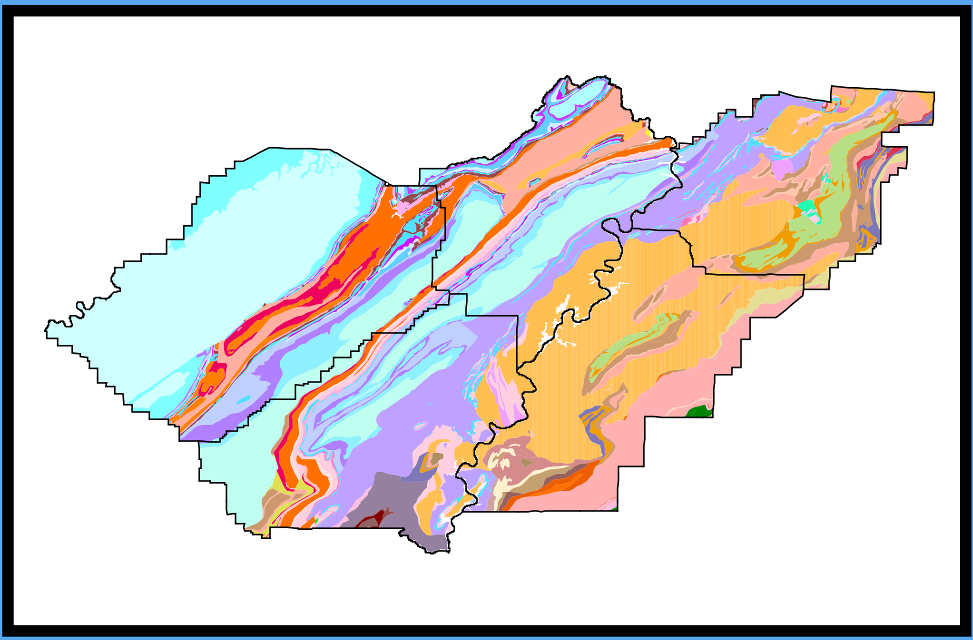
HYDROGEOLOGY AND VULNERABILITY TO CONTAMINATION OF MAJOR AQUIFERS IN ALABAMA: AREA 4



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Berry H. (Nick) Tew, Jr.
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WATER INVESTIGATIONS PROGRAM

CIRCULAR 199 D

HYDROGEOLOGY AND VULNERABILITY TO CONTAMINATION OF MAJOR AQUIFERS IN ALABAMA: AREA 4

By

David C. Kopaska-Merkel, Lewis S. Dean,
and James D. Moore

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

Tuscaloosa, Alabama
2005

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Febuary 21, 2005

The Honorable Bob Riley
Governor of Alabama
Montgomery, Alabama

Dear Governor Riley:

It is with pleasure that I make available to you and the citizens of Alabama the publication "Hydrogeology and Vulnerability to Contamination of Major Aquifers in Alabama: Area 4," by David Kopaska-Merkel, Lewis S. Dean, and James D. Moore. It is published as Circular 199D of the Geological Survey of Alabama and is the result of a cooperative effort between the Geological Survey and the Alabama Department of Environmental Management.

The publication contains information on the geology, characteristics of the major aquifers, and public water supply wells in Calhoun, Jefferson, St. Clair, Shelby, and Talladega Counties. This report is the fourth in a 13-part series that will ultimately cover the entire state. These studies will provide vital information to engineers, geologists, resource managers, city planners, and others regarding the ground water resources of Alabama.

Respectfully,

Berry H. (Nick) Tew, Jr.
State Geologist

Science and Service for the People of Alabama

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HYDROGEOLOGY AND VULNERABILITY TO CONTAMINATION OF MAJOR AQUIFERS IN ALABAMA: AREA 4

By
David C. Kopaska-Merkel, Lewis S. Dean, and James D. Moore

ABSTRACT

The Geological Survey of Alabama (GSA), in cooperation with the Alabama Department of Environmental Management (ADEM), is revising and expanding a series of hydrogeologic reports that delineates the major aquifers in Alabama and characterizes their vulnerability to contamination. The original reports were prepared by the U.S. Geological Survey in cooperation with ADEM. The state is divided into 13 areas that are addressed in separate reports. The hydrogeology and vulnerability to contamination of the major aquifers in Area 4, which includes Calhoun, Jefferson, Shelby, St. Clair, and Talladega Counties, are described in this report.

The major aquifers in the study area are the Valley and Ridge aquifer system, the Mississippian aquifer system (consisting of the Hartselle aquifer, Bangor aquifer, and Fort Payne-Tuscumbia aquifer), the Pottsville aquifer, and metasedimentary and metavolcanic aquifers. Highest yields from aquifers are associated with solution openings in carbonate rocks, which dominate the Valley and Ridge aquifer system, the Bangor aquifer, and the Fort Payne-Tuscumbia aquifer. Springs provide substantial amounts of water for municipal supply; Coldwater Spring provides an average of 17 million gallons per day to the city of Anniston.

All aquifer recharge areas in Area 4 are vulnerable to contamination from the land surface. The recharge areas of the Valley and Ridge and Mississippian aquifer systems and the metasedimentary and metavolcanic aquifers are highly vulnerable, whereas the recharge areas of the Pottsville aquifer are moderately vulnerable. Three conditions exist in the study area that may cause aquifers to be particularly vulnerable to contamination on a local scale. First, fracturing of rock materials caused by faulting may create planar zones of high permeability. Second, the production of a porous cherty soil via weathering may facilitate passage of water from the surface into the ground water system. Third, where sinkholes are present, the land surface may be directly connected to the underlying aquifer. Areas with sinkholes are extremely vulnerable to contamination. Aquifers become less vulnerable to contamination from the surface with an increasing degree of confinement by impermeable layers, such as shale, and increasing distance from conduits, such as sinkholes and fault zones. However, even deep aquifers can be vulnerable to natural sources of contamination; an example is mineralized ground water.

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

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

INTRODUCTION

The U.S. Geological Survey, in cooperation with ADEM, conducted a series of hydrogeologic studies in Alabama to delineate the major aquifers and their recharge areas and to define areas vulnerable to surface contamination. Each of the 13 areas of the state was studied by different authors Planert and Pritchett (1989) briefly summarized the characteristics of aquifers in Area 4–Calhoun, Jefferson, Shelby, St. Clair, and Talladega Counties. The Geological Survey of Alabama is updating and adding to the results of the past study in cooperation with ADEM and is providing the hydrogeologic information in a digital format that can be easily accessed.

In addition to the document you are now reading, the CD-ROM for Area 4 also contains a GIS database and a copy of the program ARC Explorer from ESRI, Inc. The GIS database includes all of the data used to make the maps that appear as plates in this report. The file Readme, located in the root directory of this CD-ROM, provides information about how to access the GIS database using ARC Explorer.

ACKNOWLEDGMENTS

The authors thank the well drillers, managers, and operators of water-supply systems in Area 4 for information they provided about wells. In addition, Enid Probst, Lynn Ford, Fred Mason, and Sonja Massey of ADEM provided assistance and suggestions in the preparation of this report. Additional information was provided by Steven D. Mann, PPM Consultants. Geographic Information Systems (GIS) support was provided by Ruth T. Collier and Douglas R. Taylor of the GSA. Their efforts are greatly appreciated.

PURPOSE AND SCOPE

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

The revised Geologic Map of Alabama (Szabo and others, 1988) at a scale of 1:250,000 provide new geologic data from which to update the previous aquifer susceptibility map (Planert and Pritchett, 1989) (plate 1). Plate 2 shows geographic and stratigraphic relationships among the geologic units mapped on plate 1. Plate 3 shows geographic and stratigraphic relationships among the major aquifers of Area 4. Plate 4 shows relationships among aquifers, aquitards, and geologic structure in cross-sectional view. Areas vulnerable to contamination from surface sources were delineated from topographic maps, geologic maps, and field investigations. Aquifer recharge areas, areas of aquifer vulnerability, and locations of public water supply wells in Area 4 are shown on plate 5. In the study by Planert and Pritchett (1989), all wells used for municipal and rural public water supplies were inventoried and water levels were measured in these wells where possible. Data on water use were compiled during the inventory. In this study, water-level data were used to prepare generalized potentiometric surface maps of the major aquifers (plates 6, 7, 8). The water-level data were collected between 1963 and 1992, as detailed in the metadata on this CD-ROM. Plates 9 and 10 are maps showing iron concentration and hardness in shallow ground water in Area 4. For this study, delineations of wellhead protection areas were derived from maps submitted to ADEM by public water systems that have completed wellhead protection projects (plate 11).

LOCATION AND EXTENT OF THE STUDY AREA

The study area is in north-central Alabama and comprises 3,929 mi^2 (square miles). The study area has a moist, temperate climate and a mean annual rainfall of about 53 inches per year. Forests cover about 72 percent of the area, agricultural acreage 17 percent, with the remainder mostly urban or wetlands. The 1995 population of the five-county study area was about 852,000. Jefferson County, which includes the City of Birmingham, comprises the largest urban area with a population in 1995 of about 578,000 people; other major cities in the study area include Anniston, Sylacauga, and Talladega (plate 1).

PREVIOUS INVESTIGATIONS

Several published reports on the structure, stratigraphy, and lithology of the study area are of note. Adams and others (1926) has provided the descriptive base of most geologic studies in Alabama since its publication. Johnston (1933) presented a comprehensive account of the ground water resources in the Paleozoic rocks of northern Alabama. Neathery and Drahovzal (1985) updated and revised descriptions of the Upper Ordovician stratigraphy of the Appalachians in Alabama. Thomas (1972) published a comprehensive description of the Mississippian stratigraphy of Alabama. Kidd (1979) defined the areal geology in Jefferson County and Thomas (1985) compiled structural sections of northern Alabama.

Reports on ground water resources, which include geologic mapping and well inventories, have been published for each of the counties in Area 4. These include Warman and Causey (1962), Moffett and Moser (1978), Causey (1963, 1965), Shamburger and Harkins (1980), Hunter and Moser, (1990), Moser (1988), and Moser and DeJarnette (1992). These reports provide a broad and useful base of geologic and hydrologic information. Guthrie and others (1998) reported on the hydrogeologic delineation of wellhead protection areas for the City of Leeds.

In 1988, the Geological Survey of Alabama published a revised geologic map for the state at a scale of 1:250,000, which provide the most up-to-date mapping of the geology of the entire study area (Szabo and others, 1988). Detailed geologic mapping at the 7.5-minute scale includes reports by Osborne (1993a, b, 1995, 1996) and coworkers (Ward and Osborne, 2000; Irvin and Osborne, 2000; Rindsberg and Osborne, 2001).

PHYSICAL FEATURES

The study area includes parts of three physiographic sections: the Cumberland Plateau, the Alabama Valley and Ridge, and the Piedmont Upland. Figure 1 shows the locations of these three sections as well as the districts within each of them (Sapp and Emplaincourt, 1975).

The Cumberland Plateau Section extends from western Jefferson County to the most western and northern parts of St. Clair County. All but the northeastern part of west Jefferson County is in the Warrior Basin District where altitudes range from 350 feet near the Black Warrior River to more than 700 feet along several ridges in the basin. Drainage within the basin is primarily west to the Locust Fork of the Black Warrior River and to the Black Warrior River. The northeastern part of west Jefferson County and the northwestern most corner of St. Clair County are in the Murphrees Valley and Blount Mountain Districts and altitudes range from 700 to 1,100 feet. The northernmost area of St. Clair County is in the Wills Valley and Blount Mountain Districts; altitudes range from 800 to 1,500 feet. Drainage in these three mountain and valley districts is also primarily west to the Locust Fork of the Black Warrior River.

The Alabama Valley and Ridge Section extends across the majority of the study area and includes several physiographic districts. From west to east, the districts are the Birmingham-Big Canoe Valley, the Cahaba Ridges, the Cahaba Valley, the Coosa Ridges, the Coosa Valley, and the Weisner Ridges.

Altitudes in the Birmingham-Big Canoe Valley range from about 500 feet in Jefferson County to about 600 feet in St. Clair County. Drainage in Jefferson County is generally west to southwest into the Black Warrior River tributaries. St. Clair County drainage is primarily east to Big Canoe Creek, which flows east to the Coosa River.

The Cahaba Ridges trend northeast through parts of Shelby, Jefferson, and St. Clair Counties. Altitudes in the Cahaba Ridges range from about 300 feet in Shelby County to about 1,100 feet in St. Clair County. Drainage from the ridges is southeast to the Cahaba River, which flows along the eastern edge of the ridges.

The Cahaba Valley District lies east of the Cahaba River and extends northward into St. Clair County east of the Birmingham-Big Canoe Valley District. Altitudes in the Cahaba Valley range from 300 feet in Shelby County to 700 feet in St. Clair County and drainage is generally west to the Cahaba River.

The Coosa Ridge District lies east of the Cahaba Valley and consists mainly of Double Oak Mountain with altitudes as high as 1,400 feet. Westward drainage off the mountains is generally into Cahaba River tributaries; eastward drainage is primarily into Coosa River tributaries.

The Coosa Valley District extends from the Coosa Ridge District on the west to the Weisner Ridges District and Piedmont Upland Section on the east. Altitudes of about 400 to 500 feet dominate the Coosa Valley west of the Coosa River. East of the

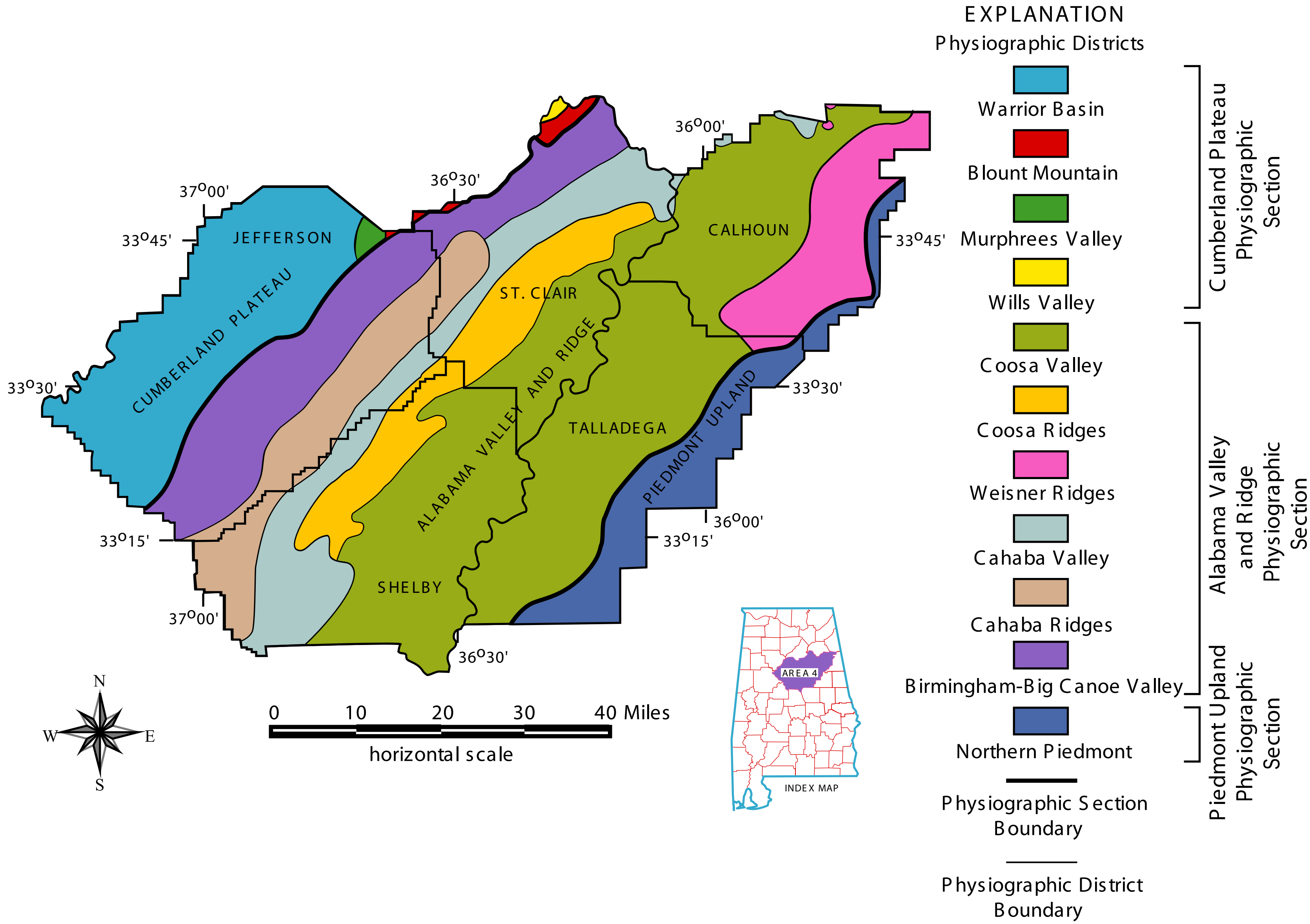

Figure 1.--Physiography of Area 4 (modified from Planert and Pritchett, 1989).

Coosa River, altitudes in the valley range from about 500 feet to as much as 1,540 feet. Drainage from the Coosa Valley District is primarily into the Coosa River.

The Weisner Ridges District, located in the northeastern corner of Talladega County and the eastern part of Calhoun County, consists primarily of Choccolocco and Coldwater Mountains. Altitudes are as high as 2,100 feet on the crest of Choccolocco Mountain. Drainage from the Weisner Ridges District is into tributaries of the Coosa River, namely Choccolocco, Terrapin, and Tallasseehatchee Creeks.

The Northern Piedmont District of the Piedmont Upland Section is located in southeastern Talladega County and most of southeastern Calhoun County. Altitudes range from about 1,900 feet on Talladega Mountain to 500 feet in the valleys to the west. Drainage is primarily westward into tributaries of the Coosa River.

STRUCTURE

The geology and physiography of Area 4 are quite complex because the region was strongly affected by large-scale tectonic activity, most of which took place during the Appalachian orogeny. Most of the study area is in the Appalachian fold and thrust belt, which consists of shallow marine to deltaic Paleozoic sedimentary strata that were deposited on a continental platform (Thomas, 1985). Precambrian and Paleozoic metasedimentary rocks crop out along the southeastern border of the study area, and are separated from the fold and thrust belt by the Talladega fault (plate 1).

Strata throughout the study area generally maintain a northeast-southwest strike, and dips are commonly to the southeast (fig. 2). Across strike, the fold and thrust belt is characterized by three structural domains (Thomas, 1985). Broad flat-bottomed synclines and narrow asymmetric anticlines comprise the northwest domain. The central domain is characterized by folds associated with large thrust-fault ramps. The southeastern domain is characterized by low-angle, broad, multiple-level thrust sheets (Thomas, 1985).

The northwest domain, which coincides with parts of the Cumberland Plateau section (fig. 1), is represented primarily by the Sequatchie anticline and Coalburg syncline. These structures deform the eastern flank of the Black Warrior foreland basin (Warrior coal field). The basin is generally underlain by gently dipping rocks of Pennsylvanian age (Pottsville Formation) (plate 1), although several small-scale structures are known (Kidd, 1979). These structural features are not visible at the scale of the figures in this report.

The central domain of the fold and thrust belt coincides with the northwestern half of the Alabama Valley and Ridge section and consists of sedimentary rocks that range in age from Cambrian to Pennsylvanian (Kidd, 1979) (fig. 1, plate 1). The structures are a series of anticlines and synclines that form northeast-southwest-trending ridges and valleys. Major structures include the Birmingham anticlinorium, Cahaba synclinorium, and the Coosa synclinorium (fig. 3).

The Birmingham anticlinorium is bounded along its west-northwestern limb by the Opossum Valley thrust fault that has a displacement of 7,000 feet or more (Kidd, 1979).

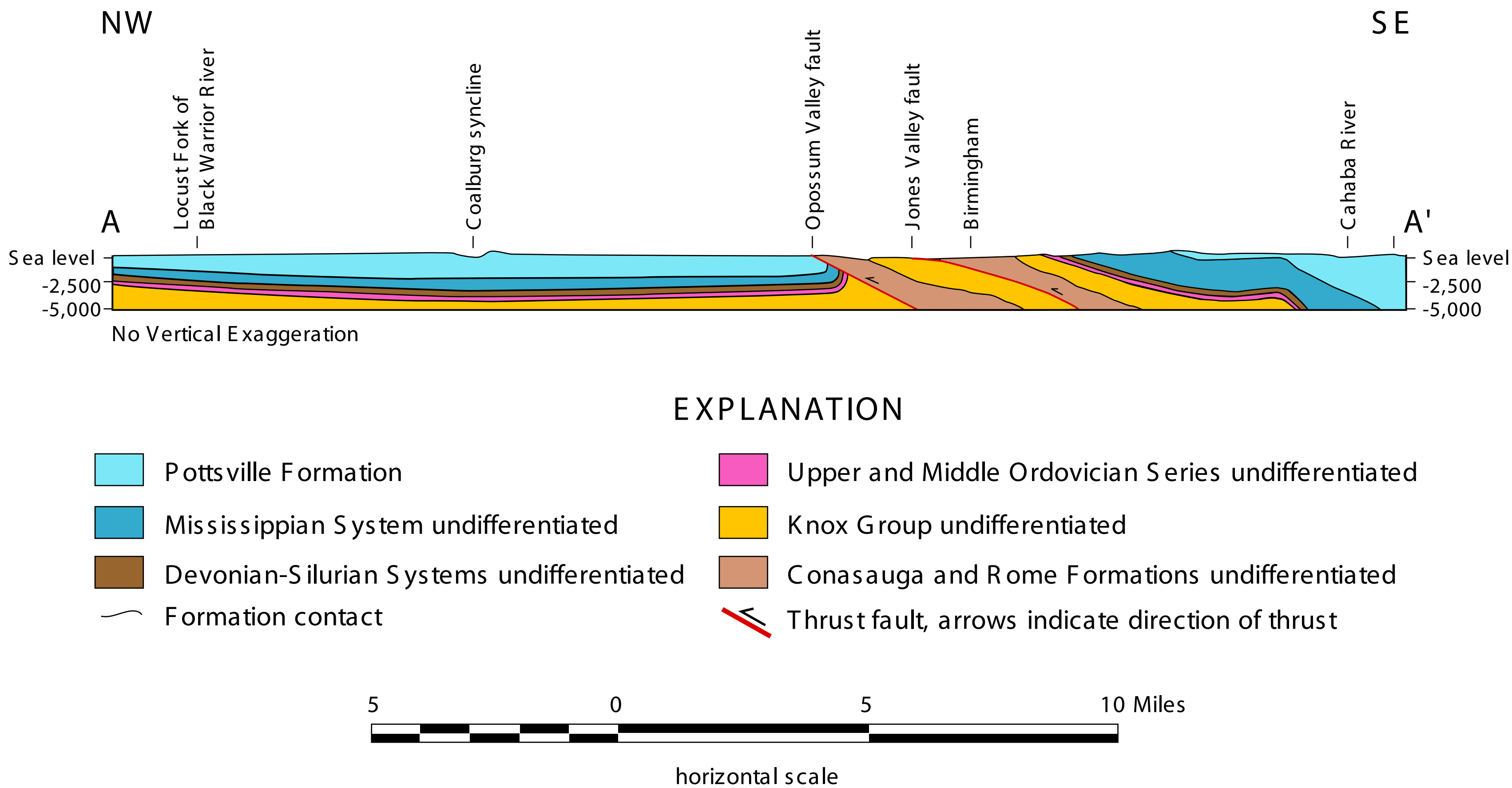

Figure 2.--Generalized geologic cross section A-A' through Jefferson County in Area 4 (line of section shown on plate 1) (modified from Hunter and Moser, 1990).

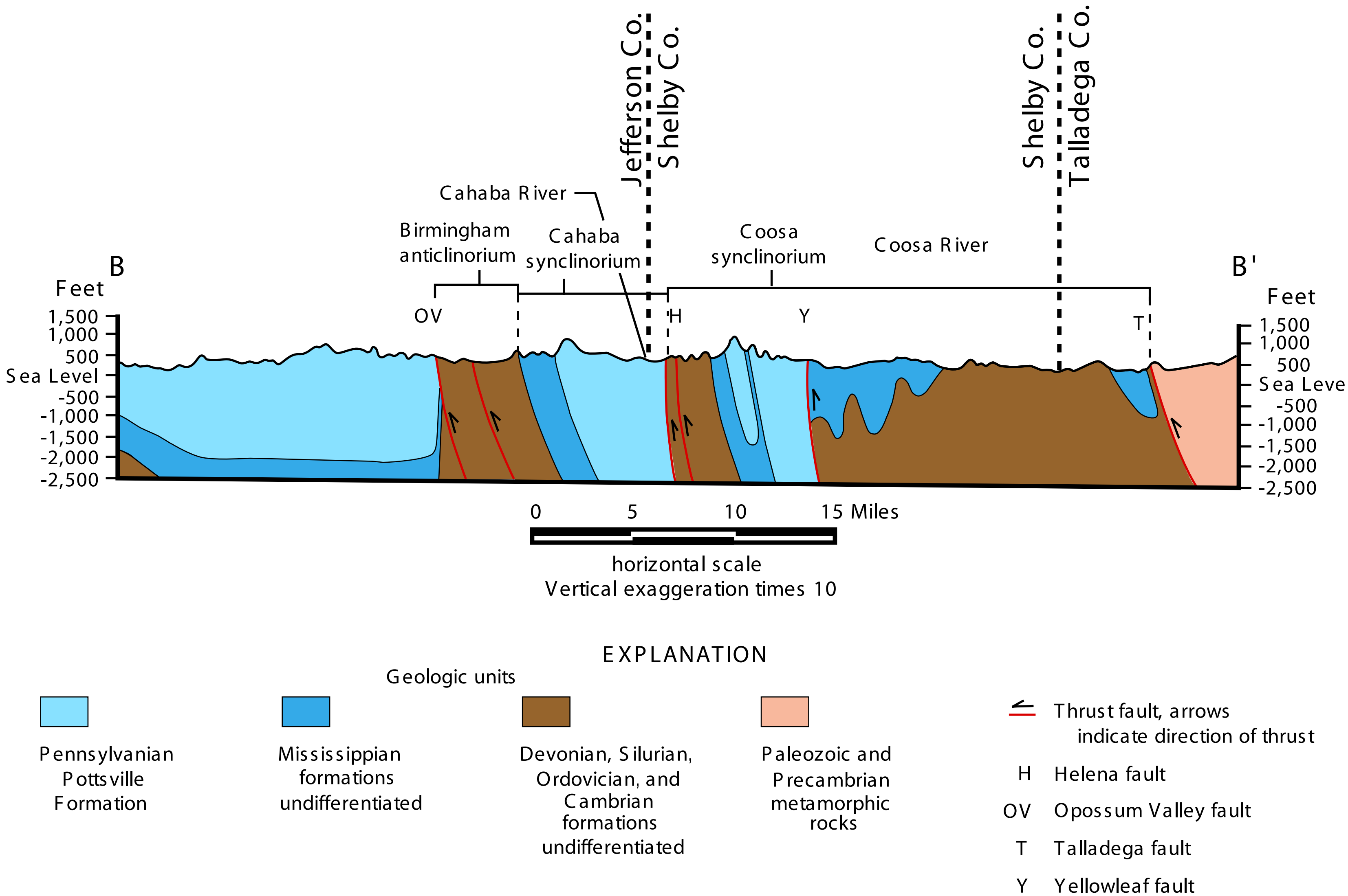

Figure 3.--Generalized geologic cross section B-B' through Area 4 (line of section shown on plate 1) (modified from Planert and Pritchett, 1989).

The Cahaba synclinorium is bounded on the northwest by the Birmingham anticlinorium and on the southeast by the Coosa synclinorium. The Helena fault marks the boundary between the Coosa and Cahaba synclinorium and has a displacement of 10,000 feet or more (Kidd, 1979). The Helena is the most extensive fault in the central domain and generally juxtaposes the Cambrian Rome Formation on the east and the Pennsylvanian Pottsville Formation or Cambrian Conasauga Formation on the west (plate 1).

The southeastern domain of the fold and thrust belt corresponds to the southeast side of the Alabama Valley and Ridge. To the southeast, the Piedmont Upland section is separated from the rest of Area 4 by the Talladega thrust fault (plate 1). Greenschist metasedimentary rocks of the Talladega slate belt crop out east of the fault and override the trailing part of the fold and thrust belt (Thomas, 1985). Metamorphic rocks of higher grade occur in the extreme southeastern part of Area 4.

STRATIGRAPHY

Area 4 is underlain by metamorphic and sedimentary rocks of Paleozoic age, and by sediments of Quaternary age. Paleozoic stratigraphy is summarized in plate 2.

Thomas (1985) divided the Paleozoic sedimentary succession above the Precambrian basement into four major components: a basal Cambrian siliciclastic sequence, a Cambrian-Ordovician carbonate shelf facies, a thin and laterally variable Middle Ordovician to Lower Mississippian sequence of shallow-marine shelf clastic and carbonate rocks, and parts of two Mississippian-Pennsylvanian clastic wedges that prograded over the carbonate shelf. Each of these four components formed under relatively stable conditions, whereas the components are punctuated by major discontinuities. Major unconformities separate the basal Cambrian siliciclastics from crystalline basement and Cambro-Ordovician carbonates from Middle Ordovician to Lower Mississippian sequences in most or all of Area 4. Deposition of the Mississippian-Pennsylvanian clastic wedges did not follow a significant period of nondeposition or erosion, but these strata record a dramatic change in the style of deposition and the sources of sediment.

Appalachian thrust faults and associated folds have displaced and deformed the youngest preserved Paleozoic strata. Metamorphism along and southeast of the Talladega thrust fault has altered rocks in the eastern part of Area 4. Quaternary sediments overlie older deposits in stream valleys.

METAMORPHIC ROCKS OF PALEOZOIC AGE

The Talladega belt extends through eastern Calhoun, eastern Talladega, and southeastern Shelby Counties and consists of greenschist metasedimentary clastic and carbonate rocks, which correlate with the Cambrian to Carboniferous rocks of the Valley and Ridge Province. The Kahatchee Mountain Group is a dominantly siliciclastic succession consisting of metamorphosed siltstone and mudstone, coarse feldspathic metamorphosed sandstone, and a minor marble unit (Raymond and others, 1988). The Sylacauga Marble Group is a predominantly carbonate succession consisting of interlayered calcite and dolomite marble, metachert, and fine metamorphosed siliciclastic rocks (Raymond and others, 1988). The Lay Dam Formation is the lower part of the Talladega Group and crops out in Shelby and Talladega Counties. The Lay Dam is made up of metamorphosed coarse siliciclastics such as arkoses, quartzites, conglomerates, and greywacke, and finer grained siltstones, sandstones, and limestones to the northeast. The Hillabee Greenstone crops out east-southeast of the Lay Dam Formation along the southeastern edge of the study area, along with smaller areas of higher-grade metamorphic rocks. With the exception of the Sylacauga Marble Group, rocks of the Talladega belt do not include major aquifers in Area 4 and are not described further in this report. See the report on Area 5 for more detailed discussions of deposits of the Piedmont physiographic or hydrogeologic province.

SEDIMENTARY ROCKS OF PALEOZOIC AGE

The Cambrian System is represented in Area 4 by the Chilhowee Group, Shady Dolomite, Rome Formation, Conasauga Formation, Brierfield Dolomite, Ketona Dolomite, and Bibb Dolomite (plate 2). The Chilhowee Group includes the Weisner Formation, Wilson Ridge Formation, Nichols Formation, and Cochran Formation (Szabo and others, 1988). The Chilhowee crops out in the Weisner Ridges and the Coosa Valley (fig. 1). Near Talladega in Talladega County, the Chilhowee Group consists of more than 1,300 feet of fluvial to shallow-marine sandstone, conglomerate, and mudstone (Thomas, 1985). The Weisner Formation, the only formation in the Chilhowee Group that is a significant aquifer in Area 4, consists of sandstone, conglomerate, and lesser mudstone (Adams and others, 1926; Johnston, 1933). The Shady Dolomite overlies the Chilhowee Group and generally forms valleys adjacent to, or occurs low on, Weisner-capped ridges. The Shady Dolomite reaches thicknesses of 500 to 1,000 feet and consists of sandy dolomite and dolomitic limestone. The Shady crops out in valleys of the Weisner Ridge District in Calhoun County and in the Coosa Valley in Talladega County. The Rome Formation overlies and crops out in proximity to the Shady Dolomite and in a narrow band east of the Helena thrust fault. Interbedded sandstones, siltstones, shales, and carbonates make up the Rome, which has an estimated thickness of 1,000 feet.

The Conasauga Formation, which crops out extensively throughout the Birmingham-Big Canoe, Cahaba, and Coosa Valleys, differs lithologically across the study area. Dolomite is common in the Coosa Valley of Talladega, southeastern St. Clair, and northeastern Shelby Counties. The unit has an estimated thickness of 2,250 feet near Sylacauga in Talladega County. Interbedded shale, limestone, and sandstone occur in Calhoun and northern St. Clair Counties, and dolomite, shale, and limestone interbeds persist in Jefferson and southwest Shelby Counties (Osborne 1993a, b, 1995, 1996; Osborne and others, 2000).

The Brierfield Dolomite is a medium-bluish-gray coarsely crystalline, thick-bedded, in part highly siliceous (cherty) dolomite. In the Cahaba Valley, the Brierfield is up to 1,500 feet thick. In the eastern Valley and Ridge, the Brierfield is equivalent to the lower Ketona Dolomite of the western Valley and Ridge (Adams and others, 1926; Raymond and others, 1988; Szabo and others, 1988).

The Ketona Dolomite is a light-gray coarsely crystalline thick-bedded pure dolomite. Thickness ranges from 250 to 760 feet. The Ketona is exposed in the southern Cahaba Valley, in the Birmingham-Big Canoe Valley, and in Murphrees Valley as far north as Chepultepec (Adams and others, 1926; Raymond and others, 1988), near Allgood, in Blount County (Szabo and others, 1988). The Ketona conformably overlies the Brierfield Dolomite where the latter is present, but otherwise overlies the Conasauga or Rome (Adams and others, 1926).

The Bibb Dolomite is a dark-gray coarsely crystalline, thick-bedded, highly siliceous dolomite, characterized by locally abundant chert. Where exposed in the southern part of the Cahaba Valley, the Bibb ranges in thickness from 250 to 500 feet (Raymond and others, 1988). The Bibb conformably overlies the Ketona Dolomite and conformably underlies the Copper Ridge Dolomite of the Knox Group (Adams and others, 1926).

The Knox Group of Cambrian and Ordovician age includes the Copper Ridge Dolomite, Chepultepec Dolomite, Longview Limestone, Newala Limestone, and Odenville Limestone (plate 2). On plate 2, the Odenville is included with the Newala Limestone. The Knox overlies the Conasauga Formation and crops out extensively in the valley areas. The maximum thickness of the unit is approximately 3,900 feet (Thomas, 1985) but thins westward to about 2,600 feet (Szabo and others, 1988). The lithology ranges from siliceous (cherty) dolomite in the lower part to fine- to coarse-grained limestone in the upper part. The five formations assigned to the Knox Group are described in Adams and others (1926).

The Middle-Upper Ordovician succession in the Cumberland Plateau and Alabama Valley and Ridge areas is divided into a dominantly carbonate western facies and a largely siliciclastic eastern facies separated by the Helena thrust fault (plates 1,2). In ascending order, the western facies in Area 4 is composed of the Chickamauga Limestone and Sequatchie Formation. The Chickamauga Limestone is composed mainly of fine- to coarse-grained, medium- to thick-bedded, pure to argillaceous limestone, locally containing abundantly fossiliferous layers. Within Area 4, the Attalla Chert Conglomerate Member is found locally at the base of the Chickamauga in Jefferson and St. Clair Counties and is up to 110 feet thick. The Chickamauga is about 260 feet thick at Birmingham in Jefferson County, and thickens northward to about 1,100 feet. The Chickamauga crops out in the western Valley and Ridge and in Wills and Murphrees Valleys. The eastern facies of the Middle-Upper Ordovician includes the Lenoir Limestone, Little Oak Limestone, Athens Shale, Greensport Formation, Colvin Mountain Sandstone, and Sequatchie Formation. The upper units are dominantly siliciclastic, whereas the Lenoir and Little Oak Limestones are generally fine- to medium-grained, medium- to thick-bedded limestone. These two units correlate in part to each other and to the lower Chickamauga Limestone. The combined thickness of the Lenoir and Little Oak Limestones ranges from less than 10 feet in Calhoun County to about 800 feet at Odenville in St. Clair County. The Athens Shale is black graptolitic fissile shale, which contains argillaceous limestone in its lower part. The Athens is found in the eastern Valley and Ridge, chiefly in the southern part and has a maximum thickness of about 300 feet. The Greensport Formation consists of variegated siltstone, microcrystalline limestone, and shale, containing irregular lenses of fine sandstone. The Greensport is found in Area 4 in the northern part of the eastern Valley and Ridge, in St. Clair and Calhoun Counties. Thickness of the Greensport Formation ranges from 200 to 250 feet. The Colvin Mountain Sandstone is light-colored well-sorted sandstone containing local concentrations of small pebbles. In Area 4, the Colvin Mountain is found in the northeastern Valley and Ridge in St. Clair and Calhoun Counties, where it ranges from 15 to 75 feet thick. The Sequatchie Formation, a largely siliciclastic unit, is the youngest Ordovician unit and thins to the southwest and northwest. In Birmingham (Jefferson County), the unit is only 3 feet thick, but it thickens eastward to a maximum of about 200 feet. The Sequatchie grades westward from siltstone, sandstone, and shale overlain by calcareous siltstone and dolomite, to calcareous mudstone with intercalated limestone beds that are locally fossiliferous (Adams and others, 1926; Drahovzal and Neathery, 1971; Drahovzal and Neathery, 1985; Raymond and others, 1988; Szabo and others, 1988).

Silurian and Devonian outcrops within the study area are limited to a narrow area across Shelby, Jefferson, northwest St. Clair, and northwest Calhoun Counties (plate 1). The Silurian Red Mountain Formation is primarily a siliciclastic unit of interbedded sandstone, siltstone, shale, and hematite with thin interbeds of bioclastic limestone. The maximum thickness of Silurian rocks is somewhat more than 500 feet. The Frog Mountain Sandstone of Devonian age is characteristically a medium- to very coarse-grained sandstone. In Calhoun County, the Frog Mountain is locally thick and apparently thickens toward the southeast to possibly as much as 200 feet. In Jefferson County, thicknesses of less than 25 feet are common. The Chattanooga Shale is a widespread black shale of Devonian age, generally less than 30 feet thick.

The Mississippian System in Area 4 includes a shallow-marine carbonate facies that is bordered on the southeast by a prograding siliciclastic wedge of deltaic to shallow-marine sandstones and shales (Thomas, 1985; Mars and Thomas, 1999) (plate 2). The Lower Mississippian Maury Shale, which unconformably overlies the Chattanooga Shale, is characterized as a greenish clay shale and ranges from a few inches to about 3 feet in thickness. The upper Lower and Upper Mississippian rocks include the Fort Payne Chert, Tuscumbia Limestone, Pride Mountain Formation, Hartselle Sandstone, Bangor Limestone, Floyd Shale, Monteagle Limestone, and Parkwood Formation. Some of these units thin or grade laterally into each other; the complex lithostratigraphy of these units was described by Thomas (1972) and by Pashin (1993).

The Mississippian carbonate facies includes the Fort Payne Chert, which is primarily a thin-bedded fossiliferous chert, and the overlying Tuscumbia Limestone, which is a thin-bedded limestone and chert. These units generally crop out on the flanks of structures and have varying thicknesses that tend to diminish southwestward in the Warrior basin and southeastward across the fold and thrust belt. The Fort Payne ranges up to about 200 feet in thickness and the Tuscumbia to about 250 feet in thickness. Lenses of the siliciclastic Pride Mountain Formation and Hartselle Sandstone overlie the carbonate facies and, through facies changes, have general equivalents in the Floyd-Parkwood succession and (to the west) in the Monteagle Limestone. The Floyd-

Parkwood siliciclastic succession passes laterally into a shallow-marine carbonate facies (Bangor Limestone) in the northwestern part of Area 4. Thicknesses generally increase southwestward in the Warrior Basin and southeastward across the Appalachians, but areas of maximum thickness of the Floyd-Parkwood interval (3,500 feet in the Coosa synclinorium) appear to coincide with structural troughs.

The Pennsylvanian System includes the uppermost part of the Parkwood Formation and the Pottsville Formation—the youngest of the Paleozoic rocks in Alabama—and crops out in the Warrior Basin as well as on the Cahaba and Coosa Ridges. Primarily a ridge-forming succession of sandstone, shale, and coal beds, the Pottsville overlies the Mississippian Bangor Limestone and the Mississippian and Pennsylvanian Parkwood Formation. The thickness of the unit increases southward to a known maximum of about 9,000 feet at the southern end of the Cahaba and Coosa synclinoria (Thomas, 1972).

SEDIMENTARY DEPOSITS OF QUATERNARY AGE

Quaternary alluvial deposits overlie older formations along major streams throughout the study area. These deposits are not shown on the geologic map (plate 1). The alluvium is irregularly stratified, locally derived fluvial sediments consisting of clay, silt, sand, and pebbles with locally abundant cobbles, boulders, and heavy minerals (Szabo and others, 1988). These strata are generally less than 30 feet thick in Area 4 (Moore and Hunter, 1991).

HYDROGEOLOGY OF THE MAJOR AQUIFERS

The geologic formations of Area 4 can be grouped into three major aquifers and one minor aquifer—the Valley and Ridge aquifer system; the Mississippian aquifer system (consisting of the Hartselle, Bangor, and Fort Payne-Tuscumbia aquifers); the Pottsville aquifer; and the metasedimentary and metavolcanic aquifers (plate 3). In Area 2 (north and northeast of Area 4), the Monteagle aquifer is included within the Mississippian aquifer system. The Nashville-Stones River aquifer in Area 1, northwest Alabama, is equivalent to the Valley and Ridge aquifer system in Area 4. Except where noted, aquifers are defined in this report using the classification of Moore (1998).

Individual aquifers are associated with major physiographic divisions in Area 4 (fig. 1), whereas aquifer systems are more widely distributed. The complex geologic structure of Area 4 has disrupted the regional continuity of rock units so that major aquifers or aquifer systems exhibit disjunctive distributions (plates 4, 5). Aquifers consisting of limestone, sandstone, and fractured rock are exposed in valleys that are separated by ridges. A given major aquifer may be present in adjacent valleys, but the two valleys may not be hydraulically connected because of faulting or folding (figs. 2, 3).

Most high-yield aquifers are carbonates, and the highest yields are from wells that penetrate interconnected dissolution cavities. Individual rock units and their water-bearing properties are described in table 1. Most rocks within the valleys are covered by a mantle of residuum, which is the product of the weathering of the underlying parent material. The presence of a mantle of residuum that may or may not be permeable allows water to occur under either water-table or artesian conditions within the aquifers. Most carbonate aquifers are productive not because of primary porosity but because they contain networks of fractures that have been enlarged by dissolution. The dissolving waters enter the rock units from the surface, which means that, in general, porosity and permeability decrease with depth. Johnston (1933) recommended that wells drilled in lithified carbonates be abandoned if an adequate supply of water is not encountered within the first 200 feet of depth.

The ridges dividing the valleys (fig. 1) and the rock types that cap them are as follows: Weisner ridges, quartzite; western edge of the Northern Piedmont, slate; Cahaba ridges, sandstone and conglomerate; and Blount Mountain, sandstone. These rocks are highly resistant to weathering, are not significantly faulted, and are relatively impermeable.

VALLEY AND RIDGE AQUIFER SYSTEM

The Valley and Ridge aquifer system is found in the Coosa, Cahaba, Birmingham-Big Canoe, and Murphrees Valleys. Formations included in this aquifer system are the Weisner Formation; Shady Dolomite; Conasauga Formation; Copper Ridge and Chepultepec Dolomites; and the Longview, Newala, Lenoir, and Little Oak Limestones. In some areas the Copper Ridge, Chepultepec, Longview, and Newala are united as the Knox Group. This aquifer system includes in the western part of Area 4 (Shelby County) the Ketona, Brierfield, and Bibb Dolomites. In the southeastern part of Area 4, the Sylacauga Marble Group is also included in the Valley and Ridge aquifer system. Most other rock units of Cambrian to Devonian age (plate 2) are included within the Valley and Ridge aquifer system (plate 3) because they do not form effective barriers to ground water movement among permeable units of the Valley and Ridge aquifer system. However, these other units also are not significant sources of ground water. The Valley and Ridge aquifer system is the Knox-Shady aquifer of Planert and Pritchett (1989) and the Valley and Ridge aquifer system of Moore (1998).

The Weisner Formation forms ridges in which the unit is tightly cemented and impermeable. A well drilled in the Weisner Formation on Choccolocco Mountain in Calhoun County reached a depth of 305 feet without producing water (Johnston, 1933). Where the Weisner underlies valleys, it locally contains poorly cemented sandstone that is both porous and permeable (Johnston, 1933). In addition, the Weisner weathers to a sandy porous subsoil that holds and transmits water effectively (Johnston, 1933). Coldwater Spring, which supplies an average of 31.2 mgd (million gallons per day) of water to the city of Anniston, produces in part from the Weisner (Johnston, 1933; Scott and others, 1987). It is not known what percentage of the discharge of Coldwater Spring is provided by the Weisner and what percentage comes from carbonate units assigned to the Valley and Ridge aquifer system (Scott and others, 1987). Were it not for Coldwater Spring the Weisner probably would not be considered a good aquifer, as it elsewhere yields only modest amounts of water to springs and wells (Johnston, 1933).

The Shady Dolomite is characteristic of the calcareous rocks in Area 4 that dissolve along fractures to create enlarged channels that can yield substantial amounts

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Quaternary	Alluvial and terrace deposits	0-30	Sand, gravel, clay	Watercourse		Not tapped by any public supply well in the study area. Limited areal extent.
Cretaceous	Coker Formation	0-30	Poorly sorted clay, sand, gravel	Coker		Not tapped by any public supply well in the study area. Limited areal extent and thickness.
Pennsylvanian	Pottsville Formation	20-9,300+	Sandstone, shale, conglomerate, coal	Pottsville	Sandstone yields moderate amounts of water, maximum yield 250 gpm.	Quality variable, commonly high in iron (>0.3 mg/L).
Pennsylvanian-Mississippian	Parkwood Formation	600-2,600	Shale, sandstone, mudstone	[redacted]	Yields some water in sandy intervals.	Water of fair quality, commonly high in iron.
	Parkwood Formation-Pennington Formations undifferentiated	350	Shale, sandstone, conglomerate, mudstone			
	Parkwood Formation and Floyd Shale undifferentiated	2,100-3,500	Shale			
Mississippian	Bangor Limestone	0-700	Limestone	Mississippian	Abundantly water bearing where solution channels are developed. Supplies many springs. Yields up to 300 gpm or more.	Hard, calcium bicarbonate waters.

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Mississippian (continued)	Paleozoic Shale undifferentiated	unknown	Shale, mudstone		Relatively impermeable and not an aquifer.	
	Floyd Shale	0-1,500	Shale		Minor amounts of water sufficient for domestic use.	
	Hartselle Sandstone	0-160	Sandstone	Mississippian	Yield typically less than 50 gpm.	Bears water of variable quality; locally high in iron.
	Monteagle Limestone	0-300	Limestone, dolomite	Mississippian		Does not crop out in study area.
	Pride Mountain Formation	0-484	Shale		Minor amounts of water of variable quality.	
	Tuscumbia Limestone	0-250	Limestone, chert	Mississippian	Dissolution channels feed many large springs and yield adequate water to drilled wells.	Cherty subsoil; excellent aquifer. Hard, calcium bicarbonate waters.
	Tuscumbia Limestone, Fort Payne Chert, Maury Formation undifferentiated	0-464	Limestone, chert, shale	Mississippian	Dissolution channels feed many large springs and yield adequate water to drilled wells. Maximum yield 1,200 gpm .	Cherty subsoil; excellent aquifer. Hard, calcium bicarbonate waters.

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Devonian	Chattanooga Shale	0-40	Shale	[redacted]	Relatively impermeable and not an aquifer.	
	Chattanooga Shale and Frog Mountain Sandstone undifferentiated	0-100+	Shale, sandstone	Valley and Ridge	Little water.	Variable quality.
	Frog Mountain Sandstone	0-210	Sandstone	Valley and Ridge	Little water.	Variable quality.
Silurian	Red Mountain Formation	0-590	Sandstone, siltstone, shale	Valley and Ridge	Yields sufficient for domestic use.	
Ordovician	Sequatchie Formation	0-200	Shale, limestone	Valley and Ridge	Relatively impermeable and not an aquifer.	
	Sequatchie Formation, Colvin Mountain Sandstone, Greensport Formation undifferentiated	215-525	Shale, mudstone, dolomite, limestone	Valley and Ridge	Yield little water.	Yields calcium bicarbonate waters, shales, and argillaceous limestones yield little water.
	Leipers Limestone	0-60	Limestone	Valley and Ridge		
	Inman Formation	0-50	Shale, limestone	Valley and Ridge		
	Chickamauga Limestone	260-1,100	Limestone	Valley and Ridge	Yields sufficient for domestic use (up to 500 gpm).	
	Attalla Chert Conglomerate Member of the Chickamauga Limestone	0-110	Conglomerate	Valley and Ridge		

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Ordovician (continued)	Colvin Mountain Sandstone	15-75	Sandstone	Valley and Ridge	Little water; variable quality.	
	Greensport Formation	200-250	Shale, mudstone, limestone	Valley and Ridge		
	Athens Shale	0-300	Shale	[redacted]	Relatively impermeable and not an aquifer.	
	Athens Shale and Lenoir Limestone undifferentiated	0-450	Shale, limestone	Valley and Ridge	Water locally abundant in limestone.	Yields hard bicarbonate water that is otherwise of quality suitable for most uses.
	Little Oak and Lenoir Limestones undifferentiated	150-1,300	Limestone	Valley and Ridge	Locally abundant water. Yield up to 2,000 gpm.	Hard bicarbonate waters but otherwise of quality suitable for most uses.
	Little Oak Limestone	0-500	Limestone	Valley and Ridge		
	Little Oak and Newala Limestones undifferentiated	200-1,500	Limestone	Valley and Ridge		
	Newala Limestone	200-1,000	Limestone	Valley and Ridge	Abundantly water bearing. Dissolution channels supply springs and drilled wells.	Hard, calcium bicarbonate waters.
	Newala and Longview Limestones undifferentiated	700-1,500	Limestone	Valley and Ridge	Yield up to about 800 gpm.	
	Longview Limestone	500	Limestone	Valley and Ridge		

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Ordovician-Cambrian	Knox Group undifferentiated	1,475-3,500	Dolomite, limestone and chert	Valley and Ridge	Abundantly water bearing; yields up to 1 million gpd. Dissolution channels supply springs and drilled wells.	Hard, calcium bicarbonate waters.
	Chepultepec and Copper Ridge Dolomites undifferentiated	1,250-3,050	Dolomite, limestone, chert	Valley and Ridge	Abundantly water bearing; yield up to 900 gpm. Dissolution channels supply springs and drilled wells.	Cherty subsoil forms an excellent ground water reservoir; excessive iron, hard, calcium bicarbonate waters.
Cambrian	Copper Ridge Dolomite	1,250-1,800	Dolomite, chert	Valley and Ridge		
	Bibb Dolomite	250-500	Dolomite, chert	Valley and Ridge	Yield up to 2,000 gpm, but commonly less than 300 gpm.	Yield moderate amounts of water of variable quality (typically hard) from dissolution channels. Bibb and Brierfield weather to cherty subsoils that form excellent reservoirs.
	Ketona Dolomite	0-760	Dolomite	Valley and Ridge		
	Brierfield Dolomite	0-1,500	Dolomite, chert	Valley and Ridge		

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Cambrian (continued)	Conasauga Formation	0-2,600	Dolomite, chert	Valley and Ridge	Interbedded limestone and sandstone may be highly productive but dolomite and shale yield little water.	Water of moderate hardness.
	Lower unnamed shale facies of Conasauga Formation	350	Shale	[redacted]	Relatively impermeable and not an aquifer.	
	Rome Formation	1,000-4,000	Mudstone, shale, siltstone, and limestone	[redacted]	Yields moderate amounts of water.	Variable water quality.
	Shady Dolomite	370-1,000	Dolomite, chert	Valley and Ridge	Yields abundant amounts of water.	Water of calcium and magnesium bicarbonate type and moderate hardness.
	Chilhowee Group undifferentiated	455-2,340	Conglomerate, mudstone and sandstone	Valley and Ridge	Relatively impermeable and not an aquifer.	
	Weisner and Wilson Ridge Formations undifferentiated	160-1,700	Sandstone, conglomerate and mudstone	Valley and Ridge	Water bearing, dependent upon fractures which may yield abundant supplies for domestic use. Maximum yield 31.2 mgd (Coldwater Spring).	

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

System	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Cambrian (continued)	Nichols Formation	65-410	Mudstone	[redacted]	Relatively impermeable and not an aquifer.	
	Cochran Formation	230+	Sandstone, conglomerate and siltstone	[redacted]	Relatively impermeable and not an aquifer.	

METAMORPHIC ROCKS

Group	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
	Hillabee Greenstone	1,000-8,500	Greenstone interlayered with phyllite and dacite	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area. Limited areal extent.
	Quartz dacite unit of Hillabee Greenstone	500-1,000	Dacite	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area. Limited areal extent.
Talladega Group	Jemison Chert and Chulafinnee Schist undifferentiated	325-975	Chert, phyllite and schist	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area.
	Butting Ram Sandstone	0-2,750	Sandstone and conglomerate	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area.
	Lay Dam Formation	3,250-14,750	Phyllite, siltstone, quartzite, conglomerate and phyllite	Metasedimentary and metavolcanic	Relatively impermeable and not an aquifer.	
	Cheaha Quartzite Member of the Lay Dam Formation	0-3,000	Quartzite and conglomerate	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area.

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

Group	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
	Heflin Phyllite	unknown	Siltstone and sandstone	Metasedimentary and metavolcanic	Relatively impermeable and not an aquifer.	
Sylacauga Marble Group	Gantts Quarry Formation	0-3,275	Marble	Valley and Ridge		Produces water from interconnected dissolution channels.
	Gooch Branch Chert	0-1,975	Marble and chert	Valley and Ridge		
	Shelvin Rock Church Formation	0-2,300	Marble	Valley and Ridge		
	Fayetteville Phyllite	0-950	Phyllite and slate	Valley and Ridge	Relatively impermeable and not an aquifer.	
	Jumbo Dolomite	0-3,275	Marble	Valley and Ridge		Not tapped by any public supply well in the study area.
	Metaclastic rocks of unknown affinity	unknown	Phyllite, slate, quartzite	Valley and Ridge		
Kahatchee Mountain Group	Wash Creek Slate	6,000	Slate, siltstone and sandstone	Metasedimentary and metavolcanic	Relatively impermeable and not an aquifer.	
	Kalona Quartzite Member of Wash Creek Slate	1,100	Quartzite and conglomerate	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area.
	Stumps Creek Formation	2,050-2,650	Siltstone	Metasedimentary and metavolcanic	Relatively impermeable and not an aquifer.	

Table 1.--Generalized section of geologic units in Area 4 and their water-bearing properties (modified from Osborne and others, 1988; Planert and Pritchett, 1989)—Continued

Group	Geologic unit	Thickness (feet)	Lithology	Aquifer	Yield	Quality of water and remarks
Kahatchee Mountain Group (continued)	Brewer Phyllite	3,050	Phyllite, slate	Metasedimentary and metavolcanic	Relatively impermeable and not an aquifer.	
	Sawyer Limestone Member of Brewer Phyllite	0-100	Limestone	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area.
	Waxahatchee Slate	6,700	Siltstone, slate and quartzite	Metasedimentary and metavolcanic	Relatively impermeable and not an aquifer.	
	Unnamed unit of graphite schist	unknown	Schist, gneiss and quartzite	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area. Limited areal extent.
Poe Bridge Mountain Group	Unnamed unit of garnet quartzite	unknown		Metasedimentary and metavolcanic		
	Ketchepedrakee Amphibolite	unknown	Amphibolite	Metasedimentary and metavolcanic		Not tapped by any public supply well in the study area. Limited areal extent.

of water to wells. Wells that do not encounter cavity systems produce only small amounts of water from the Shady. The Shady contributes to the discharge of Coldwater Spring and feeds numerous small springs in Calhoun County (Johnston, 1933).

Limestone of the Conasauga Formation in the Birmingham-Big Canoe Valley yields substantial amounts of water where the dominantly calcareous and steeply dipping strata contain well-developed dissolution channels. In the Coosa Valley where the Conasauga is shaly, it is a mediocre aquifer and is used only for domestic supplies (Johnston, 1933). The water-bearing areas are usually associated with valleys and not ridges.

The Copper Ridge and Chepultepec Dolomites are similar in their water-bearing characteristics. Both are cherty dolostones containing elaborate systems of closely spaced and interconnected dissolution channels. When rocks that have a high chert content are weathered, the chert remains unaltered, leaving a residual soil that is porous and allows rapid recharge (Adams and others, 1926; Johnston, 1933).

Water-bearing properties of the Longview, Newala, Odenville, Lenoir, and Little Oak Limestones are similar to those of other carbonate units in Area 4–most water is derived from dissolution channels. However, in contrast to older units such as the Copper Ridge and Chepultepec Dolomites, these units are less cherty and hence their subsoils are less permeable. The Longview contains a modest amount of chert in its weathered subsoil and is a mediocre aquifer, whereas subsoils developed on the Newala, Odenville, Lenoir, and Little Oak Limestones are poor aquifers because of the paucity of chert (Johnston, 1933).

The Brierfield Dolomite yields water from dissolution channels formed by the enlargement of fractures, as is typical of carbonates of the Valley and Ridge aquifer system. The unit is cherty and weathers to a porous and permeable subsoil that readily provides water sufficient for domestic use (Johnston, 1933).

The Ketona Dolomite, unlike most other carbonate units assigned to the Valley and Ridge aquifer system, is remarkably free of chert (Adams and others, 1926). As a result, subsoils that develop on the Ketona are relatively impermeable. Nevertheless, fractured Ketona contains networks of dissolution channels as do most Valley and Ridge aquifer system carbonates, and the unit can produce substantial quantities of water (Johnston, 1933).

The Bibb Dolomite closely resembles the Brierfield both in lithologic and water-bearing characteristics (Adams and others, 1926; Johnston, 1933).

The Sylacauga Marble Group is assigned to the Valley and Ridge aquifer system, even though it has been affected by Piedmont metamorphism, because of its location, lithology, and water-bearing characteristics. The Sylacauga Marble produces water from interconnected dissolution channels like those in the dolomitic carbonates described above. However, the Sylacauga Marble (except the Gooch Branch Chert) is rather pure and so subsoils developed on it are clayey and do not form productive aquifers (Johnston, 1933).

As an indication of the variability of potential yield of water from the Valley and Ridge aquifer system, the maximum yields for wells and springs, respectively, are given for the counties where the aquifer is used: Calhoun, 1,100 gpm (gallons per minute) and 32.0 mgd; Jefferson, 750 gpm and 3.6 mgd; St. Clair, 400 gpm and 3.2 mgd; Shelby, 1,600 gpm and 0.8 mgd; and Talladega, 400 gpm and 6.9 mgd (Planert and Pritchett, 1989). A potentiometric map of the Valley and Ridge aquifer system (plate 6) can be used to estimate regional trends of ground water movement in the unit.

MISSISSIPPIAN AQUIFER SYSTEM

The Mississippian aquifer system is roughly equivalent to the Tuscumbia-Fort Payne aquifer of Planert and Pritchett (1989) and to the combined Bangor, Hartselle, Monteagle, and Fort Payne-Tuscumbia aquifers of Moore (1998). The Mississippian aquifer system is found in the Cahaba, Birmingham-Big Canoe, Murphrees, and Coosa Valleys. Formations included in the Mississippian aquifer system are the Fort Payne Chert, Tuscumbia Limestone, Hartselle Sandstone, Bangor Limestone, and Monteagle Limestone (but not in Area 4) of Mississippian age. The five formations listed are united in a single aquifer system for two reasons. First, they are not separated by impermeable strata on a regional scale; on lithologic grounds, they are inferred to contain a single interconnected ground water system. Second, further evidence for the unity of the Mississippian aquifer system is provided by ground-water level measurements, which define a single potentiometric surface in Area 4 for this group of aquifers (plate 7).

The Fort Payne Chert owes its water-bearing capacity to the fact that the limestone in the cherty beds is easily dissolved, leaving a porous reservoir. Where the beds have been folded, incipient cracks in the chert have opened, enhancing the porosity of the aquifer. On the gentler slopes of the formation, broken chert fragments have accumulated, creating a highly permeable soil. The Fort Payne Chert is an important aquifer in Areas 1, 2, and 4.

The Tuscumbia Limestone, like the underlying Fort Payne Chert, is an important aquifer in Areas 1, 2, and 4. The Tuscumbia produces water from dissolution channels similar to those characterizing many of the carbonate units of the Valley and Ridge aquifer system. However, the Tuscumbia is noteworthy because it contains a well-developed network of dissolution channels almost everywhere it has been tested (Johnston, 1933). Two of the three largest springs in Alabama, Brahan (Huntsville Big) Spring in Madison County and Tuscumbia Spring in Colbert County (both in Area 1), are sourced in the Tuscumbia Limestone.

The Hartselle Sandstone is well cemented and has only fair porosity throughout most of its outcrop where it yields moderate amounts of water to wells. At Irondale in Jefferson County, however, the sandstone is soft and friable and yields are higher (Johnston, 1933). Jointing is also an important factor in development of permeability in the Hartselle Sandstone (Spigner, 1975).

The Bangor Limestone, like the other carbonate rocks, contains a network of interconnected dissolution channels that can yield large quantities of water. Dissolution porosity is most abundant in the upper Bangor, which is composed of purer carbonate than the lower part (Spigner, 1975). Individual permeable zones can be traced over more than a mile in some places (Spigner, 1975). In addition, the formation contains sufficient chert to allow the development of a fairly permeable soil (Johnston, 1933).

The water-bearing characteristics of the Monteagle Limestone will be described in the report on Area 2 (Kopaska-Merkel and others, in prep.), because the Monteagle does not crop out in Area 4.

To illustrate the variability of the Fort Payne-Tuscumbia aquifer's potential, note the maximum yields for wells and springs, respectively, for the counties where the aquifer is used: Jefferson, 1,200 gpm and 0.2 mgd; and St. Clair, 250 gpm and 2.2 mgd (Planert and Pritchett, 1989).

POTTSVILLE AQUIFER

The youngest Paleozoic aquifer in Area 4 is the Pottsville aquifer, which consists of the Pottsville Formation (plate 8). The Pottsville Formation is not a reliable source of large amounts of ground water, but for much of Areas 3 and 4, and parts of Areas 1 and 2, it is the only aquifer available. Ground water in the Pottsville aquifer is found chiefly in fractures and weathered zones; primary porosity is not an important part of the aquifer (Stricklin, 1989). In addition, ground water in the Pottsville aquifer is commonly confined by sharp permeability contrasts within the aquifer (Stricklin, 1989). The Pottsville yields small quantities of water suitable for domestic use almost everywhere it is exposed in Area 4 (Johnston, 1933). Yields typically are less than 10 gallons per minute per well.

METASEDIMENTARY AND METAVOLCANIC AQUIFERS

The metasedimentary and metavolcanic aquifers are used for water supply within the study area but are not considered major aquifers. The metasedimentary and metavolcanic aquifers consist of Precambrian and Paleozoic metamorphic and granitic rocks that are described in the report on Area 5.

RECHARGE AND MOVEMENT OF GROUND WATER

The source of recharge to aquifers is precipitation, mostly rain supplemented by occasional snow. Average annual precipitation in Area 4 is about 53 inches per year, but a large part runs off during and directly after rainstorms. Most of the remainder is returned to the atmosphere by evaporation and by transpiration of trees and other plants. A relatively small part of the total rainfall infiltrates to the water table to recharge the aquifers. The only aquifer recharge that can be measured is that which is discharged to streams. A conservative estimate of recharge can be obtained by examining the base (dry weather) flow of streams. This estimate is reasonably accurate if there is no net long-term recharge or depletion of the aquifers (the system is in a steady state). Based on data from six long-term gaging stations within the study area, the estimate for aquifer recharge in Area 4 is about 5 inches per year (Planert and Pritchett, 1989).

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

Ground water movement can be illustrated by plotting the water levels in wells on a map and contouring the water levels. The resulting map is called a potentiometric surface map. Lines drawn perpendicular to the contours from higher to lower elevations of the surface defines ground water flow paths in the aquifer. Streams are the most common natural low points on the potentiometric surface map, but in Area 4, numerous springs are found where the water table intercepts the land surface.

The general pattern of ground water movement in the Valley and Ridge aquifer system can be determined from the potentiometric surface map (plate 6). The potentiometric surface was constructed using data collected over several decades. However, natural annual fluctuations in this aquifer system generally are less than 10 feet (Planert and Pritchett, 1989) and no long-term trends are evident in data from monitored wells, so the potentiometric surface should represent average current conditions within the aquifer system. Movement of ground water is primarily from the higher altitudes adjacent to the ridges toward the center of the valleys. In addition, ground water moves "down valley" in the direction of streamflow. The potentiometric surface covers disjunct parts of Area 4, reflecting the disjunct distribution of the Valley and Ridge aquifer system (see plates 1, 4, 5).

The potentiometric surface of the Mississippian aquifer system (plate 7) shows a similar trend, with ground water moving into and down river along the Coosa Valley, and off the Cahaba Ridges into the adjacent valleys. The Mississippian aquifer system, like the Valley and Ridge aquifer system, is characterized by annual fluctuations of less than 10 feet, and by no pronounced long-term trends in monitored-well data. Potentiometric surface elevations on the Mississippian aquifer system are roughly comparable to those on the Valley and Ridge aquifer system, but the two surfaces are not congruent.

The Pottsville aquifer is the youngest important aquifer in Area 4 (plate 8). In the Coosa Valley the Pottsville potentiometric surface is similar to that of the Mississippian aquifer system. However, farther to the west in the northern Birmingham-Big Canoe Valley and on the Cahaba Ridges, the Pottsville surface is both higher and more steeply inclined. In addition, the Pottsville aquifer occurs on the Cumberland Plateau, where the potentiometric surface is gently inclined.

Several processes can cause depressions to form on aquifer potentiometric surfaces. Incised streams may gain water from the aquifers they penetrate, and this probably is a factor in Area 4 (Planert and Pritchett, 1989). Pumping from a well also can cause a depression to form in the potentiometric surface of an aquifer. However, no cones of depression in Area 4 are large enough to be visible at the scale of plates 6 through 8.

Faulting is another important factor that can influence ground water flow in Area 4. Faults are not simply cracks, but zones of crushed and disturbed rock that can transmit large quantities of ground water through otherwise impermeable strata (Johnston, 1933). Kopaska-Merkel and others (2000) published a map of iron concentration in ground water in Area 5 that showed pronounced control of long distance ground-water movement by major faults. Structural data are insufficient to completely evaluate the importance of faulting on ground water movement in the study area, but in a report on Coldwater Spring, which lies on the trace of the Jacksonville fault, Scott and others (1987) attempted to identify the recharge area for the spring. The authors estimated the recharge area for the spring was about 23 mi^2 (Scott and others, 1987). However, recharge rates determined from ground water runoff to streams during periods of low flow indicate that the recharge area for the spring could be about 90 mi^2. In other words, part of the ground water discharge appeared to come from outside the recharge area identified in the report. The discrepancy in the values suggests the importance faulting has on ground water movement throughout Area 4.

Locally, ground water availability can be affected by paving of recharge areas. Spigner (1975) suggested that recharge to the Hartselle aquifer was reduced by paving of recharge areas near Irondale in Jefferson County. Because pavement is virtually impervious, paved areas are effectively removed from the recharge areas of aquifers. The effects of paving on recharge areas are greatest in wells close to the recharge areas. The effects of reduced permeability in recharge areas will be delayed because ground water can take years to move from recharge areas to well intakes where aquifers are confined.

NATURAL DISCHARGE AND GROUND WATER WITHDRAWALS

A large part of aquifer recharge is discharged to streams through seeps and springs. At the driest time of the year, almost 600 mgd of ground water is discharged to the streams in Area 4 (Hayes, 1978). Pumpage from wells accounts for any other measurable discharge from the aquifer system. For the study area, estimated withdrawals from ground water for 1995 are as follows: public supply, 53.76 mgd; self-supplied industry, 1.84 mgd; agriculture, 1.39 mgd; and self-supplied domestic, 13.55 mgd. Ground water withdrawals for public water systems in the study area by county were as follows: Calhoun, 20.73 mgd; Jefferson, 8.97 mgd; Shelby, 11.65 mgd; St. Clair, 6.78 mgd: and Talladega, 5.63 mgd (Mooty and Richardson, 1998). The estimated total withdrawal in the study area of 71.87 mgd is equivalent to 0.38 inch per year of recharge. This figure is about 27 percent higher than a similarly derived estimate of 0.3 inch per year in the late 1980s (Planert and Pritchett, 1989). However, 1995 ground water withdrawals were only about 8 percent of the estimated recharge of 5 inches per year (Planert and Pritchett, 1989). The largest ground water users in the study area are Alabaster, Anniston, Calhoun County, Leeds, Odenville, Oxford, Pelham, Talladega, and Trussville. Locations of all public-supply wells and springs are shown on plate 1; pertinent data concerning the wells and springs, including well construction, water levels, and spring flows, are presented in appendix A.

EFFECTS OF WITHDRAWALS FROM THE AQUIFERS

Large long-term withdrawals of water from the aquifers may result in the formation of depressions on the potentiometric surfaces of the aquifers. The extent of the depressions depends on the amount of water withdrawn and the water-bearing characteristics of the sediments. No extensive depressions on the potentiometric surfaces of the aquifers were found in Area 4. Depressions on the water surfaces in aquifers caused by pumpage could induce recharge by vertical leakage from overlying saturated zones. Recharge could also be induced by pumpage in areas along major rivers where aquifers are hydraulically connected to streams. Depressions on potentiometric surfaces also create steepened hydraulic gradients near pumping centers and increase the rate of movement of water and any potential contaminants to points of ground water withdrawal.

GROUND WATER QUALITY

The mineral content of water changes as it passes through the different phases of the hydrologic cycle. Precipitation that falls on soil and rock tends to accumulate dissolved mineral matter. The amount of mineral matter dissolved in water depends on the resistance of the minerals to chemical and physical attack, the length of time the minerals are in contact with the water, and the chemical composition, temperature, and pressure of the water. In general, deeper ground water has been in the ground longer and is more mineralized.

In general, ground water in Area 4 is suitable for most uses, but some ground water quality problems have been noted. Ground water from siliciclastic reservoirs tends to contain excessive quantities of dissolved iron (plate 9), whereas ground water from carbonate reservoirs is hard to very hard (Causey, 1963; Shamburger and Harkins, 1980; Moser, 1988) (fig. 4). No secular changes in ground water quality in Area 4 have been observed (Hunter and Moser, 1990).

Ground water in the Valley and Ridge aquifer system is generally of high quality, though it ranges from moderately hard to very hard (Causey, 1963; Shamburger and Harkins, 1980; Moser, 1988; Hunter and Moser, 1990; Moser and DeJarnette, 1992), reflecting the mineral composition of carbonate rocks (limestone and dolostone) composing this aquifer system.

Ground water in the Mississippian aquifer system is generally of high quality, though some samples are moderately hard or hard (Hunter and Moser, 1990; Moser and DeJarnette, 1992). The Bangor aquifer, part of the Mississippian aquifer system, has a reputation for problems with turbidity, subsidence, contamination, and severe drilling difficulties (Spigner, 1975; Moffett and Moser, 1978). These problems may result, at least in part, from the highly weathered nature of the upper part of the formation (Spigner, 1975; Moffett and Moser, 1978). The Hartselle aquifer and the Floyd Shale, which yield some water to wells though they are not considered major aquifers, produce water that may contain excess quantities of iron (Causey, 1963; Shamburger and Harkins, 1980; Moser and DeJarnette, 1992).

Ground water in the Pottsville Formation tends to contain excess iron and manganese, and some Pottsville ground water is moderately hard (Causey, 1963; Shamburger and Harkins, 1980; Hunter and Moser, 1990). Water with iron concentrations in excess of 0.3 mg/L is considered objectionable because it stains plumbing fixtures. The U.S. Environmental Protection Agency (EPA) has defined 0.3 mg/L of dissolved iron as a secondary maximum contaminant level allowed in drinking

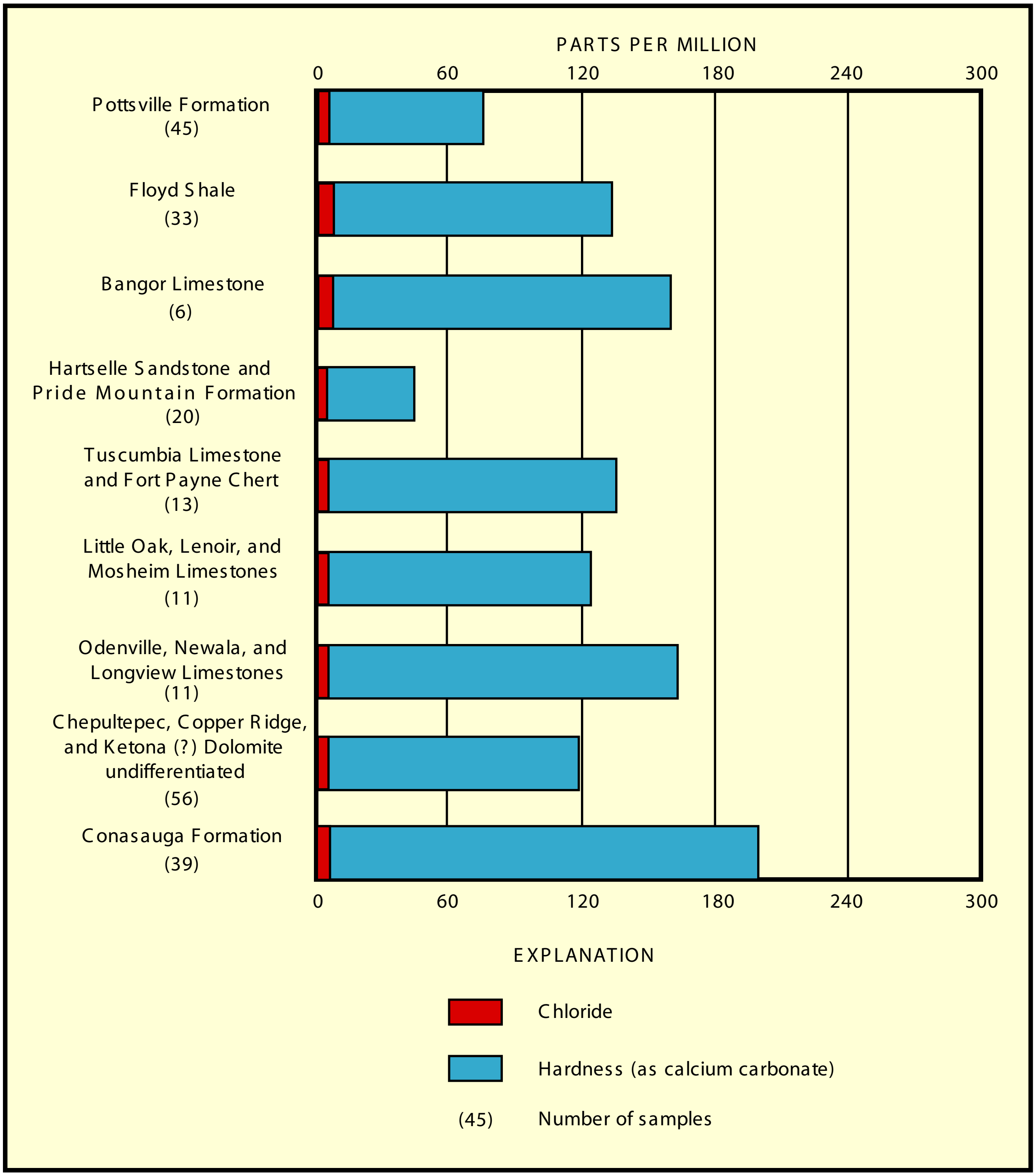

Figure 5.--Median hardness and chloride content of water from wells and springs in St. Clair County (modified from Causey, 1963).

water. Secondary maximum contaminant levels are not enforceable by federal law, but the State of Alabama has adopted this value as part of its regulations for public water supplies. Many wells completed in the Pottsville aquifer produce ground water containing greater than 0.3 mg/L of dissolved iron (plate 9; Causey, 1963; Shamburger and Harkins, 1980; Moser, 1988; Hunter and Moser, 1990; Moser and DeJarnette, 1992). Excess manganese (greater than the secondary maximum contaminant level of 0.05 mg/L) has the same effect as excess iron, and this value has been adopted by the State of Alabama as part of its regulations for public water supplies.

The content of dissolved iron in shallow ground water is controlled by large-scale geologic structure and stratigraphy (plates 1, 9). Ground water with high iron concentrations is found in the Pottsville aquifer in the Valley and Ridge geologic province, whereas ground water in Mississippian and lower Paleozoic carbonate aquifers in the same region is relatively low in iron (plate 1). Regional faults and folds control the surface distribution of these aquifers and hence control the distribution of dissolved iron in shallow ground water in the Valley and Ridge. Iron concentrations do not show pronounced linear patterns in the flat-lying strata of the Cumberland Plateau. Most wells in the Cumberland Plateau are completed in the Pottsville aquifer, and iron concentrations are variable but locally high. Ground water containing elevated levels of dissolved iron is also found in the Piedmont Upland in the eastern part of Area 4. The distribution of iron in ground water in the Piedmont is discussed in the report on Area 5 (Kopaska-Merkel and others, 2000).

Water hardness is caused by the presence of divalent metallic cations such as calcium and magnesium. These cations react with soap to form a precipitate, thereby increasing soap usage and reducing its cleansing action. Hardness is expressed as a concentration of $CaCO_3$ and is classified as follows: soft, 0 to 60 mg/L; moderately hard, 61 to 120 mg/L; hard, 121 to 180 mg/L and very hard, greater than 180 mg/L (Hunter and Moser, 1980). Because carbonate rocks (limestone and dolomite) are composed chiefly of $CaCO_3$ and (Ca, Mg) CO_3, areas underlain by carbonates typically yield hard water to wells. Most sandstone units are low in calcium and magnesium ions and therefore yield relatively soft water. Plate 10 illustrates the distribution of hardness in shallow ground water in Area 4. The Pottsville aquifer is the most widespread siliciclastic aquifer in Area 4, and areas underlain by the Pottsville contain softer ground water than areas underlain by the dominantly carbonate formations of the Mississippian and Valley and Ridge aquifer systems (plates 1,10).

VULNERABILITY OF THE AQUIFERS TO CONTAMINATION

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

Numerous surface sources of potential contamination include point sources such as gasoline tanks, chemical spills, pipeline and sewer leaks, treatment lagoons, and industrial sites. Potential nonpoint sources of pollution include chemicals applied to agricultural fields, confined animal feeding operations, onsite sewage system discharges, chemicals applied to lawns and gardens, and urban runoff.

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

Outcrops of all aquifers in Alabama are vulnerable to contamination from surface sources of pollution. The extent to which an aquifer can become contaminated depends on the nature of the contaminant and on the hydrogeologic characteristics of the aquifer. These hydrogeologic characteristics are highly variable from aquifer to aquifer and even within individual aquifers and are largely controlled by the permeability of the units comprising an aquifer. For instance, porosity and permeability in the Hartselle Sandstone are controlled by the degree of cementation. Hartselle strata range from tightly cemented and impermeable to weakly cemented and highly permeable. Unconfined aquifers with high permeabilities have high recharge rates (typically more than 6 inches per year) and contaminants from the surface may not be adequately filtered out as water moves toward the water table. The most vulnerable aquifers in Alabama are either unconsolidated sand and gravel or carbonate rocks that contain numerous dissolutionally enlarged joints and fractures. Only the latter is important in Area 4. Aquifers least vulnerable to contamination are typically overlain by thick (50 feet or more) relatively impermeable units such as clay or chalk. These impermeable units are either aquicludes or aquitards.

Vulnerability may also vary within aquifers. Aquifers are most vulnerable in their outcrops where water table conditions exist. Where aquifers are buried beneath other units and become confined, their vulnerability to surface contamination decreases. This is because they are protected by aquicludes or aquitards that retard the vertical downward movement of contaminants. Although this confinement affords some protection to the aquifer, no aquifer is immune to contamination from poorly constructed wells and bad management practices. Pumping of large quantities of ground water by public supply wells, industrial supply wells, or irrigation wells creates cones of depression, increases flow gradients, and draws ground water and any associated contamination, where present, toward the pumping wells. Further, some contaminants can enter an aquifer in the recharge area or in the vicinity of a poorly constructed well, move laterally through the aquifer (dissolved in moving ground water), and finally enter confined portions of the aquifer that are not very vulnerable to contamination directly from the surface. Aquifers in their outcrops may be recharged very quickly in some areas, as indicated by the rapid response of water levels in some wells to precipitation events (fig. 5). Such hydraulic connections indicate highly vulnerable conditions because water, which may contain contaminants, can move unusually quickly through the shallow ground water system to the well bore. Rapid recharge implies that filtering of contaminants in the subsurface may be ineffective.

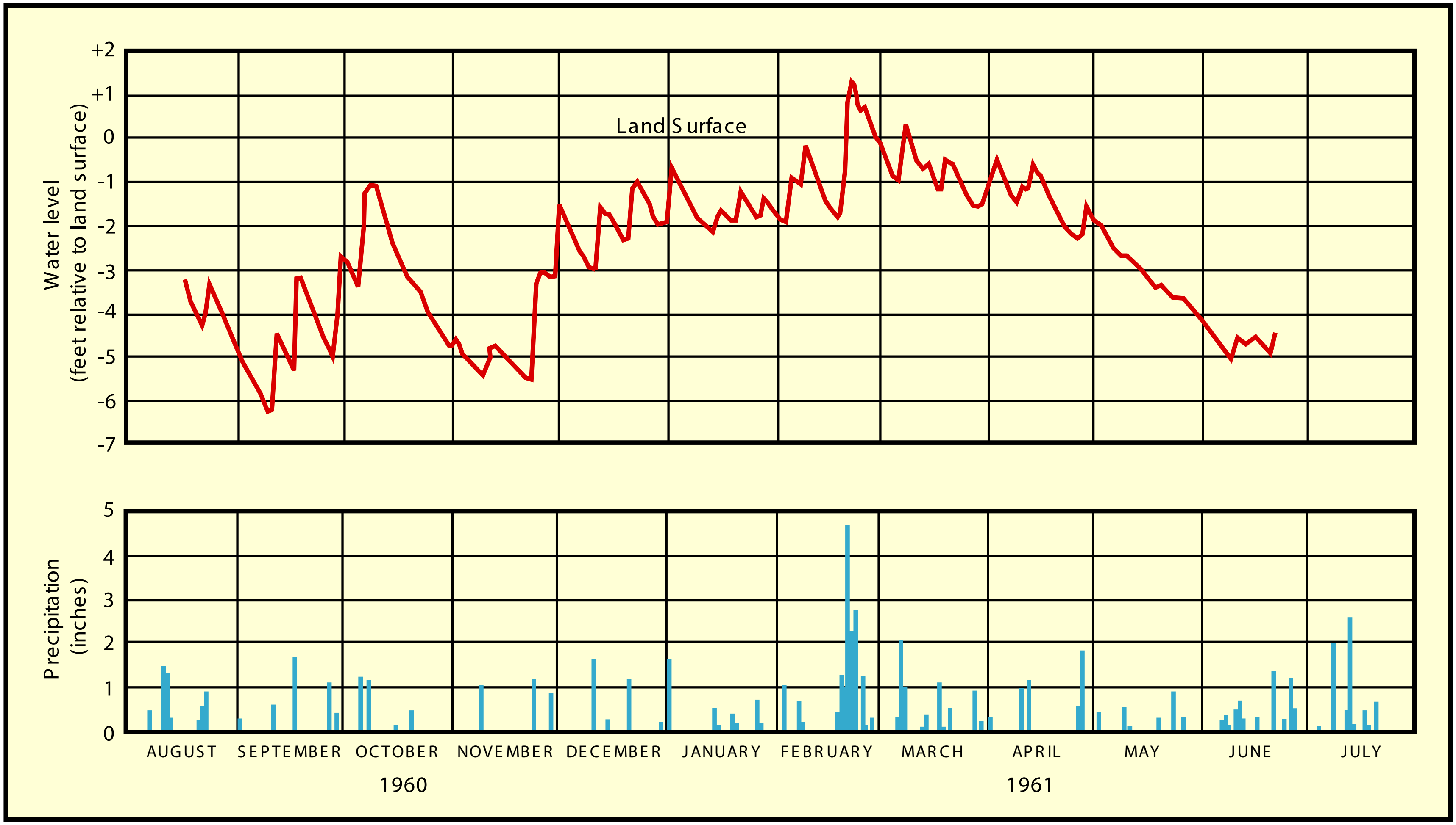

Figure 5.--Changes in water level in well STCBB-2 at Pell City and precipitation at Ashville in St. Clair County (modified from Causey, 1963).

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

High vulnerability to contamination

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

Moderate vulnerability to contamination

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

Low vulnerability to contamination

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

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

Much of the central and eastern portions of Area 4 are underlain by aquifers of the Valley and Ridge aquifer system (plates 5, 6). Most of these aquifers are cherty carbonates that are susceptible to dissolution, contain systems of dissolution channels, and weather to form highly porous soils. The recharge area of the Valley and Ridge aquifer system is highly vulnerable to contamination from the surface. A few of the lower Paleozoic units associated with the Valley and Ridge aquifer system are relatively impermeable and are mapped as confining units. The most significant of these in terms of outcrop area are the Rome Formation and the Athens Shale (plate 1); the recharge areas of these units are of low vulnerability to contamination from the surface. However, where the Rome or the Athens are less than 50 feet thick then the underlying aquifers are moderately vulnerable or even highly vulnerable to contamination from the surface.

Parts of the central portion of Area 4 are underlain by aquifers of the Mississippian aquifer system (plates 5, 7). All but one of the Mississippian aquifers are carbonate units that are susceptible to dissolution and sinkhole formation. Sinkholes are depressions in the land surface caused by the collapse of rock material into a dissolution cavity. Sinkholes are widely distributed in Area 4 (fig. 6). Sinkholes can provide a direct link to the aquifer system that could allow immediate contamination of the aquifer (Newton, 1987; Warren, 1976). The Mississippian carbonates contain systems of dissolution channels and are extremely permeable. In addition, the Bangor aquifer and especially the Fort Payne aquifer are cherty and hence are prone to developing highly permeable soils. The recharge area of the Mississippian aquifer system is considered highly vulnerable to contamination from the surface (plates 5, 7). The Mississippian Pride Mountain Formation and Floyd Shale are relatively impermeable and are mapped as confining units on plate 5. The outcrop areas of these two units are considered to be of low vulnerability to contamination from the surface. Where the Pride Mountain Formation is about 100 feet thick near Irondale in Jefferson County, it locally isolates the overlying Hartselle aquifer from the underlying Tuscumbia-Fort Payne aquifer (Spigner, 1975). In addition, the Mississippian-Pennsylvanian Parkwood and Pennington Formations, which separate the Mississippian aquifer system from the Pottsville aquifer, also are mapped as confining units and are considered to be of low vulnerability to contamination from the surface (plates 2, 3). In other words, where the Mississippian and Pennsylvanian Pride Mountain, Parkwood, and Pennington Formations and the Mississippian Floyd Shale confine Mississippian aquifers, those aquifers are substantially less vulnerable to contamination from the surface than where the aquifers crop out in their recharge areas. Locally, the Pride Mountain Formation, Floyd Shale, and Parkwood and Pennington Formations may be less than 50 feet thick because of limited deposition, erosion, or faulting. In such areas, underlying aquifers are moderately vulnerable or even highly vulnerable to contamination from the surface. However, detailed geologic mapping would be needed to define these small areas.

Much of Area 4 is underlain by the Pottsville aquifer (plates 5, 8), which is a lithified shale-sandstone unit that produces ground water chiefly from fractures and weathered zones. Long-distance ground water flow in the Pottsville is inhibited by sharp permeability contrasts and by typically low matrix permeability values within the aquifer (Stricklin, 1989). Consequently, the recharge area of the Pottsville aquifer is considered moderately vulnerable to contamination from the surface (plates 5, 8).

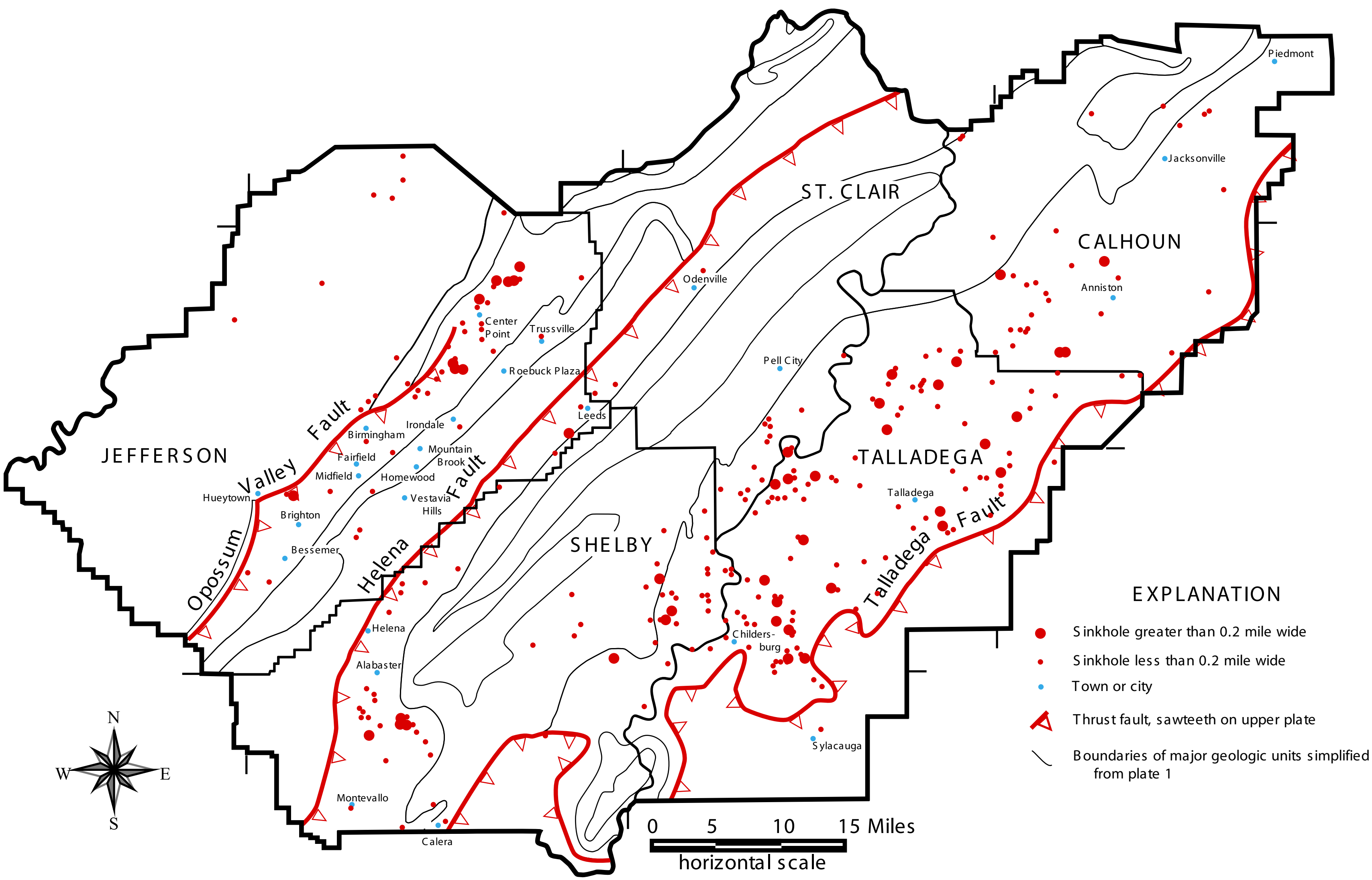

Figure 6.--Locations of sinkholes in Area 4 (modified from Planert and Pritchett, 1989).

The eastern part of Area 4 lies within the Piedmont geologic province and is underlainby a complex mix of rock types assigned to the metasedimentary and metavolcanicaquifers. Because of their broad outcrop area and locally high porosity and permeability values, the metasedimentary and metavolcanic aquifers are highly vulnerable to contamination from the surface throughout their entire recharge areas (Kopaska-Merkel and others, 2000).

In addition to the large-scale characteristics of the major aquifers, several modifying factors can increase aquifer vulnerability in Area 4. Chief among these are faulting, formation of cherty soils, and sinkholes (fig. 6). Faulted areas are potentially highly vulnerable to contamination from the surface. Fault zones or faults may be extremely transmissive and, where they crop out, may be sites of increased recharge. The increased permeability in some fault zones also represents an increase in the potential for contamination from the surface to enter the aquifer; these areas are designated as highly vulnerable to contamination. The major faults in the study area have been mapped and are shown on plates 1, 4, and 5. It is likely, however, that many additional unmapped minor faults are present in the study area.

When rocks that have a high chert content are weathered, the chert remains unaltered, leaving a residual soil that is porous and allows rapid recharge. Areas underlain by these soils tend to be more vulnerable to contamination from the surface, but a detailed geologic map or soils map showing the particular formations or soils of interest would be needed to identify these localized areas.

Some parts of Area 4 are extremely vulnerable to contamination because they coincide with the locations of sinkholes (U.S. Geological Survey 1976a, b, 1977a, b, c; Planert and Pritchett, 1989). Sinkholes are depressions in the land surface caused by the collapse of rock material into a dissolution cavity. Sinkholes can provide a direct link to the aquifer system that could allow immediate contamination of the aquifer (Newton, 1987; Warren, 1976). Locations of known sinkholes are shown on figure 4 with distinction made between smaller and larger (greatest surface dimension greater than 0.2 mile) sinkholes. Sinkholes are particularly abundant in the recharge area of the Valley and Ridge aquifer system.

PUBLIC SUPPLY WELLS AND SPRINGS

In the study area, 92 public ground water supply wells and 12 public supply springs provide water for 37 water systems (app. A; plate 1). All of the springs and about two-thirds of the wells derive water from the Valley and Ridge aquifer system. Most of the remaining wells derive water from the Mississippian aquifer system. Public water supply wells in Area 4 average about 240 feet deep and range from 100 to 500 feet deep. At Coldwater Spring, one of the three largest springs in the state, discharge ranges from a few hundred gpm to about 20,000 gpm.

WELLHEAD PROTECTION AREAS

Public water supply systems that use ground water provide water to about one-third of the population of Alabama (Mooty and Richardson, 1998). Programs that protect ground water sources from potential contamination are known as Wellhead Protection Programs (WHPP’s). Alabama's WHPP is the result of 1986 amendments to the Safe Drinking Water Act originally enacted by Congress in 1974. The 1986 amendments directed the EPA to oversee the states' development of plans and programs to protect areas providing ground water to public water supply wells or springs. Amendments in 1996 established Source Water Assessment requirements for public water supply systems using either ground water or surface water sources. The Source Water Assessment Program (SWAP) requires a Source Water Assessment Area (SWAA) delineation, contaminant source inventory within each SWAA, a susceptibility analysis of each contaminant source in the inventory, and public notification of the condition of raw water supplies, including their susceptibility to contamination. The SWAA’s are identified surface areas where potential contaminants that migrate into the ground are most likely to cause contamination of public water supply wells or springs. SWAA’s are delineated using hydrogeologic conditions or time-of-travel criteria. The revised WHPP is a voluntary program that builds on the SWAP by providing guidance for developing protection strategies in the delineated areas. Protection strategies include building a local team of concerned citizens, developing an education and outreach program, and developing management and contingency strategies. The terms SWAA and WHPA can be used to identify the same area around a public water supply well or spring and are used synonymously in this report.

Ten public water supply systems currently have WHPA’s or SWAA’s delineated in Area 4 (plate 11). The only ground water supply system in Calhoun County that has established a WHPA is Oxford. Systems in Jefferson County with delineated WHPA’s are Irondale, Leeds, Roupes Valley, and Trussville. Systems in Shelby County with delineated WHPA’s are Alabaster, Columbiana, and Wilsonville. The only system in St. Clair County with a delineated WHPA is Odenville. The only system in Talladega County with a delineated WHPA is Talladega. Public supply well and spring locations and boundaries of the WHPA’s are shown on plate 11.

SUMMARY AND CONCLUSIONS

The geology and physiography of Area 4 are complex because of past large-scale tectonic activity. Most of the study area is in the Appalachian fold and thrust belt, which consists of Paleozoic sedimentary strata. Paleozoic metasedimentary and metavolcanic rocks crop out along the southeastern border of the study area, are separated from the fold, and thrust belt by the Talladega fault.

The geologic formations in Area 4 can be grouped into four major aquifers—the Valley and Ridge aquifer system, Mississippian aquifer system (including the Bangor, Hartselle, and Fort Payne-Tuscumbia aquifers), Pottsville aquifer, and metasedimentary and metavolcanic aquifers. The complex structure in the area has disrupted the regional continuity of the formations so that individual aquifers are associated with the major valleys in the study area and the same major aquifer type may be present in adjacent valleys but may not be hydraulically connected because of faulting or folding.

Aquifers coincide with the physiographic districts of the Coosa Valley, Cahaba Valley, Birmingham-Big Canoe Valley, and Murphrees Valley. These aquifers are tapped within their outcrop areas where they are also recharged. Most rocks are covered by a mantle of residuum, which is a product of weathering of the underlying parent material. Water may occur in either water-table or artesian conditions within the aquifers. Highest yields from aquifers are associated with dissolution openings in carbonate rocks. Springs provide substantial amounts of water for municipal supply with the largest being Coldwater Spring in Calhoun County.

For the study area, estimated major withdrawals from ground water are as follows: public supply, 53.76 mgd; self-supplied industry, 1.84 mgd; agriculture, 1.39 mgd; and self-supplied domestic, 13.55 mgd (Mooty and Richardson, 1998). The estimated total withdrawal of 71.87 mgd (which includes minor withdrawals for uses not listed here) is equivalent to 0.38 inch per year of recharge. The largest ground water users in the study area are Alabaster, Calhoun County, Leeds, Odenville, Oxford, Pelham, Talladega, and Trussville.

All aquifer recharge areas are vulnerable to contamination from the surface. The recharge areas of the Valley and Ridge and Mississippian aquifer systems and the metasedimentary and metavolcanic aquifers are highly vulnerable, whereas the recharge areas of the Pottsville aquifer are moderately vulnerable. Two conditions exist in the study area that may cause the aquifers to be exceptionally vulnerable to contamination on a local scale—rock materials that are fractured in places due to faulting, and weathered cherty soils that tend to be porous. Sinkholes may provide direct connections between the surface and the aquifer; local areas around sinkholes are extremely vulnerable to contamination.

In the study area, 92 public ground water supply wells and 12 public supply springs provide water for 37 water systems. All of the springs and about two-thirds of the wells derive water from the Valley and Ridge aquifer system. Most of the remaining wells derive water from the Mississippian aquifer system. Public water supply wells in Area 4 average about 240 feet deep and range from 100 to 500 feet deep. Spring discharge ranges from a few hundred gpm to about 20,000 gpm in the case of Coldwater Spring, one of the three largest springs in the state. Ten public water supply systems currently have wellhead protection or source water protection areas delineated in Area 4.

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RELATED LINKS

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

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

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

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

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

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

http://www.ucowr.sui.edu/
Universities Water Information Network (UWIN)
UWIN maintains several databases for providing water information. Over 100 different water related links are listed by categories.

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

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

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

http://danpatch.ecn.purdue.edu/~safeh2o/wq/
National Extension Water Quality Database
This site allows for searches in a database that has 2,500 abstracts and 1,500 documents on all aspects of water quality. The documents are full text and list available contacts. Also available are Quick Time Movies.

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

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

APPENDIX A

Records of public water-supply wells and springs in Area 4

Explanation of table headings

SYSTEM, Water system name.
PWS ID, Public water system identification number as assigned by the ADEM.
SE ID, Source identification number as assigned by the
GSA ID, Well identification number assigned by the GSA.
DEPTH, Total depth of well in feet.
YEAR DRILLED, Year the well was completed and ready for operation.
DRILLING CONTRACTOR, Name of driller.
ALTITUDE, Elevation of land surface in feet above mean sea level.
AQUIFER: Єbf, Brierfield Dolomite; Єc, Consauga; Єch, Chilhowee Group; Єcl, lower unnamed shale facies of the Conasauga Formation; Єk, Ketona Dolomite; Єr, Rome Formation; Єs, Shady Dolomite; Єu, Cambrian undifferentiated; Єwwr, Weisner and Wilson Ridge Formations; tg, Talladega Group; Mb, Bangor Limestone; Mfp, Fort Payne Chert; Mh, Hartselle Sandstone; mm, Moffits Mill Schist; MS, Mississippian aquifer system; Mtfp, Tuscumbia-Fort Payne Formations; Ppv, Pottsville Formation; Oc, Chickamauga Limestone; Chepultepec and Copper Ridge Dolomites; OЄk, Knox Group; Olol, Little Oak and Lenoir Limestones; On, Newala Limestone; Onlv, Newala and Longview Limestones; Ou, Ordovician undifferentiated; sm, Sylacauga Marble; VR, Valley and Ridge aquifer systems, The formation names (for example, Brierfield Dolomite) identify parts of the Valley and Ridge that aquifer system have been assigned to particular named geologic units.
WATER LEVEL, Water level in feet below land surface. For springs, measured flows are given in gallons per minute (gpm).
DATE MEASURED, Date of water-level measurement.
WELL CONSTRUCTION, YIELD, REMARKS, gpm is gallons per minute.

Appendix A.--Records of public water-supply wells and springs in Area 4

CALHOUN COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Anniston	133	1	CALW-12				596	OЄk, Cs, Cwwr	20,000 gpm	10/18/28	Coldwater Spring. USGS No. 68. Considered to be a surface water source by USEPA and by ADEM because the spring basin is open to the air.
Calhoun County	131	1	CALF-68				580	VR (On)	2,128 gpm	10/23/89	Seven Springs. Measured flow 2,128 gpm on 7/15/57. Measured flows range from 272 to 3,360 gpm.
Calhoun County	131	2	CALF-42				531	VR (On)	1,600 gpm	10/15/28	Read's Mill Spring. Measured flow of 2,673 gpm on 12/7/87. Measured flows range from 1,600 to 3,319 gpm.
Calhoun County	131	3	CALG-01				615	VR (OЄk)	1,430 gpm	10/10/77	Webster Chapel Spring. Measured flow 120 gpm 10/29/87. Measured flows range from <4.5 to 1,430 gpm.

EXPLANATION

Appendix A.--Records of public water-supply wells and springs in Area 4--Continued

CALHOUN COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Jacksonville	154	1	CALL-21				651	VR (Єc)	456 gpm	12/9/87	Big Spring or Town Spring. Flow ranges from 0 to 1,440 gpm. Average flow 1,150 gpm. USGS No. 12.
City of Jacksonville	154	2	CALL-1				627	VR (Єc)	820 gpm	12/8/89	Germania Springs. Average flow 2,200 gpm. USGS No. 11.
Town of Oxford	162	1	CALW-02	355	1985	Graves Well Drilling Co.	355	VR (Єr)	26.4	1/13/88	Casing: 12-in. from 0 to 160 ft, open hole below. Reported theoretical yield of 2,750 gpm. Permitted by ADEM to pump 1,500 gpm. Coldwater well or Well No. 1.
Town of Oxford	162	2	CALY-01	175	1987	Graves Well Drilling Co.	668	VR (OЄk)	57.6	1/13/88	Casing: 6-in. Reported theoretical yield 3,500 gpm. Permitted by ADEM to pump 1,000 gpm. Cavity from 150 to 170 ft. McIntosh well, Frye well, or Well No. 2.

EXPLANATION

Appendix A.--Records of public water-supply wells and springs in Area 4--Continued

CALHOUN COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Oxford	162	3	CALU-04	257	1987	Graves Well Drilling Co.	670	VR (Ꞓs)	23.9	2/9/88	Casing: 12-in. steel from 0 to 212 ft; 8-in. screen from 212 to 252 ft. Reported theoretical yield of 4,300 gpm. Permitted by ADEM to pump 1,500 gpm. Choccolocco well or Well No. 3.
Town of Weaver	168	1	CALS-8	409	1956	Carl Pace	719	VR (Ꞓc)	37.9	12/16/87	Reported drawdown of 16 ft after pumping at 300 gpm for 16 hrs on 7/17/56. Pump set at 101 ft. Cavities at 93, 143, 198, and 200 ft. Tends to pump muddy water after a rain. USGS No. 16.
Town of Weaver	168	2	CALS-06	125	1972	Graves Well Drilling Co.	720	VR (Ꞓc)	56	9/28/72	Well diam. 12 in. Reported to yield water from a large cavity. Well No. 3. USGS No. 18.

EXPLANATION

JEFFERSON COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Irondale	751	1	JEFW-4	250	1949	H. W. Peerson	750	MS (Mb)	28	8/2/49	Casing: 10-in., from 0 to 60 ft; screened, 10-in.; from 166 to 250 ft, open hole. Reported pumping 175 gpm in 1977. City Well No. 1. USGS No. 43.
City of Irondale	751	2	JEFW-7	312	1954	H. W. Peerson	720	MS (Mb)	20	9/3/54	Casing: 10-in., from 0 to 125.4 ft; 8-in., from 0 to 209 ft; screened 8-in., from 125 to 200 ft; slotted. Reported pumping 330 gpm in 1977. City Well. No. 2. USGS No. 44.
City of Irondale	751	3	JEFW-5	225	1964	H. W. Peerson	725	MS (Mb)	15	1/1/64	Casing: 16-in., from 0 to 65 ft; 12-in., from 0 to 95 ft; 8-in., from 0 to 164 ft; screened 10-in., from 90 to 160 ft; perforated. Reported pumping 400 gpm in 1997. USGS No. 45. City Well No. 4.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Irondale	751	4	JEFW-16	303	1976	Graves Well Drilling Co.	738	MS (Mtfp)	94.2	1/9/76	Casing: 20-in.; from 0 to 30 ft; 14 in., from 0 to 265 ft; louvered screens, 8-in., from 265 to 300 ft. Reportedly pumped 1,200 gpm in June, 1977. City Well No. 5.
City of Irondale	751	6	JEFW-28	320	1996	Miller Drilling Co.	755	MS (Mtfp)	165	6/21/96	Casing: 12-in., from 0 to 272 ft; screen 12-in., from 272 to 306 ft. Reported pumping 1,000 gpm in 1997. City Well No. 6. Also known as Swim Club well.
City of Leeds	753	1	JEFY-2	195	1972	Graves Well Drilling Co.	660	MS (Mtfp)	60.5	7/5/72	Casing: 18-in., from 0 to 150 ft; 12-in., from 150 to 170 ft; screen 10-in., from 170 to 175 ft; Jackson Screen. City well 1. USGS No. 50.

EXPLANATION

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Leeds	753	2	JEFY-04	245	1972	Graves Well Drilling Co.	660	MS (Mtfp)	32.5	6/26/72	Casing: 12-in., from 0 to 140 ft; 8-in., from 135 to 155 ft; screen 8-in., from 155 to 195 ft, liner. Reported pumping 1,200 gpm in 1977. City well 2. USGS No. 51.
City of Leeds	753	3	JEFY-02	301	1982	Graves Well Drilling Co.	660	VR (Ou)	36.5	1/10/83	Casing: 16-in., from 1 to 227 ft; 12-in., from 2 to 227 ft; screen 12-in., from 227 to 280 ft; open hole. City well 3. USGS No. 48.
City of Leeds	753	4									See under St. Clair County.
City of Leeds	753	5	JEFY-1				618	VR (Oc)	815 gpm	4/12/77	Rowan Spring. USGS No. 49.
City of Leeds	753	6									See under St. Clair County.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Roupes Valley	760	1	JEFQQ-37	210	1975	Graves Well Drilling Co.	540	MS (Mtfp)	81.8	5/1/75	Casing: 14-in., from 0 to 140 ft; 10-in., from 0 to 210 ft; screened 10-in., from 180 to 210 ft. Reported yield 500 gpm after 24 hrs pumping; specific capacity of 9.5 gpm/ft in 1975. City Well No. 2. USGS No. 114.
Town of Roupes Valley	760	2	JEFPP-21	175	1979	Graves Well Drilling Co.	635	MS (Mtfp)	50	3/20/87	Casing: 18-in., from 0 to 60 ft; 14-in. from 60 to 95 ft; 12-in. from 95 to 110 ft; 10-in. liner perforated from 104 to 160 ft; 8-in. open hole from 160 ft to TD. Production capacity 520 gpm. City Well No. 3 or Lou George Loop well. USGS No. 113.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Roupes Valley	760	3	JEFQQ-38	236	1989	Graves Well Drilling Co.	560	MS (Mtfp)	115	5/31/89	Casing: 18-in. from 0 to 130 ft; 12-in. from 110 ft to TD; slotted 175-235 ft. Production capacity 520 gpm. City Well No. 5.
Town of Roupes Valley	760	4	BIBB-6	133	1991	Graves Well Drilling Co.		MS (Mtfp)	44.08	8/1/98	Casing: 18-in. from 0 to 53 ft; 12-in. from 53 to 111.5 ft; 8-in. from 105 ft to TD; grouted to 111.5 ft. Casing slotted from 113 to 133 ft. Production capacity 500 gpm. City Well No. 6. Gilmore well. This well is actually located in Bibb Co. but is listed here in order to keep records for the Town of Roupes Valley together.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Trussville	761	1	JEFL-5	186.5	1936	H. W. Peerson	740	MS (Mtfp)	42	1936	Casing: 14-in., from 0 to 62 ft; 12-in., from 62 to 108 ft; 10-in., from 108 to 132 ft; 6-in., from 132 to 186 ft. Drawdown 22.5 ft after 24 hrs pumping 183 gpm in 1936. Specific capacity of 8.1 gpm/ft. Production capacity 120 gpm. Old City Well No. 1. USGS No. 35.
City of Trussville	761	2	JEFL-6	186	1936	H. W. Peerson	731	MS (Mtfp)	43	1936	Casing: 14-in. from 0 to 47 ft; 12-in. from 47 to 115 ft; 10-in. from 115 to 186 ft. Reported drawdown 21.5 ft after 24 hrs pumping 174 gpm in 1936. Specific capacity 8.1 gpm/ft.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Trussville	761	3	JEFL-4	158	1960	H. W. Peerson	775	MS (Mtfp)	47	4/29/60	Casing: 16-in., from 0 to 40 ft; 10-in., from 0 to 84 ft. Reported drawdown 74 ft after 4 hrs pumping 250 gpm, 6 hrs pumping 314 gpm, and 14 hrs pumping 415 gpm on 4/29/60. Specific capacity 4.2 gpm/ft. USGS No. 37.
City of Trussville	761	4	JEFL-22	110	1963	H. W. Peerson	725	MS (Mtfp)	24	1963	Casing: 24-in. from 0 to 26 ft; 18-in. from 26 to 55 ft; 16-in. from 55 to 78 ft. Pumping 650 gpm in 1978 and 590 gpm in 1997. USGS No. 38.
City of Trussville	761	5	JEFL-10	219	1969	Graves Well Drilling Co.	757	MS (Mtfp)	17.5	5/20/69	Casing: 16-in., from 0 to 112 ft; 14-in., from 102 to 138 ft; 8-in., from 132 to 170 ft. Pumping 1,000 gpm in 1978 and 1,200 gpm in 1997. USGS No. 34.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Trussville	761	6	JEFL-23				765	MS (Mtfp)	17	6/7/96	Pumping 230 gpm in 1997. Roebuck Plaza well (from ADEM database). USGS No. 39.
City of Trussville	761	7	JEFL-24	142	1986	Weldon Drilling Co.	765	MS (Mtfp)	13		Casing: 18-in. from 0 to 20 ft; 12-in. from 20 to 83 ft; 8-in. from 20 ft to 142 ft; screened from 122 to 142 ft. Pumping 1,025 gpm in 1997. City Well No. 6 (ADEM FRDSII database, 1999). USGS No. 33.
City of Trussville	761	8	JEFL-25	155	1990		740	MS (Mtfp)	22		Casing: 24-in., from 0 to 12 ft; 18-in., from 12 to 94 ft; 14-in., from 94 to 126 ft; screened 10-in., from 126 to 155 ft. Water-bearing zones at 122 and 150 ft. City Well No. 7.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

JEFFERSON COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Trussville	761	9	JEFL-26	300	1990		690	MS (Mb)	14	1991	Casing: 18-in., from 0 to 22 ft; 12-in., from 22 to 235 ft; screened 10-in., from 235 to 285 ft. Water-bearing at 279 ft. Pumping 650 gpm in 1997. City Well No. 9.
City of Trussville	761	10	JEFL-27	289	1991		695	MS (Mb)	42	6/7/96	Casing: 18-in., from 0 to 42 ft; 16-in. from 42 to 47 ft; 12-in., from 47 to 156 ft; screened 10-in., from 156 to 268 ft. Water-bearing at 100, 138, 144, 147, 162, 188, 191, and 266 feet. Drawdown 54.55 ft on step test 4/10-11/1991. Pumping 1,250 gpm in 1997. Cherokee Dr. Well.
City of Trussville	761	15	JEFL-28	345	1995	Miller Drilling Co.	725	MS (Mb)	47	3/1/99	Casing: 18-in. from 0 to 10 ft; 12-in., from 10 to 249 ft; open hole below. City Well No. 11. City Park Well.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Alabaster	1148	1	SHEW-2	179	1964	H. W. Peerson	486	VR (OЄccr)	33	7/2/64	Casing: 12-in., from +5 to 51 ft; 10-in., from +5 to 62 ft; open hole below. Drawdown 24 ft after 24 hrs pumping 450 gpm in 1964. Reported pumping 300 gpm in 1980 and also in 1996. City Well No. 1, Ballpark Well. USGS No. 126.
City of Alabaster	1148	2	SHEW-18	350	1980	Alpine Construction Co.	467.43	VR (OЄccr)	66	12/1/97	Casing: 16-in. from 0 to 142 ft; 8-in. slotted steel liner from 142 to 208 ft, 8-in. open hole below. Reported pumping 600 gpm in 1996. City Well No. 1, 8th St. Well.

EXPLANATION

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Alabaster	1148	3	SHEW-17	360	1974		482	VR (OЄccr)	39	12/1/97	Casing: 14-in. from 0 to 138 ft; 10-in. from 138 to 176 ft. Below 176 ft well diameter 9.5 in. Reported pumping 1,150 gpm in 1996. City Well No. 3, Bermuda Hills (Berm HL) Well. USGS No. 127.
City of Calera	1150	1	SHEBB-7	195	1976	Graves Well Drilling Co.	485	VR (Єk)	25	3/17/87	Casing: 14-in, from 0 to 87 ft. Drawdown 5 ft. Reported pumping 830 gpm in 1987. City Well No. 2, Co. Rd. 107. USGS No. 135.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge		Date measured	Well construction, yield, remarks
City of Calera	1150	2	SHEBB-4	120	1966	H. W. Peerson	485	VR (Єbf)	36		1966	Casing: 12-in., from 0 to 56 ft; 10-in., from 52 to 79 ft; 8-in. perforated from 72 to 100 ft. Drawdown 12 ft. after 24 hr test pumping at 500 gpm. City Well No. 1, Co. Rd 22.
City of Columbiana	1151	1	SHEDD-5	219	1968	Southern Supply Co.	435	VR (On)	0.4	18	8/21/1968 3/87	Casing: 10-in., from 0 to 93 ft. Drawdown 7.5 ft after 24 hrs step test with final rate of 825 gpm in 1968. Produces from cavity at 195 to 220 ft. Pump rated 650 gpm. City Well No. 1. USGS No. 151.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Columbiana	1151	2	SHEDD-3	219	1968	H. W. Peerson	435	VR (On)	3.5	8/21/68	Casing: 16-in., from 0 to 19 ft; 12-in., from 0 to 93 ft. Drawdown 3.5 ft after 24 hrs step test with final rate of 400 gpm in 1968. Pump rated 650 gpm. City Well No. 2. USGS No. 152.
City of Columbiana	1151	3	SHEGG-01	240	1977	Graves Well Drilling Co.	440	VR (OЄk)	37	6/4/87	Casing: 14-in., from +2 to 76 ft. Reported pumping 225 gpm in 1979. Drawdown 19 ft after step test pumping greater than 300 gpm. City Well No. 3. USGS No. 153.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Columbiana	1151	4	SHEGG-02	300	1982	Graves Well Drilling Co.	455	VR (OЄk)	37	3/1/87	Casing: 12-in., from +2 to 122 ft; uncased 12-in. in rock, from 122 to 199 ft; uncased 6-in. in rock, from 199 to 300 ft. Reported pumping 300 gpm in 1982. Drawdown 32 ft. City Well No. 4. USGS No. 154.
City of Columbiana	1151	5	SHEGG-6	216	1979	Graves Well Drilling Co.		VR (OЄ k)			Casing: 24-in., from 0 to 30 ft; 20-in., from 0 to 106 ft; 14-in., from 0 to 148 ft.
Town of Harpersville	1156	1	SHEG-02	210	1980	Graves Well Drilling Co.	465	VR (Onlv)	14.5	4/14/80	Casing: 12-in., from 0 to 102 ft; open hole, from 102 to 210 ft. Reported pumping 150 gpm in 1987. Test well no. 10. Drawdown 10 ft. City Well No. 2. Hwy 79 in Harpersville. USGS No. 99.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Helena	1157	1	SHEM-7	400	1951	H. W. Peerson	420	VR (Ꞓk)	2.4	6/20/68	Casing: 8-in., from 0 to 65 ft. Reported pumping 180 gpm in 1987. Drawdown 5 ft. Pump rated 275 gpm. City Well No. 1. USGS No. 119.
City of Helena	1157	3	SHEM-12	160		Graves Well Drilling Co.	455	VR (Ꞓr)	90	6/5/87	Casing 14-in. Drawdown 15 ft. Reported pumping 325 gpm in 1987. Pump rated 375 gpm. City Well No. 3. USGS No. 117.
City of Helena	1157	4	SHEM-13	200	1987	Graves Well Drilling Co.	505	VR (OꞒccr)	80	6/5/87	Pump rated 1,300 gpm. City Well No. 4. USGS No. 118.
City of Montevallo	1160	1	SHEAA-10	100	1975	Graves Well Drilling Co.	460	VR (Ꞓk)			Pump rated 425 gpm. City Well No. 1.
City of Montevallo	1160	2	SHEAA-7				370	VR (Ꞓbf)	325 gpm flow + 750 gpm pump	9/10/68	Little Spring; was Shoal Creek Spring. Flow 1,000 to 3,000 gpm. Reported pumping 600 gpm in 1987. USGS No. 132.

EXPLANATION

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Montevallo	1160	3	SHEAA-11	405	1986	Graves Well Drilling Co.	430	VR (Єbf)			ADEM recommended casing to 170 ft. Pump rated 400 gpm. City Well No. 2, behind Montevallo Middle School. USGS No. 131 is probably test well for this one.
City of Pelham	1163	1	SHEJ-01	287	1987	Graves Well Drilling Co.	520	VR (OЄccr)	49	Dec-87	Casing: 22-in., from 0 to 91.5 ft; 18-in., from 0 to 151.57 ft; screened from 275 to 279 ft Pump rated at 1,750 gpm. Campbell Ridge well.
City of Pelham	1163	2	SHEJ-15	238	1982	Graves Well Drilling Co.	510	VR (OЄccr)	70	4/13/82	Casing: 18-in., from 0 to 138 ft; 14-in., from 138 to 154 ft; 10-in. shutter screens, from 150 ft to TD. Cavity, from 229.6 to 233.7 ft. Drawdown 17 ft. Pump rated 1,740 gpm. Well No. 3; Indian Hills Well No. 2.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Pelham	1163	3	SHEJ-11	205	1963	H. W. Peerson	490	VR (O€ccr)	65	1968	Casing: 10-in., from 0 to 149 ft. Drawdown 10 ft after 24 hrs pumping 270-300 gpm in 1963. Pump rated 350 gpm. Well No. 4; Indian Hills Well No. 1. USGS No. 121.
City of Pelham	1163	9	SHEM-14	240	1983	Graves Well Drilling Co.	520	MS (Mtfp)	91.17	11/1/97	Casing: 30-in., from 24 in. above surface to 110 ft; 18-in. from 110 to 141.58 ft; 14-in. screens over 12 in. screens from 141.58 to 180.96 ft. Drawdown 37 ft. Pump rated 1,700 gpm. Chandalar Well.
Town of Spring Creek	1443	1	SHEGG-5	193	1990	Miller Drilling Co.		VR			Casing: 20-in., from 0 to 60 ft; 18-in., from 0 to 87 ft, open hole below. City Well No. 1. Pump rated at 300 gpm.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Vincent	1168	1	SHEG-2				435	VR (Onlv)	715 gpm	9/17/68	Spring. USGS No. 98. Reported in 1941 to be two springs.
Town of Wilsonville	1171	1	SHET-1	125	1939	H. W. Peerson	435	VR (OЄccr, On)	16.1	7/30/68	Casing: 10-in., from 0 to 22 ft; 8-in., from 0 to 85 ft. Drawdown 9.24 ft while pumping 183 gpm in 1941. City Well No. 1. USGS No. 136.
Town of Wilsonville	1171	3	SHET-9	402	1998	Graves Well Drilling Co.	440	VR (OЄk)	23.5	2/20/98	Casing: from 0 to 100 ft; perforated from 68 to 92 ft; bridge plug at 107 ft. Pumped 300 gpm for 72 hr. with 10 ft 4 in. of drawdown. Old city well No. 3. Also Graves test well no. 1-98.
Town of Wilsonville	1171	4		90				VR chert			Casing, 10-in., drawdown 19 ft, static water level 28 ft, new city well No. 3.
Town of Wilton	1172	1	SHEJJ-6	215	1923		410	VR (Єbf)	40	9/1/97	Drawdown 24 ft. City Well No. 1.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

SHELBY COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Wilton	1172	2	BIBH-2	243	1994	Graves Well Drilling Co.		VR (Ꞓbf)	41	1993	Casing: 20-in., from 0 to 21 ft; 16-in., from 0 to 68 ft; 12-in., from 0 to 144 ft. City Well No. 2. This well is located in Bibb Co. but is listed here to keep records for the Town of Wilton together.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

ST. CLAIR COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Ashville	1176	1	STCK-3				565	VR (OЄk)	670 gpm	6/8/61	Ashville Spring. USGS No. 9.
Town of Ashville	1176	2	STCK-19	163	1990	Weldon Drilling Co.	640	VR (Єc)	19.75	5/19/95	Casing: 10 in. City Well No. 1. Slasham Well.
City of Leeds	753	4	STCZ-7				670	VR (Olol)	400 gpm	6/7/61	Weems Spring. Reported pumping 1 mgd in 1987. USGS No. 53. Other public water sources for Leeds are located in Jefferson County.
City of Leeds	753	6	STCZ-03	303	1984	Dependable Drilling Co.	720	MS (Mtfp)	96.29	7/17/84	Casing: 18-in., from 0 to 210 ft; 12-in., from 0 to 210 ft; screened 10-in., from 205 to 235 ft, perforated; 8-in., from 230 to 303; open hole. City well 4. USGS No. 52.
Town of New London	1437	1	STCEE-01	210	1981	Graves Well Drilling Co.	490	VR (OЄk?)	40	11/10/81	Casing: 12-in. Drawdown 12 ft. City Well No. 1. USGS No. 95.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

ST. CLAIR COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of New London	1437	2	STCCC-016	246	1989	Miller Drilling Co.	515	VR	13	1/1/98	Casing: 6-in., from 0 to 105 ft. Pump rated at 600 gpm. City Well No. 2, 8 mi. N from Town Hall on US 231.
Town of Odenville	1203	1	STCX-19	150	1974		700	MS (Mtfp)	60	1979	Casing: 12-in.; screened from 95 to 150 ft. Drawdown 30 ft. City Well No. 3; Kerr Rd. Cooks Springs Well. USGS No. 28.
Town of Odenville	1203	2	STCQ-01	245	1983	Weldon Drilling Co.	700	MS (Mh)	30	3/1/87	Casing: 12-in., from 0 to 160 ft; 8-in., from 145 to 166 ft; bottom 5 ft perforated. Drawdown 28 ft; static water level 40 ft. City Well No. 4; off Pleasant Valley Rd. Former test well no. 7. USGS No. 26.
Town of Odenville	1203	3	STCX-20	270	1986		745	MS (Mh)	110	1987	Casing: 12-in.; screened from 208 to 270 ft. Drawdown 30 ft; static water level 110 ft. City Well No. 5; off Oak Ridge Ln. USGS No. 27.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

ST. CLAIR COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Odenville	1203	4	STCP-14	150	1982		800	MS (Mtfp)	154	2/1/99	Casing: 12-in.; screened from 90 to 270 ft. City Well No. 6; Shanghai Rd./St. Clair Prison.
Town of Odenville	1203	5	STCQ-14	312	1995	Miller Drilling Co.	700	MS (Mh)	20	6/15/94	Casing: 12-in., from 0 to 275 ft; open hole from 275 to 312 ft. City Well No. 7. Near New Hope Church.
Town of Odenville	1203	6		264				VR (weather-ed chert)			Casing: 8-in., drawdown 32 ft, static water level 20 ft, City Well No. 9.
Pell City	1204	1	STCCC-11	253	1964	H. W. Peerson	537	VR (cherty weather-ed lime-stone)	97	3/9/64	Casing: 12-in., from 0 to 101 ft; 8-in., from 0 to 120 ft. Screened 8-in., from 120 to 253 ft. Drawdown 50 ft. City Well No. 2, Golf Course Rd., City Well A. USGS No. 59.
Pell City	1204	2	STCBB-02	279	1976	Graves Well Drilling Co.	550	VR (cherty weather-ed lime-stone) (OЄk)	8.19	4/12/72	Casing: 18-in., from 0 to 38 ft; 12-in., from 0 to 103 ft; open below. Drawdown 20 ft after 72 hrs pumping step test in 1976. City Well B.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

ST. CLAIR COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Pell City	1204	3	STCCC-08	186	1965	H. W. Peerson	545	VR (cherty weather-ed lime-stone)	61	1/8/65	Casing: 14-in., from 0 to 52 ft; 10-in., from 0 to 175 ft; screened 11 ft of 8 in. slotted liner. Drawdown 43 ft after 24 hrs. pumping at 254 gpm on 1/8/65. Pump rated at 250 gpm. Mays Bend Well. USGS No. 86.
Pell City	1204	4	STCCC-02	231	1964	H. W. Peerson	545	VR (cherty weather-ed lime-stone)	60	1/8/64	Casing: 12-in., from 0 to 132 ft; 8-in., from 0 to 209 ft, slotted from 122 to 209 ft. City Well No. 1, 16th Ave. S., City Well B. USGS No. 57.
Town of Ragland	1208	1	STCS-17	300	1977	Hawley Dodson and Son	500	Ppv	36.5	6/1/87	Casing: 8-in. Drawdown 17 ft. City Well No. 1. There is another city well also 300 ft deep. USGS No. 21.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

ST. CLAIR COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Ragland	1208	2	STCS-03	170	1974	Hawley Dodson and Son	480	Ppv	26.2	11/1/74	Casing: 12-in. from 0 to 55 ft. Drawdown 15 ft. City Well No. 2.
Town of Riverside	1209	1	STCV-12	115	1976	Graves Well Drilling Co.	500	VR (OЄk)	29.4	10/29/75	Casing: 12-in., from 0 to 107 ft. Drawdown 16 ft. City Well No. 1. USGS No. 62.
Town of Riverside	1209	2	STCV-13	106	1976	Graves Well Drilling Co.	510	VR	39.58	6/1/75	Casing: 12-in. from 0 to 98 ft. Drawdown 16 ft. City Well No. 2. USGS No. 61.
Town of Springville	1211	1	STCM-8				710	VR (OЄccr, Єk)	900 gpm	1961	Two springs. USGS No. 8.
Town of Steele	1213	1	STCB-5	250	1954	Carl Pace	640	VR (OЄccr, Єk)	40	3/25/54	Casing: 8-in. from 0 to 165 ft. Drawdown 60 ft afer 24 hrs. pumping 150 gpm on 3/26/54. City Well No. 1 (FRDSII, 1995) or City Well No. 2 (USGS, 1989). USGS No. 6.
Town of Wattsville	1216	1	STCW-01	176	1969	H. W. Peerson	610	MS	31.94	3/1/87	Drawdown 28 feet while pumping at 200 gpm in 1969. Pump rated at 450 gpm. Test Well No. 2. City Well No. 1. USGS No. 55.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

ST. CLAIR COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Town of Wattsville	1216	2	STCW-04	195	1972	Graves Well Drilling Co.	610	MS (Mfp)	72	8/30/72	Tested at 157 gpm in 1972. Pump rated at 450 gpm. Test Well No. 10. City Well No. 2. USGS No. 54.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

TALLADEGA COUNTY

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Central Talladega County	1739	1	TALW-25	179	1984	Graves Well Drilling Co.	530	Ou	35.6	7/9/84	Casing: 10-in. from 0 to 160 ft; 10-in. open hole below. Pump rated at 240 gpm. Production Well No. 2. Formerly owned by Sycamore Water Authority.
City of Childersburg	1228	1	TALV-10	425	1959	Virginia Well and Supply Co.	401	VR (OЄk)	22	2/25/69	Casing: 12-in. from 0 to 52 ft; 10-in., from 52 to 71.3 ft. Drawdown 46 ft after 48 hrs pumping 450 gpm in 1962. Pump rated 600 gpm. City Well No. 1. USGS No. 139.
City of Childersburg	1228	2	TALV-06	300	1975	Graves Well Drilling Co.	455	VR (OЄk)	31.7	10/30/75	Casing: 6-in., from 0 to 45 ft. Drawdown 9 ft after 72 hrs pumping in 1986. Pump rated 275 gpm. City Well No. 2. New Pine Crest Well. USGS No. 141.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

TALLADEGA COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Childersburg	1228	3	TALBB-25	278	1969	H. W. Peerson	500	VR (OЄk)	40	9/1/82	Casing: 8-in. from 0 to 227 ft; screen 6-in., from 202 to 277 ft. Drawdown 50 ft. Pump rated 175 gpm. City Well No. 3. USGS No. 150.
City of Childersburg	1228	4	TALV-08	310	1971	H. W. Peerson	405	VR (OЄk)	12.43	2/4/86	Casing: 10-in., from 0 to 275 ft; open hole, 275 to TD. Drawdown 68 ft. Pump rated 280 gpm. City Well No. 4. Yarbrough Trailer Court well. USGS No. 138.
City of Childersburg	1228	5	TALV-07	200	1985	Graves Well Drilling Co.	425	VR (OЄk)	39.3	4/4/80	Casing: 18-in., from 0 to 63 ft; 12-in., from 63 to 77 ft. Drawdown 39 ft after 72 hrs pumping 300 gpm in 1986. Pump rated 450 gpm. City Well No. 5. Killough Height well. USGS No. 140.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

TALLADEGA COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
Lake Tate Assoc.	1475	1	TALGG-7	200	1974	Carl Pace	798	mm (tg)	72	2/24/86	Casing: 6-in., from 0 to 160 ft. Pump rated at 28 gpm. USGS No. 148.
City of Lincoln	1245	1	TALC-13	260	1957	Carl Pace	529	VR (OЄ k)	60.45	1/14/86	Casing: 8-in., from 0 to 90 ft. Reported to have produced 300 gpm in 1962. Drawdown 75 ft. Pump rated at 180 gpm. City Well No. 1 (FRDSII, 1999). USGS No. 64.
City of Lincoln	1245	2	TALC-02	175	1970	Graves Well Drilling Co.	498	VR (OЄk)	27	9/24/72	Casing: 10-in., from 0 to 45 ft. Reported to have produced 260 gpm. Drawdown 46 ft. Pump rated at 400 gpm. City Well No. 2. USGS No. 63.
City of Munford	1247	1	TALG-12	300	1960	Carl Pace	685	VR (OЄk)	135	1/15/86	Casing: 8-in., from 0 to 100 ft. Reported pumping 75 gpm in 1977. Pump rated at 168 gpm. City Well No. 1. USGS No. 74.

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

TALLADEGA COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Sycamore	1378	1	TALW-02	179	1984	Graves Well Drilling Co.	535	VR (OЄk)	35.6	1984	Casing: 10-in. from 0 to 160 ft. Reported drawdown of 34.5 ft after 4 hrs of pumping at 150 gpm. City Well No. 1. Was Well No. 2 when drilled.
City of Sylacauga	1258	3	TALAA-01	151	1969	Graves Well Drilling Co.	500	VR (OЄk)	31.56	4/30/69	Casing: 8-in. Pump rated at 175 gpm. Coosa Valley Country Club well. USGS No. 144.
City of Sylacauga	1258	4	TALAA-02	130	1968	Graves Well Drilling Co.	580	VR (sm)	114.5	2/20/86	Casing: 12-in. Drawdown 16 ft. Pump rated at 500 gpm. Main Ave. Well. USGS No. 147.
City of Talladega	1260	3	TALM-15	381	1974	Graves Well Drilling Co.	560	VR (Єu; Єr)	43	6/2/87	Casing: 12-in., from 0 to 100 ft; open below. Drawdown 7 ft. Bingham St. well. USGS No. 79.
City of Talladega	1260	4	TALM-04	175	1977	Graves Well Drilling Co.	498	VR (Єu)	76.86	4/20/77	Casing: 12-in., from 0 to 148 ft; open hole below. Drawdown 25 ft. Grant St. well. USGS No. 82.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

TALLADEGA COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Talladega	1260	5	TALN-15	450	1957	Carl Pace	686	VR (OЄk)	35	1957	Casing: 10-in., from 0 to 130 ft; 6-in. from 150 to 169 ft. Pumped at 350 gpm in 1987. Mt. Olive well. Also called Black Snake Rd. well. USGS No. 78.
City of Talladega	1260	6	TALM-05	322	1966	Adams-Massey Drilling Co.	580	VR (Єc)	29.09	3/11/87	Casing: 10-in., from 0 to 242 ft. Drawdown 70 ft after 24 hrs pumping at 1,000 to 1,200 gpm. Harmon Park Well. USGS No. 81.
City of Talladega	1260	7	TALM-9	203	1955	Carl Pace	560	VR (Єcl, Єr, Єs, Єch)	57	10/3/55	Casing: 10-in., from 0 to 202 ft. Drawdown 27 ft while pumping at 1,100 gpm. Specific capacity 40.7 gpm/ft. Sloan Ave. Well. USGS No. 80.
City of Talladega	1260	8	TALG-17	126	1974	Graves Well Drilling Co.	535	VR (OЄk)	33	6/17/74	Casing: 10-in. from 0 to 100 ft; 10 in. open hole below. Speedway well 1.

EXPLANATION

Appendix A.--Records of public water supply wells and springs in Area 4--Continued

TALLADEGA COUNTY--Continued

System	PWS ID	SE ID	GSA ID	Depth	Year drilled	Drilling contractor	Altitude	Aquifer	Water level or spring discharge	Date measured	Well construction, yield, remarks
City of Talladega	1260	9	TALH-15	318	1986	Graves Well Drilling Co.	560	VR (OЄk)	60	2/5/86	Casing 16-in., from 0 to 73 ft; 12-in.; from 73 to 148 ft; 12 in. open hole below. Speedway well 2. Airport Well.
Water Works, Inc.	1229	1	TALK-6				500	VR			Pump rated at 125 gpm. Well No. 1. Water Works, Inc., previously known as Country Club Estates.

APPENDIX B

Record of selected wells and springs in Area 4

Explanation of table headings

SYSTEM, Water system name.
PWS ID, Public water system identification number as assigned by the ADEM.
SE ID, Source identification number as assigned by the
GSA ID, Well identification number assigned by the GSA.
DEPTH, Total depth of well in feet.
YEAR DRILLED, Year the well was completed and ready for operation.
DRILLING CONTRACTOR, Name of driller.
ALTITUDE, Elevation of land surface in feet above mean sea level.
AQUIFER: Єbf, Brierfield Dolomite; Єc, Consauga; Єch, Chilhowee Group; Єcl, lower unnamed shale facies of the Conasauga Formation; Єk, Ketona Dolomite; Єr, Rome Formation; Єs, Shady Dolomite; Єu, Cambrian undifferentiated; Єwwr, Weisner and Wilson Ridge Formations; tg, Talladega Group; Mb, Bangor Limestone; Mfp, Fort Payne Chert; Mh, Hartselle Sandstone; mm, Moffits Mill Schist; MS, Mississippian aquifer system; Mtfp, Tuscumbia-Fort Payne Formations; Ppv, Pottsville Formation; OЄccr, Chepultepec and Copper Ridge Dolomites; OЄk, Knox Group; Olol, Little Oak and Lenoir Limestones; On, Newala Limestone; Onlv Newala and Longview Limestones; Ou, Ordovician undifferentiated; sm, Sylacauga Marble; VR, Valley and Ridge aquifer systems, The formation names (for example, Brierfield Dolomite) identify parts of the Valley and Ridge aquifer system that have been assigned to particular named geologic units.
WATER LEVEL, Water level in feet below land surface. For springs, measured flows are given in gallons per minute (gpm).
DATE MEASURED, Date of water-level measurement.
WELL CONSTRUCTION, YIELD, REMARKS, gpm is gallons per minute.

Appendix B.—Records of selected wells and springs in Area 4

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
Camp Sumatanga	1		370			800				Well no. 3.
Camp Sumatanga	2		286		C.R. Killian	830				Cased 6 in., 0 to 90 ft.
Camp Sumatanga	3		160	1972	Graves Well Drilling Co.	780				Cased 6.25 in., 0 to 100 ft. Screened 6.25 in., 100 to 160 ft. Well no. 2.
Camp Sumatanga	4		175	1972	Graves Well Drilling Co.	780				Cased 6.25 in., 0 to 93 ft. Screened 6.25 in., 93 to 175 ft. Well no. 1.
Town of Steele	5		100	1950s		595				Well no. 1
Town of Trafford	7	JEFB-1	300	1950	H.W. Peerson	480	Ppv			Casing 8 in., 0 to 42 ft. Open hole 42 to 300 ft. Drawdown 65 ft. after 5 hours pumping 120 gpm (1954).
Girl Scouts of America	13	CALK-56				1,140	Єch		8/21/85	Spring. Supplies Girl Scout Camp. Estimated flow 20 gpm.

[1] Numbers correspond to those in Bossong (1989).
[2] Defined in explanation on previous page.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
U.S. Army	14					720	Єr	3.7	7/10/85	Reilly Lake, Fort McClellan.
Town of Weaver	15	CALS-6	300		H.W. Peerson	778	Єr		7/09/85	Not measured; no access for tape. Abandoned.
Ray McMinn	17	CALS-12	95		Carl Pace	711	Єc		8/02/85	Supplies trailer park. Not measured.
Emmett Carroll	19					670	OЄk	64.1	7/24/85	Supplies nightclub.
Town of Ragland	20		300	1955	H.W. Peerson	490				Cased 8 in., 0 to 26.5 ft. Open hole 8 in., 26.5 ft to 245 ft 6 in., 245 to 300 ft. Well no. 2. Supplementary well.
Town of Ragland	22	STCS-8	305		H.W. Peerson	492	Ppv	8	12/07/55	Cased 8 in., 0 to 26.5 ft. Drawdown 80 ft after 24 hrs. pumping 100 gpm (1955). Abandoned.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
Town of Ragland	23					490				Abandoned
Town of Ragland	24	STCS-7	320		H.W. Peerson	500	Ppv	6	12/28/55	Cased 8 in., 0 to 25 ft. Drawdown 84 ft after 24 hrs. pumping 130 gpm (1955). Abandoned.
Town of Ragland	25	STCS-18			Dodson	525	Ppv			TW 79-4.
Town of Odenville	29	STCS-12	200		R.M. Towns	730	Olol	25	1960	Well no. 1. Reported yield about 100 gpm (1963). Supplementary well (1987).
Town of Odenville	30		444	1968	H.W. Peerson	720				Well no. 2. Cased 8 in., 0 to 50 ft. Supplementary well (1987).
Town of Margaret	31					660				
Roddams Trailer Park	32					760				Well no. 1.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
City of Trussville	36		320	1950	H.W. Peerson	730		29	1950	Well no. 2. Casing 10 in., 0 to 60 ft; 8 in., 0 to 160 ft; 6 in., 0 to 254 ft.
Town of New Castle	40		450			520	Ppv			Casing 12 in., 0 to 50 ft; 6 in., 0 to 50 ft.
City of Irondale	41		235		Graves Well Drilling Co.	755	Mtfp			Reported pumping 260 gpm (1987).
City of Irondale	42		330		Graves Well Drilling Co.	740	Mtfp			Reported pumping 625 gpm (1977).
Southern Railway	46					730				Well no. 2.
Southern Railway	47					730				Well no. 1.
Pell City	58			1977	Graves Well Drilling Co.	490		25	12/86	Cased 10 in., 0 to 100 ft. Well no. A.
Pell City	60					600				Abandoned, sandy. Well no. C.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
Talladega Industrial Park	65		349	1985	Graves Well Drilling Co.	525	OЄk	53.76 31.2	1/23/86 3/11/87	Casing 12.75 in., 0 to 147 ft. Drawdown of 57 ft after pumping for 30 hours at 703 gpm. Well no. 3.
Talladega Industrial Park	66		126		U.S. Base	530		45	6/02/87	Reported pumping 250 gpm (1987). Well no. 1.
Talladega Industrial Park	67		300		Graves Well Drilling Co.	530		11.2 42	3/87 6/02/87	Cased 10 in., 0 to 100 ft; 6 in. below. Reported pumping 250 gpm (1987). Well no. 3.
W. H. McClean	69		80		Dingler	660	Єch	41.2	8/01/85	Supplies Don Lee trailer park.
Camp Lee United Methodist Church	70		65		Carl Pace	805	Єs	6.7	7/25/85	Supplies Camp Lee.
Spring Valley Foods	71		190		Adams & Massey	750	Єs		8/21/85	Supplies processing plant. Well no. 2.
Spring Valley Foods	72		201		Adams & Massey	760	Єs	60.8	8/21/85	Supplies processing plant. Well no. 1.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
City of Munford	73	TALF-7	275		Carl Pace	645	OЄk	106.33 100.32 106.73 120	1/16/80 4/23/85 10/24/85 3/10/87	Cased 6 in., 0 to 120 ft. Reported pumping 75 gpm (1977). Well no. 1.
Camp Mac	75		200			760				Well no. 1.
Camp Mac	76		240			760				Well no. 2.
Camp Mac	77		150			780				Well no. 3.
Griffin Park	83					500		71.5	3/87	Well no. 1.
Griffin Park	84					520		71.15	3/87	Well no. 2.
Jackson Trace Estates	85					700				
River Terrace Estates	87					550				Briarwood well.
River Terrace Estates	88					565				Magnolia well.
Lake Front Estates	89				Graves Well Drilling Co.	560				
Lake Front Estates	90				Graves Well Drilling Co.	500				

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
Camp Cosby	91				Graves Well Drilling Co.	490				Reported pumping 250 gpm in summer (1987). Well no. 1.
Camp Cosby	92				Graves Well Drilling Co.	520				Well no. 2.
Alpine Bay	93		170 300			510		50	6/10/87	Cased 12 in., 0 to 300 ft; 16 in.; 0 to 60 ft. 800 gpm.
Country Club Estates	94		300			500				
Graves/ Sterrett-Vandiver Water	96		300	1982	Graves Well Drilling Co.	550		33.25	10/03/82	Cased 9 in., 0 to 9 ft; open hole, 9 to 300 ft. 140 gpm test. Well no. 2.
Graves Well Drilling Co./ Sterrett Vandiver Water	97		175		Graves Well Drilling Co.	540		31.5	8/15/73	Cased 8 in., 0 to 170 ft. Reported pumping 200 gpm (1987). Well no. 1.
Harpersville Water Board	100	SHEG-10	92	1960		455	Onlv	17	1960	Reported pumping 60 gpm (1960). Supplemental well.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
Westover Water and Fire Protection Authority	101		314	1968	Associated Drillers	485	Onlv	34.4 45	7/22/-68 3/87	Cased 10 in., 0 to 20 ft. 280 gpm 19.5 ft draw-down, 2 hr test (1970). Well no. 1.
State of Alabama Highway Department	102		300	1979	Graves Well Drilling Co.	525		3.16	1/15/79	Cased 6.25 in., 0 to 53 ft. Drawdown 22 ft; pumping 200 gpm (1979). Well no. 2.
Double Oak Mountain State Park	103		285	1968	Alabama Highway Dept.	630	Ppv	30.5	2/25/68	Cased 6 in., 0 to 210 ft.; open hole, 210 to 285 ft. Rest area closed (1986). Rest area on highway 280.
Double Oak Mountain State Park	104									State lake supplies to Pelham. Reported pumping 275 gpm (1987). Fish camp well.
Mars Hill Trailer Park	105					530				Test well – park use only·

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
L. Hollis Trailer Park	106		145		James McCarty	460				Well no. C.
L. Hollis Trailer Park	107					480				Well no. 2.
L. Hollis Trailer Park	108		350			480				Well no. 1.
L. Hollis Trailer Park	109				James McCarty	480				Well no. 3.
Mars Hill Trailer Park	110		245		James McCarty	500				Supplementary well (1987). Well no. B.
Mars Hill Trailer Park	111		300		James McCarty	500				Supplementary well (1987). Well no. A.
Hercules Plant	112	JEFKK-1	300	1954	H.W. Peerson	460	Oc	10	1955	
Roupes Valley Water and Fire Protection Authority	115		142	1973	Graves Well Drilling Co.	550		89.9	12/26/76	Casing 16 in., 0 to 100 ft., 10 in., 0 to 140 ft; 8 in., 138 to 168 ft perforated. Well no. 1.
L. Hollis Trailer Park	116					480				Well no. 2.

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
City of Pelham	120				H.W. Peerson	440				Cross Creek well.
City of Pelham	122				State of Alabama	480				Indian Trails well.
City of Pelham	123		202.46	1982	Graves Well Drilling Co.	565				Cased 12 in., 0 to 140 ft. Obley well.
City of Pelham	124			1965	H.W. Peerson	460	On	19	11/30/65	Cased 12 in., 0 to 90 ft; 8 in. 90 to 145 ft. Reported 300+ gpm capacity (1968). King Valley Well.
L. Hollis Trailer Park	125					480				Well no. 2.
University of Montevallo	128		305	1977	Graves Well Drilling Co.	475		75	12/02/77	Used mostly for irrigation. Cased 16 in., 0 to 80 ft., 10 in., 0 to 136 ft.
University of Montevallo	129	SHEAA-8	157	1962	H.W. Peerson	420	Ꞓbf	56	8/13/62	Cased 12 in., 0 to 50 ft; 10 in., 0 to 80 ft. Reported pumping 300 gpm (1987).

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
Town of Wilton	130	SHEJJ -2				400	OЄk			Spring. Reportedly pumped at 200 gpm, 4 to 5 hrs per day (1980).
City of Montevallo	133		375	1983	Graves Well Drilling Co.	460		93.0	4/87	Tested 750 gpm. Reported pumping 400 gpm (1987). Well no. 1.
City of Calera	134	SHEB B-4	100	1966	H.W. Peerson	495	Єbf	36	9/19/66	Standby well. Cased 12 in., 0 to 56 ft; 10 in., 52 to 79 ft. Reported pumping 450 to 500 gpm (1987). Well no. 2.
Town of Sycamore	142		198	1983	Graves Well Drilling Co.	560			10/17/83	Cased 10 in., 0 to 160 ft.; open hole, 160 to 198 ft. Well no. 2.
Town of Sycamore	143		212		Graves Well Drilling Co.	500				Cased 8 in., 0 to 60 ft. Well no. 1.
Avondale Mills	145					545				Ivey Plant Well

Appendix B.—Records of selected wells and springs in Area 4--Continued

Well Owner	Well Number[1]	GSA ID	Depth (feet)	Year drilled	Drilling contractor	Altitude (feet)	Aquifer[2]	Water level or spring discharge (feet, gpm)	Date measured	Well construction, yield, remarks
City of Sylacauga	146	TALAA -22	388	1953		560	O€s	33 105	2/05/54 2/20/86	Cased 12 in., 0 to 137 ft. Drawdown 100 ft after 72 hrs pumping 900 gpm (1954). Park well.
Avondale Mills	149	TALAA -13	560			510	O€s	10	10/22/28	Pumped at 100 gpm. Not in use in 1987. Walco well.

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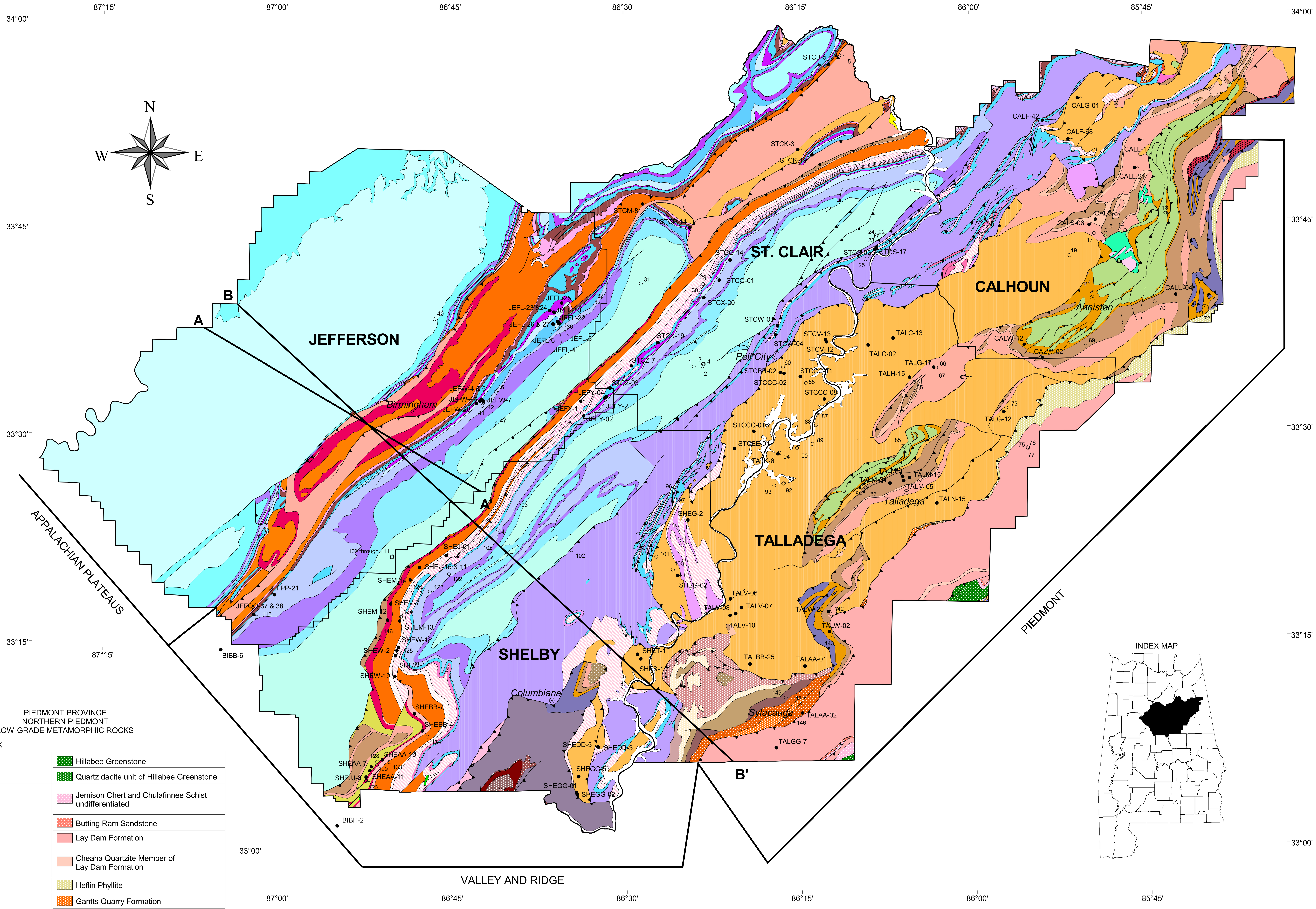
GEOLOGY, LOCATIONS OF PUBLIC WATER SUPPLY WELLS AND SPRINGS, AND LOCATIONS OF GEOLOGIC CROSS SECTIONS IN AREA 4

Geology modified from Szabo and others (1988)

By Lewis S. Dean and David C. Kopaska-Merkel

2004



SCALE

10 0 10 Miles

EXPLANATION

- TALV-07 Public water supply well or spring number
- Public water supply well
- Public water supply spring
- 4 Selected or inactive public water supply well or spring number
- Selected or inactive public water supply well
- Selected or inactive public water supply spring
- County Seat
- Thrust or reverse fault, sawteeth on upper plate, dashed where inferred.
- ? Nature of contact uncertain
- Fault for which sense of movement is unknown
- A—A' Line of cross section

Note: Some fault teeth are not visible at this scale but can be viewed when enlarged.

SYSTEM	SERIES	GROUP	GEOLOGIC UNIT
Quaternary	Holocene		Alluvial and low terrace deposits

COASTAL PLAIN PROVINCE

Cretaceous	Upper	Tuscaloosa	Coker Formation

VALLEY AND RIDGE AND APPALACHIAN PLATEAUS PROVINCES

System	Geologic unit
Pennsylvanian	Pottsville Formation
	Pottsville Formation (upper part) Applachian Plateaus Province
	Pottsville Formation (lower part) Appalachian Plateaus Province
	Pottsville Formation (upper part) Valley and Ridge Province
	Pottsville Formation (lower part) Valley and Ridge Province
Pennsylvanian-Mississippian	Parkwood Formation
	Parkwood and Pennington Formations undifferentiated
	Parkwood Formation and Floyd Shale undifferentiated
Mississippian	Bangor Limestone
	Paleozoic Shale undifferentiated
	Floyd Shale
	Hartselle Sandstone
	Pride Mountain Formation
	Tuscumbia Limestone
	Tuscumbia Limestone, Fort Payne Chert, Maury Formation undifferentiated
Devonian	Chattanooga Shale
	Chattanooga Shale and Frog Mountain Sandstone undifferentiated
	Frog Mountain Sandstone
Silurian	Red Mountain Formation
Ordovician	Sequatchie Formation
	Sequatchie Formation, Colvin Mountain Sandstone, Greensport Formation undifferentiated
	Chickamauga Limestone
	Attalla Chert Conglomerate Member of the Chickamauga Limestone
	Colvin Mountain Sandstone
	Greensport Formation
	Athens Shale
	Athens Shale and Lenoir Limestone undifferentiated
	Little Oak and Lenoir Limestones undifferentiated
	Little Oak Limestone
	Little Oak and Newala Limestones undifferentiated
	Newala Limestone
	Newala and Longview Limestones undifferentiated
	Longview Limestone
Ordovician-Cambrian	Knox Group undifferentiated
	Chepultepec and Copper Ridge Dolomites undifferentiated
Cambrian	Copper Ridge Dolomite
	Bibb Dolomite
	Ketona Dolomite
	Brierfield Dolomite
	Conasauga Formation
	Lower unnamed shale facies of Conasauga Formation
	Rome Formation
	Shady Dolomite
	Chilhowee Group undifferentiated
	Weisner and Wilson Ridge Formations undifferentiated
	Nichols Formation
	Cochran Formation

PIEDMONT PROVINCE
NORTHERN PIEDMONT
LOW-GRADE METAMORPHIC ROCKS

	GROUP OR COMPLEX	
Precambrian? to Paleozoic		Hillabee Greenstone
		Quartz dacite unit of Hillabee Greenstone
	Talladega Group	Jemison Chert and Chulafinnee Schist undifferentiated
		Butting Ram Sandstone
		Lay Dam Formation
		Cheaha Quartzite Member of Lay Dam Formation
		Heflin Phyllite
	Sylacauga Marble Group	Gantts Quarry Formation
		Gooch Branch Chert
		Shelvin Rock Church Formation
		Fayetteville Phyllite
		Jumbo Dolomite
		Metaclastic rocks of unknown affinity
	Kahatchee Mountain Group	Wash Creek Slate
		Kalona Quartzite Member of Wash Creek Slate
		Stumps Creek Formation
		Brewer Phyllite
		Sawyer Limestone Member of Brewer Phyllite
		Waxahatchee Slate

HIGH-GRADE METAMORPHIC AND IGNEOUS ROCKS

Poe Bridge Mountain Group	Unnamed unit of graphite schist	
	Unnamed unit of garnet quartzite	

MAFIC AND ULTRAMAFIC ROCKS

	Ketchepedrakee Amphibolite

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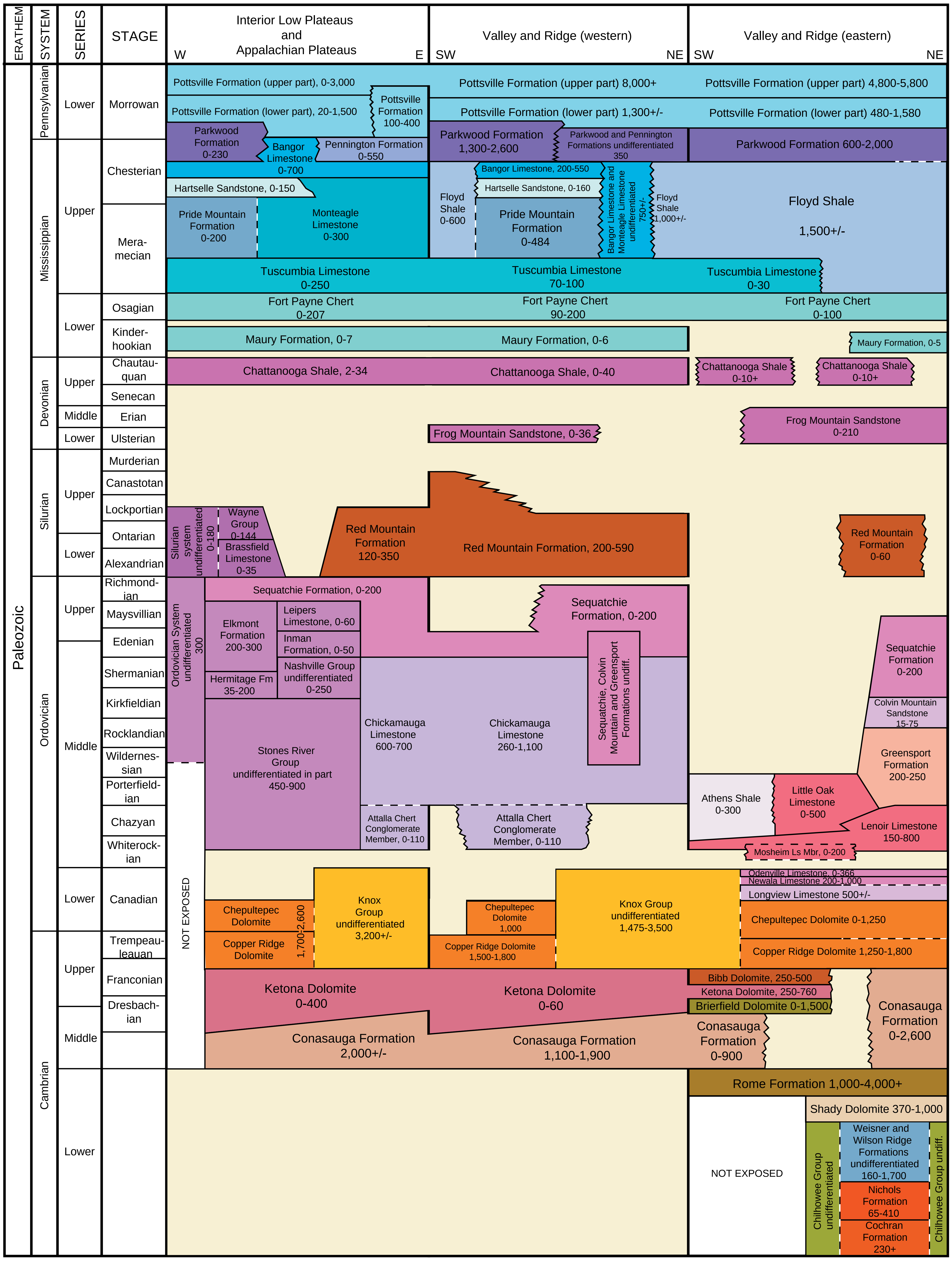

Interval of erosion or nondeposition.

Range of thickness of geologic units given in feet.

STRATIGRAPHIC RELATIONSHIPS AMONG EXPOSED PALEOZOIC UNITS IN THE APPALACHIAN PLATEAUS AND VALLEY AND RIDGE PROVINCES

Geology modified from Szabo and others (1988)
By David C. Kopaska-Merkel 2004

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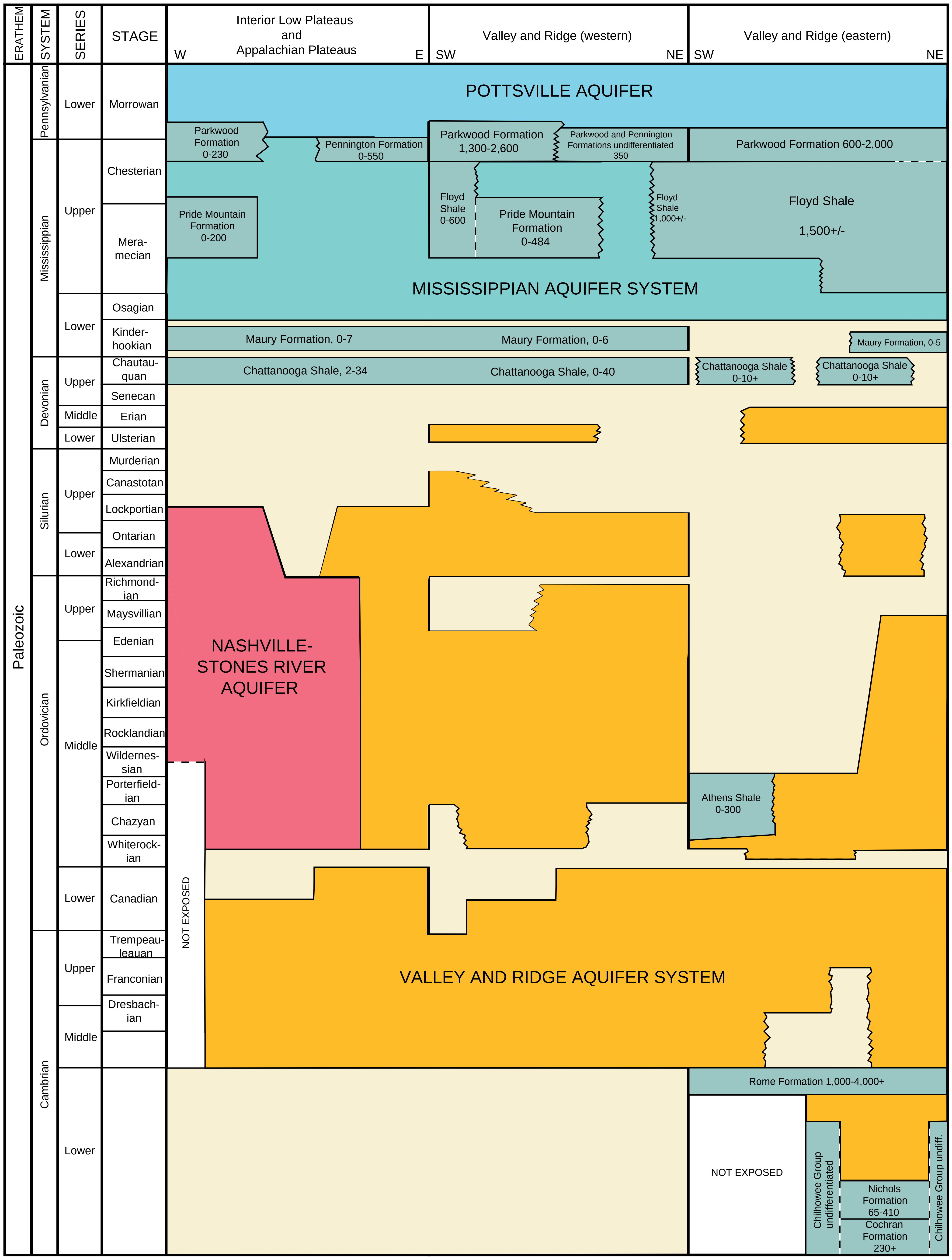

Interval of erosion or nondeposition.

Aquitard or other non-aquifer interval (including range of thickness in feet).

STRATIGRAPHIC AND GEOGRAPHIC DISTRIBUTION OF MAJOR AQUIFERS IN THE APPALACHIAN PLATEAUS AND VALLEY AND RIDGE PROVINCES

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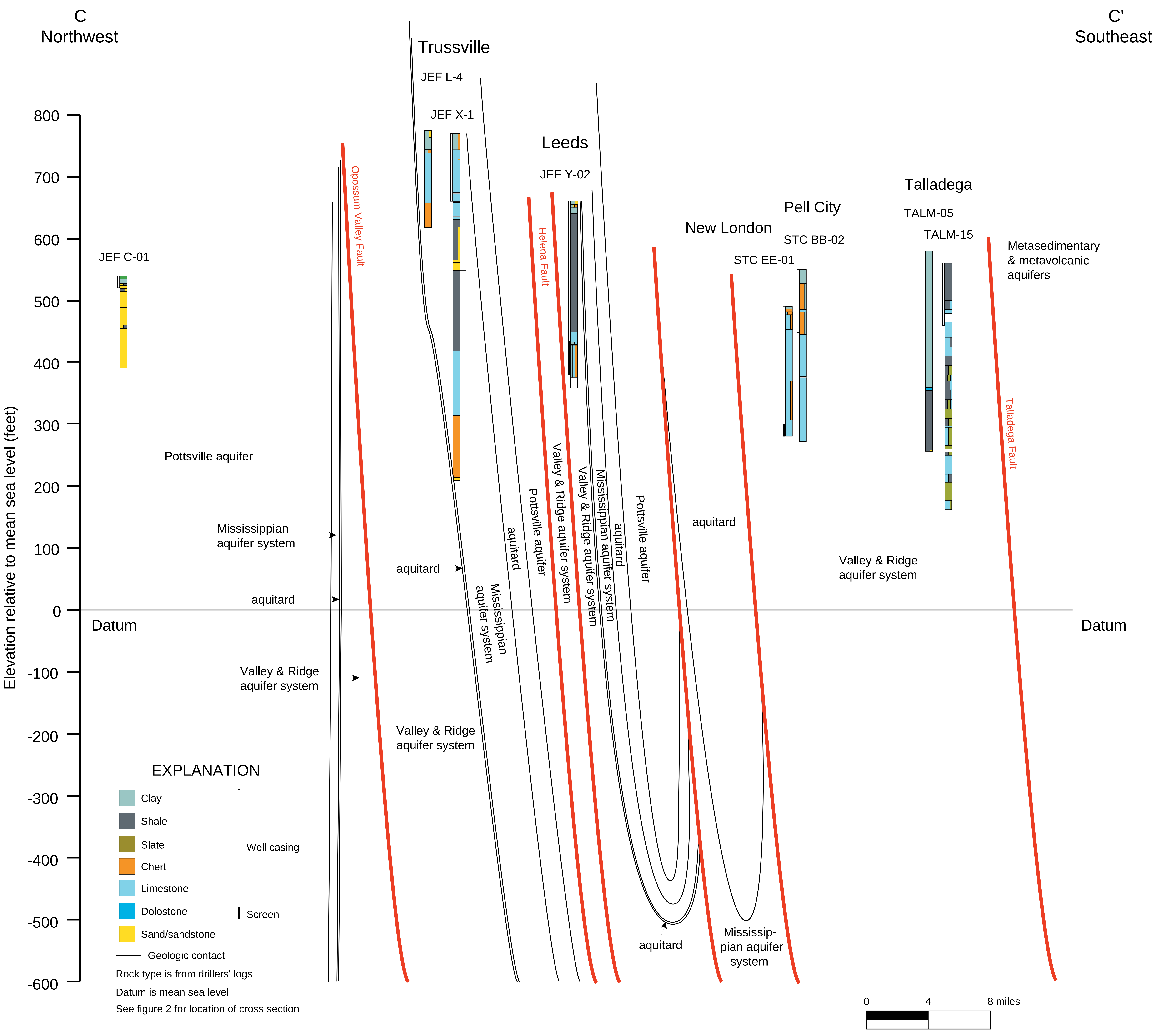

HYDROGEOLOGIC CROSS SECTION OF APPALACHIAN PLATEAU, VALLEY AND RIDGE, AND PIEDMONT GEOLOGIC PROVINCES IN AREA 4

By
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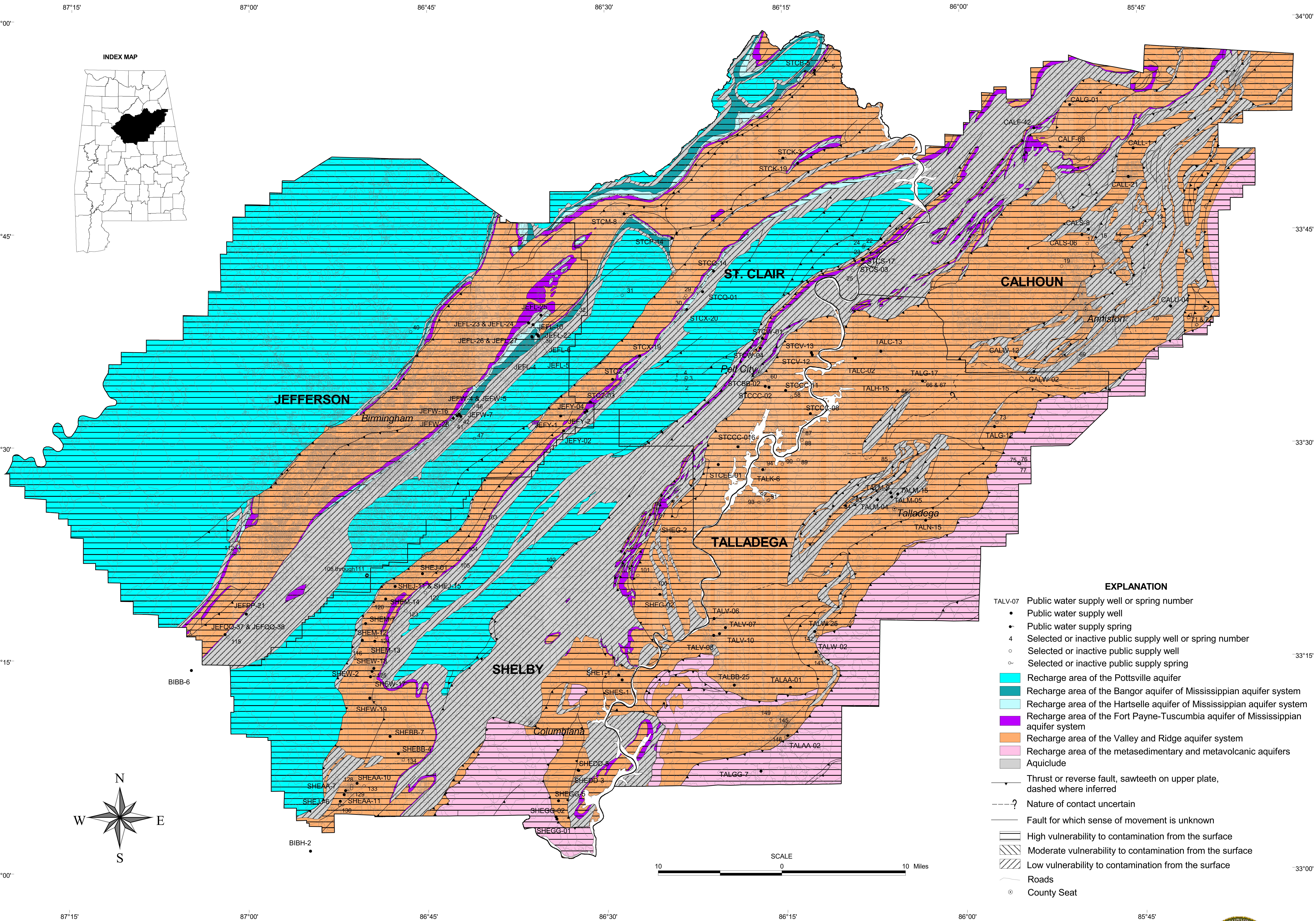

AQUIFER RECHARGE AREAS, AREAS OF VULNERABILITY, AND LOCATIONS OF PUBLIC WATER SUPPLY WELLS AND SPRINGS IN AREA 4

By David C. Kopaska-Merkel

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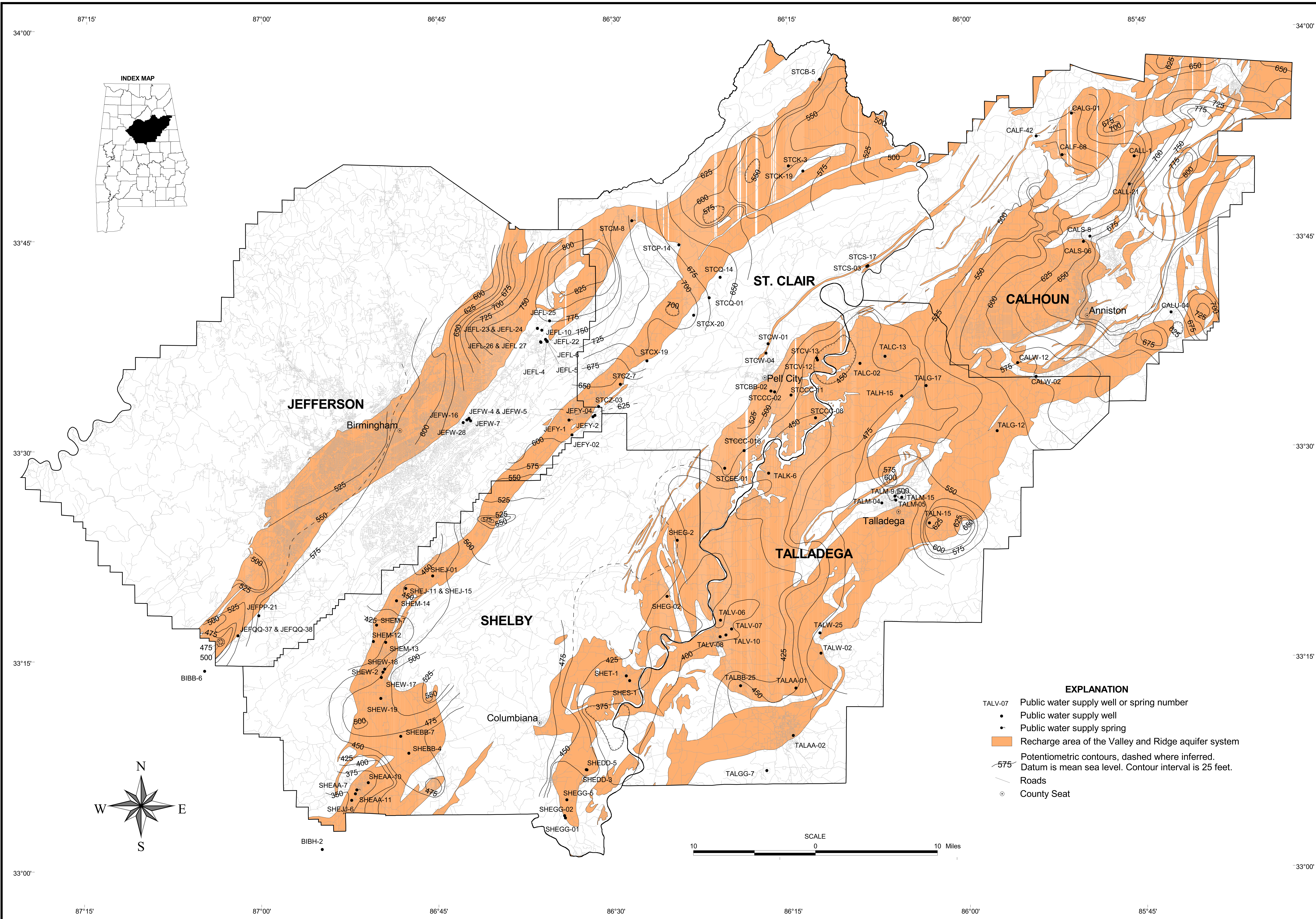

POTENTIOMETRIC SURFACE AND RECHARGE AREA OF THE VALLEY AND RIDGE AQUIFER SYSTEM IN AREA 4

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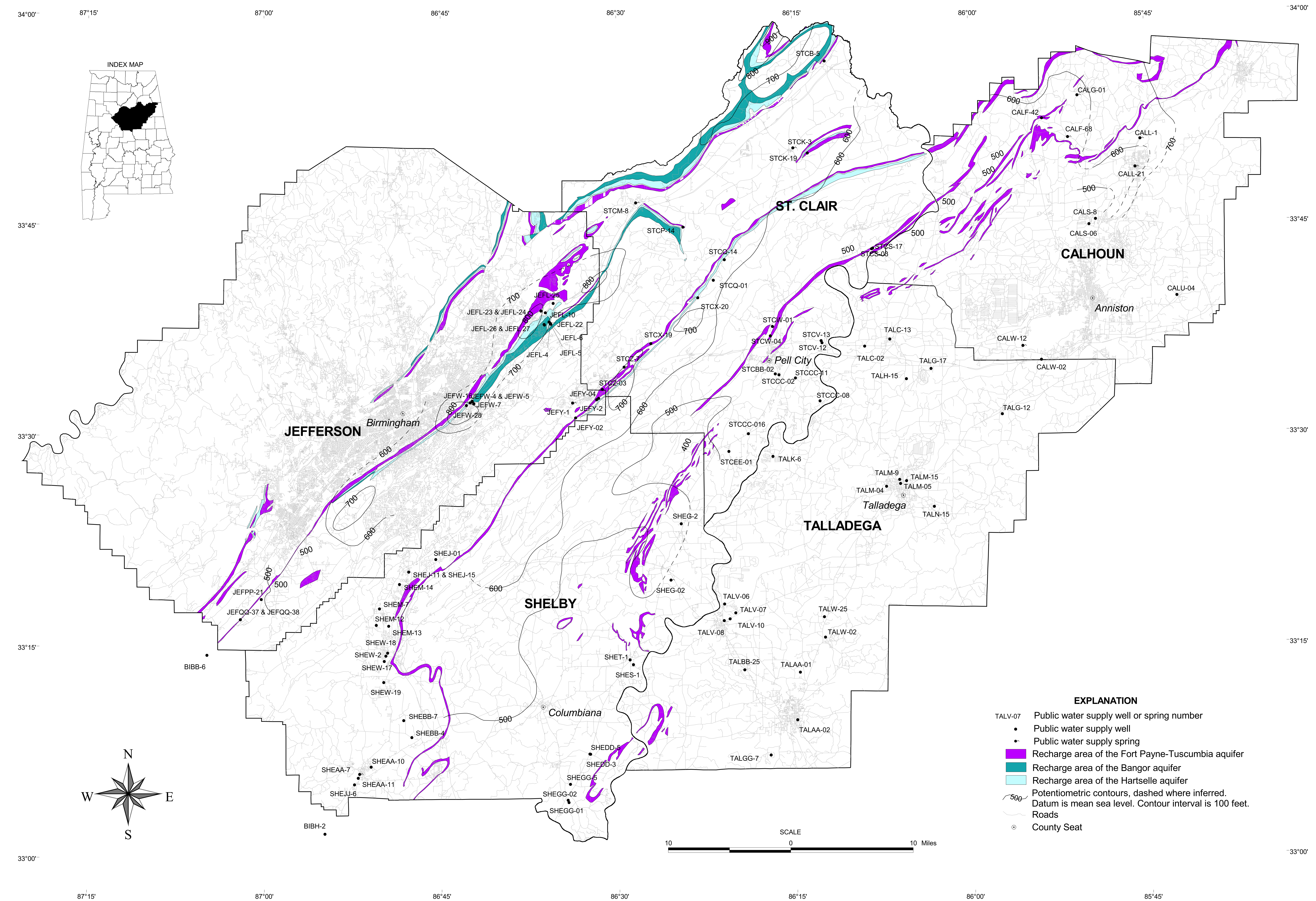

POTENTIOMETRIC SURFACE AND RECHARGE AREA OF THE MISSISSIPPIAN AQUIFER SYSTEM (HARTSELLE, BANGOR, AND FORT PAYNE -TUSCUMBIA AQUIFERS) IN AREA 4

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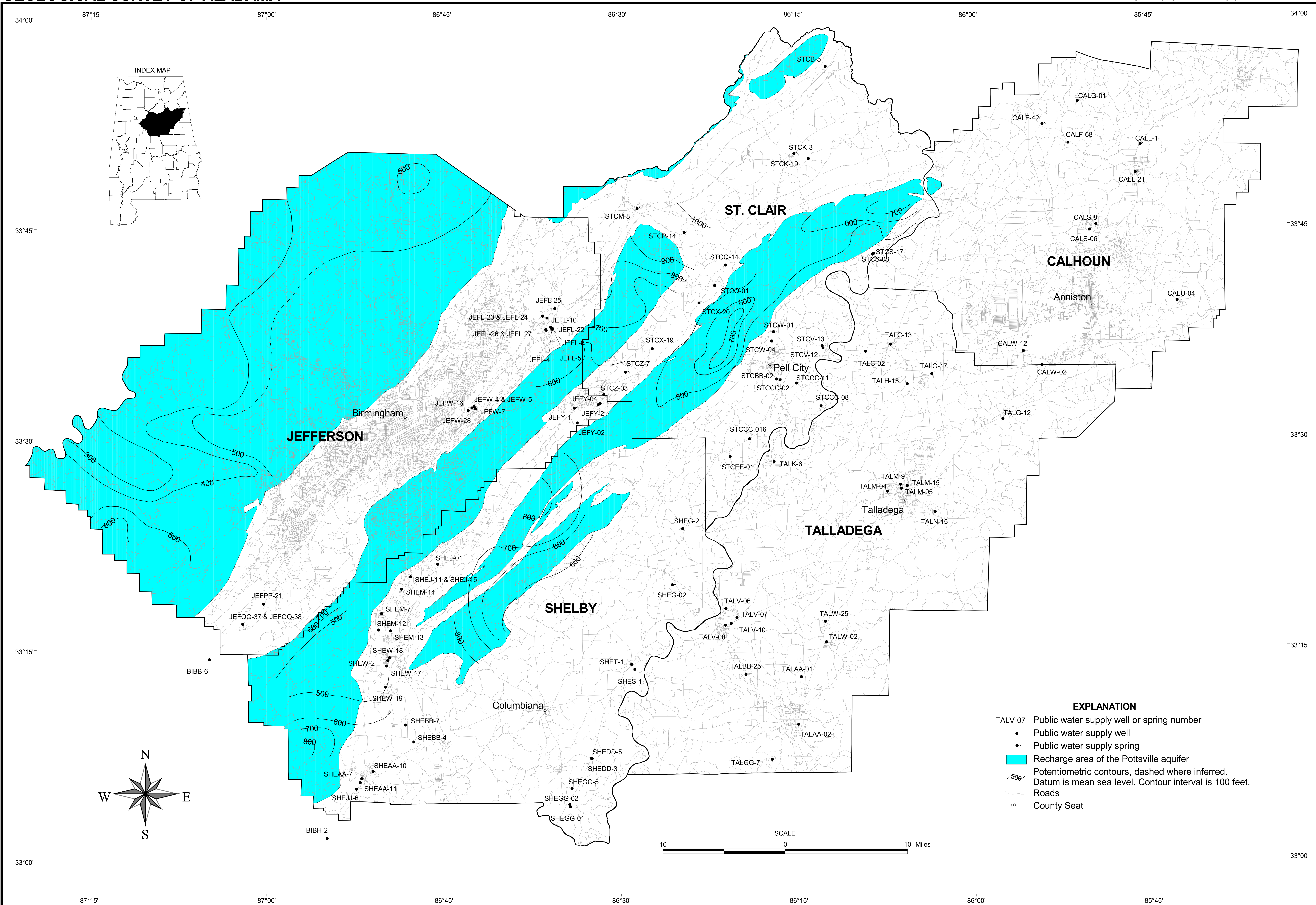

POTENTIOMETRIC SURFACE AND RECHARGE AREA OF THE POTTSVILLE AQUIFER IN AREA 4

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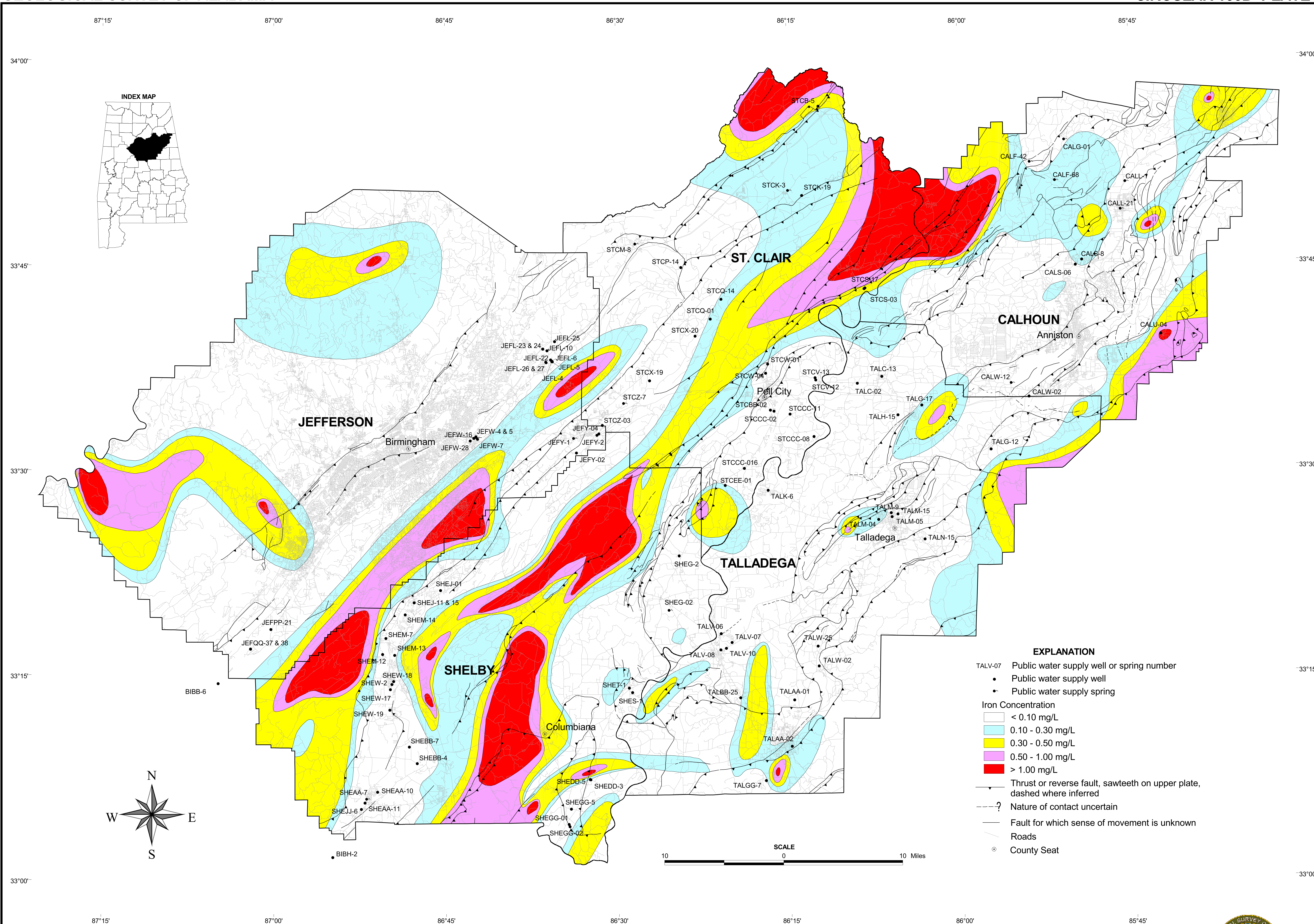

CONCENTRATION OF IRON IN SHALLOW GROUND WATER IN AREA 4

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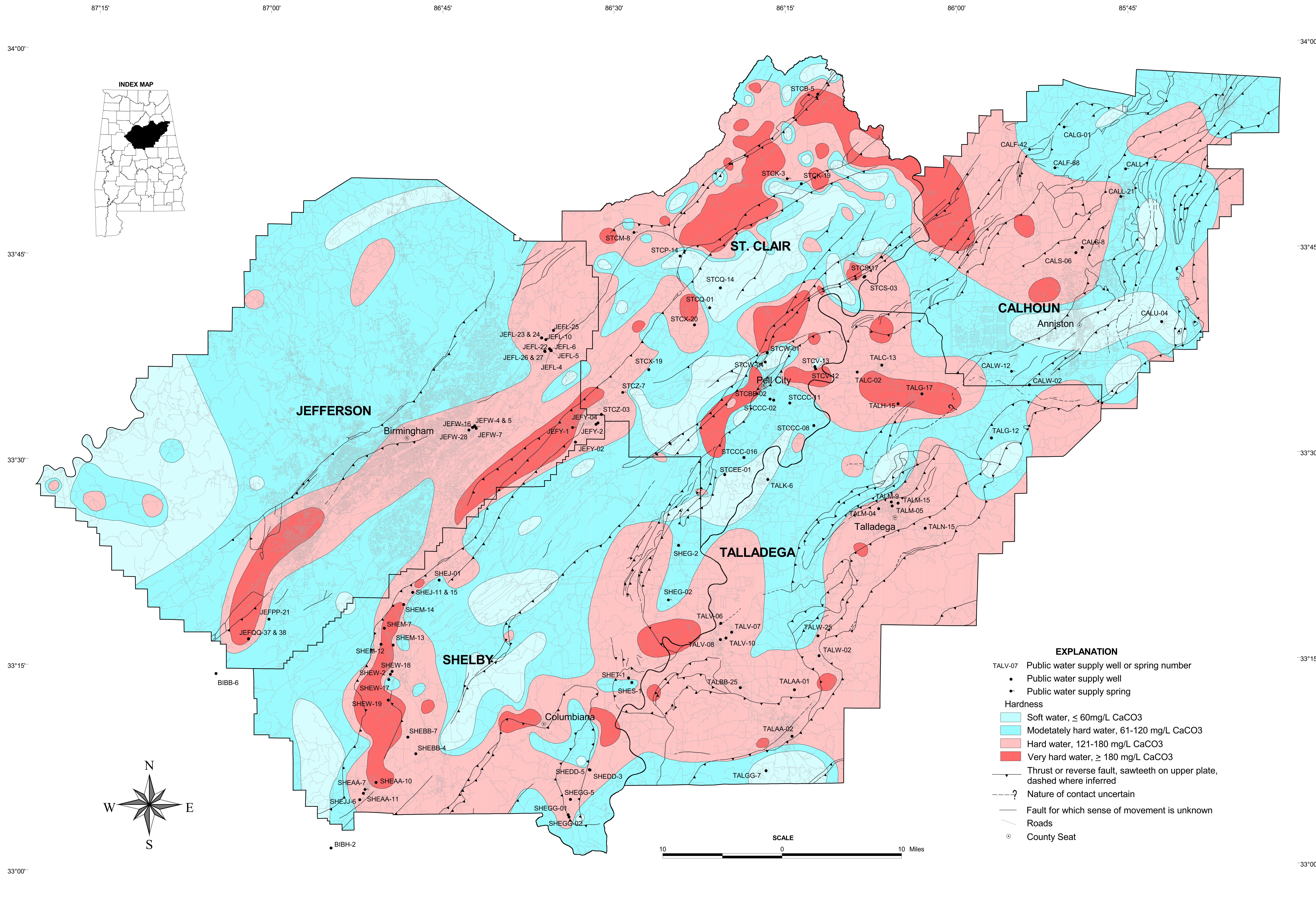

HARDNESS IN SHALLOW GROUND WATER IN AREA 4

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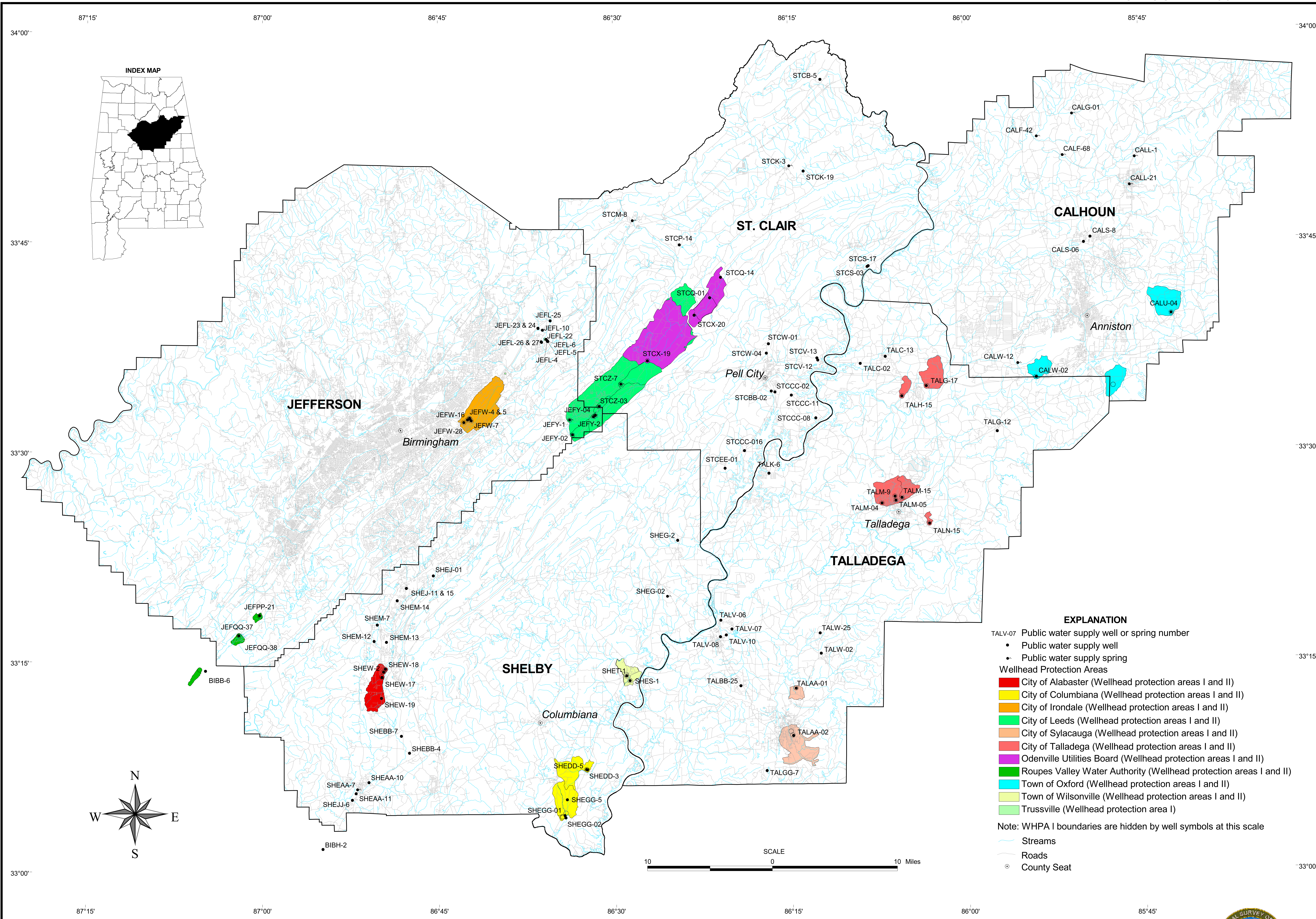

LOCATIONS OF PUBLIC WATER SUPPLY WELLS AND SPRINGS AND WELLHEAD PROTECTION AREAS IN AREA 4

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