SUMMARY RESULTS OF TEST WELL DRILLING IN THE NORTH-CENTRAL AND NEW MARKET AREAS BY THE MADISON COUNTY WATER DEPARTMENT, MADISON COUNTY, ALABAMA

OPEN-FILE REPORT 0806

GEOLOGICAL SURVEY OF ALABAMA

Berry H. Tew, Jr.
State Geologist

SUMMARY RESULTS OF TEST WELL DRILLING IN THE NORTH-CENTRAL AND NEW MARKET AREAS BY THE MADISON COUNTY WATER DEPARTMENT, MADISON COUNTY, ALABAMA

A REPORT TO THE

MADISON COUNTY WATER DEPARTMENT

OPEN FILE REPORT 0806

By
Stephen P. Jennings
and
Marlon R. Cook

Submitted in partial fulfillment of a contract with Madison County Water Department

Tuscaloosa, Alabama
2008

CONTENTS

	Page
Introduction	1
Purpose and scope	1
Project areas	2
Geology	4
General geology	4
Hydrogeology of the Fort Payne Chert	6
Water level and pumping test data	11
Conclusions	12
References cited	13
Appendix A: Well-site geological sample logs	14
Appendix B: Alabama Department of Environmental Management Form 60-Notification of Intent to Drill a Water Well and Certification of completion	20

ILLUSTRATIONS

PLATES
(in pocket)

Plate
1. Structure map – top of the Chattanooga Shale, north-central area, Madison County, Alabama
2. Geologic cross section – Madison County Water Department test wells, Alabama A&M University Thomas Agricultural Research Station, Madison County, Alabama
3. Test well J geophysical logs
4. Test well L geophysical logs
5. Test well M geophysical logs
6. Test well N geophysical logs

FIGURES

Figure
1. Index map showing the north-central and New Market areas, Madison County, Alabama 3
2. Geologic map of Madison County, Alabama 5
3. Fort Payne Chert samples from test well N, interval 70 to 80 feet 9

TABLES

Table
1. Locations of test wells drilled by the Madison County Water Department, 2008 4
2. Water level data from test wells drilled by the Madison County Water Department, 2008 11

SUMMARY RESULTS OF TEST WELL DRILLING IN THE NORTH-CENTRAL AND NEW MARKET AREAS BY THE MADISON COUNTY WATER DEPARTMENT, MADISON COUNTY, ALABAMA

By
Stephen P. Jennings and Marlon R. Cook

INTRODUCTION

Due to rapid and continued development in Madison County in north-central Alabama, the Madison County Water Department (MCWD) requires additional water sources to meet the growing demand. In 2003, MCWD contracted the Geological Survey of Alabama (GSA) to recommend potential water well drilling sites in the New Market area of Madison County and in an area in the north-central part of the county north of Huntsville. Analyses and interpretations of the hydrogeology of the areas were completed in 2003 (Baker and Henderson, 2003). The study identified 23 potential drilling sites in the New Market area and 15 sites in the north-central area, all to be drilled to the Devonian Chattanooga Shale for testing the overlying Mississippian Fort Payne Chert, the principal water-bearing geologic unit in the region. Based upon the data and recommendations published therein, MCWD selected a site in the New Market area and three sites on property owned by Alabama A&M University in the north-central area for drilling test wells. In 2007, GSA was contracted to assist MCWD in the development of plans for drilling and possible testing of the wells, to provide well-site geological duties and advice, and to analyze the hydrogeological data collected.

PURPOSE AND SCOPE

This report presents a summary of the hydrogeological data collected during test well drilling and should be considered an update and supplement to the data and hydrogeological interpretations presented by Baker and Henderson (2003). The data and interpretations presented herein document the results of the test well drilling conducted for the Madison County Water Department in the fall of 2007 and will aid in any future investigations in the area. Because drilling results indicated that the potential for water

production from the test wells was limited, no extensive pumping tests were conducted, and only minimal well development and pump testing data for sites J and N are included in this report.

Due to the exploratory nature of the drilling program and the poor understanding of the hydrogeology of the region, the emphasis of this report is the information gained regarding the structural geology and stratigraphy. Because the structural configuration of the top of the Chattanooga Shale was a major factor in the site selection process (Baker and Henderson, 2003), a revised structure contour map of that formation boundary is presented for a portion of the north-central area as plate 1. A geologic cross section in the north-central area was also constructed for this report (plate 2) to aid in presenting the data and geological interpretations. The new data gained by the drilling the test well in the New Market area do not indicate the need for substantive revision to the map of the top of the Chattanooga Shale in that area presented by Baker and Henderson (2003). Although the test well drilling did not result in the successful completion of a viable water supply for the citizens of Madison County, considerable knowledge was gained to aid in future exploration efforts.

PROJECT AREAS

The New Market area is in the northeastern part of Madison County, approximately 17 miles northeast of Huntsville, Alabama (fig. 1). Site J (Baker and Henderson, 2003), located approximately 2.8 miles northeast of the town of New Market in the valley of Mountain Fork, was selected by MCWD for test drilling. The drill site is located on land owned by the Madison County Water Department adjacent to the water treatment facility of MCWD. Table 1 provides information about test well locations and ground elevations. The locations were established by MCWD personnel using Global Positioning System (GPS) methods, and ground level elevations were estimated from 7.5-minute topographic quadrangles. Ground level elevations vary from about 725 feet to 1,525 feet above mean sea level within 1 mile of the site.

The three drill sites selected by MCWD in the north-central part of the county, sites L, M, and N of Baker and Henderson (2003) and corresponding test wells designated TW-L, TW-M, and TW-N on plates 1 and 2, are located on the Winfred J.

Figure 1. – Index map showing the north-central and New Market areas, Madison County, Alabama.

Thomas Agricultural Research Station of Alabama A&M University, approximately 11.8 miles north of Huntsville (fig. 1). The Alabama A&M agriculture research facility and surrounding area is termed the "north-central area" in this report. The drill sites are northeast of Briar Fork of the Flint River in an area of gently rolling topography (plate 1). Surface elevations vary from about 720 to 840 feet above sea level within approximately 1 mile of the drill sites area.

Table 1.—Locations of test wells drilled by the Madison County Water Department, 2008 (A&M refers to Alabama A&M University)

Site No.	Site Name	Location	Latitude (north)	Longitude (west)	Ground level elevation (feet)
1	New Market (Site J)	Section 26, T. 1 S., R. 2 E.	34.92455	86.38720	760
2	A&M (Site L)	Section 6, T. 2 S., R. 1 E.	34.90156	86.55453	775
3	A&M (Site M)	Section 6, T. 2 S., R. 1 E.	34.89928	86.56729	770
4	A&M (Site N)	Section 1, T. 2 S., R. 1 W.	34.89791	86.57516	765

GEOLOGY

GENERAL GEOLOGY

Lying on the southeastern flank of the Nashville Dome, the strata in the New Market and north-central areas generally dip to the south-southeast at about 20 to 40 feet per mile (Chaffin and Szabo, 1975; Szabo and Chaffin, 1982). Sedimentary rocks of Ordovician, Silurian, Devonian, and Mississippian ages are exposed in Madison County (fig.2). The geologic units drilled during the course of this project include the Silurian Brassfield Limestone, the Devonian Chattanooga Shale, and the Lower Mississippian Maury Formation and Fort Payne Chert. The Fort Payne is the principal aquifer in the region and was the primary target for the four test wells described and discussed herein.

The Fort Payne Chert is composed primarily of light-gray to very dark gray chert, gray, brownish-gray, and greenish-gray siliceous limestone and dolomite, and minor gray and green shale beds. The unit is commonly fossiliferous, with crinoids and brachiopods the most abundant and conspicuous fossils. Conformably below the Fort Payne Chert is the Maury Formation which is a thin (1 to 2 feet) but widespread interval of green, commonly glauconitic, and locally calcareous shale that is mapped in the New Market

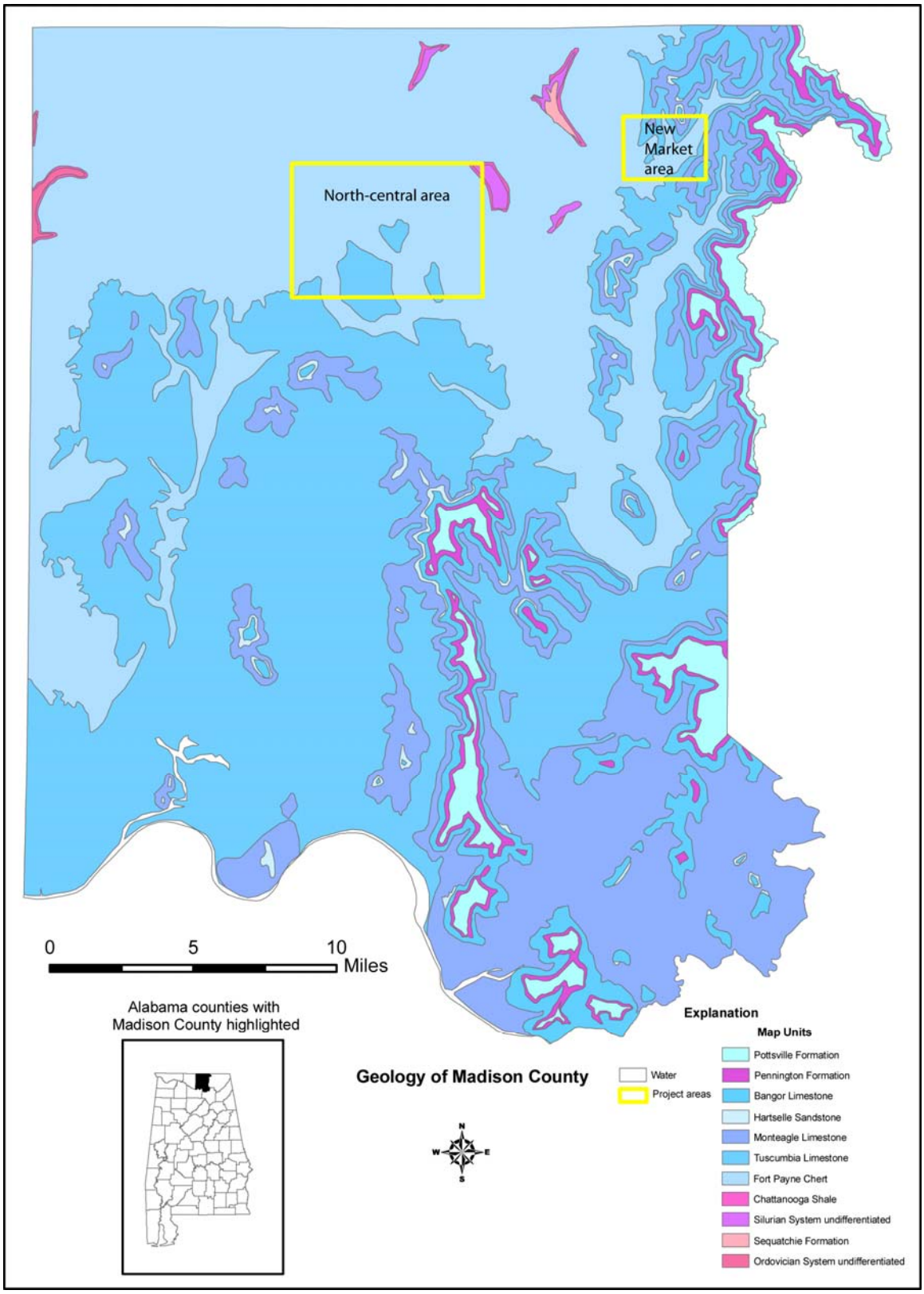

Figure 2. – Geologic map of Madison County, Alabama.

and north-central areas as part of the Fort Payne Chert (Chaffin and Szabo, 1975; Szabo and Chaffin, 1982). The Maury overlies the Chattanooga Shale, which is a relatively thin (5 to 20 feet) interval of black to brownish-black, carbonaceous, fissile shale that locally contains minor siltstone and fine-grained sandstone beds and lenses. Easily recognizable not only by its color, the Chattanooga Shale is also conspicuous on fresh exposures and in drill cuttings for its petroliferous and sulfurous odor. The unit also exhibits a relatively high response on natural gamma radiation logs, making the Chattanooga a useful mapping horizon. The Chattanooga Shale unconformably overlies the Silurian Brassfield Limestone, a 20- to 40-foot-thick interval of greenish-gray to brownish-gray limestone with minor greenish-gray shale beds.

HYDROGEOLOGY OF THE FORT PAYNE CHERT

The maximum thickness of the Fort Payne Chert is approximately 160 feet in the New Market area (Szabo and Chaffin, 1982) and about 150 feet in the north-central area (Chaffin and Szabo, 1975). However, only approximately 100 feet of Fort Payne at the New Market site and a maximum of about 90 feet at the north-central sites were present due to removal by weathering and erosion.

At each site the Fort Payne Chert is overlain by a highly weathered interval (residuum) consisting of soil, clay, and limestone and chert fragments. This soil, clay, and weathered rock residuum layer, termed regolith, is formed in place from the weathering and decomposition of the parent rock over which it lies and is 20 to 33 feet thick in the project test wells. The hydrogeological significance of the regolith is that locally the clay beds probably somewhat restrict downward percolation of surface water (rain and/or water in streams and impoundments), thus reducing potential recharge to the Fort Payne aquifer but also acting to protect the aquifer from possible contaminants. However, data indicate that the Fort Payne aquifer is a water-table aquifer, and thus the regolith does not act as a true confining layer.

The ground-water storage and transmissive properties of the Fort Payne Chert aquifer result primarily from locally present solution cavities, fractures transverse to bedding, and bedding plane conduits. Although beyond the scope of this report, the presumably long and complex diagenetic history of the Fort Payne sediments has included considerable dissolution of carbonate grains and cements. Karst features of

various scales are evident in the project areas, especially in the north-central area, and are likely related to dissolution of Fort Payne carbonate rocks. Less susceptible to dissolution from slightly acidic waters, chert, which results from the silicification of carbonate sediments, is the predominant lithology of the Fort Payne, both in outcrop and in the subsurface. Fractures are believed to be important in hydraulically connecting the dissolution cavities and bedding plane dissolution features, and they likely have acted to augment dissolution.

Recognizing and mapping lineaments as indicators of fractures and dissolution features was an important component of the drill-site identification and rating rationale of Baker and Henderson (2003) along with mapping of the structurally low areas evident at the top of the Chattanooga Shale. The structural lows were thought to be important in mapping thicker areas of the prospective Fort Payne Chert and in locating areas of flexure due to downwarping of the brittle chert that may have resulted in increased fracturing and dissolution in the Fort Payne. A revised structure contour map of the top of the Chattanooga Shale in a portion of the north-central area is shown in plate 1. The interpreted low area mapped by Baker and Henderson (2003) that extended across the northeastern sections of T. 2 S., R. 1 W. and sections 5 and 6 of T. 2 S., R. 1 E. has been reduced in areal extent in the updated and revised interpretation. The results of drilling of test wells L, M, and N and additional well data indicate that the structurally low and high areas correspond generally with the surface topography, likely reflecting direct relationships with features that result from subtle folding, fracturing, and dissolution of the carbonate rocks in the area. The major trend in the structural contours, surface topography, and surface drainage is about North 30° West with additional but less pronounced trends of about North 60° West and North 65° East. The geologic cross section shown in plate 2 illustrates an overall east-northeast dip component of the Chattanooga Shale and the overlying Mississippian Maury Formation and Fort Payne Chert along the line of cross section.

Plate 2 also shows tentative, informal hydrostratigraphic subdivision of the Fort Payne Chert that is present into three zones, here denoted as zones “A”, “B”, and “C”, based on lithologic characteristics seen in well cuttings (Appendix A) and from the geophysical well logs and driller’s logs. Note that on plate 2 and in the following

discussion that geophysical log responses are shown at the scales recorded in each well in the field by the logger. Some editing of the field prints of logs (plates 3, 4, 5, and 6) was necessary for inclusion in plate 2 due to the presence of casing and/or upon reaching the static water level, nullifying the self-potential (also termed spontaneous potential) and resistivity logs in casing or above static water level and nullifying the usefulness of the caliper logs inside casing. Natural gamma response is likely somewhat attenuated due to being run through casing but is still valid and a useful lithologic indicator. The geological interpretations presented here are the result of analyses of the combination of geophysical well logs, well site geological descriptions of drill cuttings and other observations by the geologist, and the driller's logs and observations.

The lowermost zone, "A", is characterized by greenish-gray dolomite, limestone with variable chert content, and shaly limestone. Glauconite is sparingly present in some well cuttings in this zone, especially in the lowermost beds. As seen in outcrops elsewhere in the region this interval grades downward into the thin, green, locally glauconitic Maury Formation. As exhibited by the natural gamma log, this interval is slightly more argillaceous and the geophysical log resistivities are lower than the overlying beds of zone "B". The caliper log and drilling characteristics indicate few fractures. As shown in plate 2, zone "A" appears to thin to the lowermost few feet of the Fort Payne in test well N.

Zone "B" overlies "A" and is characterized by gray dolomitic chert in the upper beds and light brownish-gray, fine crystalline limestone and cherty limestone in the lower beds. Higher resistivities, very low natural radioactivity, and few indications of fractures are seen in the geophysical log response. The driller, however, noted a "soft spot" in test well L at 92 to 93 feet, probably at a bedding plane boundary between dolomitic chert and an underlying limestone interval He also indicated that there is a fracture in test well N in the lower part of zone B. A tentative correlation of the top of zone "B" to a drilled depth of about 60 feet in test well N is based on a slight color change of the cuttings and a drilling rate change that was noted in the field by the driller. Tan to light-gray chert in Zone B of test well N exhibits visible fossil moldic porosity (fig. 3). The presence of steel casing placed to a depth of 87.75 feet in test well N prior to logging precludes the use of all log measurements recorded except the natural gamma log.

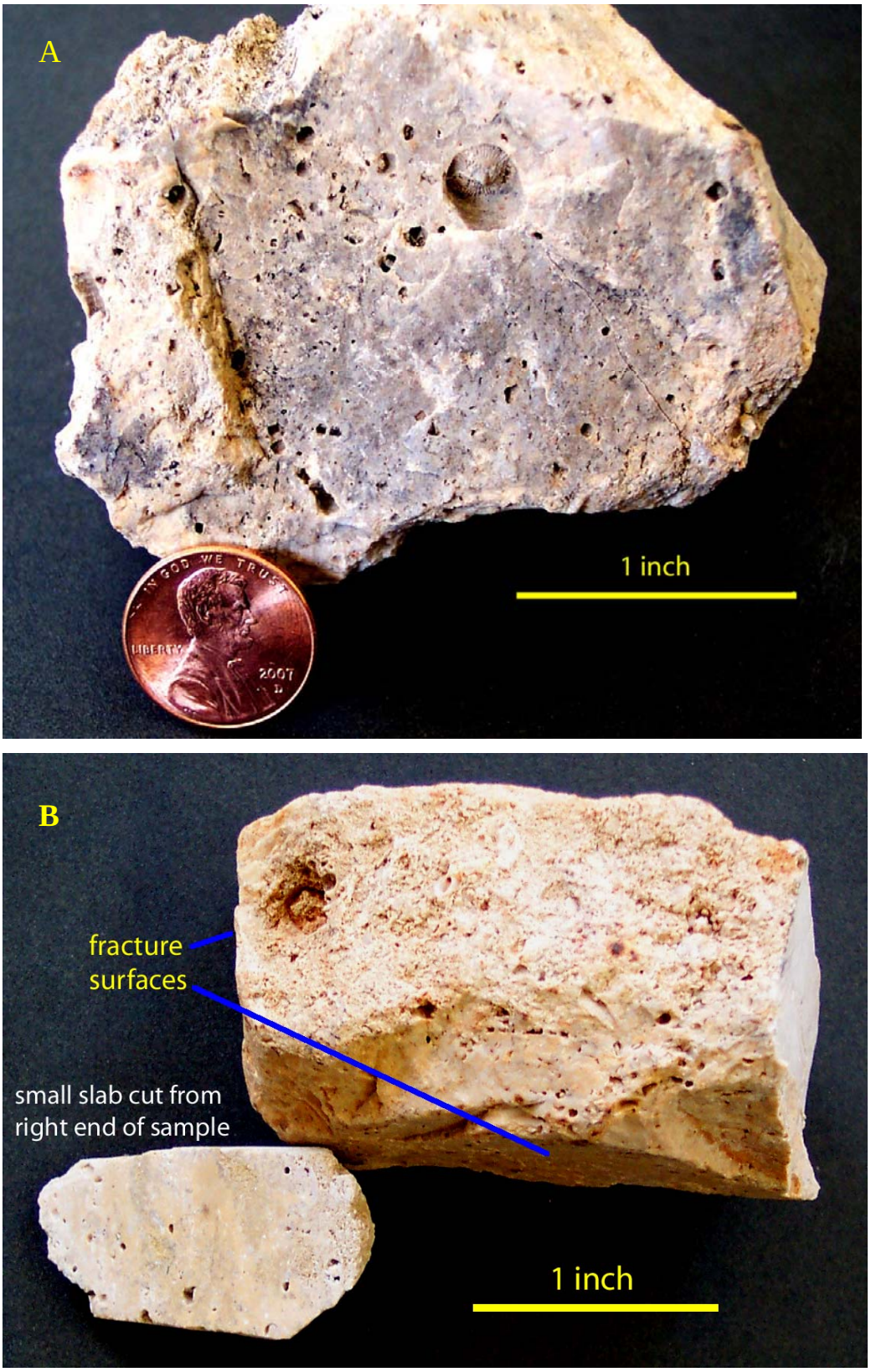

Figure 3. –Fort Payne Chert samples from test well N, interval 70 to 80 feet. (A) fossil moldic porosity is common, and (B) fracture planes are oriented nearly perpendicular to a fossil moldic bedding plane.

Zone “C” is the uppermost zone in the Fort Payne Chert recognized in the test wells in the Alabama A&M area. The zone is characterized by abundant chert, light- to medium-gray cherty dolomite, and tan siliceous limestone. Geophysical logs indicate a minor but perceptible increase in clay content as shown by the gamma ray logs, generally lower resistivities as seen in test well L, and a significant increase in fractures and/or thin soft “washout” beds as shown by the caliper logs in test wells L and M. Several of these were noted by the driller as “soft spots” or fractures. The base of the “void” noted by the driller in test well N is interpreted here to correlate with the base of zone C in test wells L and M. The uppermost beds of this zone show the effects of increased weathering and grade upward into regolith. The highly weathered beds and the regolith were cased off by the driller to prevent caving and allow for testing of the Fort Payne Chert aquifer.

A significantly higher fluid conductivity is indicated in test well L at depths below approximately 99 feet in spite of lower fluid temperature measurements in the same interval of the Fort Payne Chert (plate 4). These measurements of fluid properties are interpreted to indicate a change in ground-water chemistry and hence likely evidence of ground-water flow within Zone B. A generally similar pattern of fluid conductivity and temperature was measured in test well M at a depth of about 100 feet (plate 5), in Zone A. In test well N, two sets of measurements (log “runs”) of the fluid conductivity and temperature were recorded (plate 6), the first log run conducted prior to the driller pulling the casing upward from 87.75 feet to 87.25 feet, and the second set of measurements recorded approximately 20 minutes after the casing was pulled up. (The rationale for pulling up the casing was to increase the borehole surface area to hopefully increase ground water flow into the borehole). The earlier log run shows a change in fluid conductivity and fluid temperature at approximately 96 feet, in Zone A. The data from the second log run is not in agreement with the measurements from the first run with regards to fluid conductivity and temperature measurements, patterns of changes, depths, and magnitudes of values. The meaning of these data is not well understood. However, because casing was set to a depth of 87.75 feet on the first run and was pulled up to 87.25 feet prior to the second run, perhaps fluid conductivity and/or temperature had not stabilized for the second run or the turbidity of the water was significantly altered.

Moreover, most of the Fort Payne Chert aquifer was cased off in this well, possibly affecting natural ground-water conditions, including flow, in the interval that was logged.

WATER LEVEL AND PUMPING TEST DATA

Static water levels measured on various dates during the general time of drilling or testing operations are shown in table 2. Static water levels in table 2 and shown on plate 2 likely reflect the elevation of the water table in the Fort Payne Chert aquifer, though the water level measurement for test well L shown on plate 2 was made on November 30, 2007, whereas the measurements for test wells M and N were made December 5, 2007. Static water levels measured at test wells L, M, and N were below the base of the regolith, indicating that the Fort Payne aquifer is unconfined in the area. Although the water level measured by the logger in the New Market test well J was 18.9 feet below land surface on November 30, 2007, and the top of the Fort Payne Chert is at a drilled depth of about 20 feet, the lithologic characteristics of the regolith at that site do not indicate that the regolith acts as a confining layer. Moreover, the driller's reported water level for test well J was 32 feet below land surface (date not recorded), at a depth 12 feet below the top of the Fort Payne Chert.

Table 2.—Water level data from test wells drilled by the Madison County Water Department, 2008

(Water levels measured in feet below land surface)

Measured by	Test well J		Test well L		Test well M		Test well N	
	Level	Date	Level	Date	Level	Date	Level	Date
GSA	NA	NA	39.94	11/29/07	72.23	12/05/07	53.95	11/30/07
	NA	NA	NA	NA	NA	NA	53.80	12/12/07
Logger	18.90	11/30/07	42.20	11/30/07	76.66	12/05/07	55.55	12/05/07
Driller	32	NA	48	NA	75	NA	55	NA

Although the potential for pumping large volumes of water did not appear promising in any of the test wells, tests of short duration of the Fort Payne Chert aquifer were conducted on test wells J and N. As indicated by the driller (Appendix B), the

open-hole test conducted on the Fort Payne Chert in test well J resulted in 20 feet of water-level drawdown after only 1 hour of pumping at 130 gallons per minute. The test of the Fort Payne Chert in test well N through perforated casing from 81 to 88 feet deep resulted in the water level declining from approximately 55 feet to near the pump-setting depth just above the perforations in approximately an hour of pumping at a rate of 80 gallons per minute. No pumping tests were attempted on test wells L and M.

CONCLUSIONS

The results of drilling a single test well at the Madison Water Department water treatment facility near New Market, Alabama, and three test wells in the north-central Madison County area on the property of Alabama A&M University did not indicate the Fort Payne Chert aquifer had the potential to support the construction of high-capacity water-supply wells in these areas. In addition, at the New Market site the Silurian Brassfield Limestone had insufficient potential for water supply needs. The interpreted structural low at the north-central site is much smaller in areal extent than was originally thought. Also, the previously interpreted lineaments were not useful indicators of the presence of favorable geologic and/or hydrologic conditions necessary for development of large ground-water supplies. Useful geologic and hydrogeologic information was collected at all of the drill sites, however, and re-interpretation of the data along with new data provides better understanding of the hydrogeology of the New Market and north-central areas.

The Fort Payne Chert aquifer that is present at the Alabama A&M University agriculture research facility is informally subdivided into three hydrostratigraphic units, here termed Zone “A”, Zone “B”, and Zone “C”. Lack of data does not permit the mapping of these units beyond the immediate vicinity of the test wells drilled at the research facility. Water-level data, coupled with the hydrogeologic data, indicate the Fort Payne Chert aquifer is essentially unconfined, despite the presence of overlying clay-rich regolith, and ground water in the aquifer occurs under water-table conditions.

REFERENCES CITED

Baker, R. M., and Henderson, W. P., Jr., 2003, Potential water well drilling sites, Madison County Water Department: Alabama Geological Survey, Open-file report, 6 p.

Chaffin, H. S., Jr., and Szabo, M. W., 1975, Geology and mineral resources of the Fisk quadrangle, Alabama: Alabama Geological Survey Quadrangle Series Map 5, 21 p.

Malmberg, G. T., and Downing, H. T., 1957, Geology and ground water resources of Madison County, Alabama: Alabama Geological Survey, County Report 3, 225 p.

Szabo, M. W., and Chaffin, H. S., Jr., 1982, Geology and mineral resources of the New Market quadrangle, Alabama: Alabama Geological Survey Quadrangle Series Map 8, 29 p.

APPENDIX A

WELL-SITE GEOLOGICAL SAMPLE LOGS

Miller Drilling Company
Madison County Water Department
Alabama A&M Property; Section 26, T. 1 S., R. 2 E.
New Market area, Madison County, Alabama

Test Well J
GSA No. (no samples)
Elevation (feet), G.L. 760

Depth (feet)	Well-Site Sample Log
Well-site sample log	
0-10	Clay, brown to red-brown; chert fragments, white to light gray; minor limestone fragments, gray.
10-20	Clay, brown, some tan; chert fragments, tan.
20-21	Clay, tan; increase in tan chert fragments as above.
21-24	Chert, probably bedded, blue-gray, some white, translucent; minor vuggy, weathered, tan chert.
24-30	Limestone, light to medium gray, slightly fossiliferous; dolomitic chert, blue-gray translucent, some white weathered chert.
30-40	Dolomitic chert, medium gray; limestone, light to medium gray, slightly fossiliferous.
40-52	Dolomitic chert and limestone as above.
52-62	Dolomitic chert, medium to dark gray, fine crystalline.
62-70	Chert, medium gray, slightly dolomitic.
70-82	Chert as above, slightly dolomitic; minor white translucent chert.
82-92	Chert, light gray, slightly dolomitic.
92-102	Chert as above; dolomite, light to medium gray; trace of dark gray-brown dolomitic chert.
102-112	Limestone, medium grayish-brown; chert, light to medium gray, trace dark brownish-gray chert.
112-121	Limestone, medium gray to light brownish-gray; chert, light to dark gray; minor, green, dolomitic shale near base of interval.
121-121.5	Shale, very dark brownish-gray, fissile; trace of sulfur and gypsum crystals; sulfurous and petroliferous odor.

121.5-124	Shale, very dark brownish-gray, fissile; sulfurous and petroliferous odor.
124-135	Limestone, medium gray, some brownish-gray, fine to medium crystalline.
135-140	Limestone, as above; minor dolomite, light to medium gray, fine crystalline.
140-145	Limestone, as above, increase in fine crystalline; minor dolomite as above.
145-155	Limestone, as above with increase in brownish-gray to buff color.
155-165	Limestone, medium gray to greenish-gray, minor brownish-gray, fossiliferous in part (grainstone); minor greenish-gray shaly limestone, fine crystalline; minor glauconite, minor dolomite.
165-175	Limestone, as above with dolomitic, shaly limestone; trace of glauconite.
175-184	Shale, greenish-gray, calcareous; minor limestone and dolomite as above; trace of dark organic detritus in shale and limestone.

Note: Following the drilling of the interval from 0 to 121.5 feet, a pump test of the open-hole interval from 24 to 121.5 feet was conducted. Geophysical logs were then run in the hole, followed by re-entering the test hole and drilling from 121.5 to 184 feet. Geophysical logs were not run in the interval from 121.5 to 184 feet and no pump tests were conducted on this deeper interval.

Miller Drilling Company
Madison County Water Department
Alabama A&M Property; Section 6, T. 2 S., R. 1 E.
North-central Madison County, Alabama

Test Well L
GSA No. (no samples)
Elevation (feet), G.L. 775

Depth
(feet)

Well-Site Sample Log

Well-site sample log

0-10	Clay, reddish-brown with common fragments of light gray-tan chert residuum.
10-20	Clay, reddish-brown with chert residuum fragments as above; minor gray clay.
20-30	Clay, reddish brown, increase in chert fragment abundance and particle size (some gravel-sized).
30-33	Clay, reddish-brown as above; chert “gravel.”
33-40	Chert, gravel sized fragments, weathered
40-48	Chert, gray to tan, weathered and fractured, probably bedded chert.
48-50	Limestone, light to medium gray, dense, cherty; chert, light gray to white, some gray; overall very low porosity rock.
50-72	Chert, light to medium gray, some blue-gray and translucent, dolomitic; hard drilling with some thin, slightly softer beds.
72-82	Dolomitic chert; increase in blue-gray translucent chert, dolomite, fine crystalline.
82-92	Dolomitic chert.
92-102	Limestone, light brown to buff colored, fine to medium crystalline; dolomitic chert as above.
102-112	Limestone and dolomitic chert as above.
112-122	Limestone, medium gray to gray-brown; dolomitic chert as above with some greenish-gray dolomite.
122-123	Limestone and dolomitic chert as above; increase in greenish-gray dolomite.
123-127	Shale, very dark gray to black, some silty beds, petroliferous and sulfur odor.

Miller Drilling Company
Madison County Water Department
Alabama A&M Property; Section 6, T. 2 S., R. 1 E.
North-central Madison County, Alabama

Test Well M
GSA No. (no samples)
Elevation (feet), G.L. 770

Depth (feet)	Well-Site Sample Log
Well-site sample log	
0-10	Clay, reddish-brown with small-medium grained chert fragments ("gravel"), chert-whit to light gray-tan.
10-20	Clay, reddish-brown as above with increase in chert fragments.
20-30	Chert, white to tan, some light gray, fragmented and broken, some gravel sized; clay, brownish-red.
30-38	Chert and clay as above.
38-40	Chert, white, tan, gray, some very weathered, porous, and fossiliferous, some hard and translucent, some white and chalky; geode; fossil fragments; drilling overall harder than above. [Set casing at 40 ft.]
40-42	Chert, as above but some loose and fragmented, making small amount of water. [Need to reset casing to case off this interval.]
42-45	Chert; light tan to gray, hard. [Reset casing to 45 ft.]
45-50	Chert, light to medium gray, some blue-gray; minor greenish gray, slightly dolomitic.
50-60	Dolomite, light to medium gray, cherty, calcareous; trace of limestone, tan-gray, fine crystalline.
60-70	Dolomite, cherty, as above; at 65 ft. thin limestone bed, tan to buff colored, fractured, softer drilling and making some water.
70-80	Dolomite, light to medium gray to blue-gray, cherty; chert, blue-gray, translucent; trace of limestone.
80-90	Dolomite and chert as above; limestone, medium to dark gray, some tan to gray.
90-100	Dolomite and limestone as above; chert, blue-gray, translucent; sample overall darker than above; slight increase in limestone.

100-110	Limestone, medium gray to greenish-gray, some glauconitic limestone; minor dolomite and chert as above.
110-111	Limestone and dolomite, green to gray, glauconitic.
111-113	Shale, dark gray to black, sulfurous and petroliferous odor.

Miller Drilling Company
Madison County Water Department
Alabama A&M Property; Section 1, T. 2 S., R. 1 W.
North-central Madison County, Alabama

Test Well N
GSA No. (no samples)
Elevation (feet), G.L. 765

Depth (feet)	Well-Site Sample Log
Well-site sample log	
0-8	Clay, red-brown, minor chert fragments; chert, white to tan, weathered.
8-20	Clay, reddish-brown; chert fragments.
20-30	Chert, white to tan, fragments, some gravel sized; clay as above; increasing amount of chert downward through this interval.
30-40	Chert with some brown clay as above.
40-50	Chert and clay; chert, tan to white, weathered, fragments, some gravel sized; clay, brown.
50-60	Chert, white, some blue-gray, some fractures, weathered surfaces; clay, brown; very fast drilling—possible void.
60-70	Chert, white, tan, gray, considerable gravel-sized rock fragments, many appear rounded.
70-80	Chert, as above.
80-88	Chert, as above, some cobble-sized fragments.
88-90	Chert, very hard, blue-gray, tan.
90-99	Chert, as above; limestone, light gray to greenish-gray, minor dark gray, calcareous, some dolomitic. Fracture at 93-94 ft. by drilling.
99-100	Shale, green.
100-102	Shale, dark gray to black, petroliferous and sulfur odor.

APPENDIX B

Alabama Department of Environmental Management Form 60 – Notification of intent to drill and certification of completion (driller's logs)

NOTIFICATION OF INTENT TO DRILL A WATER WELL
AND CERTIFICATION OF COMPLETION

DRILLING CONTRACTOR: Miller Drilling | License Number: 593 | Address: 107 Helton Drive | Zip Code: Lawrenceburg TN | Date: 10-29-07

PROPERTY OWNER: Madison County Water | Address (mailing): | Zip Code:

WELL LOCATION: County: Madison | Township: 1S | Range: 2E | Section: 36 | 1/4 Section:

Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☑ Test well ☐ Monitoring well ☐ Irrigation Other:

LOCATION OF WELL: Latitude: 34.92455 | Longitude: -86.38720 | Diameter of well: 8" | Estimated depth: 185'

Estimated starting date: 11-5-07

Drilling Method: ☐ Cable tool ☑ Rotary ☐ Jetted ☐ Bored ☐ Other:

Site J

SIGNATURE of Drilling Contractor: Barry Weaver

Total Depth: 184

Completion Date: 11/28/07

Interval	Description of cuttings
0-10	Clay, Rock fragments
10-20	Clay, gravel, rock fragments
20-22	chert
22-32	Soft limestone
32-35	limestone
35-37	fracture, water
37-50	limestone
50-59	limestone 59 fracture
59-69	Solid chert
69-79	solid chert
79-89	Limestone fracture 89
89-99	soft chert
99-101	solid limestone
101-111	chert limestone
111-120	limestone
120-121	black shale

Note: This test well was deepened to a drilled depth of 184 feet in December, 2007.

Completion date: report depths below ground level

Pump: Type: ☐ Turb. ☑ Subm. ☐ Jet ☐ Cyl. Other: Intake depth: H.P.: Yield: 130 gpm

Capacity: Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level: 32 ft.
Measured pumping level: 52 ft. after 1 hrs. pumping 130 gpm
Development time prior to testing: 1 hrs.

Finish: ☐ Open hole ☐ Screened ☐ Slotted pipe ☐ Gravel pk.
Interval(s) screened: to ft.
to ; to ft.
Packer(s) set at and ft.
Screen: diam. ; Size openings

Casing:

Interval cased	Diam. (inches)	*Type pipe	*Type couplings	Interval grouted
24	8 5/8	Black	W	30

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (TC&W)
Other:
*Pipe: Black PCV Galv. Other:

Quality: Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab.

Signed Certification: Barry Weaver

*For deeper well please attach continuation sheet.

Send WHITE copy to:
ALABAMA GEOLOGICAL SURVEY
P.O. BOX 869999
TUSCALOOSA, AL 35486

Send YELLOW and PINK copies to:
ADEM DRINKING WATER BRANCH
P.O. BOX 301463
MONTGOMERY, AL 36130-1463

Retain GOLD copy for your Records

ADEM FORM 60 5/02

NOTIFICATION OF INTENT TO DRILL A WATER WELL AND CERTIFICATION OF COMPLETION

Miller Drilling 593 107 Helton Drive Lawrenceburg TN 10-29-07

DRILLING CONTRACTOR | License Number | Address | Zip Code | Date

Madison County Water

PROPERTY OWNER | Address (mailing) | Zip Code

Madison 2S 1E 6

WELL LOCATION | County | Township | Range | Section | 1/4 Section

Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☑ Test well ☐ Monitoring well ☐ Irrigation Other:

LOCATION OF WELL: 34.90156 (Latitude) -86.55453 (Longitude) 8" (Diameter of well) 160' (Estimated depth)

11-6-07 Estimated starting date

Drilling Method: ☐ Cable tool ☑ Rotary ☐ Jetted ☐ Bored ☐ Other:

Ben Weaver
SIGNATURE of Drilling Contractor

Site 6

Total Depth 113 Completion Date 11/27/07

Interval	Description of cuttings
0-10	Red clay, rock fragments
10-20	gravel, clay
20-30	gravel, voids
30-38	gravel, chert limestone
38-40	limestone, chert
40-44	broken up chert
44-45	limestone
45-50	limestone
50-58	limestone 58' soft spot
58-60	fracture
60-65	brown limestone
66-67	fracture
67-77	limestone
77-87	limestone hard
87-97	limestone
97-107	limestone
107-112	limestone
112-113	black shale

Note: The description of cuttings shown here is probably that for Site M test well.

Completion date: report depths below ground level

Pump: Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl Other____ Intake depth____ H.P.____ Yield____ gpm

Capacity: Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level 48 ft.
Measured pumping level ____ ft. after ____ hrs. pumping ____ gpm
Development time prior to testing ____ hrs.

Finish: ☐ Open hole ☐ Screened ☐ Slotted pipe ☐ Gravel pk.
Interval(s) screened: ____ to ____ ft; ____ to ____ ; ____ to ____ ft.
Packer(s) set at ____ and ____ ft.
Screen: diam. ____ ; Size openings ____

Casing:

Interval cased	Diam. (inches)	*Type pipe	*Type couplings	Interval grouted
47	8 3/8	Black	W	30

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (TC&W)
Other:
*Pipe: Black PCV Galv.; Other:

Quality: Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab.

Signed Certification: Ben Weaver

*For deeper well please attach continuation sheet.

Send WHITE copy to: ALABAMA GEOLOGICAL SURVEY P.O. BOX 869999 TUSCALOOSA, AL 35486

Send YELLOW and PINK copies to: ADEM DRINKING WATER BRANCH P.O. BOX 301463 MONTGOMERY, AL 36130-1463

Retain GOLD copy for your Records

ADEM FORM 60 5/02

NOTIFICATION OF INTENT TO DRILL A WATER WELL AND CERTIFICATION OF COMPLETION

Miller Drilling 593 107 Helton Drive Lawrenceburg TN 10-29-07

DRILLING CONTRACTOR | License Number | Address | Zip Code | Date

Madison County Water

PROPERTY OWNER | Address (mailing) | Zip Code

WELL LOCATION: Madison (County) 2S (Township) 1E (Range) 6 (Section) ____ (1/4 Section)

Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☒ Test well ☐ Monitoring well ☐ Irrigation Other: ____

LOCATION OF WELL: Latitude 34.89928 Longitude -86.56729 Diameter of well 8" Estimated depth 160

Estimated starting date 11-7-07

Drilling Method: ☐ Cable tool ☒ Rotary ☐ Jetted ☐ Bored ☐ Other: ____

Barry Weaver
SIGNATURE of Drilling Contractor

Site M

Total Depth 127 Completion Date 11/29/07

Interval	Description of cuttings
10'-20'	clay, small rock fragments
20-30	clay, brownish red.
30-40	Clay, small rock fragments
40-48	weathered gravel, limestone chert
48-60	Chert limestone
60-70	limestone chert
70-80	71 soft limestone 72-78 solid limestone
81-82	fracture
82-85	limestone
85-86	soft spot
86-88	limestone
88-92	limestone
92-93	soft spot
93-102	Solid
102-112	Solid
112-119	brown shale
119-123	brown green shale
123-127	black shale

Note: The description of cuttings shown here is probably that for Site L test well.

Completion date: report depths below ground level

Pump: Type: ☐ Turb. ☐ Subm. ☐ Jet ☐ Cyl Other ____ Intake depth ____ H.P. ____ Yield ____ gpm

Capacity: Tested by: ☐ pumping ☐ air lift ☐ bailer ☐ none; Measured Static Water Level 75 ft.; Measured pumping level ____ ft. after ____ hrs. pumping ____ gpm; Development time prior to testing ____ hrs.

Finish: ☐ Open hole ☐ Screened ☐ Slotted pipe ☐ Gravel pk.; Inerval(s) screened: ____ to ____ ft; 58 to ____; ____ to ____ ft.; Packer(s) set at ____ and ____ ft.; Screen: diam. ____; Size openings ____

Casing:

Interval cased	Diam. (inches)	*Type pipe	*Type couplings	Interval grouted
50	8 5/8	Black	W	34

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (TC&W)

Other: ____

*Pipe: Black PCV Galv.; Other: ____

Quality: Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical

Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab.

Signed Certification: Barry Weaver

*For deeper well please attach continuation sheet.

Send WHITE copy to: ALABAMA GEOLOGICAL SURVEY P.O. BOX 869999 TUSCALOOSA, AL 35486

Send YELLOW and PINK copies to: ADEM DRINKING WATER BRANCH P.O. BOX 301463 MONTGOMERY, AL 36130-1463

Retain GOLD copy for your Records

ADEM FORM 60 5/02

NOTIFICATION OF INTENT TO DRILL A WATER WELL AND CERTIFICATION OF COMPLETION

DRILLING CONTRACTOR: Miller Drilling | License Number: 593 | Address: 107 Holton Drive | Zip Code: Lawrenceburg TN | Date: 10-29-07

PROPERTY OWNER: Madison County Water | Address (mailing): | Zip Code:

WELL LOCATION: County: Madison | Township: 2S | Range: 1W | Section: 1 | 1/4 Section:

Distance and direction from nearest town, community, road junction or other reference point

WELL TO BE USED FOR: ☐ Private supply ☐ Public supply ☐ Industrial supply ☑ Test well ☐ Monitoring well ☐ Irrigation Other:

LOCATION OF WELL: Latitude: 34.89791 | Longitude: -86.57516 | Diameter of well: 8" | Estimated depth: 160'

Estimated starting date: 11-8-07

Drilling Method: ☐ Cable tool ☑ Rotary ☐ Jetted ☐ Bored ☐ Other:

Bury Weaver
SIGNATURE of Drilling Contractor

Site N

Total Depth: 102 | Completion Date: 12/3/07

Interval	Description of cuttings
0-10	Red clay, small Rock Fragments
10-20	Rock fragments, clay
20-30	gravel shorded, fine rock fragments
30-40	gravel, fine rock fragments
40-50	big gravel, broken up
50-60	void
60-70	weathered Rock
70-80	big broken up gravel, water bearing
80-89	gravel, 88 Limestone chert
89-90	limestone chert
90-93	limestone chert
93-94	fracture
94-99	limestone chert
99-100	green Shale, Black Shale
100-102	black shale

Completion date: report depths below ground level

Pump: Type: ☐ Turb. ☑ Subm. ☐ Jet ☐ Cyl Other: Intake depth: H.P.: Yield: gpm

Capacity: Tested by: ☑ pumping ☐ air lift ☐ bailer ☐ none
Measured Static Water Level: 55' ft.
Measured pumping level: ft. after 10 hrs. pumping 80 gpm
Development time prior to testing: 1hr hrs.

Finish: ☐ Open hole ☐ Screened ☑ Slotted pipe ☐ Gravel pk.
Interval(s) screened: 81' to 88 ft.
to ; to ft.
Packer(s) set at: and ft.
Screen: diam.: ; Size openings:

Casing:

Interval cased	Diam. (inches)	*Type pipe	*Type couplings	Interval grouted
88	8 5/8	Black	W	31

*Couplings: Threaded & Coupled (T&C) Welded (W) Threaded & coupled & welded (T,C&W)
Other:
*Pipe: Black; PCV; Galv.; Other:

Quality: Water analysis obtained? (check) ☐ No ☐ Bacteriological ☐ Chemical
Analysis by: ☐ Ala Geol. Surv. ☐ U.S. Geol. Surv. ☐ Ala Health Dept. ☐ Private lab.

Signed Certification: Bury Weaver

*For deeper well please attach continuation sheet.

Send WHITE copy to:
ALABAMA GEOLOGICAL SURVEY
P.O. BOX 869999
TUSCALOOSA, AL 35486

Send YELLOW and PINK copies to:
ADEM DRINKING WATER BRANCH
P.O. BOX 301463
MONTGOMERY, AL 36130-1463

Retain GOLD copy for your Records

ADEM FORM 60 5/02