1	135	1.2	210	NA	6.2	NA	1.0
7	O0001	Calhoun	2212	19541202	512	66	949	7.8	5	22	2.8	157	4.6	135	1.6	220	0.5	4.4	NA	2.1
8	K0004	Calhoun	1990	19600611	629	62	1100	7.9	5	19	3.6	198	7.9	150	0.4	265	NA	8.1	NA	0.2
9	J0004	Webster	2235	19701118	652	58	1230	7.8	0	20	2.0	230	6.0	163	0.2	302	0.3	14	NA	0.2
10	L0006	Noxubee	1832	19810111	666	30	1200	7.8	NA	9.0	1.7	260	3.6	200	<.1	290	0.4	14	0.17	NA
11	J0001	Calhoun	2384	19670322	881	68	1650	7.7	5	23	2.6	300	3.7	196	0.4	418	0.4	16	NA	NA
12	Q0018	Noxubee	2670	19850129	1100	91	2000	7.6	<1	29	4.4	390	6.3	NA	0.2	530	1.6	15	0.96	NA

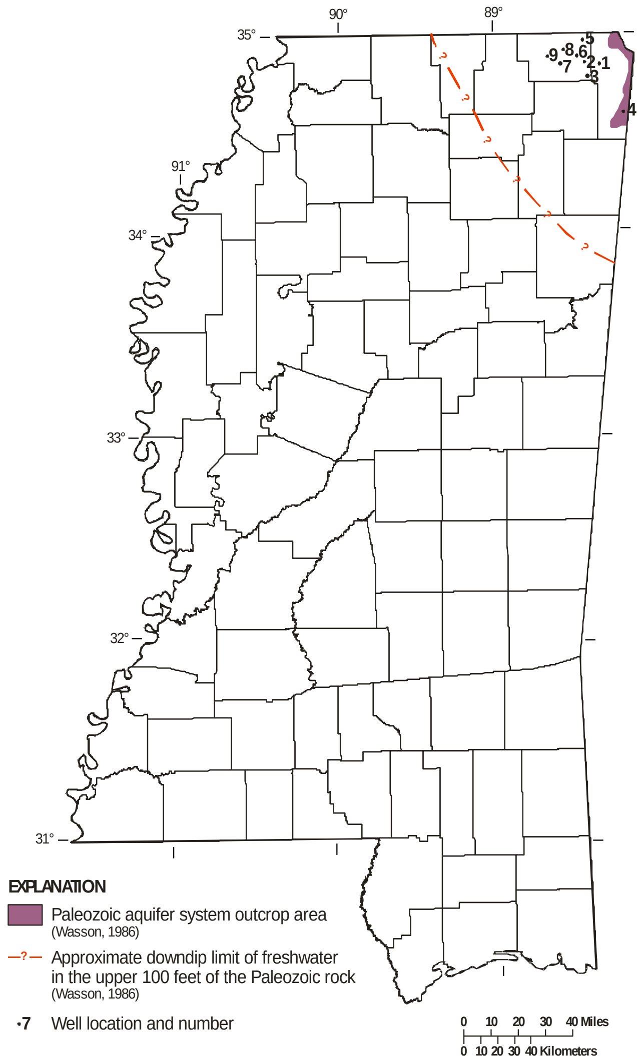


Figure 16. Location of the Paleozoic aquifer system outcrop area and selected wells.

Paleozoic Aquifer System – Dissolved-solids concentrations generally increase downdip of the top surface in the Paleozoic aquifer system. Dissolved-solids concentrations also increase with depth in the fairly separated aquifers that comprise the Paleozoic aquifer system (Wasson, 1986). Chemical analyses from selected freshwater wells (fig. 16) representative of the range of dissolved-solids concentrations found in the Paleozoic aquifer system are listed in table 15.

For all wells screened in the Paleozoic aquifer system, dissolved-solids concentrations ranged from 39 to 475 mg/L with a median value of 142 mg/L (fig. 17); hardness ranged from 21 to 150 mg/L with a median value of 96 mg/L (fig. 18); specific conductance ranged from 61 to 2,330 µS/cm with a median value of 296 µS/cm (fig. 18); pH ranged from 5.2 to 8.2 standard units with a median value of 7.2 standard units (fig. 19); color ranged from 0 to 30 platinum-cobalt units with a median value of 5 platinum-cobalt units (fig. 19); iron ranged from 0.010 to 17 mg/L with a median value of 3.2 mg/L (fig. 20); and nitrate ranged from 0.1 to 0.3 mg/L with a median value of 0.2 mg/L (fig. 20).

Table 15. Typical water-quality data for freshwater wells completed in the Paleozoic aquifer system

[Depth, well depth in feet below land surface; ROE, residue on evaporation at 180 degrees Celsius, equivalent to total dissolved solids; SC, specific conductance in microsiemens per centimeter at 25 degrees Celsius; pH, standard pH units; color, platinum-cobalt units; all other concentrations in milligrams per liter; Ca, calcium, Mg, magnesium, Na, sodium; HCO_3, bicarbonate; SO_4, sulfate; Cl, chloride; F, fluoride; SiO_2, silica; Fe, iron; NO_3, nitrate; NA, no data]

Map	Well	County	Depth	Date	ROE	Hardness	SC	pH	Color	Ca	Mg	Na	K	HCO_3	SO4	Cl	F	SiO_2	Fe	NO_3
1	D0052	Tishomingo	280	19850605	43	21	61	6.5	25	5.8	1.7	1.9	1.1	NA	6.6	2.5	0.2	9.5	16	NA
2	L0023	Alcorn	536	19731212	97	83	170	6.9	NA	26	4.5	2.1	5.9	103	7.2	1.3	0.1	8.7	2.3	NA
3	L0056	Alcorn	570	19910615	104	72	230	6.8	30	22	4.2	4.6	4.2	NA	13	5.5	<.1	8.6	3.0	NA
4	K0001	Tishomingo	150	19830608	142	110	291	7.2	17	36	4.0	16	1.1	NA	4.7	14	0.2	8.7	0.020	NA
5	D0008	Alcorn	493	19561004	113	84	212	7.6	5	25	5.3	10	2.8	110	9.4	5.5	0.3	NA	NA	0.2
6	H0122	Alcorn	442	19730209	205	96	388	7.1	10	29	5.7	38	5.2	136	11	4.8	0.3	9.4	3.4	NA
7	K0089	Alcorn	475	19731212	214	130	340	7.5	NA	39	7.8	26	7.5	146	9.4	44	0.1	9.1	0.35	NA
8	G0058	Alcorn	460	19620816	286	130	516	7.3	0	38	7.6	50	4.5	141	10	84	0.4	5.6	NA	NA
9	F0068	Alcorn	660	19780926	475	120	936	7.6	5	34	9.3	130	5.6	160	19	200	0.6	9.0	<0.010	NA

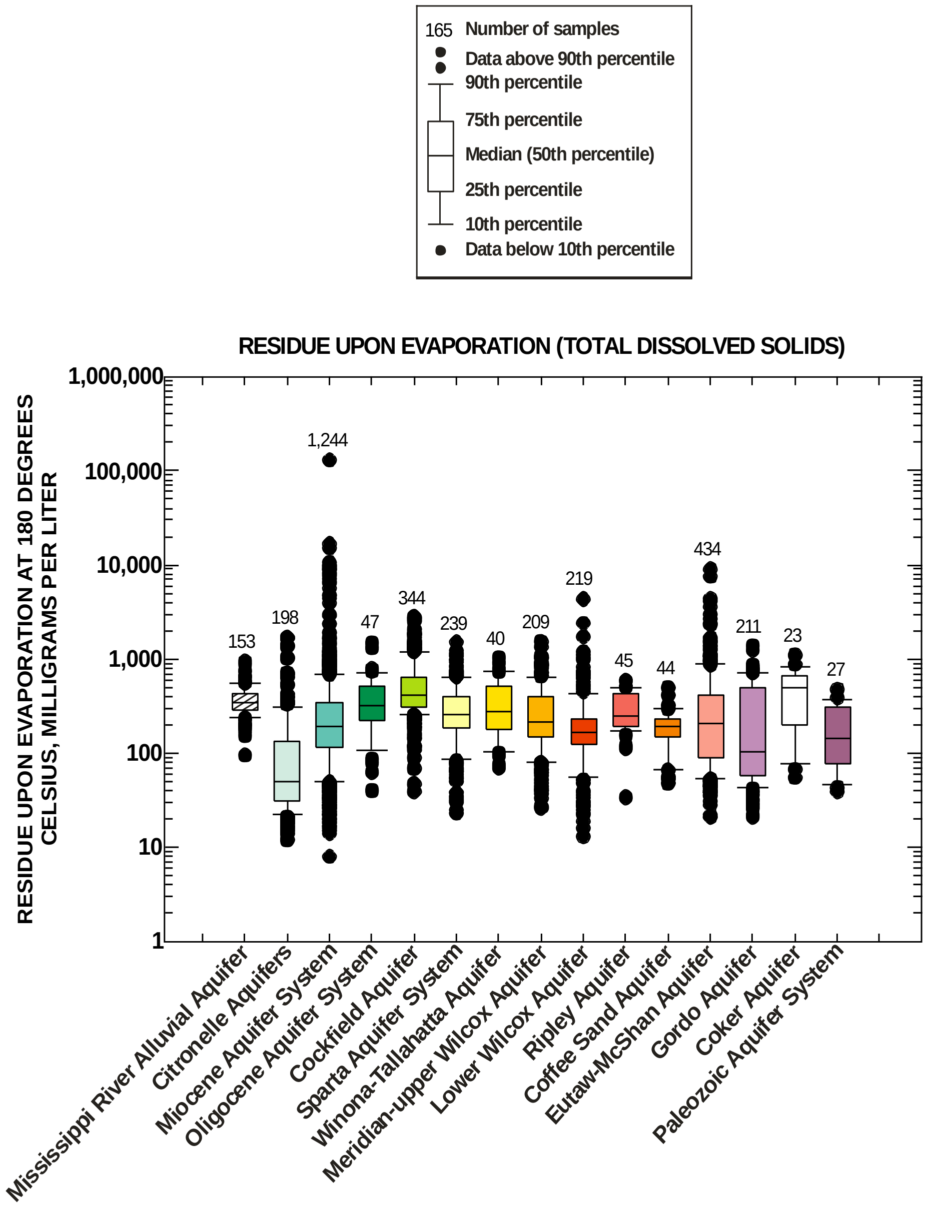


Figure 17. Distribution of residue upon evaporation (total dissolved solids) for each principal aquifer in Mississippi.

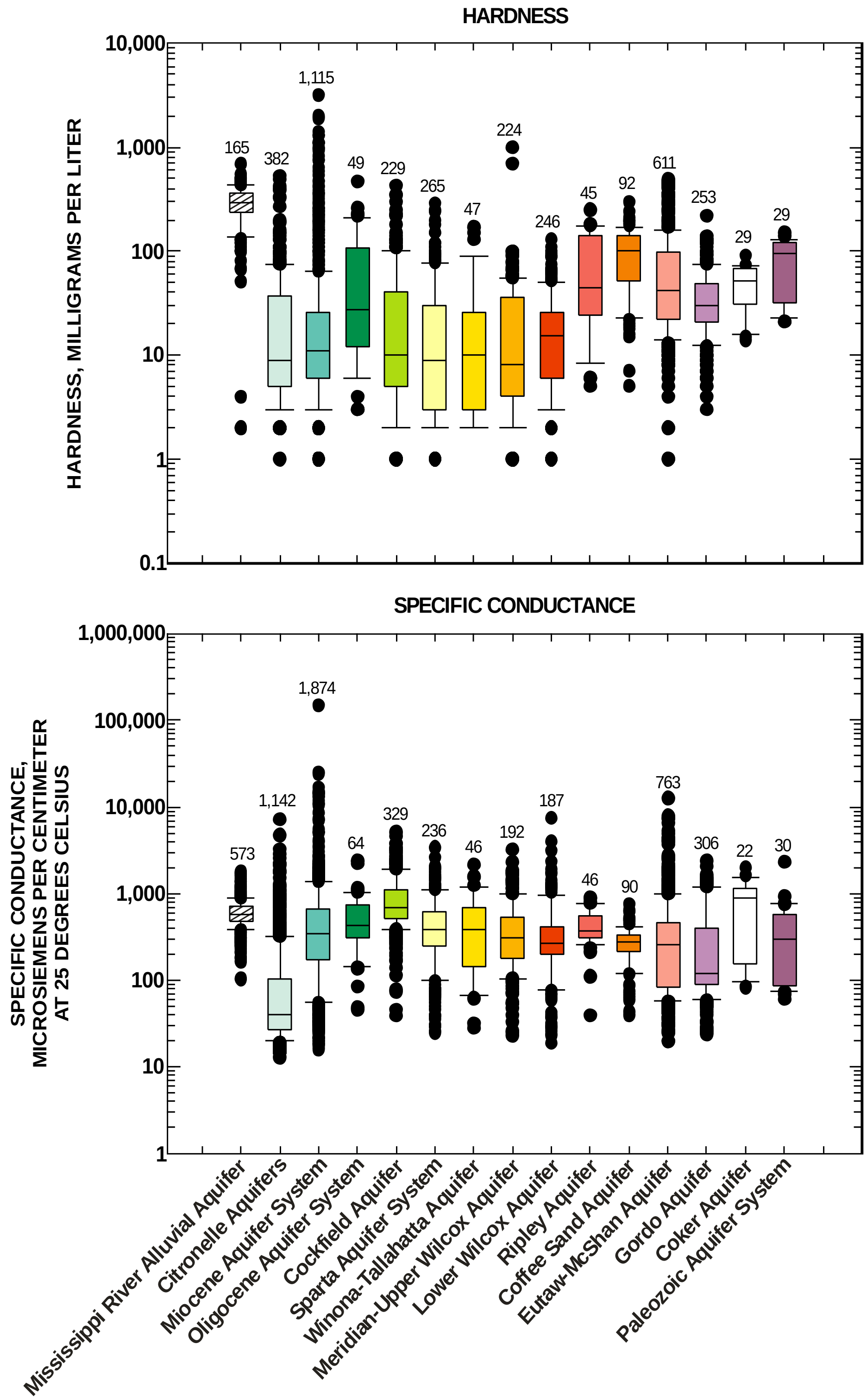


Figure 18. Distribution of hardness and specific conductance for each principal aquifer in Mississippi.

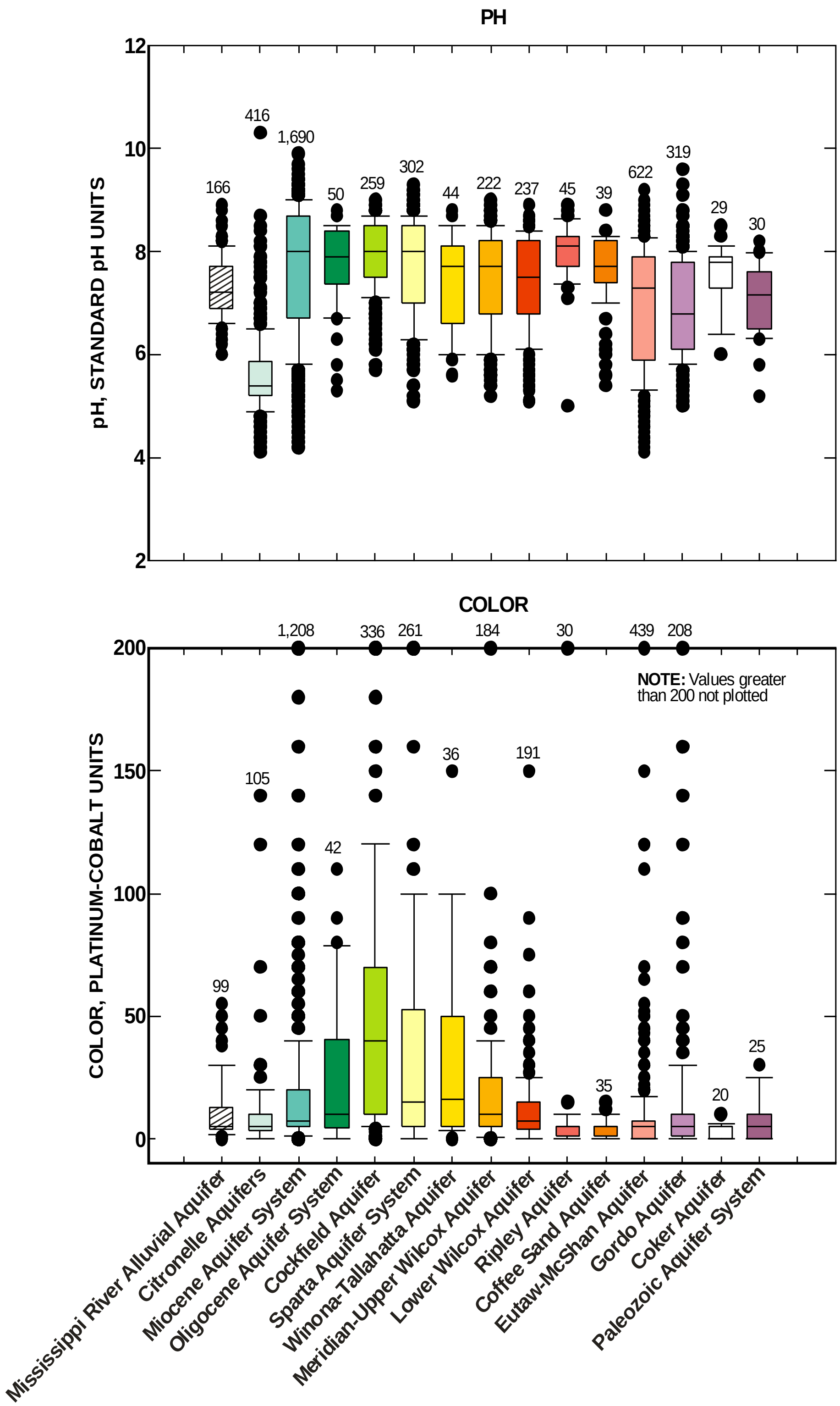


Figure 19. Distribution of pH and color for each principal aquifer in Mississippi.

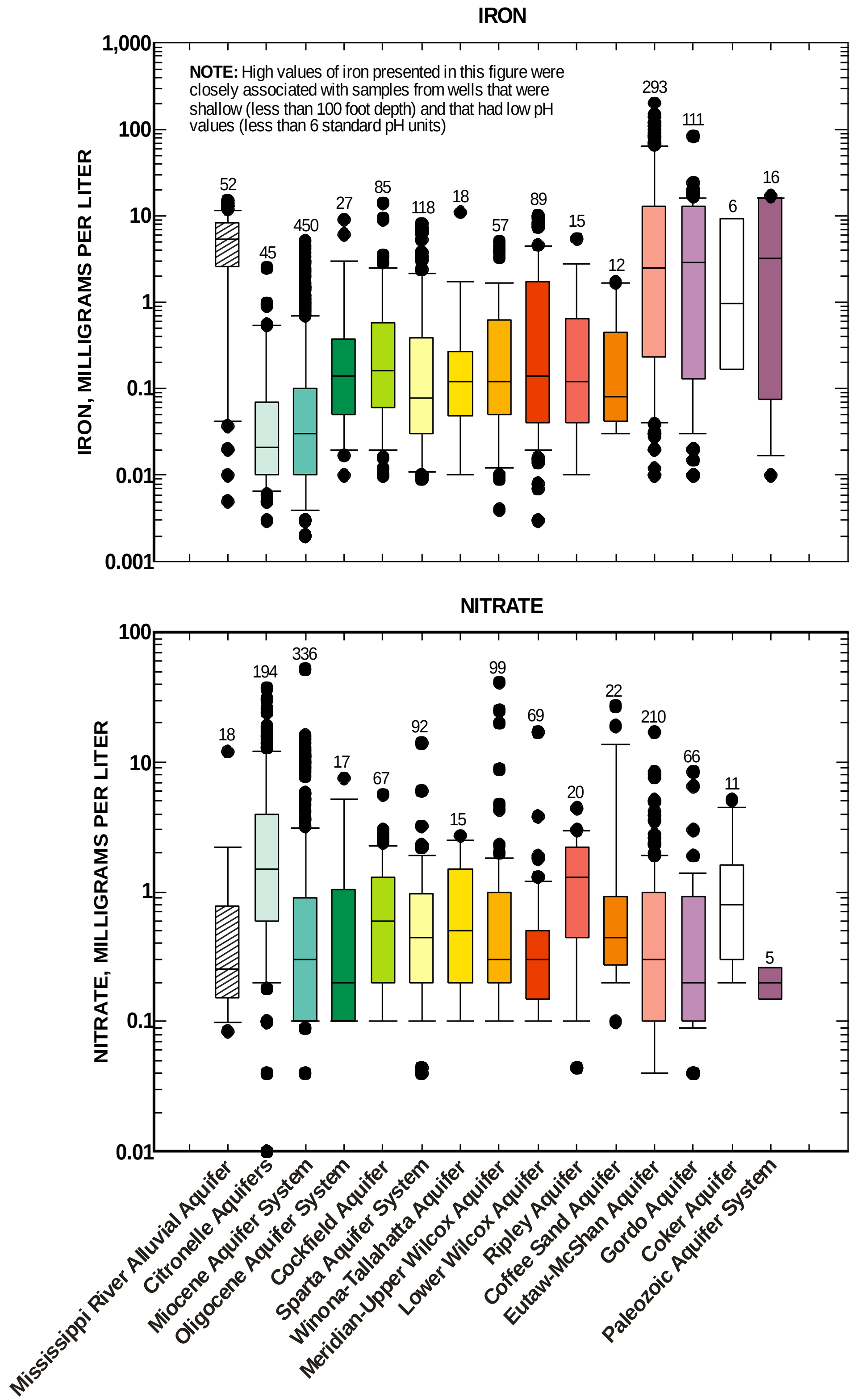


Figure 20. Distribution of iron and nitrate for each principal aquifer in Mississippi.