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Reinvestigation of a Hydrogeologic Feasibility Study for a Proposed Surface Water Reservoir in Smith County, Mississippi

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REINVESTIGATION OF A HYDROGEOLOGIC FEASIBILITY STUDY FOR A PROPOSED SURFACE WATER RESERVOIR IN SMITH COUNTY, MISSISSIPPI

By

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The United States Forest Service desires to build a 2,700 acre surface water reservoir by constructing a dam to impound water on Oakohay Creek in Smith County, Mississippi. A previous study from 2007 deemed the proposed location based on the hydrologic and geologic characteristics. The reinvestigation study objectives focused on the site's hydrology and geology. The hydrologic study was accomplished by developing daily water storage models for the proposed reservoir. Archived data from the Southern Regional Climate Center were used in the models. The geologic study evaluated the Glendon Limestone through field surveying, ground penetrating radar, sonic rig drilling, surface water quantity measurements, and surface water quality analysis. A dedicated stream monitoring station was installed along the banks of Oakohay Creek. ArcGIS 9.3.1 and Microsoft Excel were used to support the objectives. Results from the study suggest that the proposed site location is suitable for reservoir development.

DEDICATION

This thesis is dedicated to my family; their love and support have been instrumental in the completion of my master's degree.

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CHAPTER I

INTRODUCTION

The purpose of this study was to reevaluate the Oakohay Creek watershed, Smith County, Mississippi, for the feasibility of constructing a multi-purpose surface water reservoir. This feasibility study follows in the footsteps of a previous study: *Hydrogeologic Assessment of a Proposed Reservoir Site, Smith County, Mississippi* by Jason McIlwain, 2007. In the 2007 study the reservoir site was deemed not suitable based on the hydrologic and geologic characteristics. Due to the major impact the development of a reservoir would have on the economy a reevaluation study was conducted in order to evaluate two of the three reasons why the reservoir site was deemed not suitable in the previous study. The two items being revaluated for the proposed reservoir project are hydrology and geology.

Monetary benefits is a reason why the reservoir project has been proposed because revenues from the reservoir could be used to the improve Smith County's roads and schools (Ballweber and Stiel, 2005). The tax base model of the proposed reservoir is being based off a reservoir, Tellico Lake, located southwest of Knoxville, Tennessee that was constructed in 1976. Smith County is in need of additional revenues due to the Bienville National Forest having decreased timber sales (Ballweber and Stiel, 2005). The completed project is expected to be a major source of revenue, generating an estimated 183 million dollars through residential and recreational activities, including business and infrastructure development (Ballweber and Tagert, 2008).

Evaluating the proposed reservoir's hydrology and geology were the two objectives. The first objective was a hydrologic study that evaluated the proposed reservoir's daily water storage. This was accomplished by developing daily water storage models. Historical evaporation and precipitation data archived at the Southern Regional Climate Center were used to develop the models. The second objective was a geologic study which focused on the state of the limestone in the Glendon Formation within the reservoir footprint area. The geologic study was accomplished by: field surveys, ground penetrating radar, sonic rig drilling, surface water quantity measurements, and surface water quality analysis. A dedicated stream monitoring station was installed along the banks of Oakohay Creek. ArcGIS 9.3.1 with Spatial Analyst and Microsoft Excel were used to support the objectives.

Oakohay Creek (pronounced "Cohay" locally) is one of three principal streams in Smith County and is responsible for draining approximately 31 percent or 202 square miles (Luper, 1972). The location of the proposed dam is due north of the intersection of Oakohay Creek and Little Oakohay Creek. Water would be impounded at the 400 foot contour line within the Oakohay Creek watershed. Surface area of the reservoir would be 2,689 acres and a drainage basin of about 21,890 acres making it the largest reservoir in Smith County. The majority of the reservoir site is located on Bienville National Forest while the remaining property is privately owned. The Oakohay Creek proposed reservoir project is a joint interest project managed by the Mississippi Water Resources Research Institute. The project is funded by the United States Forest Service for the Bienville Resources and Development Council which is an interlocal agency that includes Smith, Jasper, Rankin, and Simpson counties (Ballweber and Tagert, 2008).

CHAPTER II

SETTING

Location and Population

As seen in Figure 1, the study area is located in Smith County, Mississippi, USA, which is located in the southeastern part of the state. The population of Smith County in 2007 was recorded as 16,009 (SCEDD, 2011). The proposed reservoir location by way of state and county roads is approximately 50 miles southeast of Jackson, Mississippi, the capital of Mississippi, and 120 miles south of Starkville, Mississippi, location of Mississippi State University. In 1833, the Smith County was named after Major David Smith (SCEDD, 2011). The area of the county measures 635 square miles (406,500 acres) and has a maximum north-south boundary of 30 miles and a maximum east-west boundary of 24 miles (Thornton, 2001; Luper, 1972).

Smith County is made up of five municipalities, they include: Taylorsville, Polkville, Mize, Sylvarena, and Raleigh which serves as the county seat. Raleigh was originally named Indian Springs before it was renamed after Sir Walter Raleigh (Perry, 1976). Raleigh currently has a population of 1,230 people and is the municipality closest to the proposed reservoir (SCEDD, 2011). The proposed reservoir by way of road is located approximately 6 miles northwest of Raleigh. Figure 2 is a map of the proposed reservoir site which is located 1 ½ miles west of State Highway 35 and 2 miles north of State Highway 18. State Highway 18 and State Highway 35 intersect in Raleigh, Mississippi.

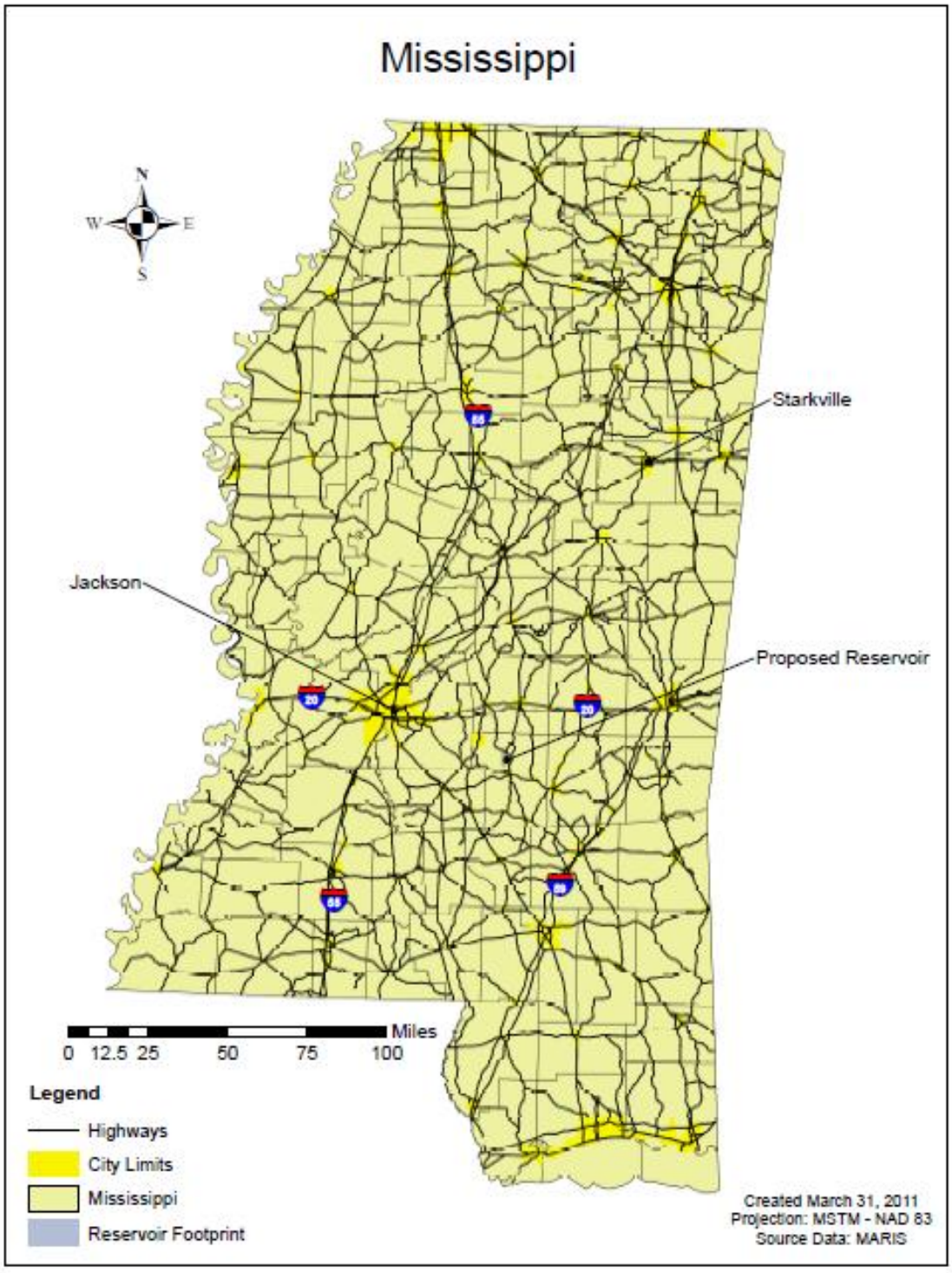


Figure 1 Location of the proposed reservoir in relation to Mississippi, USA

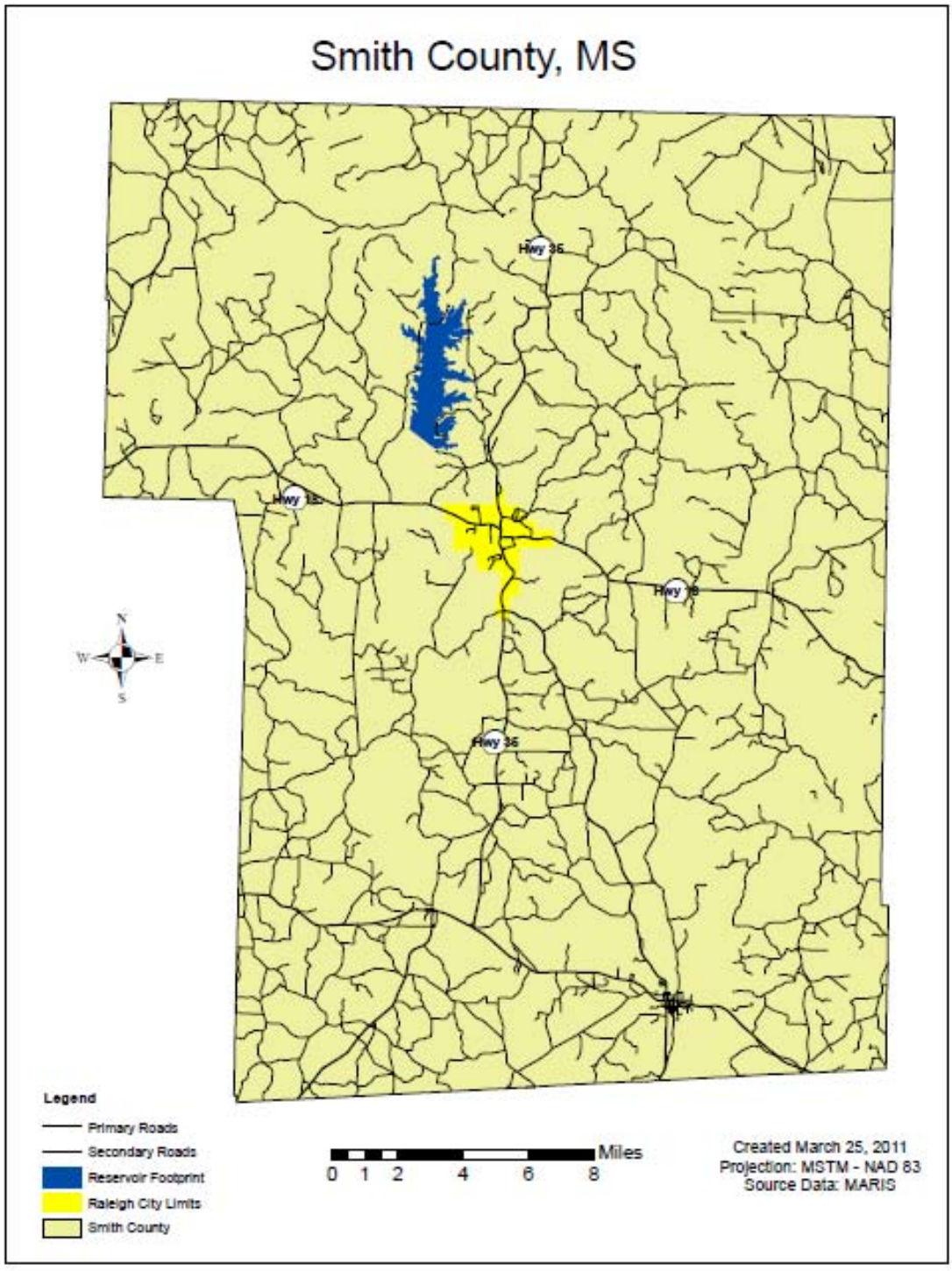


Figure 2 Location of the proposed reservoir in relation to Smith County, MS

Land Use

Figure 3, inside the blue line, shows how the vast majority of the land located within the reservoir footprint area is forested. The Bienville National Forest is majority of this forest and is used for timber farming. The Bienville National Forest's area is 72,623 acres or about 28 percent of the total area of Smith County. Approximately 77 percent of Smith County is covered in loblolly short leaf pine in the uplands and oak, hickory, gum, and cypress in the bottom lands. Timber is typically harvested for use as lumber, paper, fiberboard, and plywood products. The remaining property that is not used for timber production is used for cultivated crops (3%), pasture land and hay (19%) and poultry farms (1%). Approximately ten years ago there were about 250 poultry farms located throughout the county that raised about 96 million broilers each year (Thornton, 2001). Poultry farmers use their chicken waste, litter, to fertilize fields (McIlwain, 2007). This practice may potentially have a negative impact on the proposed reservoir water quality due to the high amounts of contaminants that could be transported into the reservoir via storm water runoff.

Figure 3 Aerial map of proposed reservoir

Mineral Resources

Smith County has mineral resources such as: sand, gravel, clay, limestone, oil, and gas (Thornton, 2001). Bentonite clay from the Bucatunna Clay member of the Vicksburg Group was previously mined ¾ to 1 mile due west of the intersection of Yellow Bill Creek and Oakohay Creek. Bentonite that was mined had an average thickness of about 3 ½ feet and was mined from between the ledges of the Glendon limestone (Luper, 1972). Limestone in Smith County was mined from the Glendon Member of the Vicksburg Group to produce agricultural lime (Thornton, 2001). The limestone could also be used to produce cement (Luper, 1972). The mine closest to the study area was located about 1 mile southeast of Sylvarena, Mississippi. Four oil and gas fields are located in Smith County (Thornton, 2001). There are two oil fields near the study area. Boykin Church Field is located approximately 1 to 1 ½ miles to the west of the study area. Boykin Church Field is located in Sections 16 and 17 of Township 2 North, Range 7 East. Raleigh Oil Field is the other oil field. It is currently active and is located approximately 7 miles south of the proposed reservoir dam location in Sections 27, 28, 29, 33, and 34, of Township 2 North, and Range 7 East (Luper, 1972).

Physiography

Mississippi is part of the lowland area adjacent to the Gulf of Mexico known physiographically as the Gulf Coastal Plain Province (Wax, 2006). Smith County is located in the East Gulf Coast Plain Section which is comprised of three of the twelve subdivisions that are found in Mississippi. The three subdivisions are the Jackson Prairie, the Vicksburg Hills, and the Piney Woods (Luper, 1972). The study area is located in both the Vicksburg Hills and the Piney Woods subdivision. The northern section of the study area is located in the Vicksburg Hills subdivision. The Vicksburg Hills subdivision

is 9 to 15 miles in width and runs in a northwest to southeast trend. Its terrain has gentle slopes and is underlain by the Forest Hill Formation and the Vicksburg Group (Luper, 1972; Thornton, 2001). The Piney Woods subdivision encompasses the southern part of the study area and makes up about 55 to 60 percent of Smith County. It is classified by the Catahoula Formation, the Hattiesburg Formation, and the Citronelle Formation. Fifteen to twenty percent of the Piney Woods Subdivision is comprised of the Leaf River, Strong River, and Oakohay Creek terraces and floodplains (Thornton, 2001).

Topography

Smith County topography has three distinct features: upland areas, rolling hills, and broad lowland areas. Oakohay Creek watershed is separated from the Leaf River drainage basin by a distinct ridge that extends in a north-south direction for approximately 12 miles with a maximum elevation of 600 feet. State Highway 35 and the municipality of Raleigh are located upon this ridge. Oakohay Creek lowlands area has a maximum width of 1 ½ miles and an elevation of 350 feet (Luper, 1972). Oakohay Creek flows southward into the Leaf River which drains into the Pascagoula River, and into the Gulf of Mexico (McIlwain, 2007).

The proposed reservoir dam, Figure 4, is located in the southwest quarter of section 22, T3N, R7E, through Section 27, T3N, R7E, into the western edge of Section 26, T3N, R7E of the USGS Raleigh, Mississippi 1:24,000' scale topographic map (McIlwain, 2007). Reservoir footprint area at full capacity, 400' contour line, would extend ½ mile north of State Highway 481 for a total distance of approximately 5 miles north of the dam site.

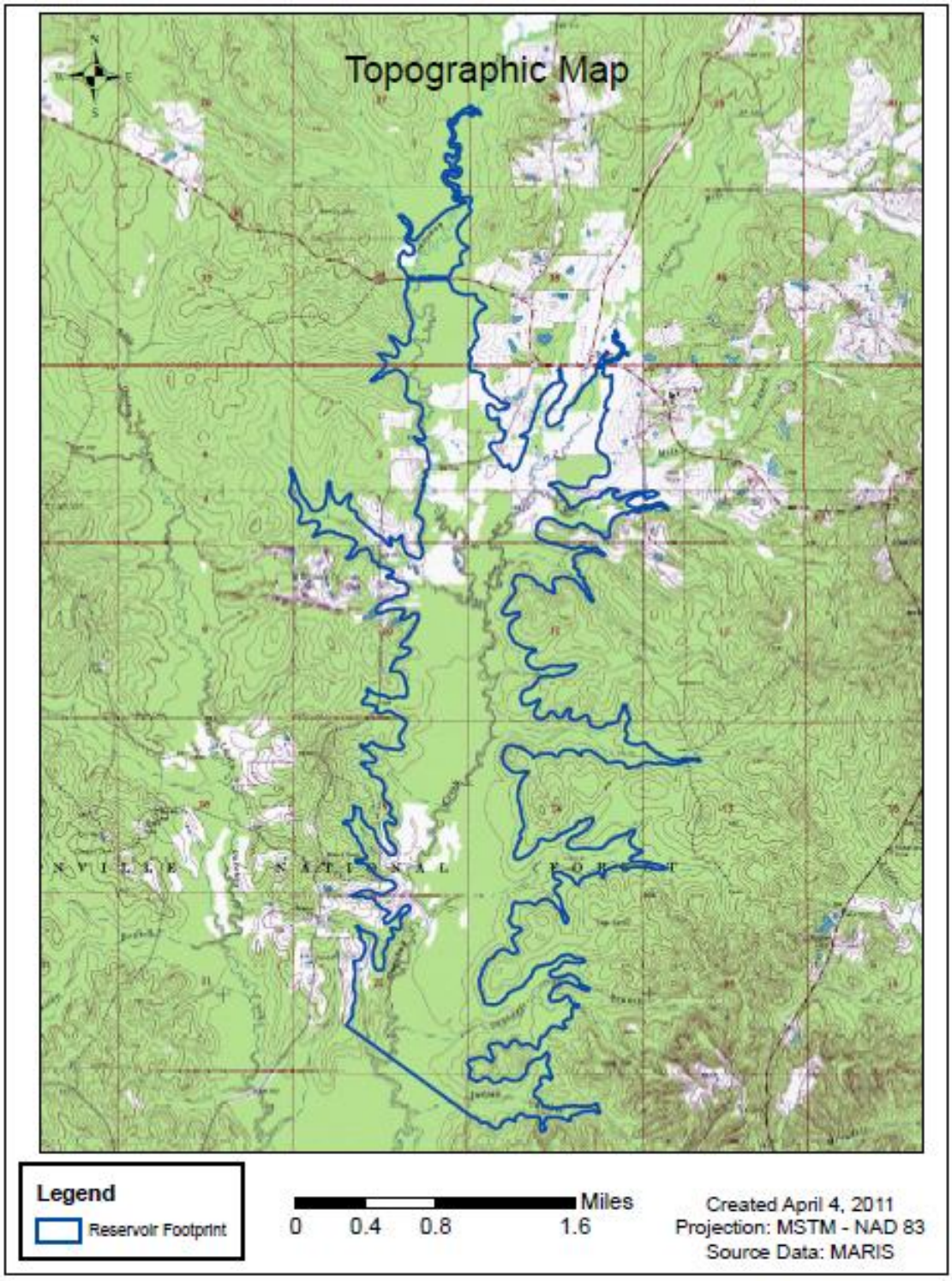


Figure 4 USGS 1:24,000 topographic map of proposed reservoir

Climate

Climate in Smith County, Mississippi is characterized by long, hot summers and cool, short winters. Precipitation is generally heavy throughout the year and extended periods of drought are rare (Thornton, 2001). These characteristics are controlled by the North America landmass to the north, Gulf of Mexico to the south, and the state of Mississippi subtropical latitudinal position. Mississippi climate is also connected globally by phenomena such as El Niño and La Niña which can cause weather patterns to differ from the norm due to rainfall and temperature variances, spurring tornadoes and hurricanes (Wax, 2006).

The weather station located in Forest, Mississippi was used in the following weather analysis. Forest, Mississippi is located about 20 miles north of the study area. The data in Table 1 was obtained from the Southern Regional Climate Center. The center provided a 30 year record, 1971 to 2000, of data for precipitation, maximum temperature, minimum temperature, and mean temperature. The following data were obtained from the monthly averages of the 30 year time span. Average precipitation amounts range between 3.7 to 6.5 inches per month. Average maximum temperatures range between 57 to 91 degrees Fahrenheit. Average minimum temperatures range between 34 to 69 degrees Fahrenheit. Average temperatures range between 45 to 80 degrees Fahrenheit (SRCC, 2011).

Table 1 Thirty year mean climate data

Forest, Mississippi: Weather Station Data (1971-2000)													
Variables	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Precipitation (in.)	6.2	5.6	6.5	5.9	4.8	4.4	5.6	4.3	3.7	3.7	5.4	5.8	61.94
Maximum Temp. (°F)	57	63	70	77	83	89	91	91	87	78	68	59	75.9
Minimum Temp. (°F)	34	37	44	50	59	65	69	68	63	51	42	37	51.5
Mean Temp. (°F)	45	50	57	63	71	77	80	80	75	64	55	48	63.7

Hydrology

As seen in Figure 5, Smith County has three main drainage basins. Strong River, labeled as "1", is the western most basin and drains approximately 13 percent of Smith County (88 square miles). Oakohay Creek is the primary basin in the study and is labeled as "2". It is the central drainage basin collecting about 31 percent of the county's drainage (202 square miles). Headwaters of Oakohay Creek develop in south-central Scott County and flow in a southwesterly to southerly direction until 4 miles north of Mize where the creek flows in a southerly direction until it exits Smith County. Leaf River basin is the eastern most basin and is labeled as "3", it drains about 46 percent of the county (294 square miles). The remaining area of Smith County, estimated at about 10 percent, is drained by two minor basins (Luper, 1972).

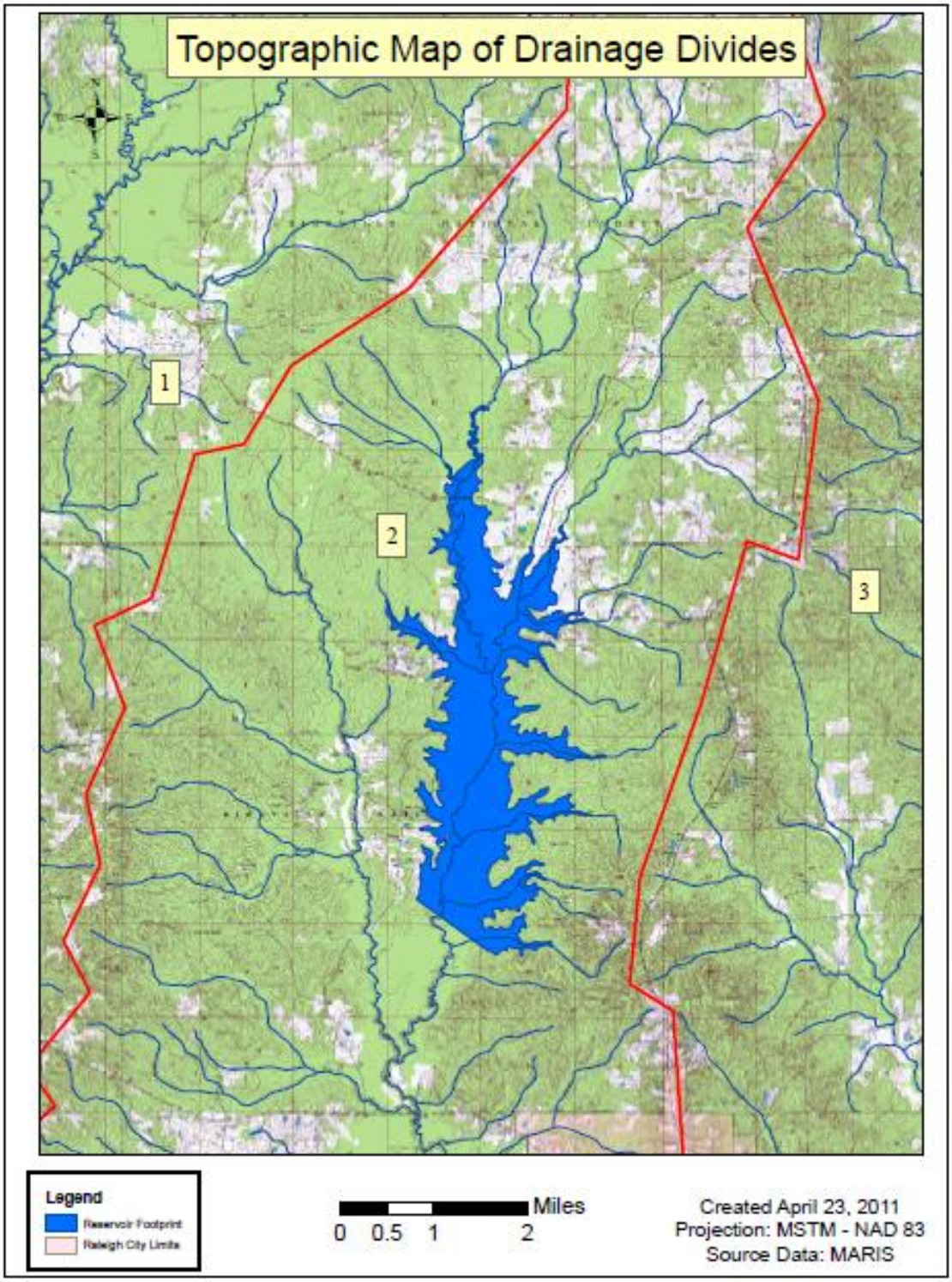


Figure 5 Topographic map of drainage divides

Geology

Figure 6 is a Mississippi Department of Environmental Quality map which depicts the surface geology of Mississippi. The surface geology of Smith County is pictorialized in Figure 7 while the surface geology of the study area is pictorialized in Figure 8. The surface geology represented in Figure 7 and Figure 8 is as follows: Hattiesburg Formation (light green), Catahoula Formation (brown), Vicksburg Group (blue), Forest Hill Formation (olive green), Jackson Group (light blue), and the reservoir footprint (grey). Ages of the surface geology are from the Neogene and Quaternary systems and from the upper Eocene, Oligocene, Miocene, Pleistocene, and Recent series. All of the surface geology are from sedimentary origin and are from both marine and non-marine environments due to sea level cycles of transgression and regression (Luper, 1972). Due to the sea level cycles the lithologies are wide ranging: clay, silt, sand, sandstone, marl, limestone, and siltstone. The following section on stratigraphy will provide additional information.

The surface geology exposed is lenticular in shape and does not provide a consistent bed for mapping exposed at the surface; therefore, the Glendon Limestone subsurface map was used in order to obtain a structural analysis of the study area (Luper, 1972). A subsurface structure map, Figure 9, of the top of the Glendon Limestone from the 1972 Mississippi Geological Survey Bulletin was scanned and overlaid onto a 1:24,000 USGS topographic map. The northern half of the reservoir is located where the Glendon Formation outcrops. The contour lines of the Glendon Limestone can be seen in the figure. By overlaying the topographic map and the historical Glendon Limestone map in ArcGIS 9.3.1 allowed the study area's dip to be estimated. The direction of dip is southwest to south with a dip of approximately 25 feet per mile. Glendon Limestone

strike was not determined from the map; however, the Moody's Branch Marl that underlies the Glendon Limestone has a regional strike of north 61° west in the central and northern part of Smith County (Luper, 1972). The Glendon Limestone map was obtained from electrical logs of test holes drilled by the Mississippi Geological Survey, core hole tests drilled by private industry and oil wells. Data used to map the Glendon Limestone also indicated there were no surface faults or shallow subsurface faults; however, deep subsurface faults do exist in Smith County (Luper, 1972). The study area was located south of the Pickens-Pollard Fault Zone. Two salt domes are present in Smith County but neither are within the footprint of the reservoir.

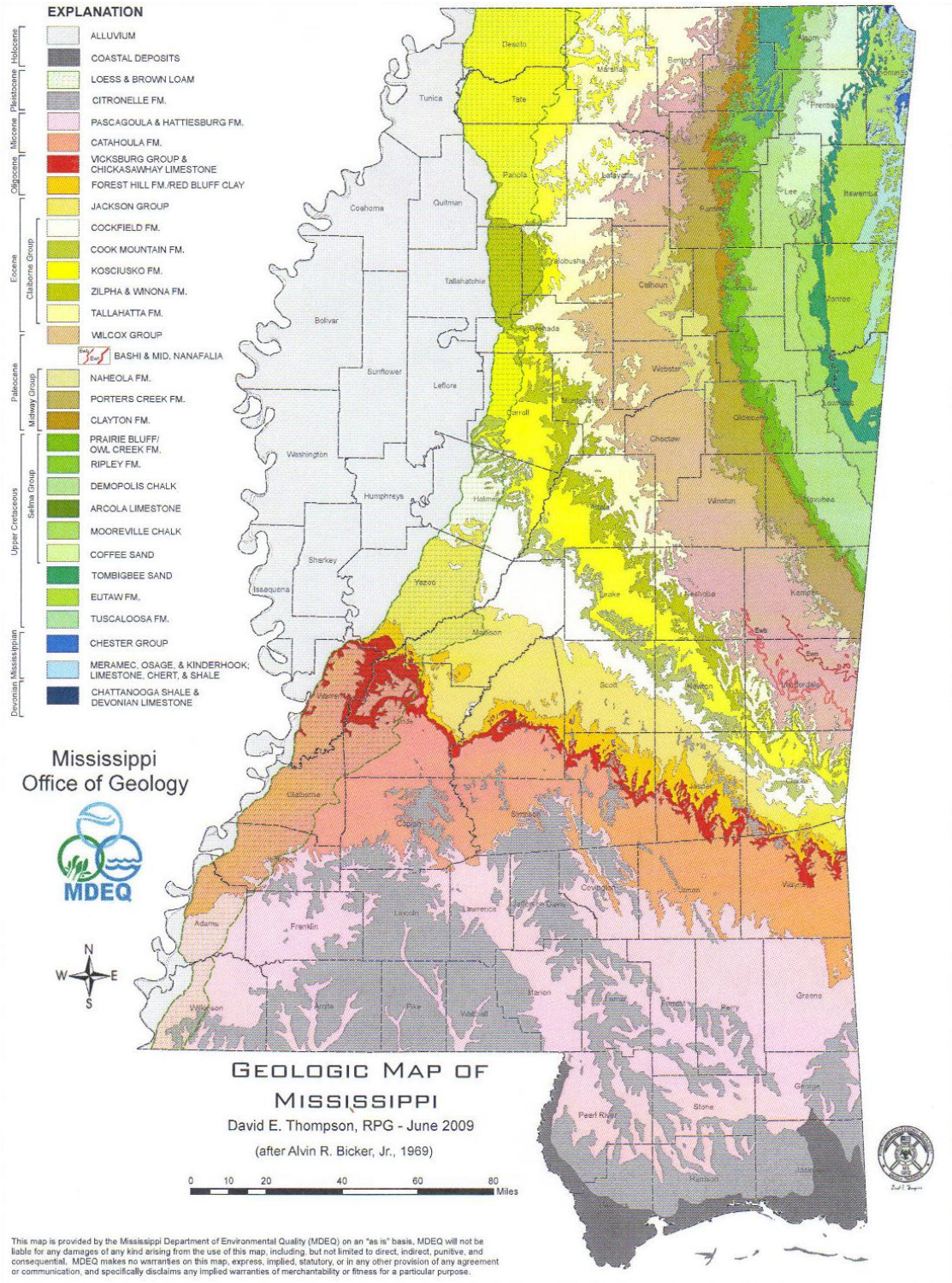


Figure 6 Surface geology map of Mississippi (MDEQ, 2011)

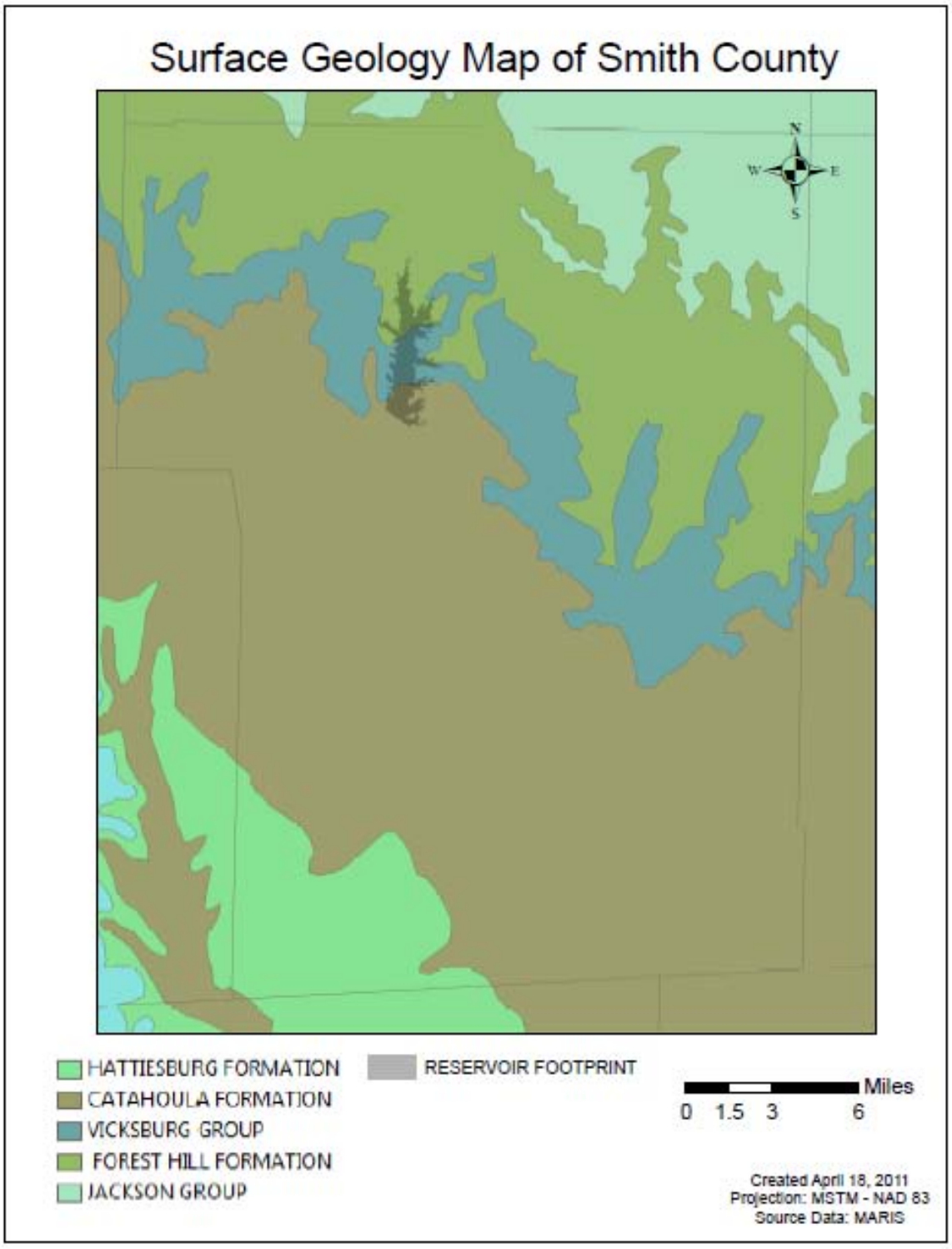


Figure 7 Surface geology map of Smith County, Mississippi

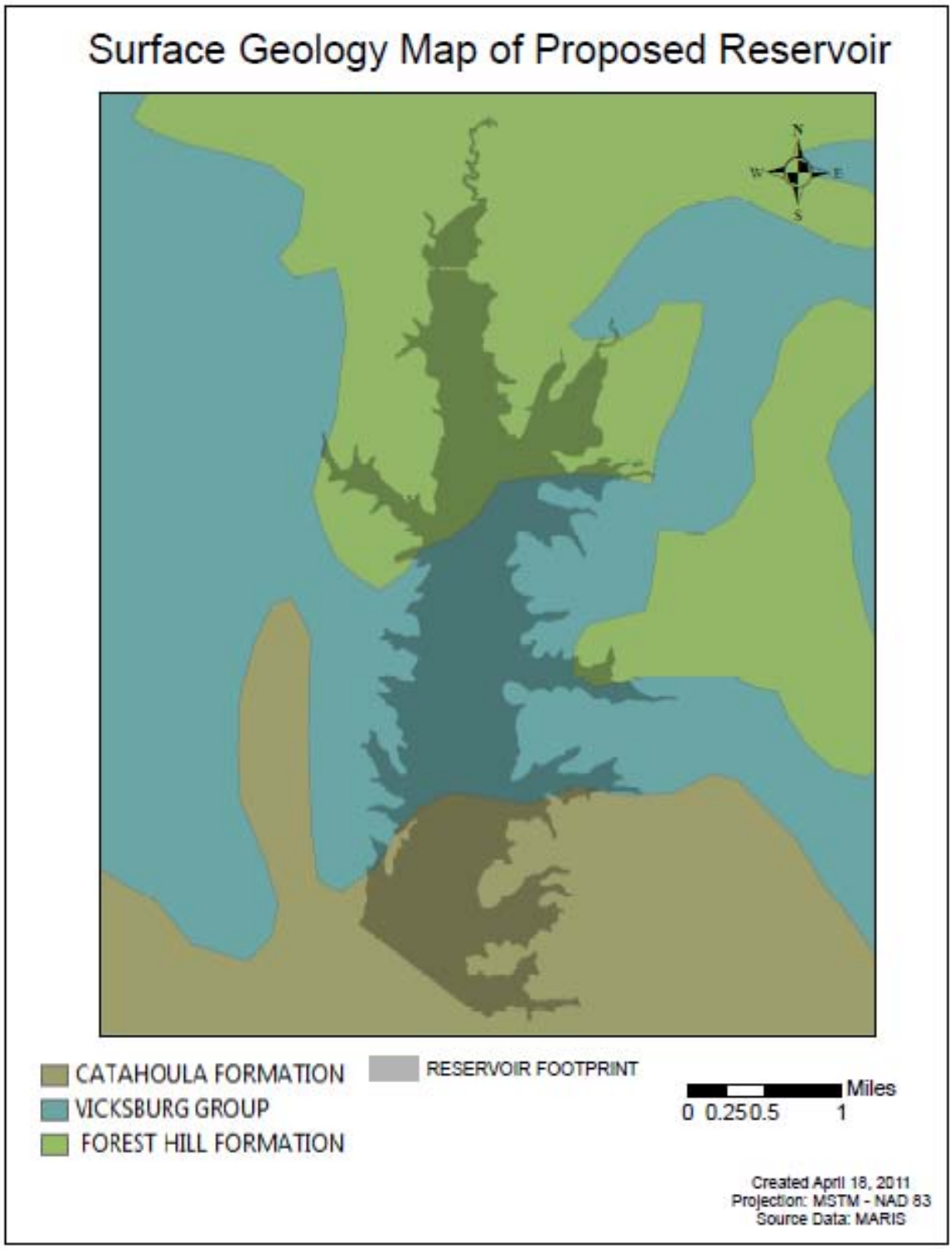


Figure 8 Surface geology map of the proposed reservoir

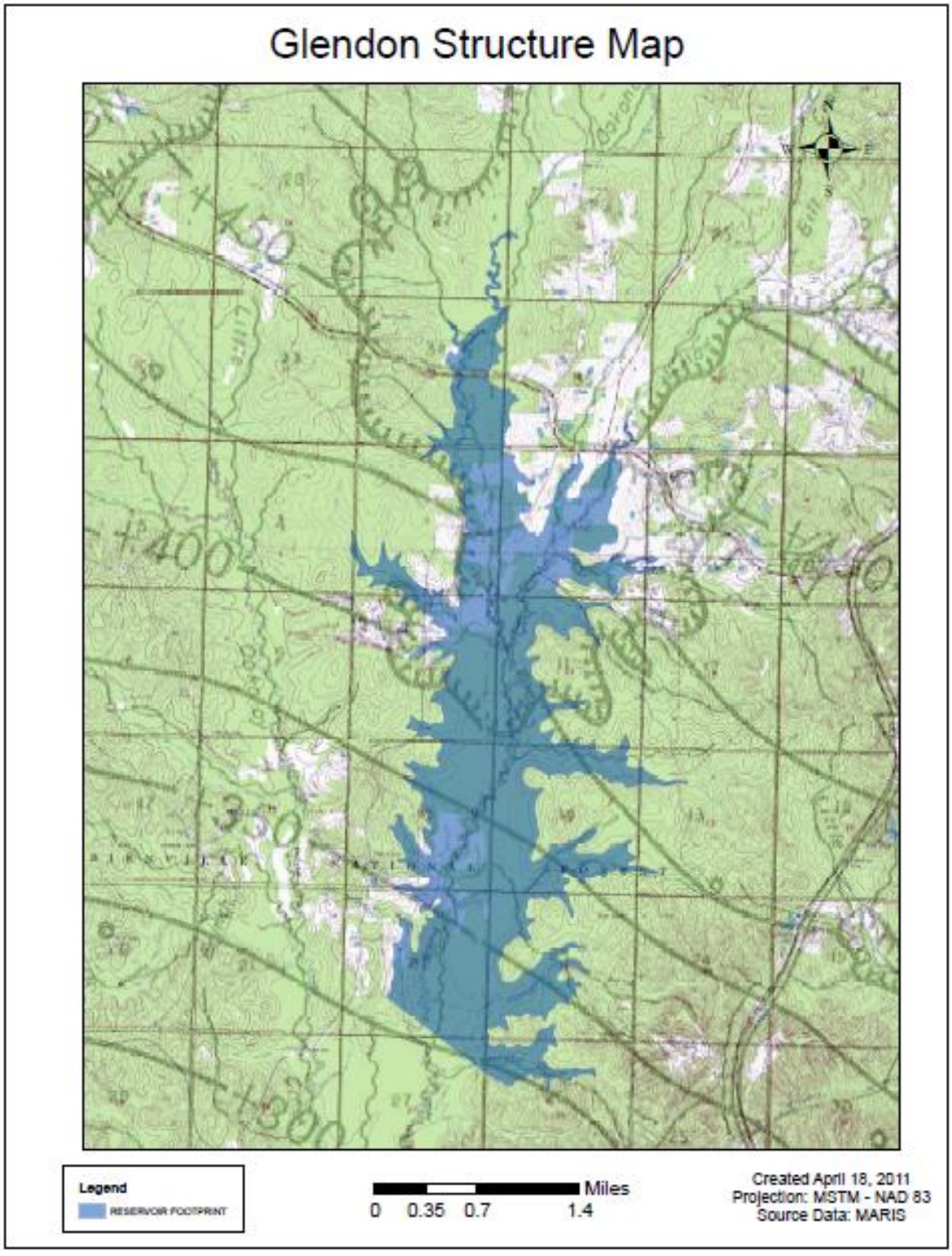


Figure 9 Glendon Limestone subsurface structure map with proposed reservoir

Stratigraphy

Exposed stratigraphic units in Smith County are shown in Table 2. All exposed strata are sedimentary deposits and range in age from the Eocene series to present day. The total amount of exposed strata in Smith County is approximately 1350 feet and the youngest strata are exposed in the southwestern section (Luper, 1972). Table 3 shows the strata ranging in age from oldest to youngest are: Yazoo Formation of the Eocene Series; the Forest Hill Formation of the Oligocene Series; the Vicksburg Group of the Oligocene Series; the Catahoula Formation of the Miocene Series; the Hattiesburg Formation of the Miocene Series; the Citronelle Formation of the Pleistocene Series; the terrace deposits of the Pleistocene Series; and the alluvium of the Holocene Series (Thornton, 2001; Luper 1972). Only the Vicksburg Group of the Oligocene Series and its bounding units were of concern in this study. Catahoula Formation of the Miocene Series is the upper bounding unit and the Forest Hill Formation of the Oligocene Series is the lower bounding unit.

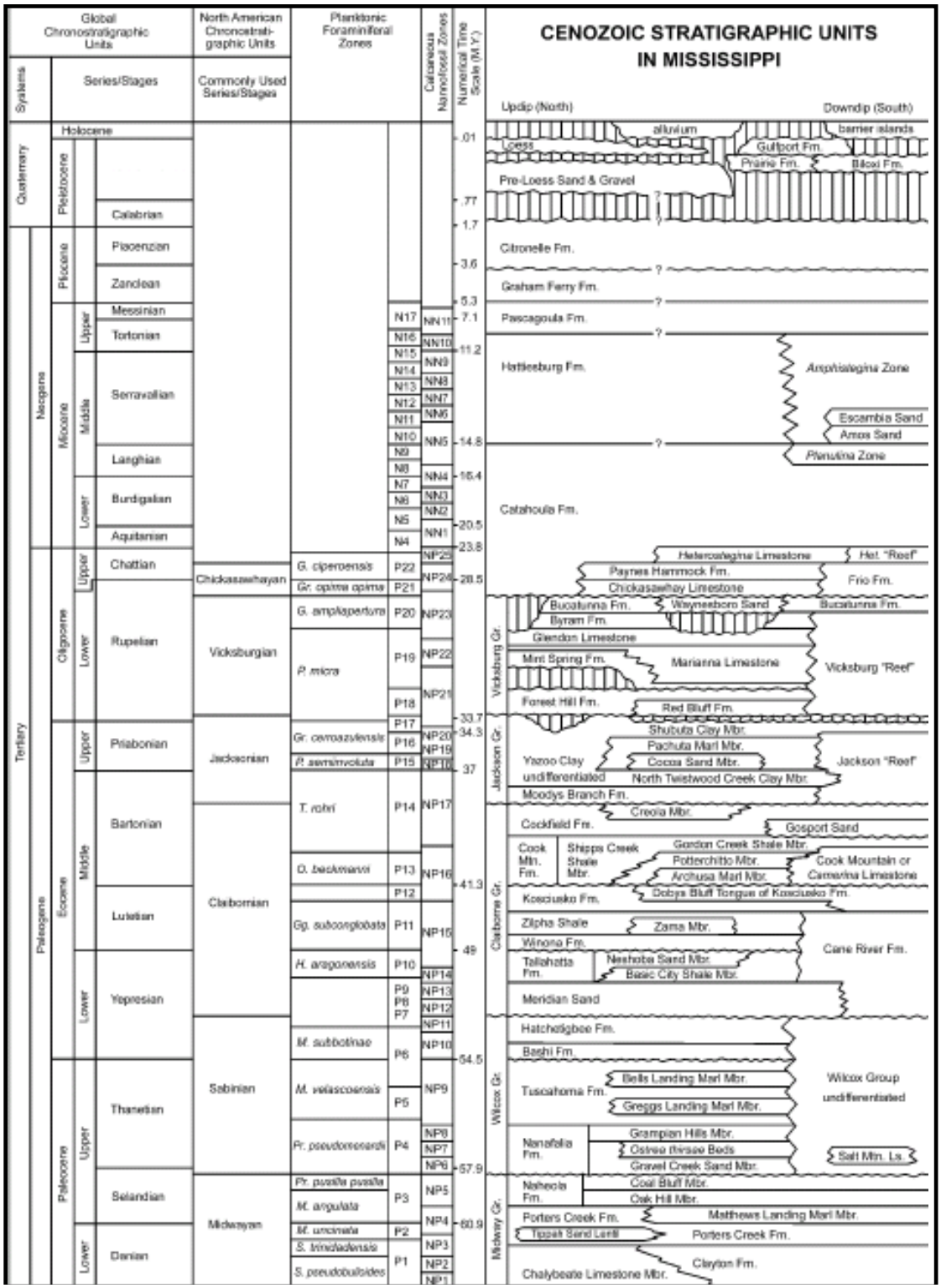
Forest Hill Formation of the Oligocene Series is the oldest unit in the study area and it outcrops in the northern portion of the reservoir footprint. Cooke proposed the name in 1918 to describe the unit above the Jackson Group and beneath the Vicksburg Group (Luper, 1972). The outcrop area runs in a general direction across the study area of northwest to southeast. Forest Hill outcrop sediments are weathered and consist of "fine-grained micaceous sand and silty clay with thin beds of lignite, lignitic sands, and carbonaceous clays" (Thornton, 2001). Lithologic character is described as "sand, gray to light-gray, fine-grained, silty, micaceous, clay, dark-gray, carbonaceous, silty, thin beds of lignite" (May 1974). The unit's lithology suggests a change from a lower high stand systems tract to an upper high stand system track with deltaic type depositions

(Tew and Mancini, 1992). The unit is overlain by the unconformable Vicksburg Group (Luper, 1972).

Table 2 Stratigraphy of exposed strata in Smith County (Luper, 1972)

SYSTEM	SERIES	GROUP	STRATIGRAPHIC UNIT	THICKNESS	LITHOLOGIC CHARACTER
QUATERNARY	RECENT		Alluvium	0–40′	Sand, fine- to coarse-grained, silt, clay, some organic material, gravel.
	PLEISTOCENE		Terrace deposits	0–158′	Sand, light-tan to buff, fine- to coarse-grained. Gravel, chert and quartz, with scattered clay lenses.
			Citronelle Formation	0–135′	Sand, red to reddish-orange, fine- to coarse-grained. Gravel, chert and quartz, with scattered clay lenses.
TERTIARY	MIOCENE		Hattiesburg Formation	Up to 90′	Clay, tan, gray to reddish-gray, sandy in part, abundant ferruginous concretions, minor amount of gray to tan, fine- to medium-grained sand.
			Catahoula Formation	Up to 550′	Sand, gray, tan to buff, kaolinitic, silty, locally indurated, forming sandstone, fine- to medium-grained. Clay, gray, buff to light-tan, maroon. Silt, light-gray, white to tan, kaolinitic, locally indurated.
	OLIGOCENE	VICKSBURG	Bucatunna Clay	24′–84′	Clay, dark-gray to black, micaceous, sparingly fossiliferous, silty, finely carbonaceous, chocolate-brown on outcrop.
			Byram Marl	5′–22′	Marl, greenish-gray, glauconitic, fossiliferous, clayey.
			Glendon Limestone	15′–59′	Limestone, gray to light-gray, fossiliferous, slightly sandy with alternating beds of gray, fossiliferous marl.
			Mint Spring Marl	5′–23′	Marl, greenish-gray, sandy to very sandy, glauconitic, fossiliferous, pyritic. Sand is medium- to coarse-grained.
			Forest Hill Formation	97′–164′	Sand, gray to light-gray, fine-grained, silty, micaceous. Clay, dark-gray, carbonaceous, silty, thin beds of lignite.
	EOCENE	JACKSON	Yazoo Formation	200′–329′	Clay, blue-gray to light-olive-gray, fossiliferous, calcareous, weathers to pale-orange and gray mottled color.

Table 3 Mississippi Office of Geology Stratigraphic Column (Dockery, 2008)



In 1848, Conrad, introduced the term Vicksburg Group. The Vicksburg group consists of four formations, all of which are placed in the Oligocene Series. This group outcrops across the middle portion of the reservoir and is comprised of four formations in order from oldest to youngest: Mint Spring, Glendon, Byram, and Bucatunna (Luper, 1972). The Glendon Limestone is the formation of concern in the study due to the potential for karst process that would affect the reservoir in a negative manner. The Vicksburg Group unconformably overlies the Forest Hill Formation and is known as a rock stratigraphic unit (Thornton, 2001).

Mint Spring is the oldest formation in this group and was named by C.W. Cooke in 1918 after an outcrop on Mint Spring Bayou in Vicksburg, Mississippi. This formation was deposited during a lower transgressive system tract and fines upwards. The upper parts of this formation vertically and laterally gradationally change into the Marianna Formation south of the study area (Tew and Mancini, 1992). Outcrops of this formation in Smith County are rare due to its thin bedding, averaging 12 feet. Weathered it is reddish-brown, sparsely glauconitic sand and in the subsurface it is "composed of greenish-gray, fossiliferous, glauconitic, pyritic, sandy marl and greenish-gray, fossiliferous, glauconitic, pyritic, sandy marl and greenish-gray, medium- to coarse-grained, glauconitic, fossiliferous sand" (Luper, 1972).

The Glendon Limestone was named from outcrops in Clarke County, Alabama by C.W. Cooke, 1917. Glendon Limestone in Smith County consists of hard limestone ledges with interbedded marl and soft limestone. This formation is described as "gray glauconitic arenaceous argillaceous and fossiliferous sediments (Luper, 1972). Glendon Limestone is indurated because it is usually cemented, fossiliferous packstone and grainstone; however, the marl is non-indurated because it consists of mudstones,

wackestones, and argillaceous marls. The Formation is believed, due to authigenic glauconite, to have been deposited during a high-system tract in a quiet marine setting with slow sedimentation rates. Interbedding of limestone and marl in the strata reflect regressive progradational highstand deposits of the depositional sequence. These deposits represent relative sea level drop after maximum transgression (Tew and Mancini, 1992). The Glendon Limestone is disconformable and is overlain by the Byram Marl.

The Byram Marl has a conformable relationship with the Glendon Limestone; therefore, sometimes the Glendon is referred to as part of the Byram Marl because it too can be a glauconitic limestone, overlain by an argillaceous limestone or marl (Galloway et. al, 1991). Byram Marl was deposited as part of the high-stand system tract and is categorized as a type 2 sequence boundary capping the Glendon Limestone (Tew and Mancini, 1992). At this time the rate of sea-level fall was less than the rate of basin subsidence. Byram Marl was named by T.L. Casey in 1902 after outcrops in Hinds County, Mississippi. This unit is described as a clay-marl, greenish-gray, glauconitic, and fossiliferous. Exposures of this unit are rare in the study area due to thin bedding, averaging 11 feet (Luper, 1972).

The Bucatunna Clay overlies the Byram Marl in a conformable manner. The Byram Marl is the youngest formation in the Vicksburg Group and it consists of "dark-gray to black micaceous sparingly fossiliferous silty finely carbonaceous clay to thin gray clayey fossiliferous marl beds near Raleigh" (Luper, 1972). B.W. Blanpied and others proposed the name for this unit in 1934. Outcrops of the Bucatunna Clay are rare in Smith County due to weathering (Luper, 1972).

A.C. Veatch in 1905 coined the name, Catahoula Formation, from the outcrops in Catahoula Parish, Louisiana. The contact between the Byram Marl and the Catahoula Formation is unconformable and part of the Miocene Series (Luper, 1972). However, some dispute this statement and place the Catahoula Formation as part of the Oligocene Series. This dispute is due to the formation containing no age-diagnostic fossils (Tew, 1992). The Catahoula Formation outcrops in the southern portion of the study area and is defined by the sediments found above the Vicksburg Group and below the Hattiesburg Formation. The Hattiesburg Formation is only present in the southwestern segment of the County; therefore, it is not present in the study area. The Catahoula Formation has a high degree of induration in outcrops due to kaolinization of clays and surficial weathering (Li and Meylan, 1994). These sandstones are friable and unconsolidated in the subsurface (Luper, 1972). The Catahoula Formation is fluvial in origin and composed of sand, silt, kaolinite clay, with interbedded layers of sandstone (Li and Meylan, 1994). "The sands are gray tan to buff fine- to medium-grained kaolinitic and silty. The clays are gray buff tan and maroon in color locally lignitic and micaceous. The silt and siltstones are light-gray white to tan and sandy in places" (Luper, 1972).

The Citronelle Formation of the Pleistocene Series, the terrace deposits of the Pleistocene Series and alluvium deposits from recent times cover much of the outcropping Catahoula Formation in the streams. Citronelle Formation consists of fine to coarse grained sand, chert and quartz gravels with lenses of clay (Thornton, 2001). The terrace deposits name was given to deposits that differ from the Citronelle Formation. They are primarily found above the 400 foot contour mark and are comprised of sand, gravel, and clays lenses. Alluvium deposits of the Quaternary System are extensively found on lowland areas such as former flood plains and stream terraces (Thornton, 2001;

Luper, 1972). Figure 10, modified from Li and Meylan, 1994 shows how erosion causes sedimentary depositions in the streams and lowland areas. The figure is not to scale.

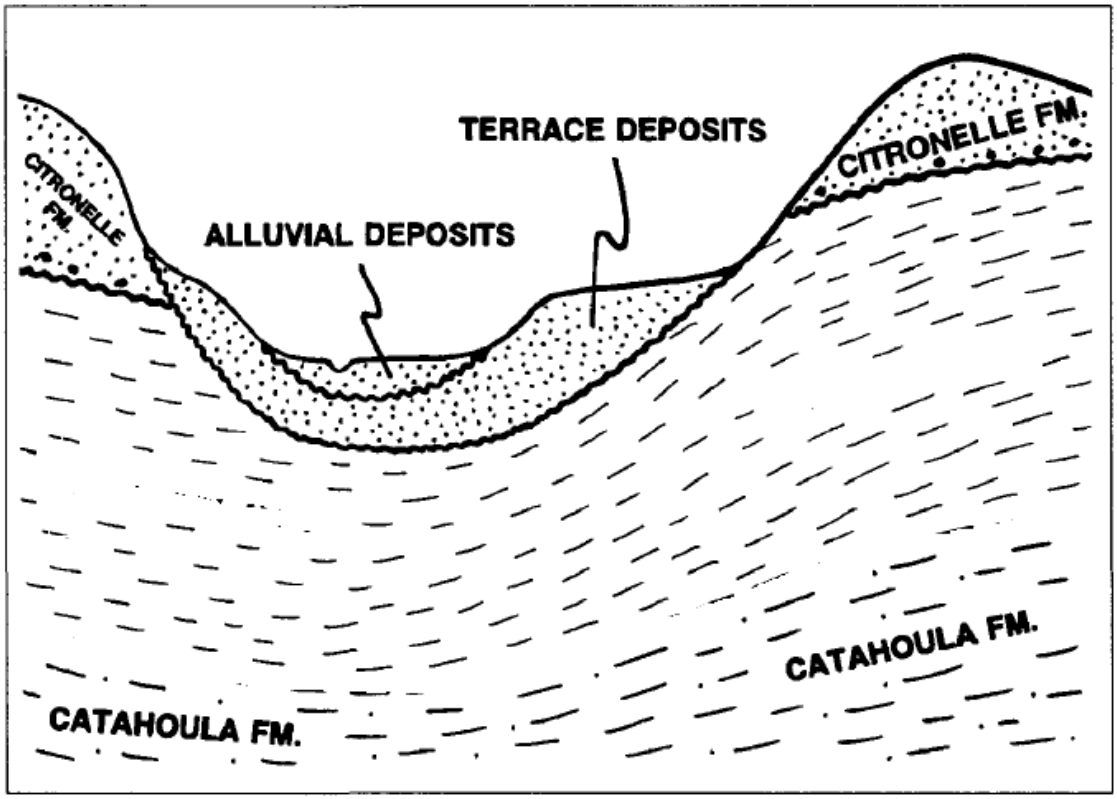


Figure 10 Schematic cross section of erosional deposits

Soils

A custom resource soil report was generated using the United States Department of Agriculture, Natural Resource Conservation Service, Web Soil Survey. An area of interest was selected using the Web Soil Survey. The area of interest selected generally matches the basic shape and location of the proposed reservoir. Figure 11 defines the area of interest for the soil report. Figure 12 is the legend for the area of interest. Table 4 lists the results for the area of interest. Five major soils in the area of interest are Boswell

loam, Kirkville fine sandy loam, Savannah fine sandy loam, Stough fine sandy loam, and Trebloc fine loam (USDA, 2011).

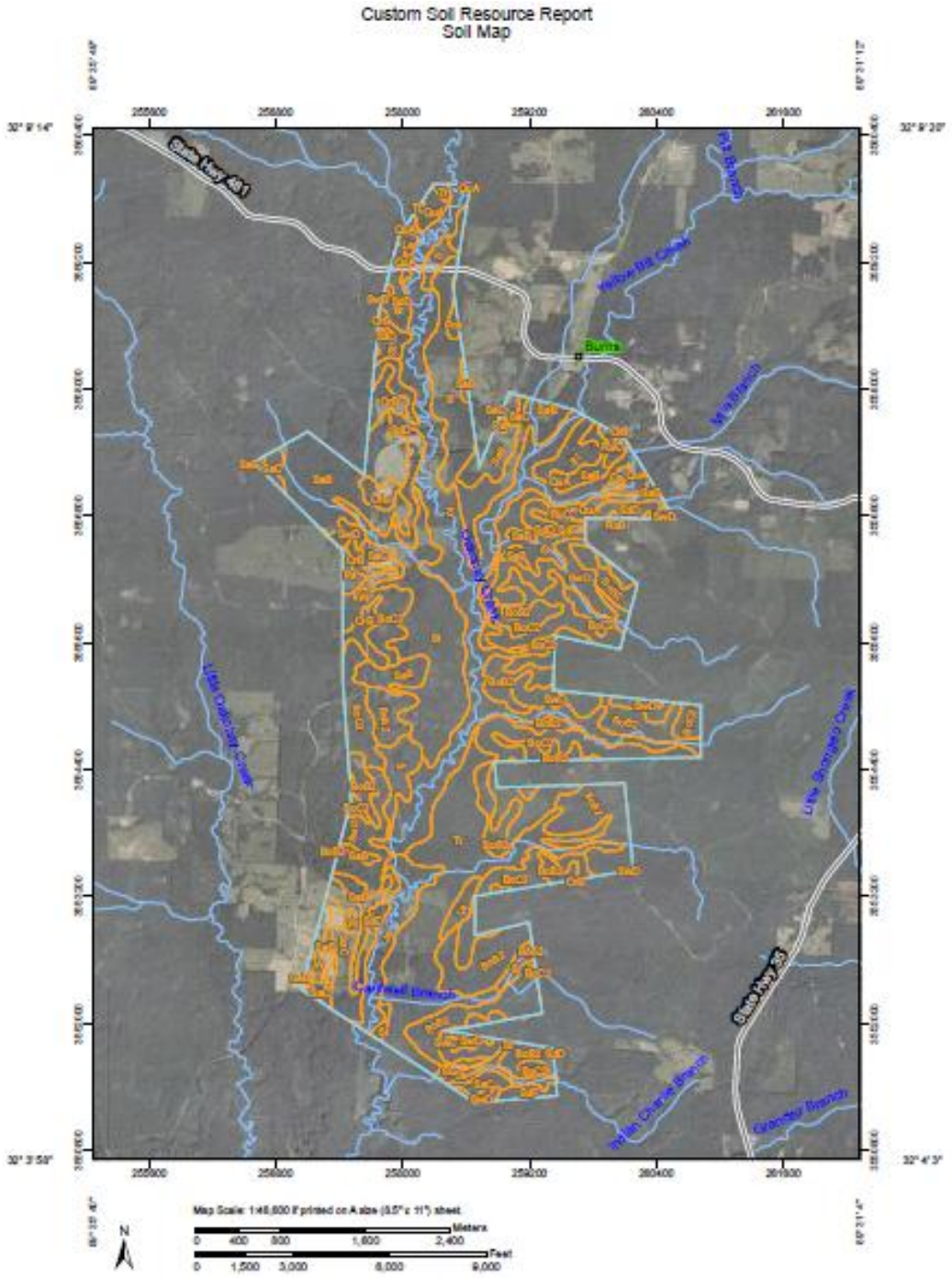


Figure 11 Area of interest

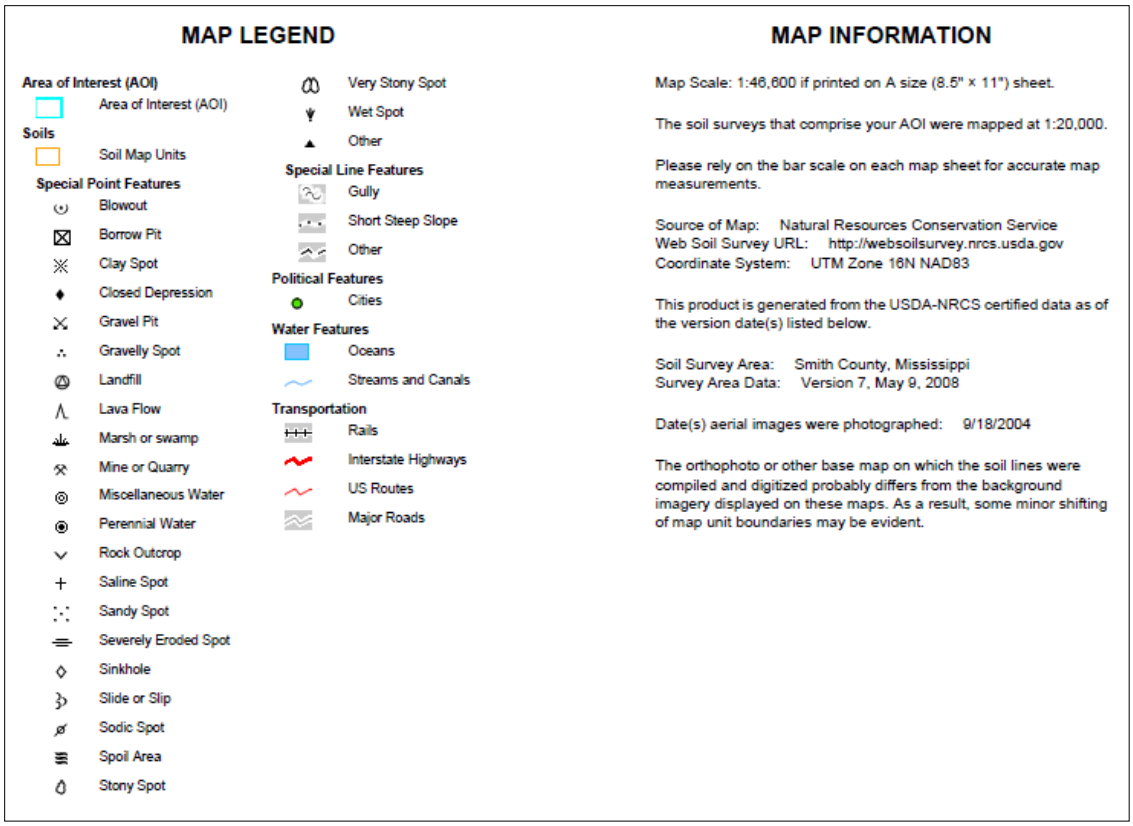


Figure 12 Legend for the area of interest

Table 4 Results for the area of interest

Smith County, Mississippi (MS129)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
BoB2	Boswell loam, 2 to 5 percent slopes, eroded	681.9	16.4%
BoC2	Boswell loam, 5 to 8 percent slopes, eroded	449.6	10.8%
Ca	Cahaba fine sandy loam, 0 to 2 percent slopes	4.8	0.1%
Je	Jena fine sandy loam, occasionally flooded	98.7	2.4%
Kr	Kirkville fine sandy loam, occasionally flooded	572.2	13.8%
Le	Leeper clay loam, occasionally flooded	26.6	0.6%
OrB	Ora fine sandy loam, 2 to 5 percent slopes	86.4	2.1%
Pa	Pits-Udorthents complex	15.5	0.4%
PrA	Prentiss fine sandy loam, 0 to 2 percent slopes	7.2	0.2%
QuA	Quitman fine sandy loam, 0 to 2 percent slopes, occasionally flooded	64.8	1.6%
RuB	Ruston fine sandy loam, 2 to 5 percent slopes	2.5	0.1%
RuC	Ruston fine sandy loam, 5 to 8 percent slopes	21.1	0.5%
SaB	Savannah fine sandy loam, 2 to 5 percent slopes	393.4	9.5%
SaC	Savannah fine sandy loam, 5 to 8 percent slopes	146.8	3.5%
SdD	Smithdale fine sandy loam, 8 to 15 percent slopes	160.3	3.9%
SdF	Smithdale fine sandy loam, 15 to 35 percent slopes	22.1	0.5%
St	Stough fine sandy loam, 0 to 2 percent slopes, occasionally flooded	655.8	15.8%
SwB	Sweatman fine sandy loam, 2 to 5 percent slopes	2.9	0.1%
SwC	Sweatman fine sandy loam, 5 to 8 percent slopes	8.1	0.2%
SwD	Sweatman fine sandy loam, 8 to 15 percent slopes	274.1	6.6%
Tr	Trebloc silt loam, frequently flooded	449.2	10.8%
W	Water	12.0	0.3%
Totals for Area of Interest		**4,156.0**	**100.0%**

CHAPTER III

LITERATURE REVIEW

The research for the study focused on hydrology and geology at the location for the Oakohay Creek proposed reservoir. More specifically the study focused on the quantity of water available for impoundment and the ability of the impounded area to retain water. Previous hydrologic and geologic studies have been performed locally as well as in other locations in the southeastern United States. The study at hand focused around previous research conducted by McIlwain (2007). The previous study investigated the same proposed reservoir location's hydrologic, geologic, and water quality conditions.

Hydrology

Boswell (1970) investigated water resources in Smith County as well as surrounding counties. Luper (1972) provided information about hydrology in Smith County, Mississippi. The reservoir hydrologic budget equation was proposed by the U.S. Department of the Interior, Bureau of Reclamation (1985). The equation stated: change in total storage = precipitation – evapotranspiration + or – runoff + or – underflow. Domenico and Schwartz (1990) provide technical expertise on groundwater and surface water interactions before and after the impoundment is created. T.C. Winter and others have researched the interaction of surface water and groundwater. The majority of research was conducted in the northern United States (Winter and others, 2000; Winter and others, 1998; Mau and Winter, 1997, Winter and others, 1988; Winter and Carr,

1984; and Winter, 1980, Winter, 1976). Topography, geology, hydrogeologic properties, precipitation, and groundwater flow affect the interaction processes present within a basin (Cey and others, 1998). Deming (2002) created a graphic representation of groundwater and surface water relations. Also, Deming (2002) discussed the use of Hydrographs to represent stream discharge over time. Schmitz and others (2004; 2005) presented a report to Pickering and Associates with climatological water budgets, and chemical and physical properties of the McCurtain Creek Watershed in Choctaw County, Mississippi. Rawlings (2005) published a master's thesis for a proposed reservoir that included information about research methods for studying hydrology and geology in Choctaw County, Mississippi.

Geology

Cooke (1918) published research that was conducted in Mississippi and Alabama on the Glendon Formation and the units that are contained within including the Mint Spring, Marianna, and Byram. MacNeil (1944) published information on the Oligocene stratigraphy of the southeastern United States. Luper (1972) provided geological information about Smith County through field reconnaissance and soil borings. Hazel (1980) recategorized the Glendon Limestone Member of the Byram Marl to the Glendon Formation of the Vicksburg Group. White (1988) created a graphic representation of carrying capacity of generalized evolving underground drainage system with a hydrograph. Also, White (1988) discussed hydrogeochemistry and the reaction of water, calcite, and carbon dioxide. Tew (1992) researched the indurated and non-indurated alternating beds of the Glendon Formation. Huddleston (1993) observed differences in the Glendon Formation from Georgia to the Mississippi River. Water quality standards

for Mississippi were published by the Mississippi Department of Environmental Quality (MDEQ) Office of Pollution (2007). The numerical data for water quality standards and exceedances are provided in tables 5 and 6. MDEQ (2000) provided water quality assessment of three reservoirs in Smith County.

Table 5 State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters: Recreation Standards

Parameter	Minimum	Maximum	Monthly Average/Mean
Fecal Coliform	-	400/100mL more than 10% of the time.	Mean of 200/100mL based on a minimum of 5 samples over 30-days with no less than 12 hours between individual samples.
Specific Conductance	-	1,000 µmhos/cm	-
Temperature	-	90°F	-
Dissolved Soilds	-	1,500mg/L	750mg/L
pH	6.0 s.u.	9.0 s.u.	-
Dissolved Oxygen	4 mg/L	-	5 mg/L

Table 6 State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters (MDEQ, 2007): All Waters

Parameter	Fresh Water		Human Health (µg/L)	
	Acute (µg/L)	Chronic (µg/L)	Water & Organisms	Organisms Only
Aldrin	3.0		0.00013	0.00014
Ammonia	[g]	[g]	-	-
Arsenic (III), Total Dissolved	340 [f]	150 [f]	-	-
Arsenic, Total Dissolved			0.078 [i]	24
Cadmium, Total Dissolved	1.03 [b,f]	0.15 [b,f]	5	168
Chlordane	2.4	0.0043	0.0021	0.0022
Chlorine	19	11	-	-
Chromium (Hex), Total Dissolved	16 [f]	11 [f]	98	1470
Chromium (III), Total Dissolved	323 [b,f]	42 [b,f]	100	140468
Copper, Total Dissolved	7.0 [b,f]	5.0 [b,f]	1000	1000
Cyanide	22.0	5.2	200	220000
4,4 DDT	1.1	0.001	0.00059	0.00059
Dieldrin	0.24	0.056	0.000135	0.000144
2,3,7,8 TCDD (Dioxin)			1.0 ppq [d]	1.ppq [d]
alpha-Endolsulfan	0.22 [j]	0.056 [j]	110 [k]	240 [k]
beta-Endosulfan	0.22 [j]	0.056 [j]	110 [k]	240 [k]
Endosulfan Sulfate	0.22 [j]	0.056 [j]	110 [k]	240 [k]
Endrin	0.086	0.036	0.76	.814
Heptachlor	0.52	0.0038	0.000208	0.000214
gamma-BHC (Lindane)	0.95	0.08	0.0186	0.0625
Lead, Total Dissolved	30 [b,f]	1.18 [b,f]	15	-
Mercury (II), Total Dissolved	2.1 [f]	0.012	-	-
Mercury			0.151	0.153

Table 6 (continued)

Nickel, Total Dissolved	260 [b,f]	29 [b,f]	607	4584
Phenol	300	102	300	300
Pentachlorophenol	8.7	6.7	0.28	8.2
PCB 1242	0.2	0.014	-	
PCB 1254	0.2	0.014	-	
PCB 1221	0.2	0.014	-	
PCB 1232	0.2	0.014	-	
PCB 1248	0.2	0.014	-	
PCB 1260	0.2	0.014	-	
PCB 1016	0.2	0.014		
Total PCB	-	-	0.00035	0.00035
Selenium, Total Dissolved	11.8 a,[f]	4.6 [f]	50	3365
Silver, Total Dissolved	0.98 [b,f]	-	100	-
Toxaphene	0.73	0.0002	0.00073	0.00075
Zinc, Total Dissolved	65 [b,f]	65 [b,f]	5000	5000

[b] Hardness dependent parameter. Criteria are indicated at hardness of 50 mg/l as CaCO3.
Equations for criteria calculation of hardness dependent parameters can be found in *Quality Criteria for Water*. The equation is applicable for instream hardness ranges from 25 mg/l to 400 mg/l. If instream hardness is less than 25 mg/l, then a hardness value of 25 mg/l should be used to calculate the criteria. If instream hardness is greater than 400 mg/l, then a hardness of 400 mg/l should be used to calculate the criteria.

[d] Criteria for 2,3,7,8 TCDD based on a risk factor of one in one hundred thousand (10-5).

[f] Parameter subject to water effects ratio equations where:
CMC = WER * Acute
CCC = WER * Chronic

[g] Ammonia criteria are dependent on pH, temperature, and/or salinity

[i] Refers to the inorganic form only.

[j] Applies to the sum of α and β isomers.

[k] Applies to individual isomers of Endosulfan including α, β, and Endosulfan Sulfate.

CHAPTER IV

STATEMENT OF PROBLEM

The United States Forest Service desires to build a surface water reservoir by constructing a dam to impound water from Oakohay Creek. Due to the proposed reservoir location two areas of concern arise. The concerns are hydrology and geology. (1) The reservoir will be designed to maintain a full pool water level at the 400 foot contour interval. There is concern about whether or not the creek could supply the quantity of water needed to maintain the proposed reservoir's water level. The influent water source for the reservoir, Oakohay Creek, is approximately a zero baseflow stream. Baseflow is seasonal flow from the sum of deep and shallow subsurface flow. (2) The proposed reservoir footprint area would include a formation known as the Glendon Limestone. The Glendon Limestone could pose to be a problem for reservoir water retention if karst processes have formed features where water loss would occur. Three potential negative scenarios are: connected conduits in the Glendon Formation would never allow the reservoir to reach full pool, dissolution at the dam site causing dam failure, or increased pressure head changes in the reservoir causing sediment filled conduits to blow out, with flow bypassing the dam.

Hypothesis

The proposed site location on Oakohay Creek, Smith County, Mississippi is not suitable for the development of a surface water reservoir based on the outcome of the daily water storage models and the condition of the limestone in the Glendon Formation.

Objectives

The study focuses on the two reasons why the proposed reservoir location was deemed not suitable in a previous study. The two objectives of the study were to reinvestigate the hydrology and geology of the proposed reservoir. The objectives will study the problem through (1) developing daily water storage models for the proposed reservoir and (2) studying the limestone in the Glendon Formation using a variety of investigative techniques.

CHAPTER V

METHODOLOGY

Investigation Overview

The two objectives of the study were to evaluate the proposed reservoir's hydrology and geology. The first objective, hydrologic study, was accomplished by developing daily water storage models for the proposed reservoir. Several different historical evaporation and precipitation data were used in the models. Software used to complete this objective included ArcGIS 9.3.1 with Spatial Analyst capabilities and Microsoft Excel (Figure 13). The second objective was accomplished through a geologic study which focused on the Glendon Limestone within the reservoir footprint area. Investigative techniques used on the Glendon Limestone include: field surveys, ground penetrating radar, and sonic rig drilling. Data from surface water quantity measurements and surface water quality analysis of Oakohay Creek, Little Oakohay Creek, and Shongelo Creek, as well as ArcGIS 9.3.1 and Microsoft Excel, were used to complete this objective. A dedicated stream water level indicator and rain gauge were installed along the banks of Oakohay Creek to assist with stream monitoring. Global Positioning System (GPS) waypoints were taken with a Garmin eTrex handheld GPS device. Latitudinal and longitudinal coordinates as well as all other field data were recorded in the USFS Smith County Reservoir "Rite in the Rain" field book. The results from the objectives suggest that the proposed site location is suitable for reservoir development.

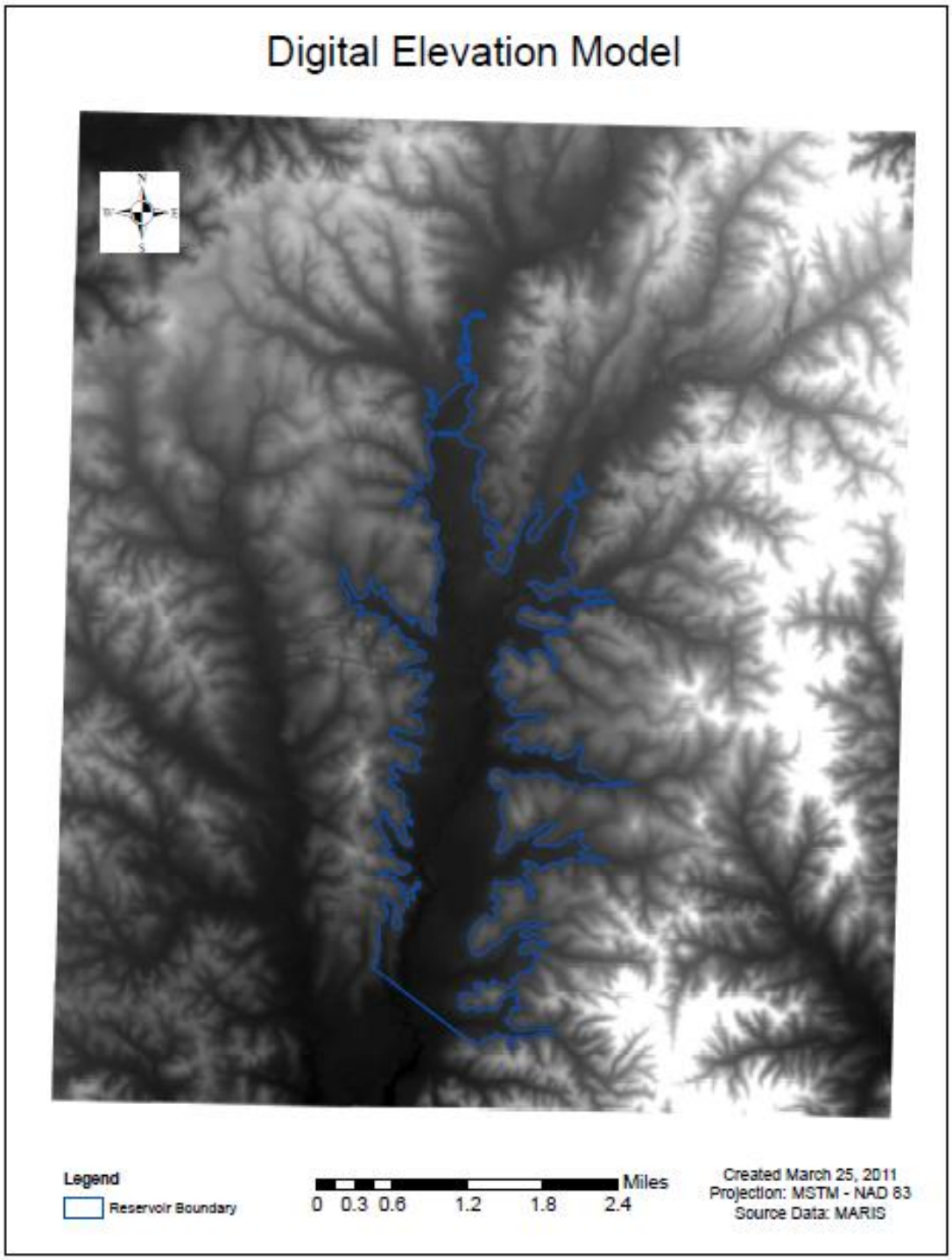


Figure 13 DEM for proposed reservoir

Reservoir Daily Water Storage Models

The hydrologic study had three parts: creation of a digital elevation map (DEM) using ArcGIS 9.3.1. with Spatial Analyst, collecting historical data, and creation of reservoir daily water storage models. An ArcGIS 9.3.1 DEM was utilized to calculate the proposed reservoir volume. Data from the Mississippi Automated Resource Information System (MARIS) was used for DEM data. The cubic meters measurement produced by the DEM was converted into acre-feet for use in the models. The drainage basin area, not including the reservoir footprint area, was also calculated in acres.

Historical evaporation and precipitation data from 1961-2002 were obtained by Mississippi State University personnel from the Southern Regional Climate Center. All values were in Julian calendar form. Evaporation data (coefficient 0.8) from Starkville, Mississippi and precipitation data from White Oak, Mississippi weather stations were used. These locations were selected for evaporation and precipitation data because of their proximity to the proposed reservoir and their quantity and quality of data. The evaporation data had zero missing data points. The precipitation data had 141 missing data points out of 14,965; however, data from the Mize and Raleigh weather stations were used to fill in 74 missing data points. Therefore, data missing from the precipitation record equaled less than 0.5 percent. Missing data were given a value of zero. Three different precipitation data sets were created from the 1961-2002 data. The first data set used the highest precipitation year (1973), the second data set used the lowest precipitation year (1963), and the third data set used an average of all 42 years (1961-2002). The data sets were used in reservoir daily water storage models.

Microsoft Excel was the software used in the development of the daily water storage models for the proposed reservoir from historical data. The models start with the

reservoir at full pool status which is equivalent to 129,100 acre-feet of water or a water elevation of 400 feet above sea level. The models had nine columns for data. The first column contained the day of the year in Julian calendar with the February 29th date removed due to leap year. The second column contained the historical data. The historical precipitation data and historical evaporation data for each correlating date were subtracted from one another. This was done for the 1963, 1973, and 1961-2002 data sets. For example, January 1, 1961 precipitation data were subtracted from January 1, 1961 evaporation data to equal the total amount of precipitation available for runoff or infiltration. The third column multiplied the value from column two by a conversion factor of 224 to convert the value in column two to represent the amount of water in acre-feet the reservoir footprint would directly receive. The 224 number was derived from dividing the total reservoir storage area 2,689 acres by 12 inches. The fourth column multiplied the value from column two by a conversion factor of 1600 to convert the value in column two to represent the amount of water in acre-feet the reservoir footprint would directly receive. The 1600 number was derived from subtracting the total reservoir storage area (2,689 acres) from the total basin storage area (21,890 acres) and then dividing the product by 12 inches to get the total amount of water in acre-feet the basin would indirectly receive excluding the lake footprint. Indirectly received water is runoff water. The value from the total amount of water in acre-feet the basin would indirectly receive excluding the lake footprint was then multiplied by a coefficient of 0.6 which represented the percentage amount of runoff water that would be impounded by the reservoir. The runoff value of 0.6 was given due to the site locations soil characteristics, slope, urban development, and vegetative cover. Glenn Schwab and others (1996) book, *Soil and Water Management Systems* was used as a reference. If the final value in

column four was less than zero then the value in column four was equal to zero. The fifth column, baseflow, was assumed as zero for all models. The sixth column, infiltration, was the amount of water that would be lost inside the reservoir footprint area due to seepage. Based on the soil type a value of 0.0023 feet per day was used. The seventh column, outflow, was the amount of water the reservoir would have to discharge to supply the downstream portion of Oakohay Creek below the dam. A value of five cubic feet per second or 10 acre-feet per day was given to this column because the requirements set forth by the Core of Engineers are not expected to exceed 5 cubic feet per second. The eighth column, withdrawal, was the amount of water taken from the reservoir due to commercial activities. A value zero was assumed due to no known commercial activities in the area. The ninth column had an equation imbedded into it at which the reservoir volume in acre-feet was added to by columns three, four, and five and subtracted from by columns six, seven, and eight. The outcome of this equation was the daily water storage volume of the reservoir. An example of the headers for each column is shown below, Table 7. The daily water storage volume of the lake was displayed in a line graph. Storage in acre-feet was the y-axis and days of the year were the x-axis. The model was designed for further manipulations to be made once parameters such as infiltration, outflow, and withdrawal for the reservoir are in place.

Table 7 Headers for columns in reservoir daily water storage models

Day	Daily Avg P-E (Inches)	Clim-lake (P-E*224) (A-F)	Clim-basin P-E*1600*0.6 (A-F)	Baseflow 0 cfs (A-F)	Infiltration .0023ft/day (A-F)	Outflow 10 A-F/day (A-F)	Withdrawal 0 mgd (A-F)	Daily storage (A-F)

Evaluation of the Glendon Limestone

Field Surveys

There were five parts to the objective: field surveys, ground penetrating radar, sonic rig drilling, water quantity measurements, and water quality analysis. The field surveys consisted of locating and observing outcrops and were conducted by personnel from Pickering Firm (Jackson, MS) and Mississippi State University (Starkville, MS). Geologic and topographic maps were used to locate potential features of interest. The majority of the work was conducted within the reservoir footprint area. Outcrops and potential karst features within and in the vicinity of the proposed reservoir footprint were located in the field. Observations and GPS data were recorded in a table. Figure 14 is a photograph of a field team during an investigation.

Figure 14 Field survey team and reconnaissance vehicle

Ground Penetrating Radar

Ground penetrating radar (GPR) was conducted by TeaCo Geophysical (Utica, MS) at two locations that had a high probability of having subsurface karst features. Personnel from Pickering Firm and Mississippi State University were present during the surveys. The Batte and James Taylor properties were found during the field survey by Pickering Firm. The goal of this objective was to characterize the subsurface state of the Glendon Limestone. Figure 15 shows equipment that was used in the study: 50MHz (not shown), 100MHz, and 250MHz antennas, pulse EKKO Pro system sensors and software, smart kart, and an integrated Novatel Differential Global Positioning System (DGPS) unit. The DGPS collected point data on every 10^{th} trace and was accurate up to one meter. Figure 16 shows the locations of where GPR was performed in relation to the proposed reservoir.

Figure 15 GPR system, 100MHz and 250MHz antennas, and DGPS

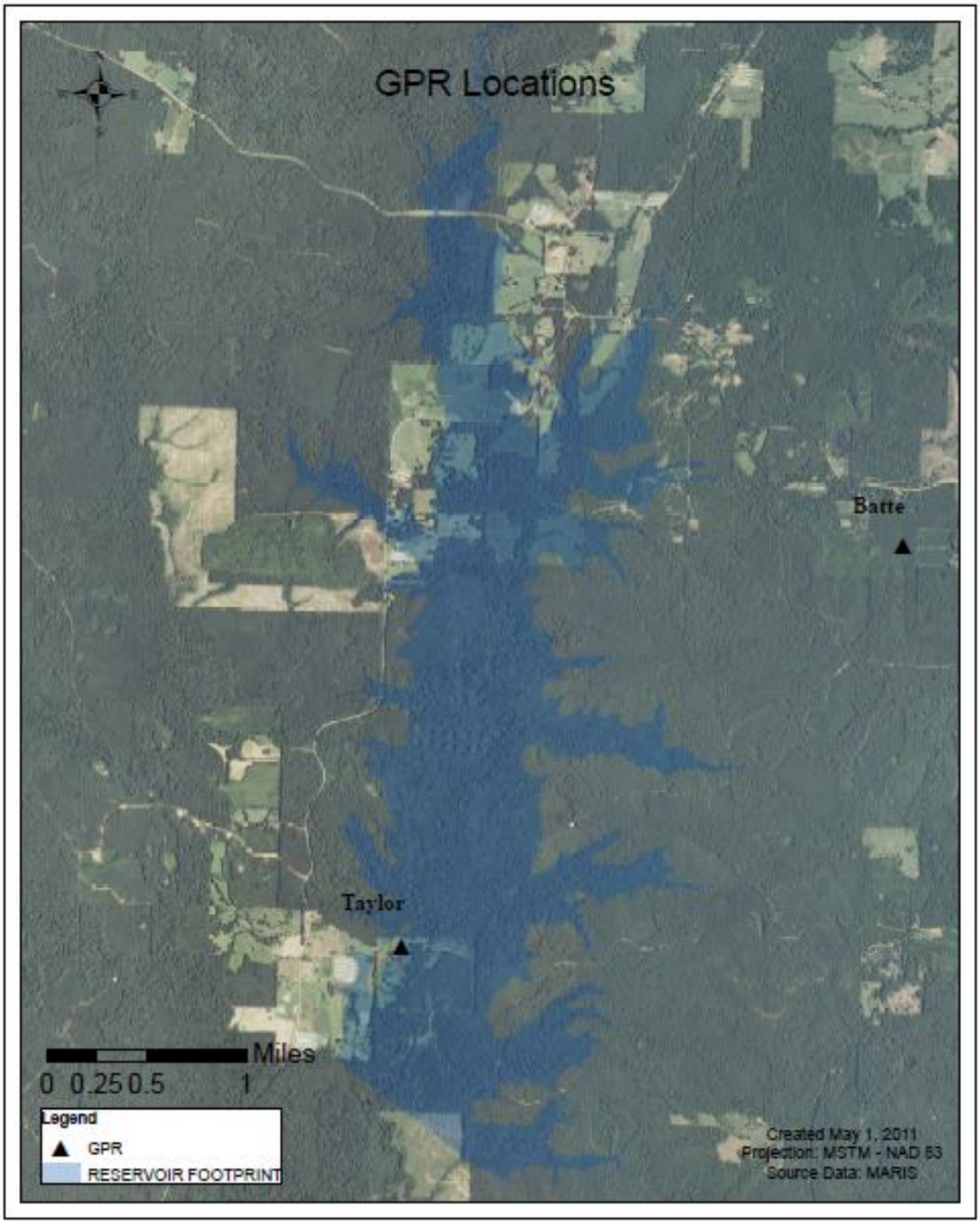


Figure 16 Aerial map for GPR work relative to proposed reservoir

Sonic Rig Drilling

Sonic rig drilling was performed on the west side of the study area to validate the GPR work, investigate previous boreholes drilled by Burns Cooley Dennis, Incorporated during the McIlwain study, and investigate areas Tellus Operating Group had reported blind holes at during a 2005 - 2006 seismic study. Sample collection of subsurface geologic material was performed by Walker-Hill Environmental (Foxworth, MS) through the use of a 2009 Sonic Drill – SDC – 450 – 14, Figure 17. Representatives from Mississippi State University and Pickering Firm were present during the drilling. Official core logging records were created by Pickering Firm. Borings that experienced loss of circulation had a 4 inch PVC pipe inserted into them. Bishops High Velocity Drain Service (Pearl, MS) used a down hole digital video camera to investigate the reason for the loss of circulation.

Figure 17 Sonic drill rig mobilizing for a new boring

Surface Water Quantity Measurements

Mississippi State University personnel collected surface water quantity measurements and water quality analysis. A dedicated stream water level indicator and rain gauge (Figure 18) was installed to assist in coordinating sampling events. The dedicated system was located at monitoring location A-8a. Equipment for the dedicated system was installed on an 8 foot, 6x6 wooden post that was concreted in place. The system includes: Morningstar SunSaver 6 solar controller, panel, battery, Teledyne ISCO 2150C telemetry modem, In-Situ Leveltroll 500 and a tipping bucket rain gauge. Figure 19 shows Oakohay Creek and the 2 inch perforated PVC pipe the Leveltroll is encased inside. The system collected data at intervals of 15 minutes and pushed them to the web hourly via a Verizon Wireless phone service to a secure Envault Corporation website. Rainfall, stream level, and temperature data were collected. C.C. Lynch and Associates (Pass Christian, MS) and Mississippi State University were both involved with the installation and maintenance of the equipment as well as the website. Additionally at site A-8a a stream pulley system was installed to assist with discharge measurement of Oakohay Creek during extreme high flows. The system consisted of two 4x4 posts, one on either side of the creek, concreted into the ground. The system called for a rope to be strung across the stream channel from one post to another with a pulley system installed to each post. This allowed for the rope with the Doppler stream profiler unit attached to it to be pulled back and forth across the stream channel for discharge measurement purposes. No bridge is present at site A-8.

Four people were needed during a sampling event. One team of two people was used to collect surface water quality data such as: field water quality data and analytical samples. Equipment used by the first team includes: TROLL 9500, RuggedReader, and

all necessary items used for analytical sampling. The second team of two people collected the surface water quantity measurements by using the ADP or conducting the debris test. This team also collected stage data using a 200 foot tape measure. Equipment used by this team included: the ADP, iPAQ pocket PC, and 200 foot tape measure. All data were recorded in the USFS Smith County Reservoir "Rite in the Rain" field book.

Figure 18 Rain gauge, interface module, battery, and solar panel

Figure 19 Submerged pressure sensor probe incased in perforated PVC

Figure 20 and 21, aerial and topographic maps, show the locations where the surface water quality and water quantity measurements were made. Three main drainage basins with sampling locations in parentheses are: Little Oakohay Creek (B-1:B-3), Oakohay Creek (A-1:A10, excluding A-8), and Shongelo Creek (C1:C6). Location A-8 was never monitored during the study due to access issues; therefore, A-8a was used instead. Little Oakohay Creek and Shongelo Creek were monitored primarily to see if water from the Oakohay Creek basin was making its way to the surrounding basins and vice versa. Field equipment used for water quantity measurements included: Teledyne Streampro acoustic doppler profiler (ADP) and a Bluetooth enabled HP iPAQ Pocket PC with StreamPro ADCP software. The ADP uses eight AA batteries. The iPAQ Pocket PC uses a rechargeable battery. Figure 22 shows the ADP and iPAQ unit at work in the field at night. The photograph was taken from a bridge looking vertically down at the creek.

The ADP unit uses "bottom tracking" technology to efficiently and effectively obtain the following information for the surface water stream: discharge (cubic feet/second), velocity (feet/second), distance (feet), and area (square feet) (StreamPro ADCP Operation Manual, 2008). Data were either obtained with three crossings of the ADP across the width of the stream channel with <5% error or a count of eight crossings with little regard to percent error values. The downstream portion of culverts and bridges were utilized to pull the ADP across the width of the stream channel with a rope. Data were collected and saved in the HP iPAQ Pocket PC until it could be downloaded. The data were processed using a HP iPAQ Pocket PC docking station and manipulated with Teledynes RDI's WinRiver II software. Once the data were downloaded it was saved on a personal computer (PC) in the office. Tables and graphs can be made from the data with the WinRiver II software. Due to the ADP only working in a water depth range of 1 foot to 26 feet it is important to note that on occasion baseflow conditions did not permit the use of the ADP. If that were the case a statistically significant estimation method from Hanks and others (2003) was used, Figure 23. The method involves measuring the width of the stream, calculating the average depth of the stream, and timing debris (i.e. leaves) at a premeasured distance between 1 – 3 feet (McIlwain, 2007). Stream discharge can then be calculated from the data collected.

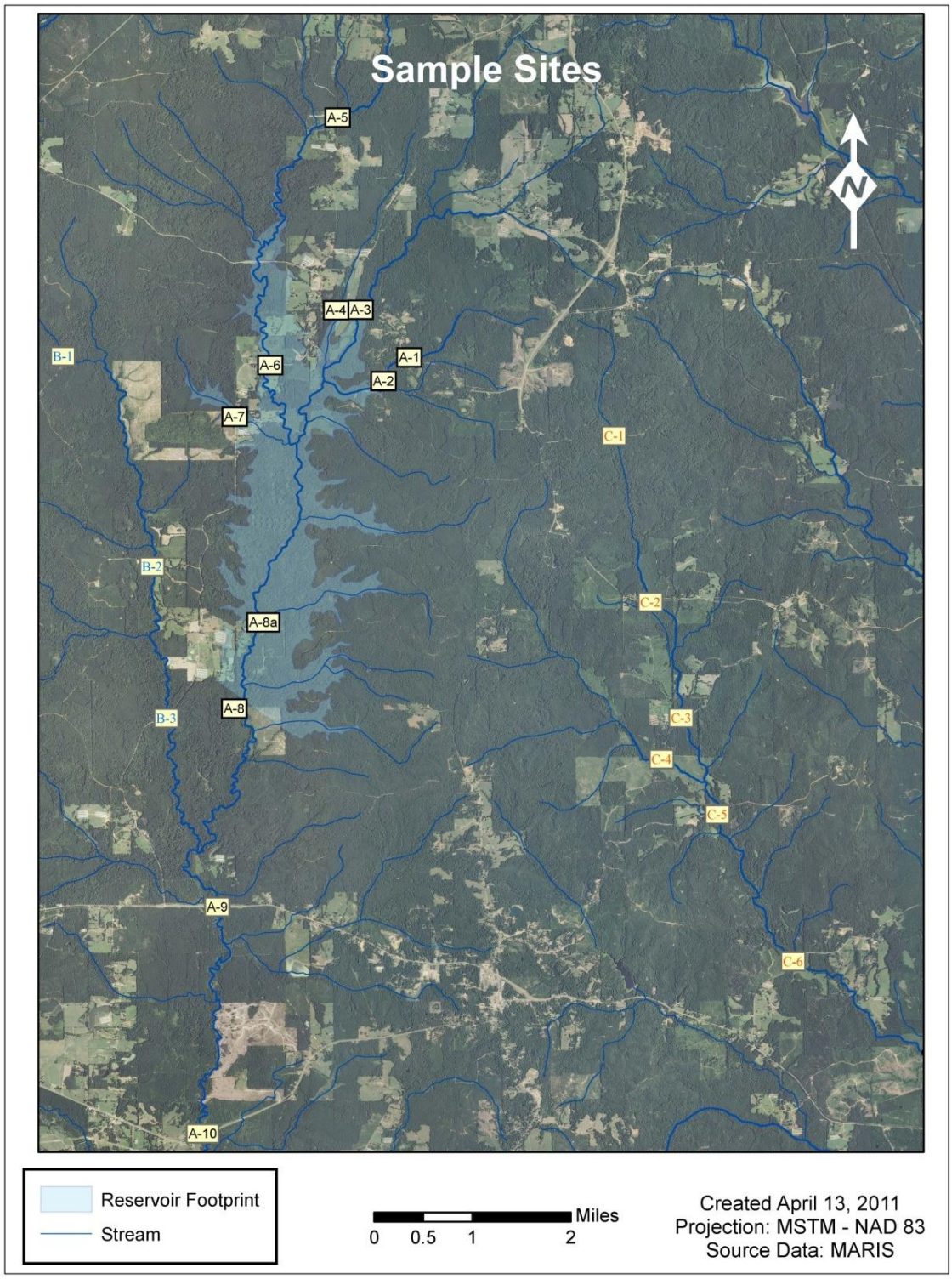


Figure 20 Aerial map with reservoir footprint and streams

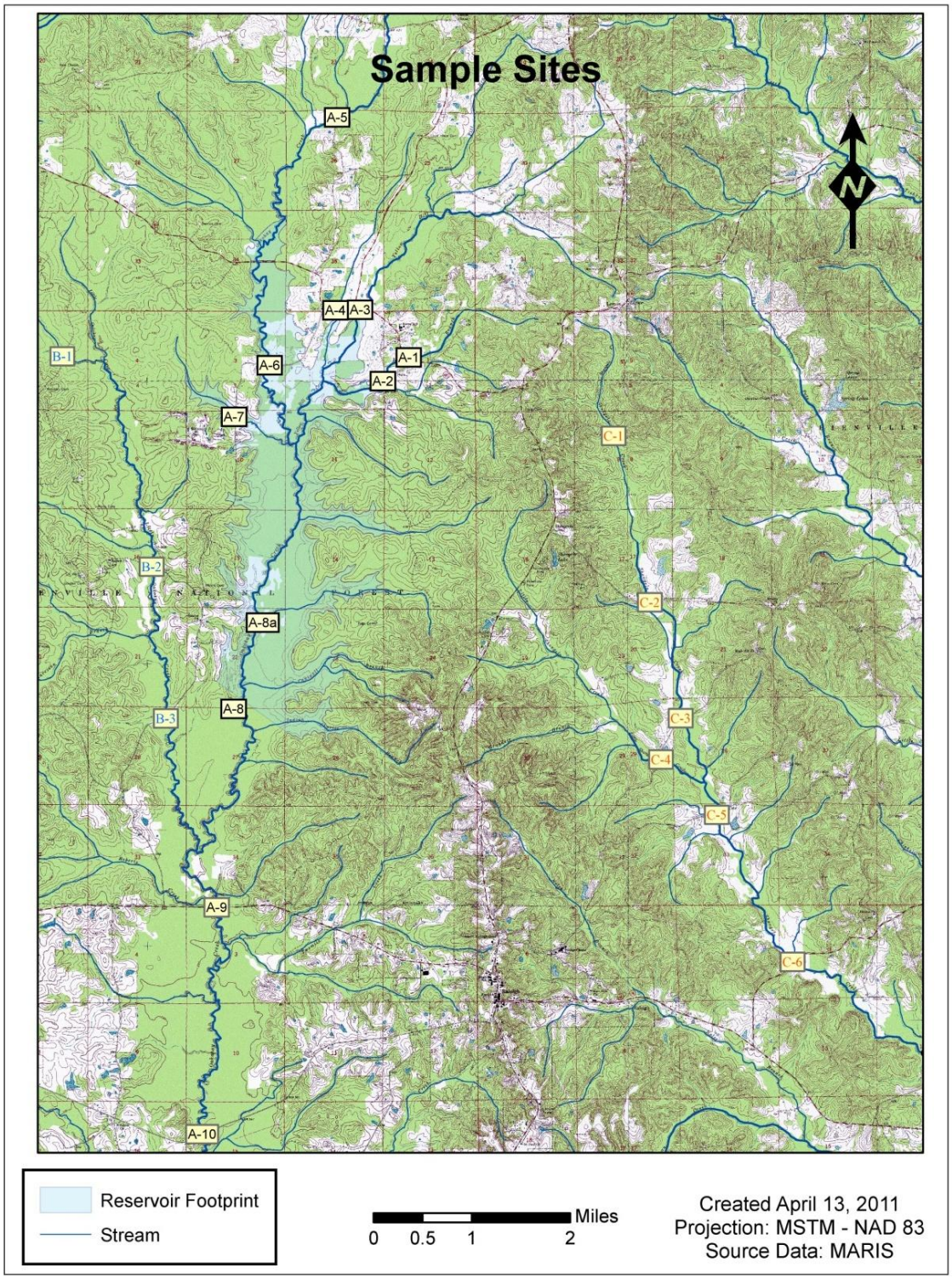


Figure 21 Topographic map with reservoir footprint and streams

Figure 22 Plan view of ADP and iPAQ in use

Stage data were taken at all surface water monitoring locations in order to create stage-discharge hydrographs. A 200 foot tape measure had a one foot weighted PVC pipe attached to it with a carbineer; therefore, all stage measurements had 1.3 feet added to their reading. The weight was added to the tape measure in order to retrieve depth measurements in flowing streams. Stage gauging points were clearly marked on the middle of the upstream portion of the culverts or bridge railings and on an overhanging tree for site A-8a due to no bridge being present. A nail hammered into a tree was used at A-8a. Stage data were collected at the beginning of sampling a location and was usually taken at the end of sampling the location. Results for all data collected were recorded in the field book.

Figure 23 Debris test in progress

Surface Water Quality Analysis

The fifth part of the objective was a surface water quality analysis study. Field equipment used in the study included: In-situ Multi-Parameter TROLL 9500 coupled with an In-Situ Ultra RuggedReader that was installed with Pocket-Situ 4. During field work the TROLL 9500 and RuggedReader were connected to one another by a 50 foot cable. Data collected in the field was saved on the RuggedReader using the "Snapshot" feature. Both the TROLL 9500 and RuggedReader can be docked to a PC for data downloads as well as software updates. The Troll 9500 takes two D batteries. The RuggedReader features a rechargeable battery. Surface water quality field parameters were measured at all of the monitoring locations that surface water quantity measurements were taken. Field parameters measured with the TROLL 9500 and RuggedReader with their respective measured parameters include: temperature (°F), pH

(s.u.), specific conductivity (µS/cm), dissolved oxygen (mg/L), turbidity (NTU), and nitrates (mg/L). Nitrates were only tested for at the end of the study do to the acquisition of a nitrate probe.

In order to ensure accurate data for each parameter the TROLL 9500 was calibrated the morning of each sampling event for: pH, specific conductivity, turbidity, nitrates, and dissolved oxygen (DO). For pH a two point calibration was performed using a buffer solution of four and seven. Conductivity was calibrated using a solution standard of 147µS/cm or 1413µS/cm for calibration. Turbidity was measured using the nephelometric turbidity units (NTU). Calibration fluids of zero (i.e. distilled water), ten, and one hundred NTU's were used. For nitrates a two point calibration was performed using a 14mg/L and 140mg/L calibration fluid. There was no specific order for parameter calibrations; except, DO was usually calibrated last because it took the longest to stabilize. DO calibration required no special fluids, only tap water.

Figure 24 shows the TROLL 9500 being deployed, RuggedReader, and tape measure with PVC weight. Surface water samples were taken on Oakohay Creek for laboratory analysis. Environmental Testing & Consulting, Incorporated (Memphis, TN) was used for the analytical analysis of surface water samples. The laboratory provided sampling bottles with sample preservatives, temperature blanks, coolers, and chain of custody forms.

Figure 24 TROLL 9500 being deployed

Water samples were collected by an individual using rubber gloves on the upstream portion of a culvert or bridge. The sampler used a clean plastic bottle that contained no preservatives to collect water from the stream. The sampler would then pour the water into its correct bottle, place the container in a plastic bag and in a cooler with ice. Chain of custody forms would be filled out, coolers were sealed up, and samples were shipped via FedEx at the end of the day to the laboratory. Table 8 lists the analytes which were tested for. Bold analytes were of concern in this study.

Table 8 Analytes tested for on Oakohay Creek

Analytes	Units
Alkalinity (as $CaCo_3$)	**mg/L**
Ammonia Nitrogen	mg/L
Biochemical Oxygen Demand (5-day)	mg/L
Carbon Dioxide (Estimate)	**mg/L**
Chloride	mg/L
Total Cyanide	mg/L
Total Coliform	cfu/100ml
Fluoride (w/o distillation)	mg/L
Nitrate (NO3-N)	mg/L
Nitrite (NO2-N)	mg/L
Nirtrate+Nitrite-N	mg/L
pH	**s.u.**
Total Dissolved Solids	**mg/L**
Total Phosphorus	mg/L
Phenols (Total)	mg/L
Total Aluminum	µg/L
Total Antimony	µg/L
Total Arsenic	µg/L
Total Barium	µg/L
Total Beryllium	µg/L
Total Calcium	**µg/L**
Total Cadmium	µg/L
Total Chromium	µg/L
Total Copper	µg/L
Hardness as CaCO3 (SM-2340B)	**µg/L**
Total Iron	µg/L
Total Lead	µg/L
Total Magnesium	µg/L
Total Manganese	µg/L
Total Mercury	mg/L
Total Nickel	µg/L
Total Selenium	µg/L
Total Thallium	µg/L
Total Zinc	µg/L
Fecal Coliform	cfu/100ml
Carbonate	**mg/L**
Bicarbonate (as CaCO3)	**mg/L**
Total Sulfate (SO4)	mg/L
Turbidity	**NTU**

CHAPTER VI

RESULTS

Reservoir Daily Water Storage Models

The three models all assumed the same parameters. The parameters were: baseflow of zero cubic feet per second, infiltration rate of 0.0023 ft per day, outflow of 10 acre-feet per day, and a withdrawal rate of zero gallons per day. The 1963 model was the lowest precipitation year (34.92 inches) from 1961-2002 (Figure 25). The 1973 model was the highest precipitation year (85.82 inches) from 1961-2002 (Figure 26). The 1961-2002 model was an average of all the precipitation (57.9 inches) records through those dates (Figure 27).

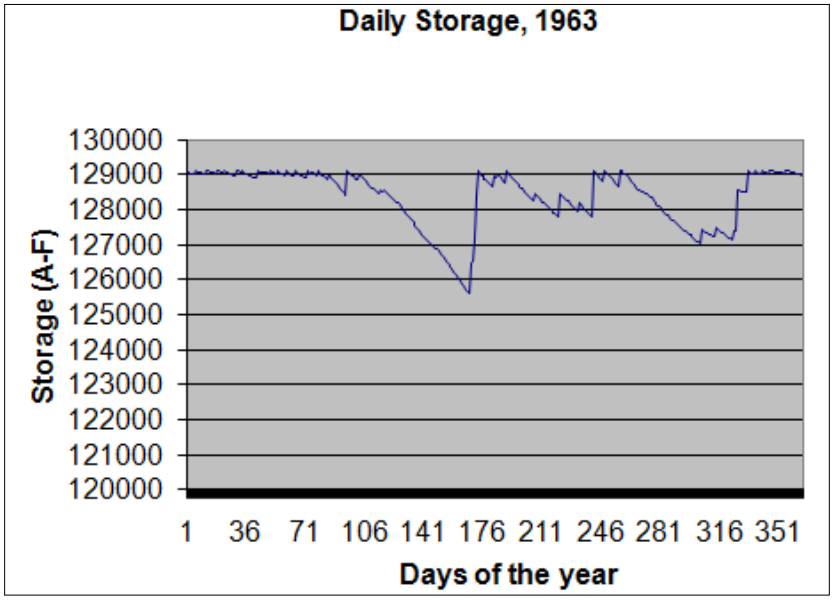


Figure 25 1963 Daily Water Storage Model for Oakohay Creek Reservoir

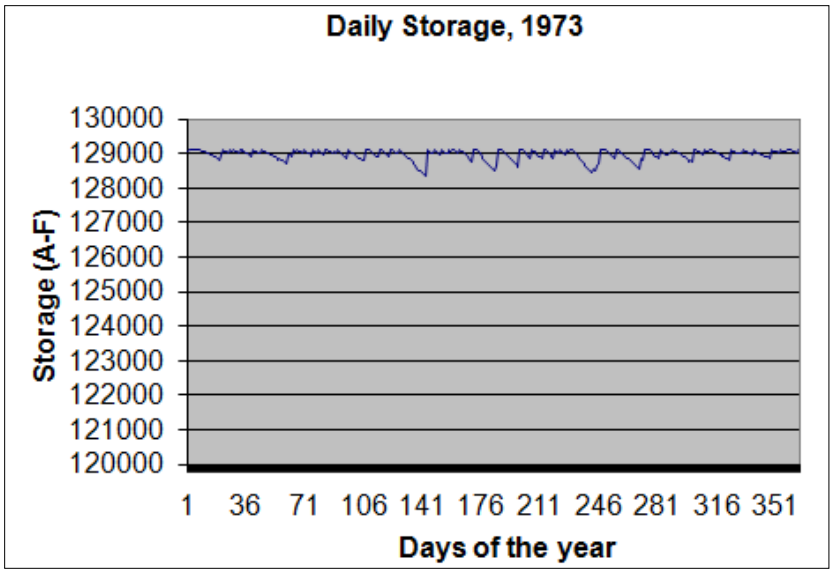


Figure 26 1973 Daily Water Storage Model for Oakohay Creek Reservoir

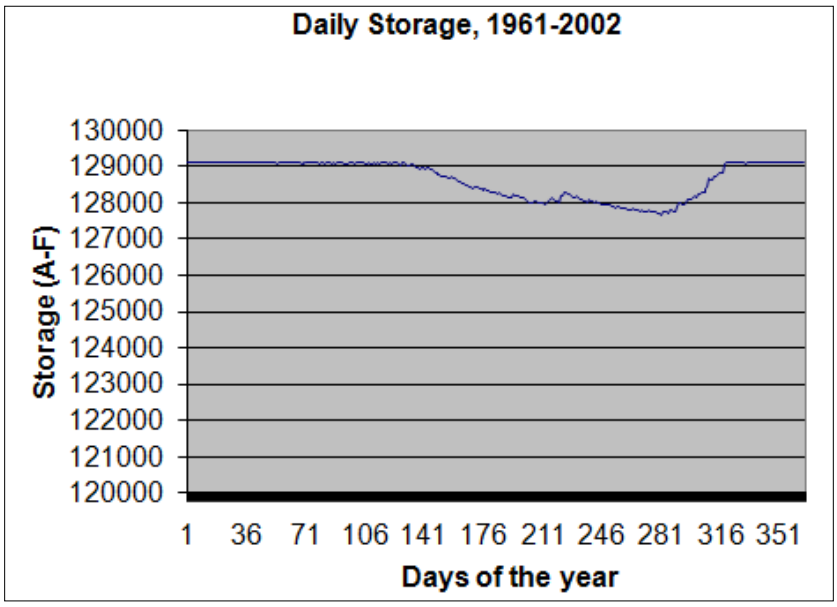


Figure 27 1961-2002 Daily Water Storage Model for Oakohay Creek Reservoir

Evaluation of the Glendon Limestone

Field Surveys

Field surveying was conducted to observe and locate outcrops. The results for this part of the objective are listed in Table 9. The results include: observation, date, and GPS waypoint data.

Table 9 Field reconnaissance data

Location	Date	Latitude	Longitude
Catahoula & Buccatunna Contact	-	N 32° 05' 48.83"	W 89° 34' 47.92"
Catahoula	-	N 32° 06' 17.89"	W 89° 34' 19.35"
James May GPS - Weathered Buccatunna	-	N 32° 07' 19.10"	W 89° 35' 52.19"
Glendon Outcrop (creek)	11.18.10	N 32.11741°	W 89.52353°
Glendon Quarry (mine)	11.18.10	N 31.98976°	W 89.36030°
Batte NE	11.18.10	N 32.11907°	W 89.52389°
Batte W	11.18.10	-	-
James Taylor Sinkholes	12.08.10	N 32.08954°	W 89.56563°
Glendon Outcrop	12.15.10	N 32° 05' 09.4"	W 89° 33' 59.1"
Glendon Outcrop	12.15.10	N 32° 05' 25.9"	W 89° 33' 52.7'
Forest Hill Outcrop	12.15.10	N 32° 05' 37.9"	W 89° 34' 02.9'
Forest Hill Outcrop	12.15.10	N 32° 05' 37.3"	W 89° 33' 59.6"
Glendon Outcrop	12.15.10	N 32° 05' 38.2	W 89° 34' 03.6"
Location across from old stage gauge	12.15.10	N 32° 04' 37.0"	W 89° 34' 07.6"
Catahoula Outcrop	12.16.10	N 32° 06' 17.1"	W 89° 34' 24.0"
Buccatunna Outcrop	12.16.10	N 32.11907°	W 89.523589°
Creek Bottom at Dam site	12.16.10	N 32° 04' 19.2"	W 89° 33' 43.7"
Glendon Dissolution in creek	01.12.11	N 32° 05' 04.1"	W 89° 34' 01.8"
Limestone Ledge in Creek	01.12.11	N 32° 05' 09.48"	W 89° 33' 57.83"
Limestone Weathering at bottom of upturned tree	01.12.11	N 32° 05' 03.2"	W 89° 34' 02.3"
Limestone in creek behind tree	01.12.11	N 32° 04' 58.4"	W 89° 34' 03.2"
Cored Limestone in Creek bottom	01.12.11	N 32° 04' 51.1	W 89° 34' 03.6"
Bentonite Mine	01.12.11	N 32° 07' 12.9"	W 89° 34' 34.6"
County Land Maintenace	01.12.11	N 32° 07' 24.1"	W 89° 34' 00.4"
James Taylor Sinkholes (New)	01.19.11	N 32° 05' 23.0"	W 89° 35' 01.8"
Glendon Outcrop	01.26.11	N 32.09521°	W 89.5036°
Catahoula Outcrop	01.26.11	N 32.05722°	W 89.50337°
Catahoula Outcrop	01.26.11	N 32.05683°	W 89.5013°
Catahoula Outcrop	01.26.11	N 32.03372°	W 89.51722°
Catahoula Outcrop	01.26.11	N 32.03072°	W 89.52741°

Ground Penetrating Radar

Ground Penetrating Radar was conducted November 18, 2010, December 8, 2010, and December 15, 2010 in order to investigate the near surface dissolution expressions of the Glendon Limestone. The November investigation was performed on the Batte

Property (32.11907°N, 89.52389°W) and the December investigations were performed on the James Taylor property (32.08954°N, 89.56563°W), Figure 16. The results for the GPR are screen shot images. A handful of example images are shown in the results section and will be interpreted in the discussion section. Images shown and discussed (Figures 28 – 32) are representative images of all the work produced. All images produced by TeaCo Geophysical in the can be seen in Appendix A.

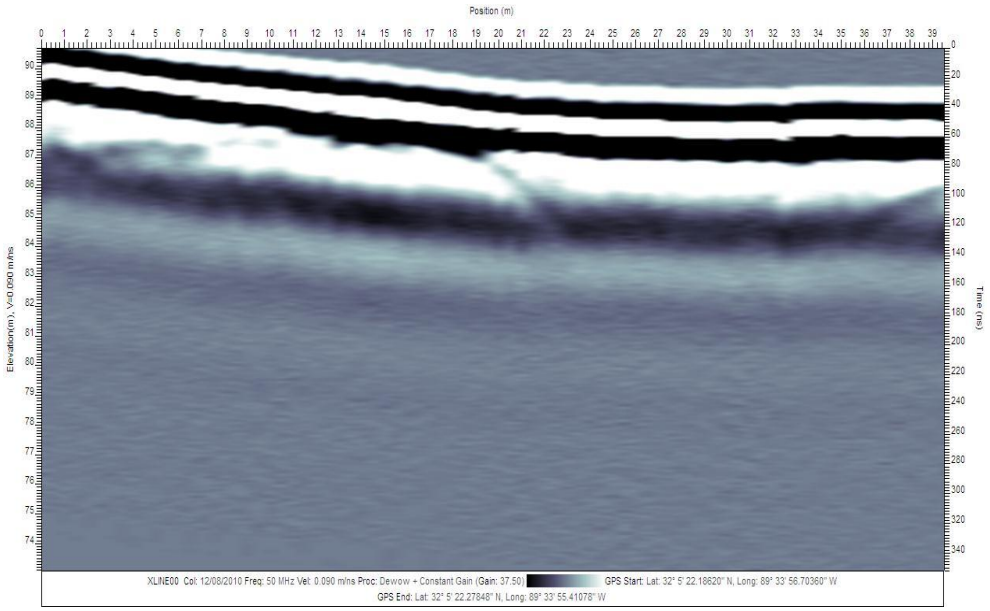


Figure 28 50MHz antenna indicates geologic structures in the subsurface (location 1)

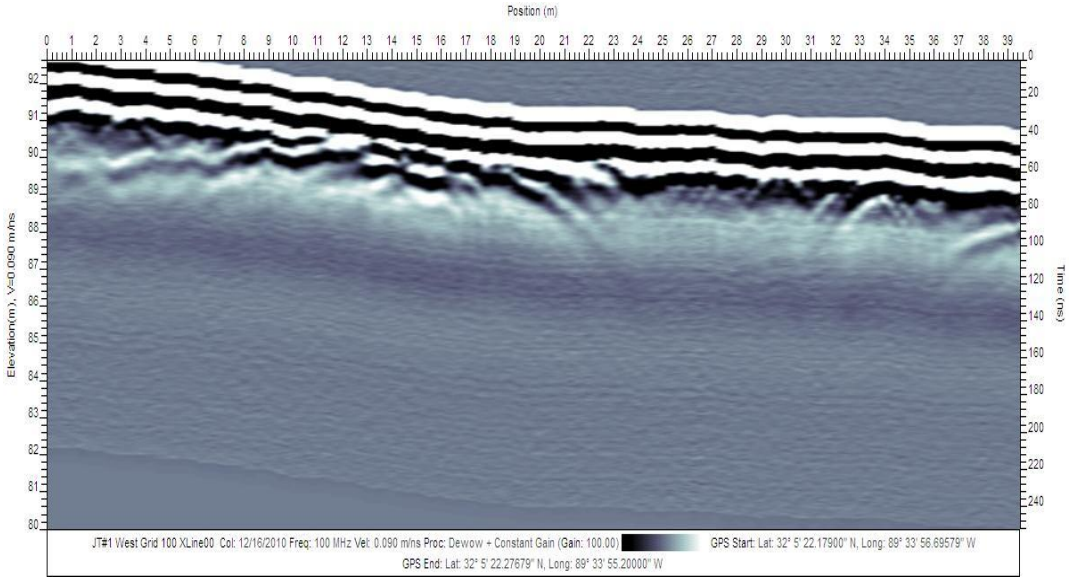


Figure 29 100MHz antenna indicates some geologic structures in the subsurface (location 1)

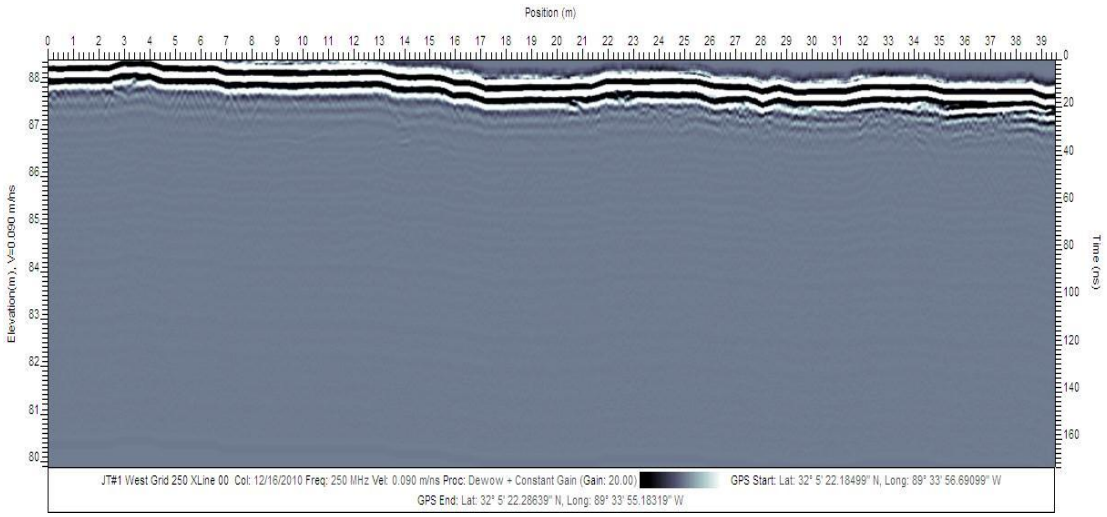


Figure 30 250MHz antenna indicates negligible data (location 1)

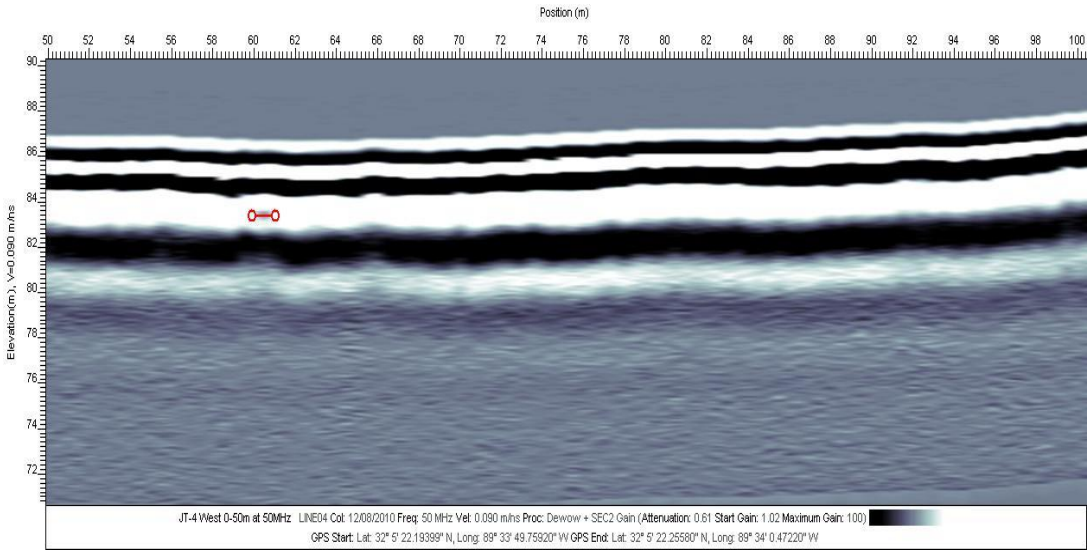


Figure 31 Red line marks a possible dissolution feature in the subsurface (line 4)

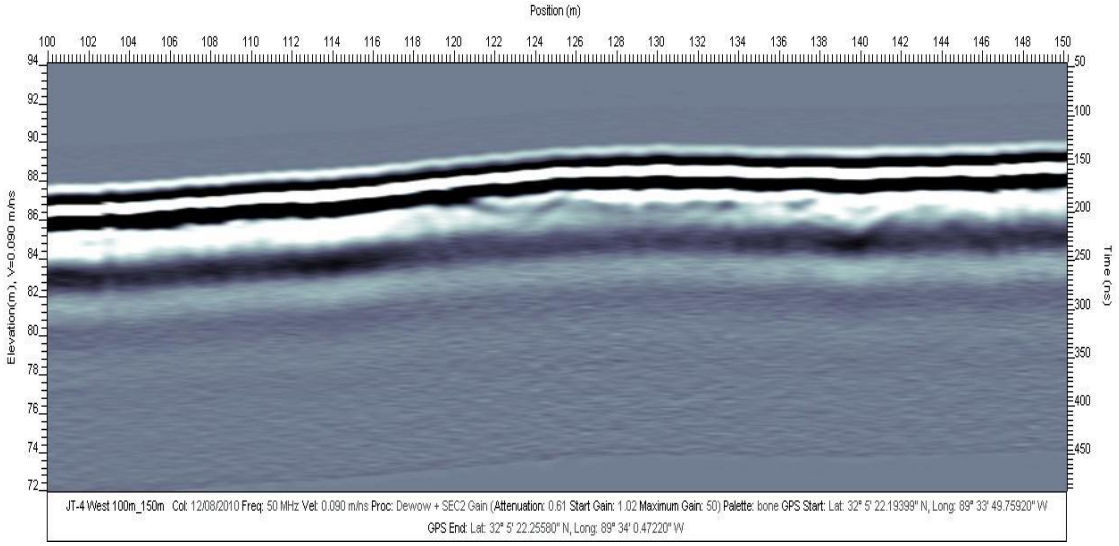


Figure 32 Subsurface anomalies noted between 116m and 144m (line 4)

Sonic Rig Drilling

Sonic rig drilling commenced on February 21, 2011 and ended February 25, 2011. A total of 17 borings were drilled and logged in five days. Table 10 displays the site, date, elevation, and GPS waypoint data for the borings. JTB stands for James Taylor Boring, BMB stands for Bentonite Mine Boring, WHB stands for Wilson Hallman

Boring, and 481 – SONIC was named due to the borings proximity to Highway 481. A few example boring logs are shown in the results section and will be interpreted in the discussion section. Boring logs shown and discussed (Table 11 – 14) are representative of all the logs produced. Additional boring logs created can be seen in Appendix B.

The goal of each boring was to obtain maximum core recovery. The cores were recovered in 10 foot sections and pushed into clear plastic sleeves. Recovery of the entire core proved to be difficult due to the hard ledges of the Glendon Limestone coupled with the soft marl interbeds. The rock bit was used to core the limestone and the clay bit was used to push through the marl. JTB-1 and 481-SONIC were the only two borings which experienced loss of circulation while being drilled. Once these two borings were completed a 4 inch PVC pipe was inserted into them in order for the boring to maintain its shape. This was done so that a down hole digital video camera could be inserted into the boring for further investigation. All other boreholes were filled with Bentonite chips and abandoned.

Table 10 Boring elevation and location

Name	Date	Elevation (FT)	Latitude	Longitude
JTB 1	02.21.11	417	N 32.089547	W 89.565271
JTB 2	02.21.11	422	N 32.089702	W 89.565188
JTB 3	02.21.11	426	N 32.089775	W 89.565166
JTB 4	02.22.11	440	N 32.08967	W 89.566434
JTB 5	02.22.11	430	N 32.089757	W 89.567277
JTB 6	02.22.11	429	N 32.085832	W 89.567672
JTB 7	02.22.11	404	N 32.08950	W 89.564457
JTB 8	02.22.11	-	N 32.08956	W 89.570028
JTB 9	02.23.11	419	N 32.089324	W 89.565538
JTB 10	02.23.11	424	N 32.089735	W 89.565715
JTB 11	02.23.11	425	N 32.089569	W 89.565739
JTB 12	02.23.11	422	N 32.089493	W 89.565754
JTB 13	02.24.11	430	N 32.089777	W 89.567107
BMB 1	02.24.11	450	N 32.122336	W 89.580064
BMB 2	02.25.11	-	N 32.120655	W 89.575891
WHB 1	02.25.11	-	N 32.127638	W 89.566861
481-SONIC	02.25.11	-	N 32.123778	W 89.526083

Table 11 James Taylor Boring – 1

BORING LOG

Page 1 of 1

Boring/Well No.: JTB-1 Name/Project No.: SMITH COUNTY RESERVOIR

Date: 2-21-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 376

Notes: LOCATION: 32.089547N, 89.565271W

Depth ft. From	Depth ft. To	SOIL STRATA DESCRIPTIONS AND REMARKS	Time
0	7	Clay (weathered marl), brown, highly weathered	
7	13	**(Bryam Fm)** -Marl, brown and black mottled, highly weathered. bentonitic	
13	15	**(Glendon Fm)** -Limestone, tan, hard, fossiliferous, calcareous	
15	19	-Marl, brown to tan, highly weathered bentonitic	
19	20	Limestone, greenish gray, hard, fossiliferous,	
20	39	**(Mint Spring Fm)** -Marl, greenish gray, soft fossiliferous, glauconitic (lost circulation) (poor recovery)	
39	40	**(Forest Hill Fm)** –Clay, dark gray, silty, carbonaceous	

Table 12 James Taylor Boring - 8

BORING LOG

Page 1 of 1

Boring/Well No.: **BMB-2** Name/Project No.: **SMITH COUNTY RESERVOIR**

Date: **2-25-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: **FAIR** Elevation: 416

Notes: **LOCATION: 32.120655N, 89.575891W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	5	**(Fill)** Clay, brown, sandy	
5	20	**(Glendon Fm)** Marl, brown and black mottled, highly weathered. bentonitic	
20	21	-Limestone, greenish gray, hard, fossiliferous, calcareous	
21	32	**(Mint Spring Fm) -**Marl, greenish gray, soft fossiliferous, glauconitic, carbonaceous at bottom	
32	40	**(Forest Hill Fm)**- Clay, dark gray, silty, carbonaceous	

Table 13 Bentonite Mine Boring - 2

BORING LOG

Page 1 of 1

Boring/Well No.: **BMB-2** Name/Project No.: **SMITH COUNTY RESERVOIR**

Date: **2-25-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: **FAIR** Elevation: 416

Notes: **LOCATION: 32.120655N, 89.575891W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	5	**(Fill)** Clay, brown, sandy	
5	20	**(Glendon Fm)** Marl, brown and black mottled, highly weathered. bentonitic	
20	21	-Limestone, greenish gray, hard, fossiliferous, calcareous	
21	32	**(Mint Spring Fm)** -Marl, greenish gray, soft fossiliferous, glauconitic, carbonaceous at bottom	
32	40	**(Forest Hill Fm)**- Clay, dark gray, silty, carbonaceous	

Table 14 481 - SONIC

BORING LOG

Page 1 of 1

Boring/Well No.: 481-SONIC Name/Project No.: SMITH COUNTY RESERVOIR

Date: 2-25-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 480

Notes: LOCATION: 32.123778N, 89.526083

Depth ft		SOIL STRATA	
From	To	SOIL DESCRIPTIONS AND REMARKS	Time
0	15	**(Bucutunna Fm)** -Clay, tan to red, silty, highly weathered—(bentonitic from 8 to 10 ft) (black mineralized zone from 13 to 15 ft)	
15	20	**(Bryam Fm)** -Marl, brown and black mottled, highly weathered. bentonitic	
20	21	**(Glendon Fm)** -Limestone, tan, hard, fossiliferous, calcareous (lost circulation below limestone)	
21	47	-Marl, brown to tan, highly weathered bentonitic (poor recovery in lower part)	
47	48	Limestone, greenish gray, fossiliferous,	
48	50	**(Mint Spring Fm)** -Marl, greenish gray, soft fossiliferous, glauconitic, carbonaceous at bottom	

Surface Water Quantity Measurements

The dedicated stream water level indicator and rain gauge installed to assist in coordinating sampling events began collecting data on February 24, 2011. Data were

collected until the unit went offline on March 9, 2011. It was believed that the unit went offline due to being flooded during the March 9, 2011 high flow event. Data collected during the time the unit was operational is shown in Figure 33.

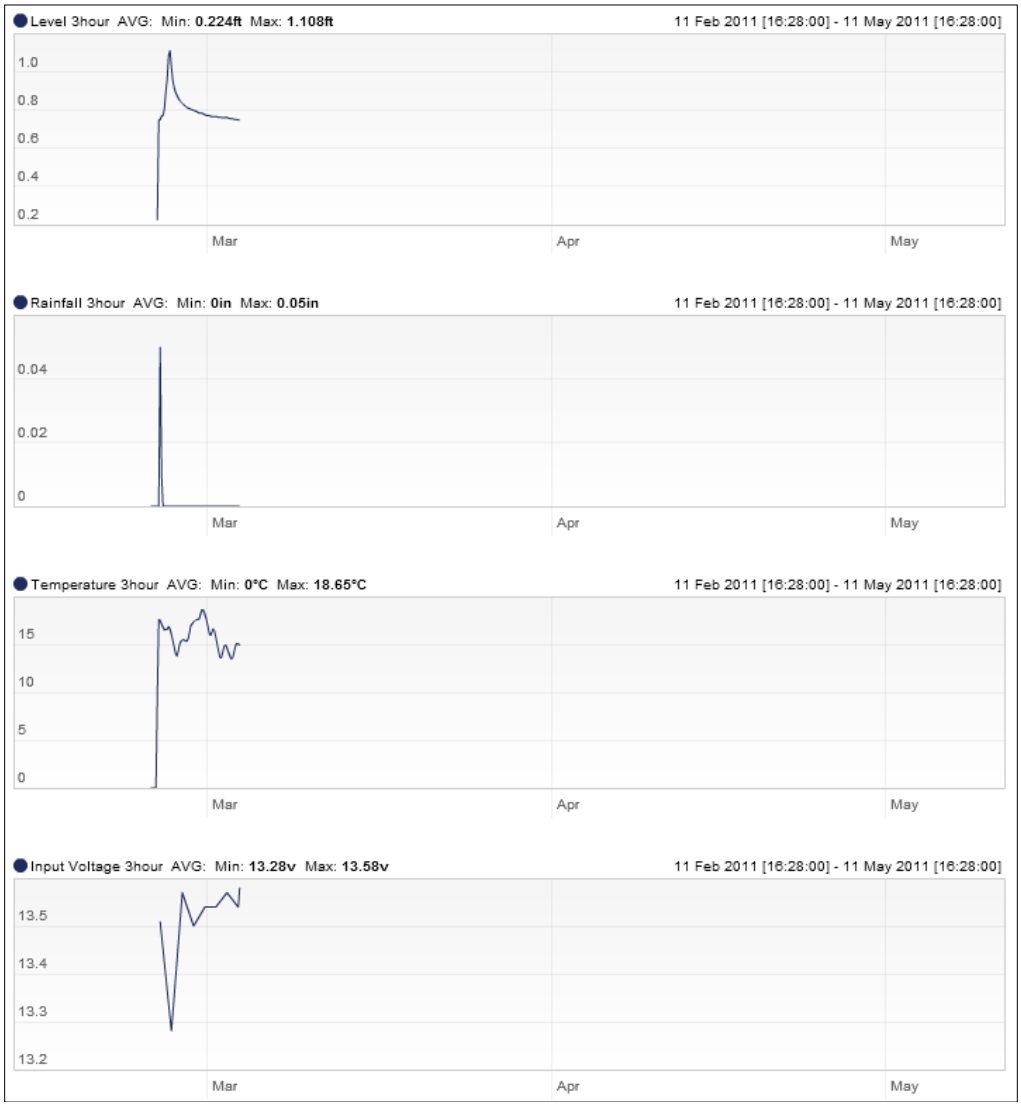


Figure 33 Historical site data for dedicated monitoring unit

Surface water quantity discharge measurements were made with the ADP or the debris test method and plotted versus the stage gauge height in order to produce hydrographs. Table 15 shows whether or not a hydrograph was built. Criteria for a

hydrograph to be built are: site must have greater than two sampling events and sampling events that do not have stage data or have discharge data recorded as no flow, zero, or error cannot be included. Therefore data recorded as no flow, stream dry, or Doppler error was discarded. On 9.16.10 sites A-1, A-2, A-4, A-7, B-1, and C-2 were dry. On 09.16.10 sites A-3, B-2, and C-2 had no flow. On 10.28.10 sites A-1, A-2, A-7, A-9, B-1, B-2, and C-3 were dry. On 10.28.10 sites B-3, C-1, and C-2 had no flow. On 10.28.10 sites A-3, A-4, A-5, and A-6 had flow but the Doppler recorded errors. On 10.28.10 sites C-4, C-5, and C-6 had minimal flow that could not be estimated with the Doppler or debris test. On 03.09.11 site A8a could not be measured for discharge using the stream pulley system due to extreme high flow and flooding.

Due to the marks where stage gauge was measured from not being surveyed in for actual elevation the elevation number of 400 feet above sea level was used for the hydrographs. Numerical data for the hydrographs are shown in Table 16. Sampling event 02.16.11 and 02.24.11 are considered baseflow events and sampling event 03.09.11 is considered a high flow event. Hydrographs for Mile Branch (A-1), Yellow Bill Creek (A-3), UT Yellow Bill Creek (A-4), Oakohay Creek (A-5, A-6, A-8a, A-9) UT to Oakohay Creek (A-7), Little Oakohay Creek (B-3), Little Shongelo Creek (C-4), Shongelo Creek (C-5), and Shongelo Creek (C-6) were created. Some of the hydrographs are shown in Figures 34 - 39. Additional hydrographs are shown in Appendix C.

Table 15 Sampling locations and hydrograph notification

Site	Latitude	Longitude	Hydrograph
A-1	33° 34' 01" N	88° 50' 20" W	X
A-2	33° 34' 01" N	88° 50' 20" W	
A-3	33° 34' 01" N	88° 50' 41" W	X
A-4	33° 34' 01" N	88° 49' 51" W	X
A-5	33° 33' 08" N	88° 48' 04" W	X
A-6	33° 28' 28" N	88° 43' 45" W	X
A-7	33° 27' 34" N	88° 42' 48" W	X
A-8a	32°05'17"N	89°33'48"W	X
A-9	33° 23' 26" N	88° 38' 39" W	X
A-10	33° 19' 44" N	88° 35' 33" W	
B-1	33° 31' 16" N	88° 46' 19" W	
B-2	33° 28' 00" N	88° 42' 28" W	
B-3	33° 25' 45" N	88° 40' 35" W	X
C-1	33° 13' 41" N	88° 29' 55" W	
C-2	33° 14' 02" N	88° 30' 34" W	
C-3	33° 14' 13" N	88° 30' 34" W	
C-4	33° 14' 23" N	88° 30' 48" W	X
C-5	33° 14' 55" N	88° 31' 20" W	X
C-6	33° 17' 44" N	88° 33' 48" W	X

Table 16 Hydrograph data

Site	Date	Stage (FT)	Discharge (Ft^3/s)
A-1	02.03.10	391.07	3.82
A-1	02.16.11	391.05	1.51
A-1	03.09.11	393.80	65.05
A-3	12.09.09	390.20	60.34
A-3	02.03.10	388.10	7.72
A-3	02.16.11	389.00	3.70
A-3	03.09.11	395.50	716.13
A-4	02.03.10	391.00	0.42
A-4	2.16.11	390.30	1.99
A-4	03.09.11	395.00	122.00
A-5	02.03.10	385.85	7.26
A-5	09.16.10	386.00	2.45
A-5	02.16.11	386.60	4.95
A-5	03.09.11	392.85	415.80
A-6	12.09.09	391.35	306.39
A-6	02.03.10	384.95	14.18
A-6	02.24.11	384.72	3.69
A-6	03.03.11	378.95	4.94
A-6	03.09.11	394.60	2152.53
A-7	12.09.09	391.40	15.44
A-7	02.03.10	391.68	0.45
A-7	02.24.11	391.40	7.52
A-7	03.09.11	394.70	66.98
A-8a	02.23.11	393.00	5.40
A-8a	02.24.11	392.50	6.43
A-8a	03.03.11	392.45	6.219
A-9	12.09.09	383.75	675.22
A-9	02.03.10	376.30	79.11
A-9	09.16.10	373.80	0.15
A-9	02.24.11	374.60	3.57
A-9	03.03.11	375.50	9.28
A-9	03.09.11	387.40	1597.40
A-9	03.17.11	376.20	70.309
B-3	02.03.10	383.25	13.15
B-3	09.16.10	381.85	0.36
B-3	03.09.11	392.65	1257.937
C-4	12.09.09	385.80	9.93
C-4	02.03.10	385.05	4.37
C-4	09.16.10	385.59	0.52
C-5	12.09.09	386.74	30.27
C-5	02.03.10	385.70	14.05
C-5	09.16.10	385.60	38.26
C-6	12.09.09	379.80	38.72
C-6	02.03.10	379.30	16.52
C-6	09.16.10	378.40	16.43

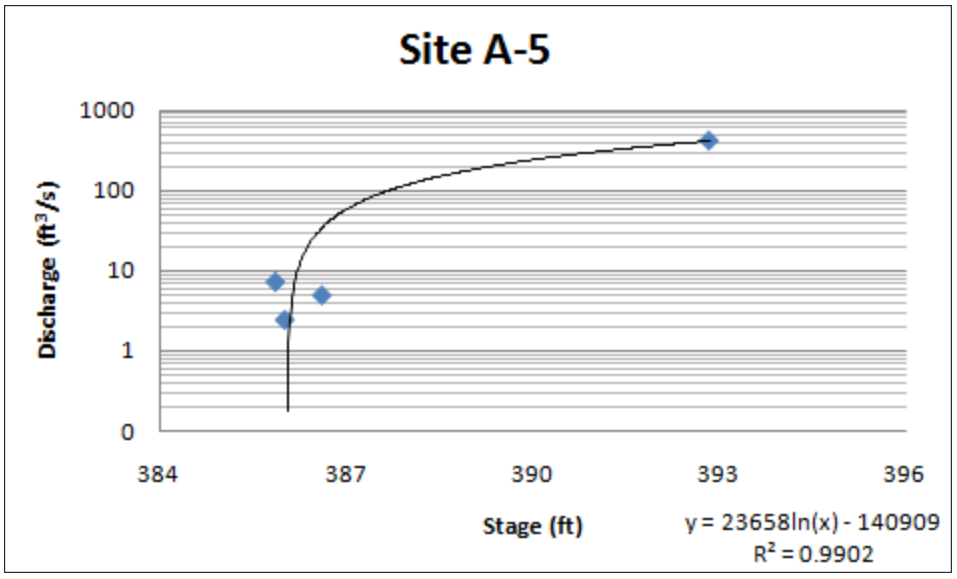


Figure 34 Hydrograph for site A-5

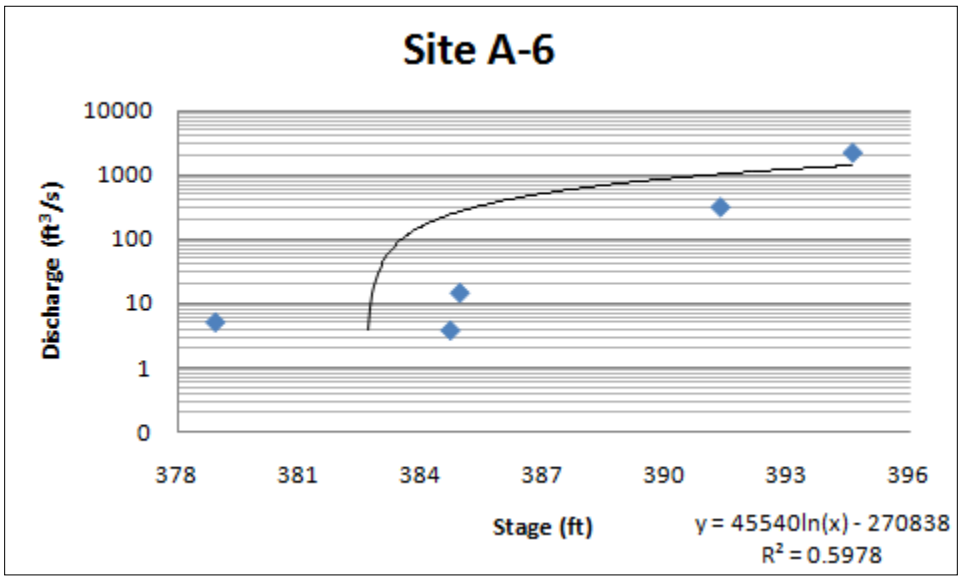


Figure 35 Hydrograph for site A-6

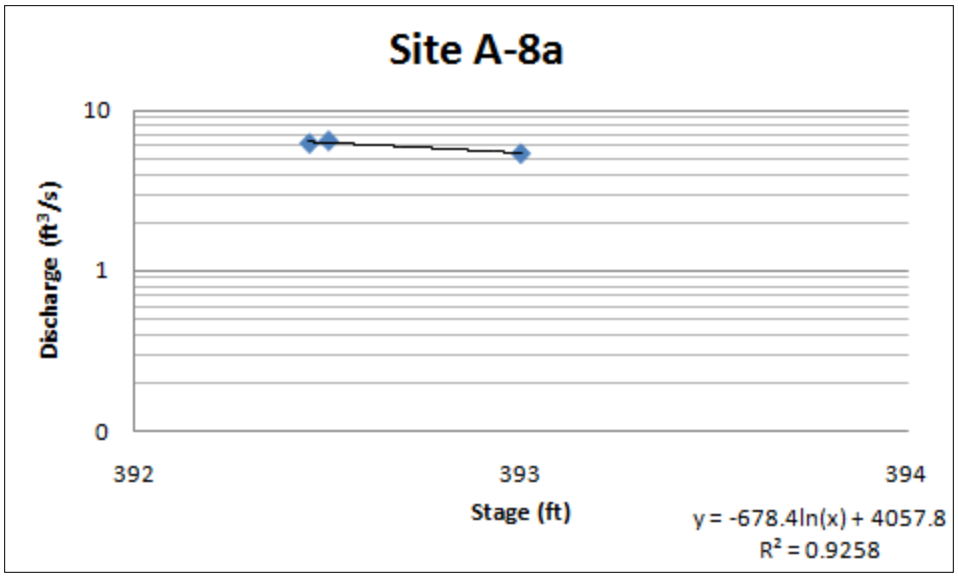


Figure 36 Hydrograph for site A-8a

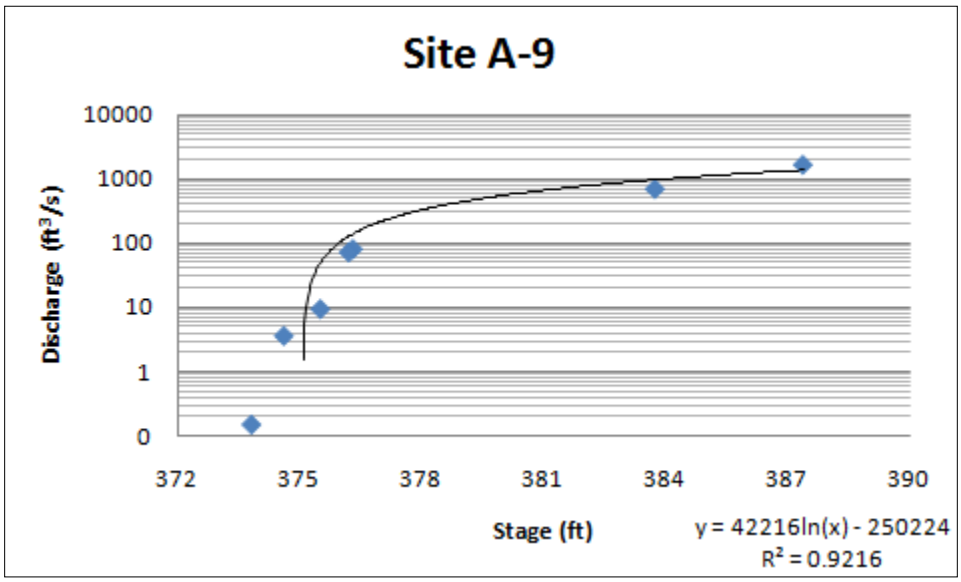


Figure 37 Hydrograph for site A-9

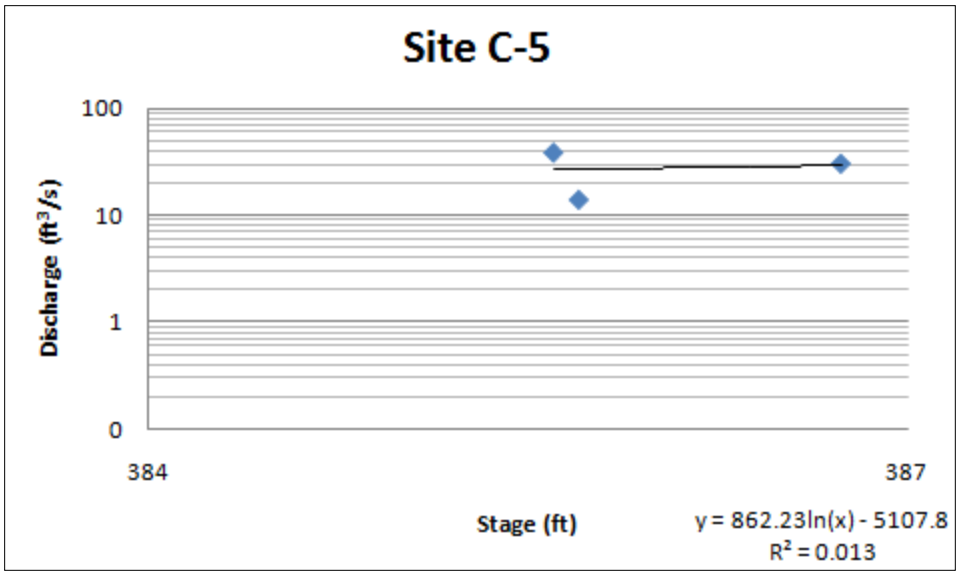


Figure 38 Hydrograph for site C-5

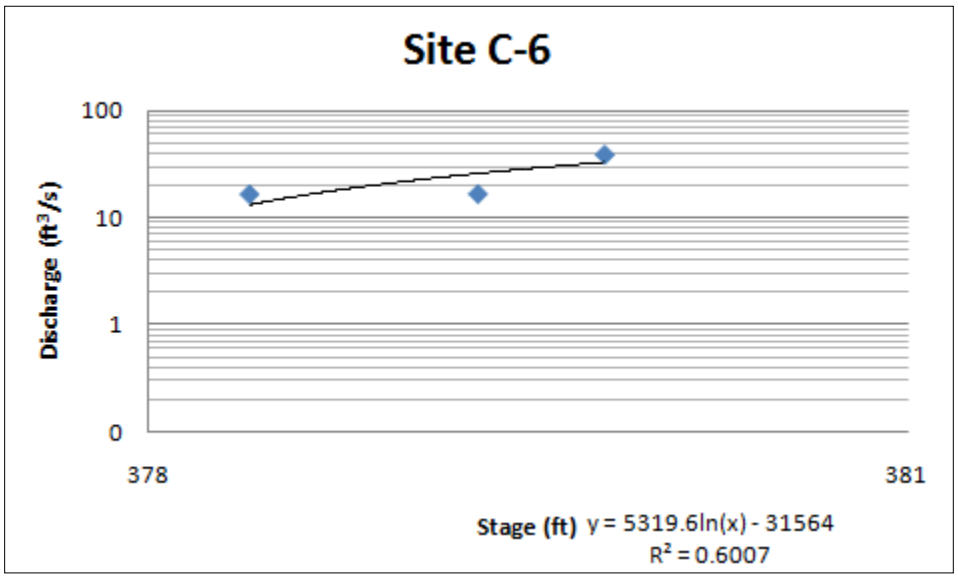


Figure 39 Hydrograph for site C-6

Surface Water Quality Analysis

Surface water quality analysis can be divided into field measurements and laboratory analysis. Table 17 displays the field measurement data. Sites A-1 through A-10 located on Mile Branch, Yellow Bill Creek, UT Yellow Bill Creek, Oakohay Creek,

and UT to Oakohay Creek were sampled for field measurements a maximum of seven events. Location A-2 was discontinued from the sampling list on 10.28.11 due to its proximity to location A-1. Sites B-1 through B-3 and C-1 through C-6 were sampled for field measurements a maximum of four events.

Laboratory analysis was done for two of the sampling events. Table 18 displays which sites had analysis done for the baseflow and high flow events. A baseflow sampling event was conducted on 02.16.11 and 02.24.11. Baseflow sampling event locations include: Mile Branch (A-1), Yellow Bill Creek (A-3), UT Yellow Bill Creek (A-4), Oakohay Creek (A-5, A-6, A-8a, A-9, A-10) and UT to Oakohay Creek (A-7). A high flow sampling event was conducted on 03.09.11. High flow sampling event locations include: Mile Branch (A-1), Yellow Bill Creek (A-3), UT Yellow Bill Creek (A-4), Oakohay Creek (A-5, A-6, A-9) and UT to Oakohay Creek (A-7 and Little Oakohay Creek (B-3). Results of the analysis performed can be seen in Table 19. The full analysis from the laboratory is in Appendix D.

Table 17 Field Measurements

Site	Date	Temperature °F	pH s.u.	Conductivity µS/cm	D.O. mg/L	Turbidity NTU	Nitrate mg/L
A-1	12.09.09	56.29	7.44	70.17	10.56	111.20	NT
A-2		56.44	7.49	41.63	10.52	108.30	NT
A-3		57.98	7.09	48.83	10.03	241.30	NT
A-4		57.91	6.71	42.14	10.03	151.80	NT
A-6		60.18	6.58	32.13	9.38	187.70	NT
A-7		57.32	6.64	40.02	10.23	52.00	NT
A-9		60.49	6.61	31.20	9.29	263.20	NT
B-2		59.37	6.27	30.85	9.62	111.00	NT
C-1		55.90	7.39	49.52	10.69	65.50	NT
C-3		56.01	7.34	69.82	10.65	76.40	NT
C-4		57.30	7.28	75.75	10.23	42.20	NT
C-5		56.77	7.11	73.90	10.41	77.30	NT
C-6		56.81	6.70	73.80	10.39	123.50	NT
B-3		59.78	6.40	27.49	9.50	88.20	NT
C-2		55.90	7.38	58.24	10.68	75.70	NT
A-1	02.03.10	45.44	6.63	140.10	13.88	14.90	NT
A-2		46.85	6.65	200.30	12.28	16.30	NT
A-3		45.76	6.34	126.90	13.72	28.00	NT
A-4		45.43	6.31	100.70	13.86	23.20	NT
A-5		44.78	6.53	89.78	14.14	27.80	NT
A-6		46.70	7.13	86.46	13.33	30.30	NT
A-7		46.72	6.72	311.00	13.36	17.60	NT
A-9		46.72	7.11	113.50	13.32	30.80	NT
B-2		47.04	7.04	188.70	13.19	24.70	NT
C-1		50.96	7.50	169.80	11.70	21.60	NT
B-3		46.34	7.21	130.20	13.48	27.70	NT
C-2		49.57	7.53	174.10	12.23	22.30	NT
C-3		49.11	7.47	206.90	12.40	17.80	NT
C-4		49.55	7.39	260.80	12.24	15.60	NT
C-5		48.57	7.29	233.70	12.59	19.10	NT
C-6		47.22	7.05	226.90	13.12	17.30	NT

Table 17 (continued)

Site	Date	Temperature °F	pH s.u.	Conductivity µS/cm	D.O. mg/L	Turbidity NTU	Nitrate mg/L
A-3	09.16.10	72.93	6.38	135.80	9.06	138.20	NT
A-5		69.94	6.26	132.50	9.92	98.30	NT
A-6		73.19	6.34	85.94	8.99	159.90	NT
A-9		78.66	6.84	87.55	7.62	23.60	NT
B-2		73.22	6.66	132.20	4.05	15.10	NT
C-1		75.91	7.63	114.90	8.28	4.10	NT
B-3		72.80	6.50	105.90	9.11	60.50	NT
C-2		76.92	7.11	161.40	8.06	53.00	NT
C-3		82.00	7.08	189.10	6.89	41.50	NT
C-4		73.59	7.16	70.65	8.89	16.20	NT
C-5		78.94	7.28	77.96	7.56	47.30	NT
C-6		74.28	6.99	93.75	8.66	16.60	NT
A-3	10.28.10	67.68	6.20	90.59	10.63	163.30	NT
A-10		69.00	6.33	55.82	10.21	27.12	NT
C-1		65.63	6.90	60.67	11.30	12.40	NT
C-4		68.80	6.63	36.56	10.26	10.80	NT
C-5		68.94	6.63	47.17	10.22	7.20	NT
C-6		68.13	6.53	50.47	10.49	9.80	NT
A-1	02.16.11	48.23	6.22	87.62	18.58	3.80	NT
A-3		51.88	6.37	53.77	12.13	18.30	NT
A-4		51.64	6.07	48.37	12.22	5.10	NT
A-5		50.50	Error	43.18	12.68	6.30	NT
A-6	02.24.11	62.59	6.75	56.00	11.05	14.90	0.44
A-7		61.02	5.99	106.30	11.59	11.50	0.32
A-8a		64.36	6.46	66.59	10.47	4.80	0.57
A-9		64.18	7.10	57.89	10.52	3.50	0.83
A-10		65.18	6.61	55.16	10.21	7.1	0.75
A-1	03.09.11	56.94	5.85	26.03	11.16	385.10	0.26
A-3		57.69	5.88	22.13	1.04	177.20	0.52
A-4		57.21	5.59	20.90	11.09	101.60	0.38
A-5		81.60	5.75	24.22	10.26	81.60	0.25
A-6		57.13	5.49	16.89	1.15	85.90	0.22
A-7		56.85	5.72	21.37	11.19	44.20	0.57
A-9		58.26	5.48	20.81	3.63	103.40	0.46
A-10		61.09	5.18	22.1	6.66	192.4	0.24
B-3		57.58	4.95	14.34	1.44	38.2	NT

Table 18 Baseflow and High Flow Lab Analysis

Site	Latitude	Longitude	Baseflow	High Flow
A-1	33° 34' 01" N	88° 50' 20" W	X	X
A-2	33° 34' 01" N	88° 50' 20" W		
A-3	33° 34' 01" N	88° 50' 41" W	X	X
A-4	33° 34' 01" N	88° 49' 51" W	X	X
A-5	33° 33' 08" N	88° 48' 04" W	X	X
A-6	33° 28' 28" N	88° 43' 45" W	X	X
A-7	33° 27' 34" N	88° 42' 48" W	X	X
A-8a	32°05'17"N	89°33'48"W	X	
A-9	33° 23' 26" N	88° 38' 39" W	X	X
A-10	33° 19' 44" N	88° 35' 33" W	X	
B-1	33° 31' 16" N	88° 46' 19" W		
B-2	33° 28' 00" N	88° 42' 28" W		
B-3	33° 25' 45" N	88° 40' 35" W		X
C-1	33° 13' 41" N	88° 29' 55" W		
C-2	33° 14' 02" N	88° 30' 34" W		
C-3	33° 14' 13" N	88° 30' 34" W		
C-4	33° 14' 23" N	88° 30' 48" W		
C-5	33° 14' 55" N	88° 31' 20" W		
C-6	33° 17' 44" N	88° 33' 48" W		

Table 19 Results of Analysis

Site	Analyte Description	Result 02.16.11	Result 03.09.11	Units
A-1	Alkalinity (as CaCO3)	99	12	mg/L
A-1	Bicarbonate (as CaCO3)	99	12	mg/L
A-1	Carbon Dioxide (Estimate)	1.7	19	mg/L
A-1	Carbonate	<2	<2	mg/L
A-1	Hardness as CaCO3(SM-2340B)	118000	21300	µg/L
A-1	pH	8	6.1	s.u.
A-1	Total Calcium	43300	6410	µg/L
A-1	Total Dissolved Solids	154	93	mg/L
A-1	Turbidity	6.1	150	NTU
A-3	Alkalinity (as CaCO3)	29	7	mg/L
A-3	Bicarbonate (as CaCO3)	29	7	mg/L
A-3	Carbon Dioxide (Estimate)	1.6	6	mg/L
A-3	Carbonate	<2	<2	mg/L
A-3	Hardness as CaCO3(SM-2340B)	37000	11500	µg/L
A-3	pH	7.7	6.3	s.u.
A-3	Total Calcium	9950	2830	µg/L
A-3	Total Dissolved Solids	114	86	mg/L
A-3	Turbidity	11	95	NTU
A-4	Alkalinity (as CaCO3)	20	7	mg/L
A-4	Bicarbonate (as CaCO3)	20	7	mg/L
A-4	Carbon Dioxide (Estimate)	3	13	mg/L
A-4	Carbonate	<2	<2	mg/L
A-4	Hardness as CaCO3(SM-2340B)	22800	10200	µg/L
A-4	pH	7.1	6.1	s.u.
A-4	Total Calcium	4770	2290	µg/L
A-4	Total Dissolved Solids	99	86	mg/L
A-4	Turbidity	9.9	48	NTU
A-5	Alkalinity (as CaCO3)	17	6	mg/L
A-5	Bicarbonate (as CaCO3)	17	6	mg/L
A-5	Carbon Dioxide (Estimate)	4	9	mg/L
A-5	Carbonate	<2	<2	mg/L
A-5	Hardness as CaCO3(SM-2340B)	23900	10100	µg/L
A-5	pH	6.9	6.2	s.u.
A-5	Total Calcium	5200	2250	µg/L
A-5	Total Dissolved Solids	102	80	mg/L
A-5	Turbidity	13	42	NTU

Table 19 (continued)

Site	Analyte Description	Result 02.24.11	Result 03.09.11	Units
A6	Alkalinity (as CaCO3)	26	4	mg/L
A6	Bicarbonate (as CaCO3)	26	4	mg/L
A6	Carbon Dioxide (Estimate)	8	5	mg/L
A6	Carbonate	<2	<2	mg/L
A6	Hardness as CaCO3(SM-2340B)	27100	8230	µg/L
A6	pH	7	6.1	s.u.
A6	Total Calcium	6700	1970	µg/L
A6	Total Dissolved Solids	70	75	mg/L
A6	Turbidity	11	56	NTU
A7	Alkalinity (as CaCO3)	62	5	mg/L
A7	Bicarbonate (as CaCO3)	62	5	mg/L
A7	Carbon Dioxide (Estimate)	15	7	mg/L
A7	Carbonate	<2	<2	mg/L
A7	Hardness as CaCO3(SM-2340B)	105000	15000	µg/L
A7	pH	6.8	6.1	s.u.
A7	Total Calcium	35400	4600	µg/L
A7	Total Dissolved Solids	134	79	mg/L
A7	Turbidity	12	28	NTU
A-9	Alkalinity (as CaCO3)	38	8	mg/L
A-9	Bicarbonate (as CaCO3)	38	8	mg/L
A-9	Carbon Dioxide (Estimate)	4	6	mg/L
A-9	Carbonate	<2	<2	mg/L
A-9	Hardness as CaCO3(SM-2340B)	37500	12800	µg/L
A-9	pH	7.2	6.1	s.u.
A-9	Total Calcium	10900	3410	µg/L
A-9	Total Dissolved Solids	56	89	mg/L
A-9	Turbidity	6.4	52	NTU

Table 19 (continued)

Site	Analyte Description	Result 03.09.11	Units

CHAPTER VII

DISCUSSION

Reservoir Daily Water Storage Models

All of the reservoir daily water storage models support the development of a reservoir based upon the results. The full reservoir value at full pool is 129,100 acre-feet. The 1963 worst precipitation year model shows a maximum drop in water level to 125,500 acre-feet at around day 160. A decrease of 3,600 acre-feet of water would decrease the amount of water in the reservoir by approximately 3 percent. The 1973 best precipitation year model shows a maximum drop of about 500 acre-feet of water at around day 135. A drop of 500 acre-feet of water would decrease the amount of water in the reservoir less than a half of percent. The 1961-2002 average precipitation model shows a maximum decrease in the amount of water in the reservoir on about day 270. The amount of water stored in the reservoir at that time is 127,800 acre-feet. A decrease of 1,300 acre-feet of water decrease the percent of water in the reservoir by approximately 1 percent.

For the sake of experimentation a fourth model was run. All values within this model stayed the same except a value of 25 acre-feet or 8 million gallons per day was placed in the seventh column, withdrawal. The 1963 lowest precipitation model was used. The model showed a maximum decrease in water availability in the basin at day 155 and was at full pool status by day 340. The amount of water stored in the reservoir

on day 155 was 123,300 cubic-feet of water or a decrease of 5 percent of the total reservoir volume. No graph for this model is shown.

Evaluation of the Glendon Limestone

Field Surveys

Outcrops located and observed during the field surveys include: the Forest Hill Formation of the Oligocene Series, the Glendon Formation from the Vicksburg Group of the Oligocene Series (Figure 40, 41), and the Catahoula Formation of the Miocene Series. The Forest Hill and Catahoula Formations were used as marker beds in order to better locate the Vicksburg Group. Weathering had an effect on the Glendon Limestone. Dissolution and erosional features were present as seen in the below figures.

Figure 40 Glendon outcrop with karst features (32°05’09.4’’ N, 89°33’59.1’’ W)

Figure 41 Glendon weathering beneath fallen tree (32° 05' 03.2" N, 89° 34' 02.3" W)

Ground Penetrating Radar

The Batte property was an area of interest for investigation due to the karst features present in the Glendon Limestone located along a creek bottom (Figure 42). The surveyed areas were prepped for GPR work by manually clearing out underbrush. Areas surveyed were located above the creek bottom on the floodplain of the creek. The Batte property is located west of the intersection of State Highway 35 and County Road 481. Batte property investigations were titled: Batte NE, Batte W, and Batte S. The property of James Taylor was the second area of interest due to the presence of three distinct sink holes (Figure 43) which may have represented surface expressions of karst geology. The site was prepped for GPR work by bush hogging the grass. James Taylor's property was located on Boykin Church Road across from Sharon Church.

Figure 42 Limestone dissolution features in creek bottom (no scale)

Figure 43 James Taylor sinkholes near Oakohay Creek

The Batte investigation took place after an overnight precipitation event of 0.25 inches under a canopy of immature pine trees. Subsurface material investigated at the Batte location was of a clayey nature and appeared to be hydrated. A 100MHz antenna was used at this location and obtained a depth of penetration of about 3 meters; therefore, very little information about the Glendon Limestone could be inferred due to the lack of penetration. However, an image displaying evidence of paleo channels and cross bedding is interpreted on the cross section Batte S in the Appendix.

Figure 44, depicts the work performed at the James Taylor site. A gridded survey (bold square) and linear surveys (lines and squares) were shot on the Taylor property. The 50MHz, 100MHz, and 250MHz antennas were used on the James Taylor site. Subsurface anomalies that could be interpreted as karst were identified in the subsurface using GPR at the James Taylor site. In the figure the red square that is bolded, location 1 ($32^{o}05'22.1''N$, $89^{o}33'56.7''W$), marks the area of the three sinkholes which was investigated by shooting GPR in a gridded pattern spaced at 2 meter increments. In Figure 45 the same sinkholes are represented by gaps in the grid pattern. The x-axis runs from the west to the east a total distance of 40 meters. The y-axis runs from the south to the north a total distance of 20 meters. The sinkhole features get less prominent when moving from the west to the east. At location 1 a comparative analysis for varying the antennas from the 50MHz, 100MHz, and 250MHz antennas was performed. The 250MHz antenna was used only briefly due to its depth of penetration being negligible. The 100MHz antenna averaged a depth of penetration of approximately 3 meters; whereas, the 50MHz antenna averaged a depth of penetration of about 11 meters. The trade off for varying the MHz of antennas is depth of penetration vs. resolution. Higher MHz antennas have a lesser depth of penetration but a greater resolution. The reason all

three antennas were used at location 1 was to maximize both penetration and resolution of subsurface data. Using the 50MHz antenna, a feature was identified that appeared to be evidence of dissolution features in the Vicksburg Limestone. The feature had a vertical offset of 4 meters and was located between 19 meters and 38 meters. The same feature could somewhat be identified using the 100MHz antenna but could not be identified by using the 250MHz antenna. In the results sections note the significant decrease in depth of penetration and increase in resolution into the subsurface as the MHz of the antennas was increased.

Figure 44 Aerial map of James Taylor GPR gridded survey and linear

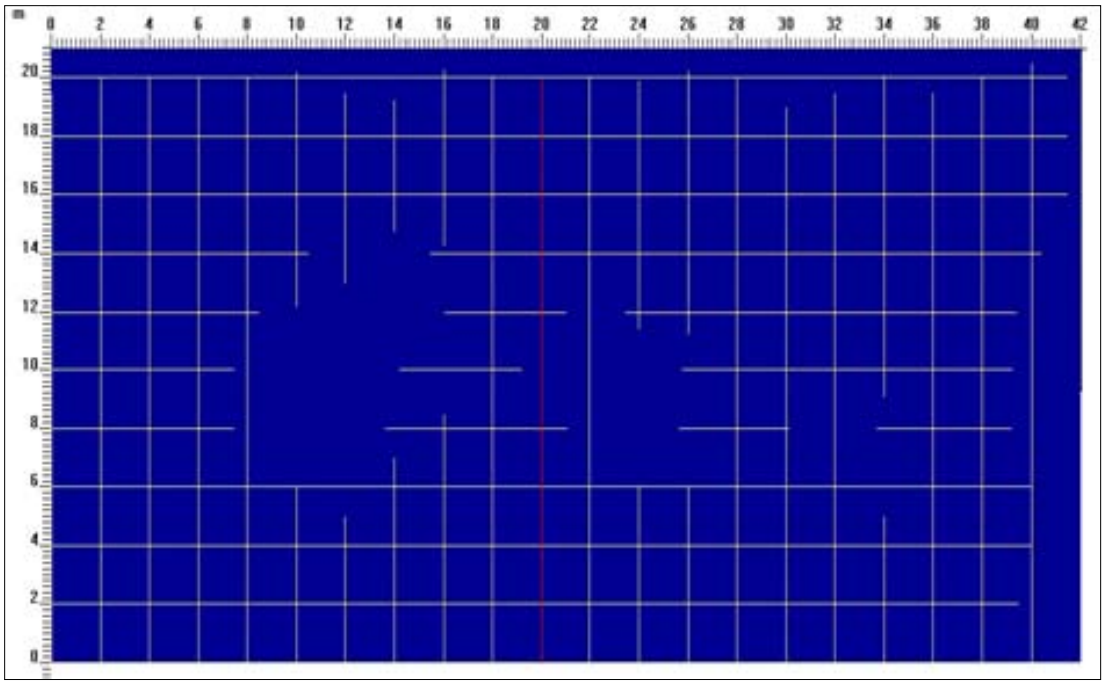


Figure 45 TeaCo Geophysical grid around James Taylor sinkholes

The GPR investigation on the property of James Taylor (Figure 16) was also investigated by shooting linear surveys on numerous other suspect features which may have represented surface expressions of karst geology. The longest survey shot was line 4 which started at 32° 5'22.19399"N, 89°33'49.75920"W and ran due west a total length of 924 feet with an elevation change of approximately 42 feet. Survey line 4 appeared to identify many karst or dissolution features in the subsurface. The apparent dissolution feature was approximately 1.3 meters wide and 2.5 meters below ground. Another example of a dissolution feature was distinguished by a significant arcuate, concave up reflector at 116 meters and an arcuate, concave down reflector at 144 meters. Based upon results from the multiple frequencies GPR surveys on both gridded and linear shoots performed by TeaCo Geophysical it was recommended that further investigation of the subsurface be conducted. The technique recommended was sonic drilling. Sonic

drilling is an invasive technique that would use core recovery to evaluate the subsurface geology.

Sonic Rig Drilling

Boreholes JTB-1 through JTB-13 were drilled to validate the GPR work (Figure 53). BMB-1, BMB-2, and WHB-1 were drilled to investigate areas Tellus Operating Group had reported blind holes at during a 2005 - 2006 seismic study. Blindholes refer to borings that are drilled and lose circulation. Borehole 481-SONIC was drilled to investigate previous boreholes drilled by Burns Cooley Dennis, Incorporated in which a seven foot bit drop was experienced (Figure 46). JTB-1 was the first borehole drilled. It was drilled within the area the GPR gridded survey had been conducted. The borehole did experience a loss of circulation of drilling water at a depth of 20 feet within the Mint Spring Marl. This formation is very sandy and it is believed that the loss of circulation was due to the permeability of the strata. A pump test was performed on this borehole on 02.24.11. The borehole had approximately 1,000 gallons of water at a rate of 1.13 gallons per second pumped into it. After the pump test was complete the 4 inch PVC pipe was left in the borehole for investigation with a down hole digital video camera on 04.20.11. The camera showed a minuscule space beneath the massive limestone which was probably formed during the pump test. Water loss during the pump test was permeating through the weathered zones as opposed to solution cavities. Water level measurements have been taken in the well. On 02.21.11 the depth to water was 16.4 feet and on 03.09.11 the depth to water was 7.8 feet. It is noted that the water level in the well is higher than the water level within Oakohay Creek thus allowing a presumption that the well and Oakohay Creek are not connected by any conduits.

Figure 46 Aerial map of sonic borehole locations

JTB-8 was the first borehole drilled which had a full sequence of stratigraphic units ranging from the Catahoula Formation to the Forest Hill Formation. The Glendon

Limestone was hard, calcareous, and reacted to hydrochloric acid (Figure 47). The borehole was filled with Bentonite chips upon completion. BMB-2 encountered the Glendon Limestone at a depth of 5 feet to 20 feet. The limestone was highly weathered and Bentonite was present. The borehole was filled with Bentonite chips upon completion. 481-SONIC was the last borehole drilled and it was the only other borehole that experienced a loss of circulation while being drilled. A 7 foot bit drop was experienced at this location in the McIlwain study; however, that was not the case this time. A loss of circulation occurred in the Glendon Limestone at a depth of 20 to 21 feet but no bit drops. A 26 foot thick section of Bentonite was encountered after drilling through the Glendon Limestone. Today it is presumed that the 7 foot bit drop experienced during the McIlwain study is a misinterpretation of data. The bit dropping at a fast rate is believed to be due to extra pressure being used to drill through the Glendon Limestone. After the bit drilled completely through the hard limestone the bit drilled through a soft Bentonite at an extremely fast rate. The interpretation of the fast bit drop assumed there to be a void. During the study Bentonite was consistently found beneath the ledges of the Glendon Limestone which also explains the blind holes reported by Tellus Operating Group during a 2005 - 2006 seismic study. A 4 inch PVC pipe was placed in the borehole to allow for the well to be further investigated with the down hole digital video camera. No void spaces or caves were seen with the camera. Highly weathered and oxidized zones similar to the cores recovered by the drill rig were seen. Highly weathered and oxidized zones of the Glendon Limestone were commonly observed above the water table and in fractured portions of the core recovered. The Glendon Limestone located beneath the water table or without fractures had not been weathered or oxidized.

Figure 47 Reaction of HCl acid and $CaCO_3$

Surface Water Quantity Measurements

The dedicated stream water level indicator and rain gauge installed to assist in coordinating sampling events did not provide the data that was hoped for due to the high flow event which caused the unit to cease transmitting data. The debris test method and ADP unit proved to be successful when monitoring discharge measurements. The accuracy of discharge measurements can be seen in the R^2 values displayed in the hydrographs. A screen shot of data produced by the Teledynes RDI's WinRiver II software is shown in Figure 48.

The hydrographs prove that the monitoring points located along Oakohay Creek have an increase in discharge amounts when moving from the north to the south. No major water losses were recorded which would indicate a potential loss of basin water in Oakohay Creek. The hydrograph for B-3 indicated no additional water from outside its basin was being collected. As did the hydrographs for C4, C-5, and C-6; however, on 09.16.10 a water loss from C-5 to C-6 was recorded. The upstream discharge monitoring

point, C-5, recorded a significantly higher discharge rate than C-6. It is believed that a possible beaver dam was the reason for the 20 cubic feet per second discharge variance between C-5 and C-6. It is therefore assumed that at the time of the study there were no conduits which connected Little Oakohay Creek to Oakohay Creek and Oakohay Creek to Shongelo Creek. All streams monitored are classified as flashy.

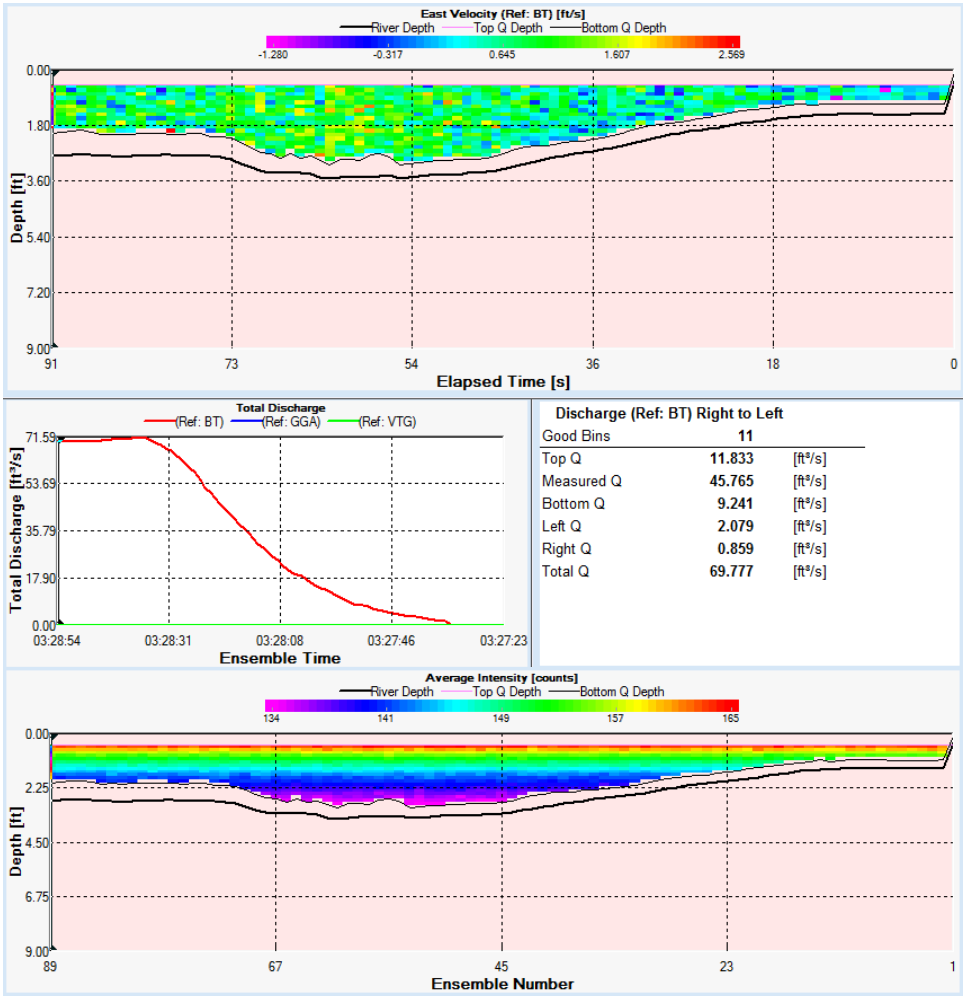


Figure 48 Site A-9 data as displayed in WinRiver II software

Surface Water Quality Analysis

The data collected from the surface water quality analysis performed in the field had very similar characteristics. Monitoring sites A-1 through A-10 (Oakohay Creek), B-1 through B-3 (Little Oakohay Creek), and C-1 through C-6 (Shongelo Creek) water quality characteristics ranged from: 82 to 44 degrees Fahrenheit; 7.63 to 4.95 s.u. pH; 311 to 14.34 µS/cm Conductivity; 18.58 to 1.04 mg/L Dissolved Oxygen; 385 to 3.50 NTU Turbidity; and 0.83 to 0.22 mg/L Nitrates. The variance in temperature was due to seasonal changes. The temperature of the surface water was warmest on 09.16.10 and coolest on 02.03.10. The pH was relatively neutral throughout the study except for the high flow event on 03.09.11 During this event the average pH was around 5.7 s.u. this reflects the pH of the rainwater. More basic pH measurements were taken when the rainwater had a greater residence time as surface water. Conductivity for all site locations is low when compared to the United States Environmental Protection Agency (EPA) averages for the nation. The EPA states that conductivity levels in rivers in the United States generally range from 50 to 1500 µS/cm. Good water quality that can support a variety of fish has a range between 150 and 500 µS/cm (EPA, 2011). Conductivity measurements were higher on 02.03.10 and lower on 03.09.11 which indicates that the longer the residence time of the rainwater with the surficial geology the greater the conductivity. Dissolved oxygen measurements thorough the study were consistent and averaged approximately 10 mg/L which is an acceptable amount for the sustaining of life. During the high flow event the lowest dissolved oxygen levels were recorded. Turbidity was higher during high flow events but the average for the entire study was approximately 64 NTU. Nitrate analysis was performed during two sampling events and levels averaged around 0.4 mg/L.

Surface water quality analysis performed in the laboratory was done twice. The first sampling event was for a baseflow event on 02.16.11 and 02.24.11. The second sampling event was for a high flow event on 03.09.11. Trends in the data were seen and due to the baseflow and high flow sampling events occurring close to the same time water temperatures were similar. During the baseflow event alkalinity, bicarbonate, carbonate, hardness, pH, total calcium, and total dissolved solids had higher values than the high flow event. During the high flow event carbon dioxide and turbidity had higher values then they did during the baseflow event. The pH and turbidity values measured in the laboratory are similar to those measured in the field. A correlation between hardness as $CaCO_3$ and discharge was made. During the baseflow event the water was classified as soft, 0-60 mg/L, and during the high flow event the water was classified as moderately hard, 61- 120 mg/L (Sutch and Dirth, 2006). As discharge amounts of water increased the hardness as $CaCO_3$ and total calcium decreased. This may be due to the rainwater having less residence time to contact the surficial geology or may be due to the increase of stream water diluting the $CaCO_3$ values. Higher values indicating water contacting $CaCO_3$ material was seen in the sampling locations where Glendon Limestone was outcropping such as at locations A-1, A-5, A-6, A-7, and B-3. Sampling locations that were located north of the Glendon Limestone had significantly less $CaCO_3$ results than the sampling locations south of the Glendon Limestone. However, sampling locations south of the Glendon Limestone saw progressively less and less $CaCO_3$ present in the water the further downstream the sampling location was from the limestone outcrops.

CHAPTER VIII

CONCLUSIONS

The hydrology and geology of Oakohay Creek has been assessed for the United States Forest Service in order to build a 2,700 acre surface water reservoir by constructing a dam to impound water on Oakohay Creek in Smith County, Mississippi. Based upon the daily water storage models the reservoir would receive an adequate supply of water in order for the water level to maintain full pool status at the 400 foot contour line for the majority of the year. Baseflow and high flow sampling event data and hydrographs can be used to support that conclusion. Even though the baseflow for Oakohay Creek was approximately zero the high amount of precipitation in Mississippi would allow for the reservoir to maintain the designated water level.

The geologic study evaluated the limestone in the Glendon Formation through field surveying, ground penetrating radar, sonic rig drilling, surface water quantity measurements, and surface water quality analysis supports the development of a reservoir at the proposed location. The results conclude that connected conduit in the Glendon Limestone, dissolution at the dam site, and sediment-filled conduit blow outs would not occur. Field surveying, ground penetrating radar, and sonic rig drilling found no areas of concern where water loss would occur. Karst processes have not formed significant features where water loss would occur within the reservoir footprint area. Surface water quantity measurements confirmed that Little Oakohay Creek, Oakohay Creek, and Shongelo Creek are not connected via subsurface conduits. Surface water quality

analysis proved that surface water was in contact with calcium carbonate material and that the greater the residence times of the water and calcium carbonate material the higher the values of certain analytes.

The Glendon Formation is located within the reservoir footprint area and it is weathering. The hard ledges of limestone located above the water table are weathering and is more friable in nature than the unweathered limestone. The soft clay marl ledges in between the limestone and located above the water table are chemically altering into Bentonite. This is believed to be true based on the Oligocene fossils molds found in the Bentonite. The process typically happens above the water table on high ridge tops. As the clayey marl chemically alters into Bentonite a volume reduction occurs thus explaining the blind holes experienced by Tellus Operating Group and Walker-Hill Environmental.

A series of three drawings that are not to scale have been devised to assist with the geologic interpretation of the area. The reservoir is displayed at full pool level. Figure 49 is the legend for the stratigraphic units of the three drawings. Figure 50 depicts surface weathering of the Glendon Formation and the transformation of the clayey marl into Bentonite. Figure 51 depicts slightly subsurface strata being oxidized and weathered. Figure 52 depicts the Glendon Formation which is unoxidized and unweathered.

Additional research for this project should be conducted before final conclusions are made as to whether or not to proceed with the development of the reservoir. The additional research should include aspects of hydrology, geology, and water quality. Further investigation of the site location should include but not be limited to: surface water quantity discharge measurements and hydrograph development, drilling on the east

side of the proposed reservoir, construction of geological cross sections from driller's logs, and water quality testing with analysis. The additional research will provide further data to either support or reject the hypothesis. However, based upon the results of this study, the proposed reservoir location is suitable for development in regards to hydrology and geology; therefore, the hypothesis is refuted.

Figure 49 Legend for stratigraphic units in study area

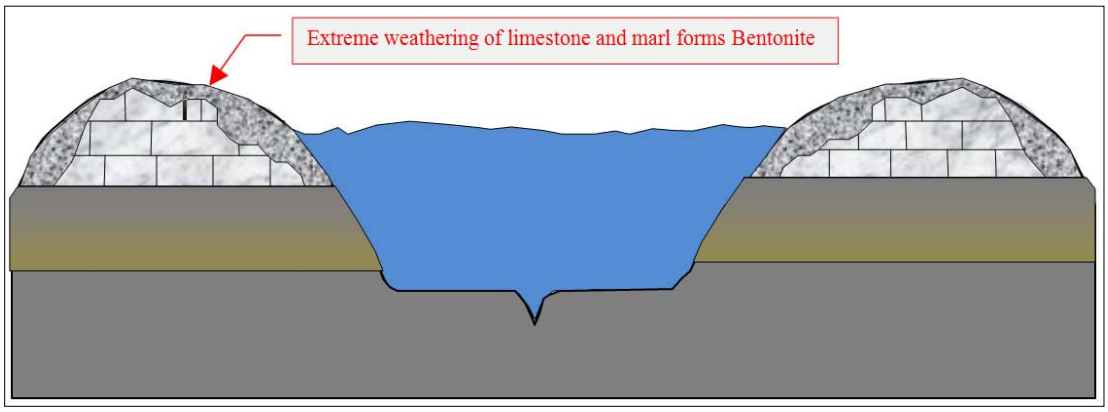


Figure 50 Surface weathering of the Glendon Limestone

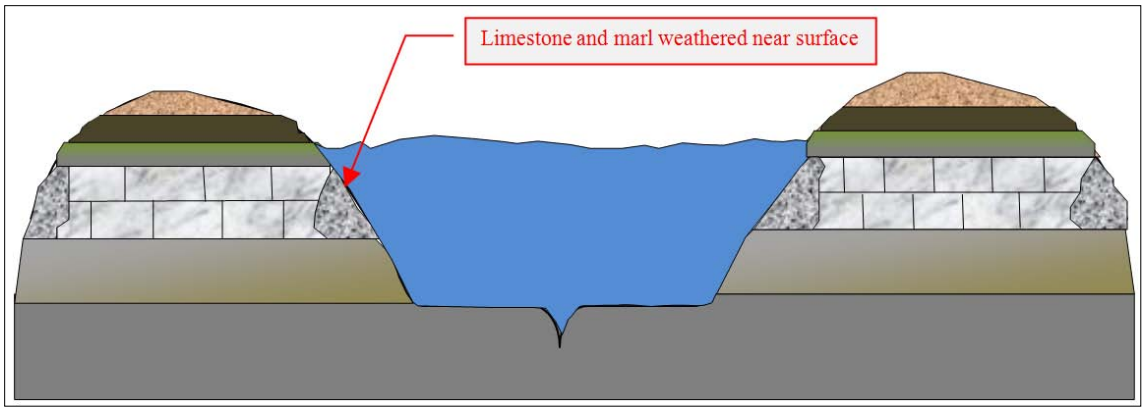


Figure 51 Subsurface Glendon Limestone being weathered and oxidized

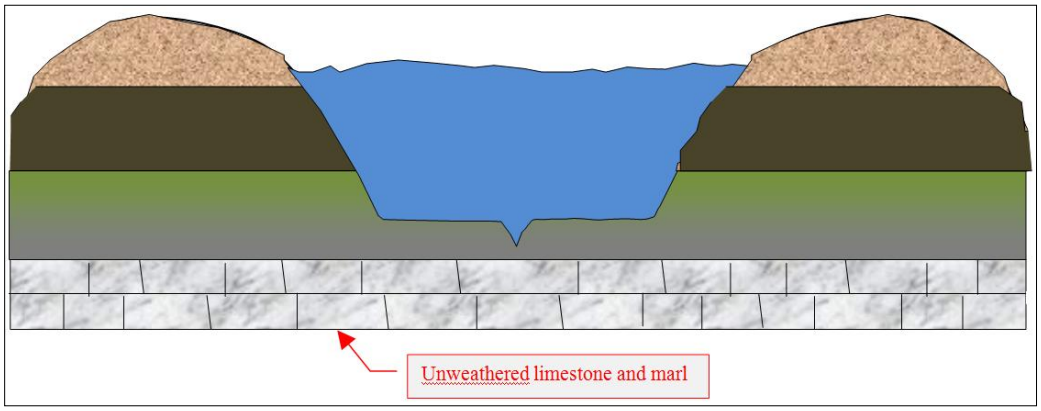


Figure 52 Unweathered and unoxidized Glendon Limestone

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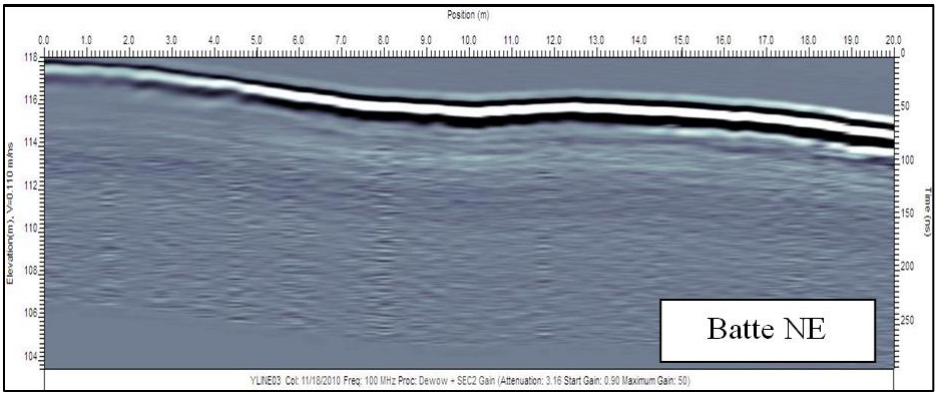
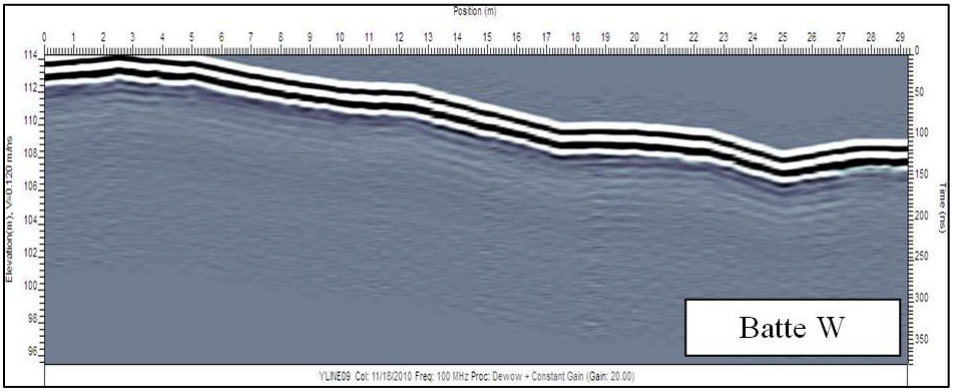
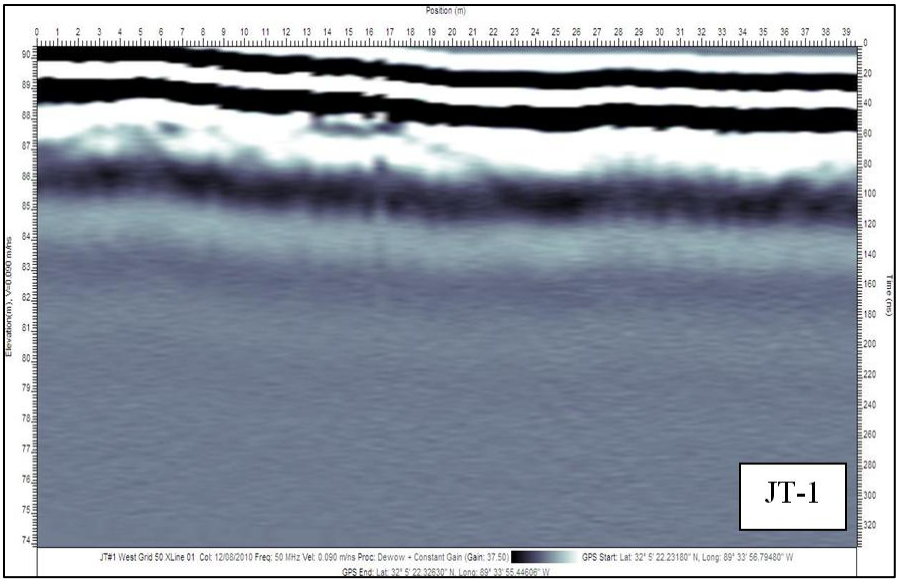
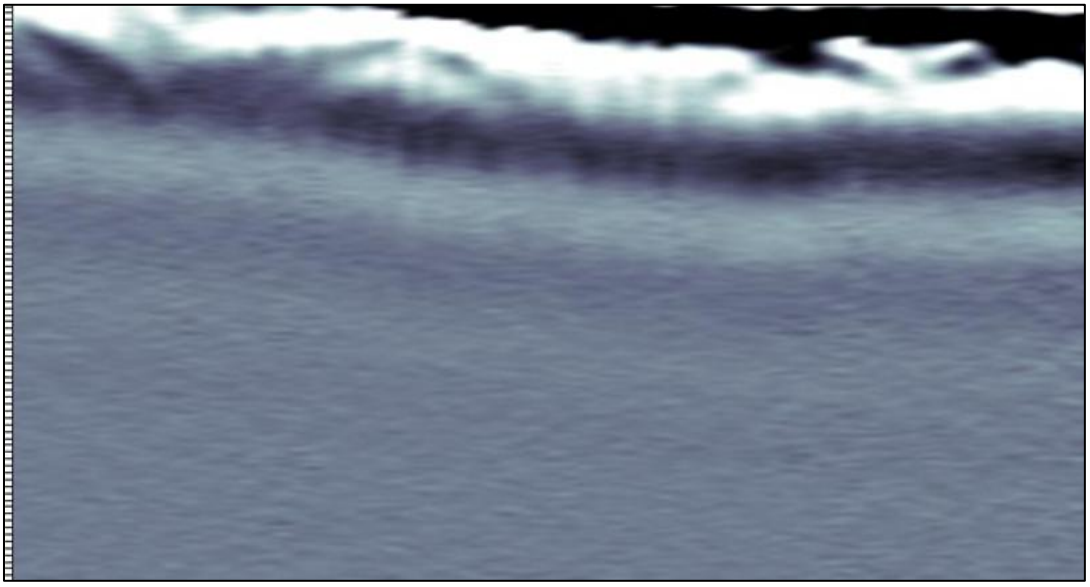
APPENDIX A

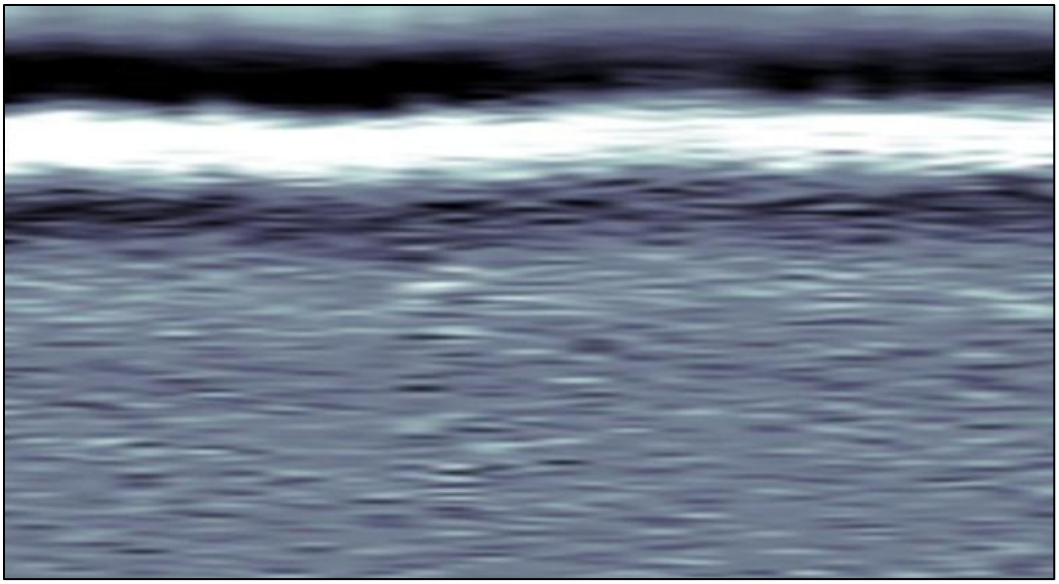
GROUND PENETRATING RADAR IMAGES

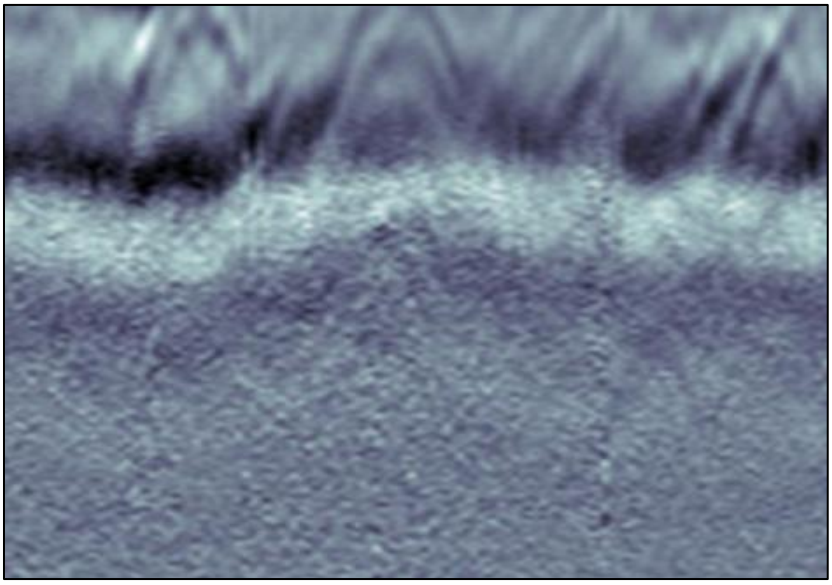


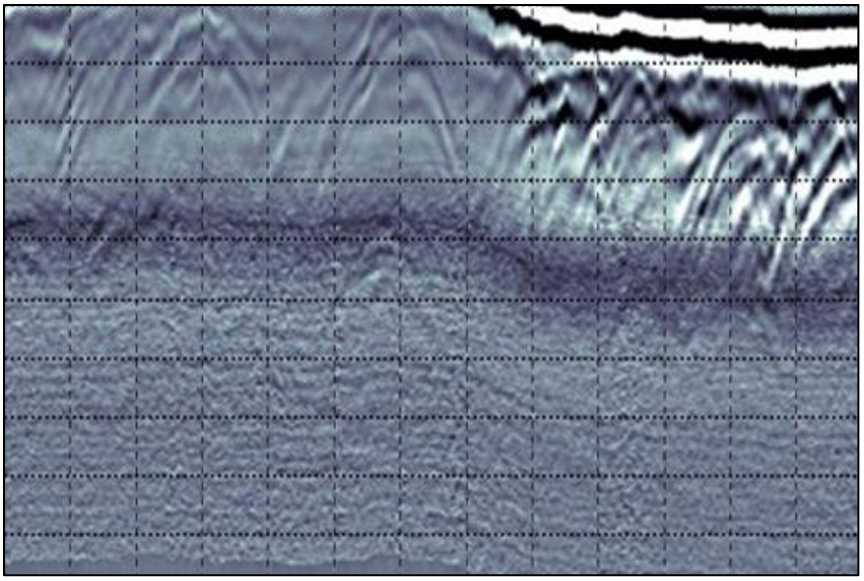


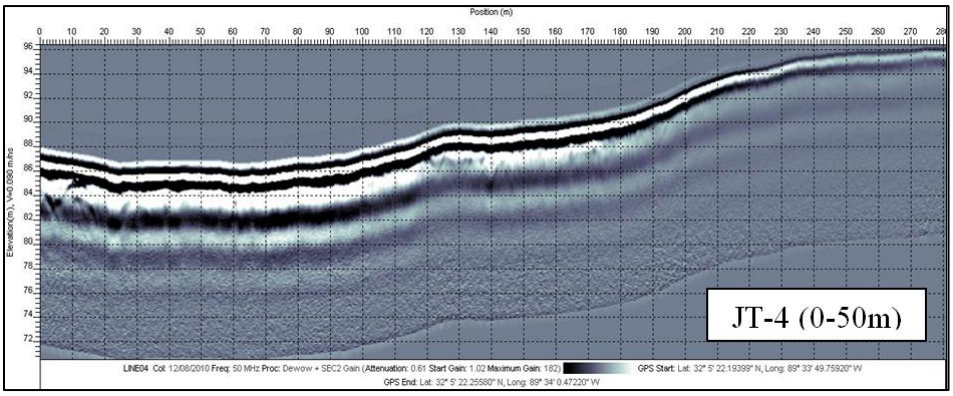


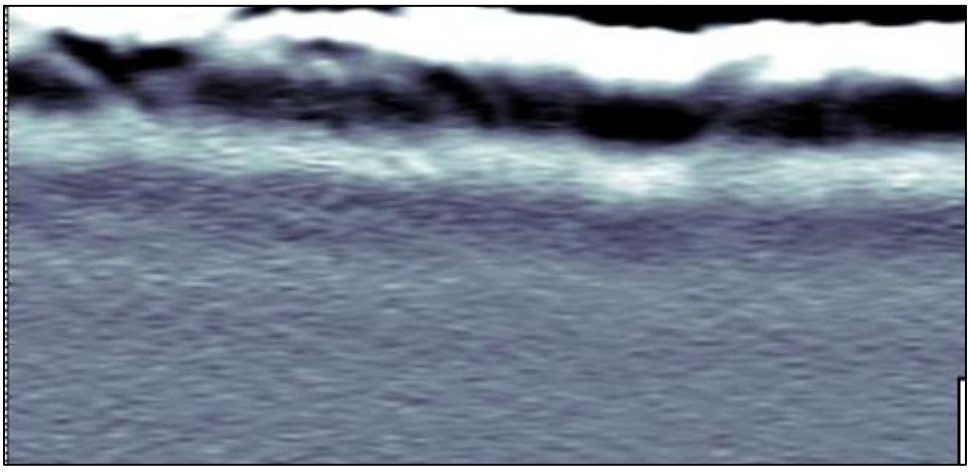


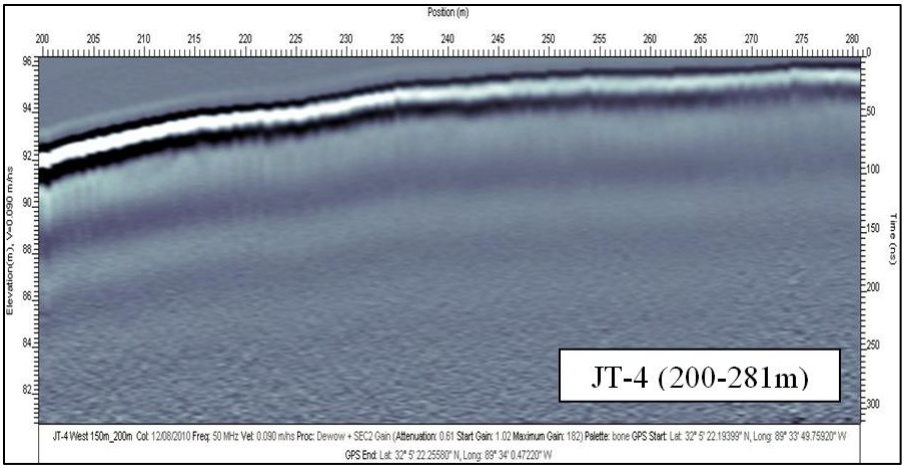


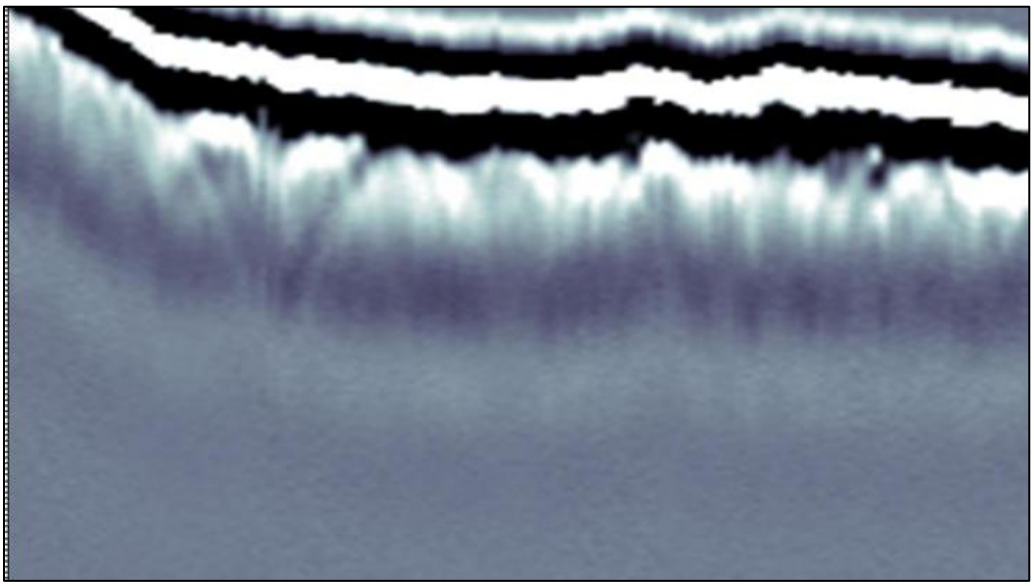












APPENDIX B

BORING LOGS

BORING LOG

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Boring/Well No.: JTB-2 Name/Project No.: SMITH COUNTY RESERVOIR

Date: 2-21-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 377

Notes: LOCATION: 32.089702N, 89.565188W

Depth ft. From	To	SOIL DATA SOIL DESCRIPTIONS AND REMARKS	Time
0	11	(Terrace)Sand, red, fine to med. grained, oxidized	
11	14	**(Glendon Fm)** -Marl, brown, highly weathered. bentonitic	
14	29	Marl, tan to greenish gray, fossiliferous, glauconitic Soft and/or voids 21to 22ft	
29	31	Limestone, greenish gray, hard, fossiliferous,	
31	36	(Mint Spring Fm) –Marl, greenish gray, fossiliferous, glauconitic	
36	40	(Forest Hill) Clay, dark gray, silty, fossils in upper part	

BORING LOG

Page 1 of 1

Boring/Well No.: JTB-3 Name/Project No.: SMITH COUNTY RESERVOIR

Date: 2-21-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 370

Notes: LOCATION: 32.089775N ,89.565166W

Depth (ft) From	Depth (ft) To	SOIL DATA SOIL DESCRIPTION AND REMARKS	Time
0	13	**(Terrace)** Sand, red and gray, ,mottled, sandy, oxidized	
13	17	**(Glendon Fm)** - Marl, tan, fossiliferous, glauconitic, weathered	
17	20	Limestone, greenish gray, fossiliferous, glauconitic	
20	35	**(Mint Spring Fm)** Marl, light gray, fossiliferous, glauconitic	
35	40	**(Forest Hill Fm)** –Clay, dark gray, silty, carbonaceous	

BORING LOG

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Boring/Well No.: JTB-4 Name/Project No.: SMITH COUNTY RESERVOIR

Date: 2-22-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 403

Notes: LOCATION: 32.089670N, 89.566434W

Depth ft		SOIL STRATA	Time
From	To	SOIL DESCRIPTIONS AND REMARKS	
0	15	**(Terrace)** Clay, red and gray, ,mottled, sandy, oxidized	
15	29.5	Sand, red and yellow, oxidized, dark brown layer at contact with tan marl	
29.5	34	**(Glendon Fm) -**Marl, tan, fossiliferous, glauconitic, weathered	
34	36	Marl, light gray, fossiliferous, glauconitic	
36	40	Limestone, greenish gray, fossiliferous, glauconitic	
40	49	**(Mint Spring Fm)** –Marl, light gray, glauconitic , fossiliferous	
49	60	**(Forest Hill Fm)** Clay, dark gray, silty, fossils in upper part	

BORING LOG

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Boring/Well No.: **JTB-5** Name/Project No.: **SMITH COUNTY RESERVOIR**

Date: **2-22-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: **FAIR** Elevation: 395

Notes: **LOCATION: 32.089757N. 89.567277W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	9	**(Terrace)**Sand, red and gray, ,mottled, sandy, med to coarse grained, oxidized	
9	14	**(Byram Fm) -**Marl, brown and black, weathered, fossiliferous, glauconitic	
14	23	Marl, tan, fossiliferous, glauconitic	
23	25	**(Glendon Fm) -**Limestone, greenish gray, fossiliferous, glauconitic	
25	30	Marl, light gray, fossiliferous, glauconitic	

BORING LOG

Page 1 of 1

Boring/Well No.: **JTB-6** Name/Project No.: **SMITH COUNTY RESERVOIR**

Date: **2-22-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: **FAIR** Elevation: 397

Notes: **LOCATION: 32.085832N. 89.567672W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	12	**(Terrace)**Sand, red and gray, ,mottled, sandy, med to coarse grained, oxidized	
12	24	**(Byram Fm) -**Marl, brown and black, weathered, fossiliferous, glauconitic	
24	27	Marl, light gray, fossiliferous, glauconitic	
27	30	**(Glendon Fm)**-Limestone, greenish gray, fossiliferous, glauconitic	
30	46	Marl, light gray, fossiliferous, glauconitic	
46	48	Limestone, greenish gray, fossiliferous, glauconitic	
48	59	**(Mint Spring Fm)** –Marl, light gray, glauconitic , fossiliferous	
59	60	**(Forest Hill Fm)** Clay, dark gray, silty, fossils in upper part	

BORING LOG

Page 1 of 1

Boring/Well No.: **JTB-7** Name/Project No.: **SMITH COUNTY RESERVOIR**

Date: **2-22-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: **FAIR** Elevation: 368

Notes: **LOCATION: 32.089500N. 89.564457W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	12	**(Alluvium)** – Clay, brown, silty grading to sand and pea gravel near Forest Hill contact	
12	20	**(Forest Hill Fm)** –Clay, dark gray, carbonaceous, micaceous	

BORING LOG

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Boring/Well No.: JTB-9 Name/Project No.: **SMITH COUNTY RESEVOIR**

Date: 2-23-2011 Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 380

Notes: **LOCATION: 32.089324 N, 89.565538W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	9	**(Terrace)** Sand, red, fining upward, silty, weathered	
9	11	(**Byram Fm**)-Clay, brown, silty, weathered marl	
11	20	Marl, medium gray, calcareous, glauconitic, fossiliferous	
20	22	**(Glendon Fm) -**Limestone, light gray, hard, calcareous, fossiliferous	
22	27	Marl, greenish gray, calcareous, glauconitic, fossiliferous	
27	28	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
28	33	**(Mint Spring Fm)** Marl, greenish gray, calcareousl, fossiliferous, glauconitic	
33	40	**(Forest Hill Fm)** – Clay, light to dark gray, silty, lignitic, fossiliferous lenses	

BORING LOG

Page 1 of 1

Boring/Well No.: JTB-10 Name/Project No.: **SMITH COUNTY RESEVOIR**

Date: 2-23-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 389

Notes: **LOCATION: 32.089735 N, 89.565715W**

Depth ft		SOIL STRATA	
From	To	SOIL DESCRIPTIONS AND REMARKS	Time
0	9	**(Terrace)** Sand, red, fining upward, silty, weathered	
9	13	**(Glendon Fm)**- Marl, brown, highly weathered	
13	17	Marl, medium gray, calcareous, glauconitic, fossiliferous	
17	20	-Limestone, light gray, hard, calcareous, fossiliferous	
20	28	Marl, greenish gray, calcareous, glauconitic, fossiliferous	
28	30	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
30	37	**(Mint Spring Fm)** Marl, greenish gray, calcareous, fossiliferous, glauconitic	
37	40	**(Forest Hill Fm)** – Clay, light to dark gray, silty, lignitic, fossiliferous lenses	

BORING LOG

Page 1 of 1

Boring/Well No.: JTB-11 Name/Project No.: SMITH COUNTY RESEVOIR

Date: 2-23-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 387

Notes: LOCATION: 32.089569 N, 89.565739W

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	8	**(Terrace)** Sand, red to brown, fining upward, silty, weathered	
8	12	**(Byram Fm)** –Marl, brown and red mottled, clayey, highly weathered	
13	19	Marl, medium gray, calcareous, glauconitic, fossiliferous	
19	20	**(Glendon Fm) -**Limestone, light gray, hard, calcareous, fossiliferous	
20	25	Marl, greenish gray, calcareous, glauconitic, fossiliferous	
25	27	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
27	29	Marl, greenish gray, calcareous, fossiliferous, glauconitic	
29	31	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
31	35	**(Mint Spring Fm)**-Marl, greenish gray to dark gray, calcareous, glauconitic, fossiliferous	
35	40	**(Forest Hill Fm)** – Clay, light to dark gray, silty, lignitic, fossiliferous lenses	

BORING LOG

Page 1 of 1

Boring/Well No.: JTB-12 Name/Project No.: SMITH COUNTY RESEVOIR

Date: 2-23-2011 Drilling Co.: WALKER Drill Rig Type: SONIC

Drilling Method: CORING

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 403

Notes: LOCATION: 32.089569 N, 89.565739W

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	7	**(Terrace)** Sand, , red to brown, fining upward, medium grained to pea gravel, silty, weathered	
7	12	**(Glendon Fm) -**Marl, brown and red mottled, clayey, highly weathered	
12	18	Marl, greenish gray, calcareous, glauconitic, fossiliferous	
18	20	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
20	22	Marl, greenish gray, calcareous, fossiliferous, glauconitic	
22	23	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
23	30	**(Mint Spring Fm)**-Marl, greenish gray, calcareous, glauconitic, fossiliferous	
30	40	**(Forest Hill Fm)** – Clay, medium to dark gray, silty, lignitic, fossiliferous lenses	

BORING LOG

Page 1 of 1

Boring/Well No.: **JTB-13** Name/Project No.: **SMITH COUNTY RESERVOIR**

Date: **2-24-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: **FAIR** Elevation: 391

Notes: **LOCATION: 32.089777N, 89.567107W**

Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	5	**(Terrace)**Sand, brown, ,mottled, med to coarse grained, oxidized	
5	15	Sand, red, silty, oxidized	
15	18	**(Byram Fm)** -Marl, tan, weathered, fossiliferous, glauconitic	
18	20	**(Glendon Fm)** -Limestone, greenish gray, fossiliferous, glauconitic	
20	28	Marl, light gray, fossiliferous, glauconitic	
28	30	Limestone, greenish gray, fossiliferous, glauconitic	
30	34	Marl, light gray, fossiliferous, glauconitic	
34	35.5	Limestone, greenish gray, fossiliferous, glauconitic	
35.5	42	**(Mint Spring Fm)** -Marl, med. Gray, wet, fossiliferous, glauconitic	
42	50	**(Forest Hill Fm)** -Clay, dark gray, carbonaceous, fossils in upper part	

BORING LOG

Page 1 of 1

Boring/Well No.: **BMB-1** Name/Project No.: **SMITH COUNTY RESEVOIR**

Date: **2-24-2011** Drilling Co.: **WALKER** Drill Rig Type: **SONIC**

Drilling Method: **CORING**

Geologist/Logger: JAMES MAY Weather Conditions: FAIR Elevation: 439

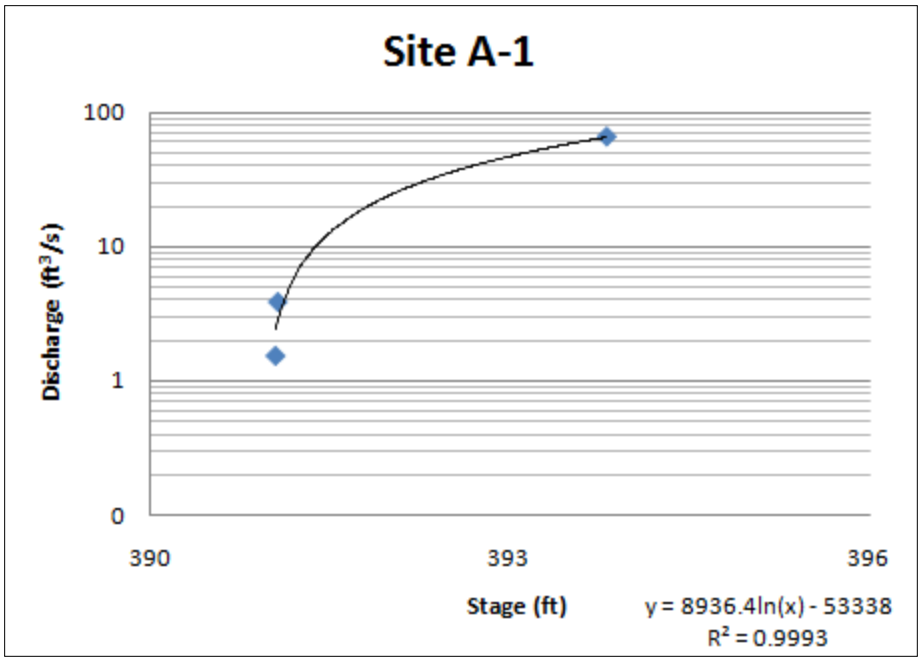
Notes: **LOCATION: 32.122325 N, 89.580085W**

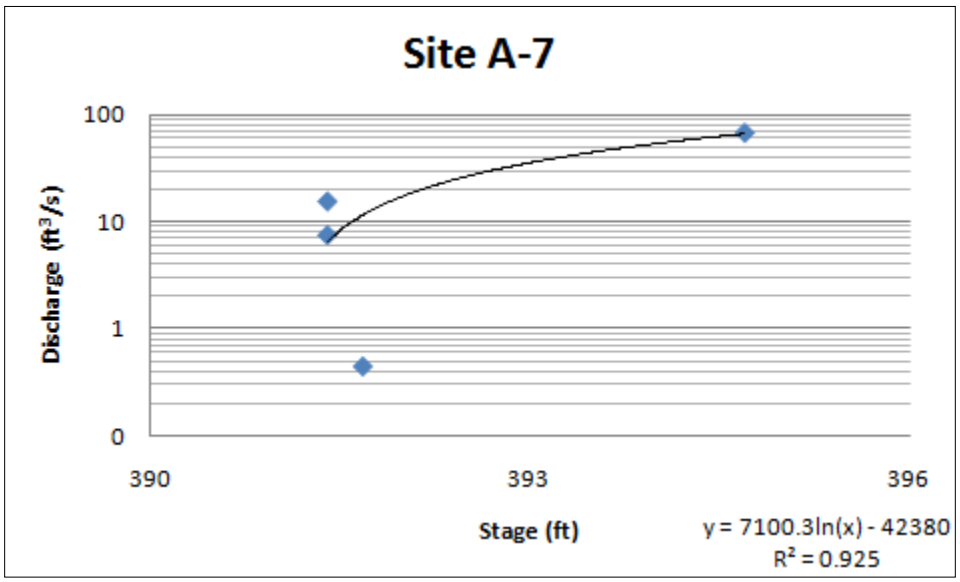
Depth ft From	Depth ft To	SOIL STRATA SOIL DESCRIPTIONS AND REMARKS	Time
0	17	**(Catahoula Fm)**-Sand, brown to red, fine to med. grained, ferruginous	
17	30	Clay, gray and red, with fine sand, waxey, ferruginous	
30	39	**(Bucatunna Fm)**-Clay, tan, bentonitic,	
39	42	Clay, dark brown, silty, carbonaceous	
42	44	Bentonite, tan, waxey (weathered Byram?)	
44	52	(**Byram Fm**)-Marl, red to dark brown, highly weathered	
52	65	Marl, greenish gray, calcareous, glauconitic, fossiliferous	
65	66	**(Glendon Fm)** -Limestone, light gray, hard, calcareous, fossiliferous	
66	66.5	Marl, greenish gray, calcareous, fossiliferous, glauconitic	
66.5	70	Limestone, light gray, hard, calcareous, fossiliferous, glauconitic	
70	80	**(Mint Spring Fm)** –Marl, greenish gray, fossiliferous, glauconitic (poor core recovery)	
80	81	**(Forest Hill Fm)** – Clay, light to dark gray, silty, lignitic	
81	90	Sand, gray, fine grained, fossiliferous lenses	

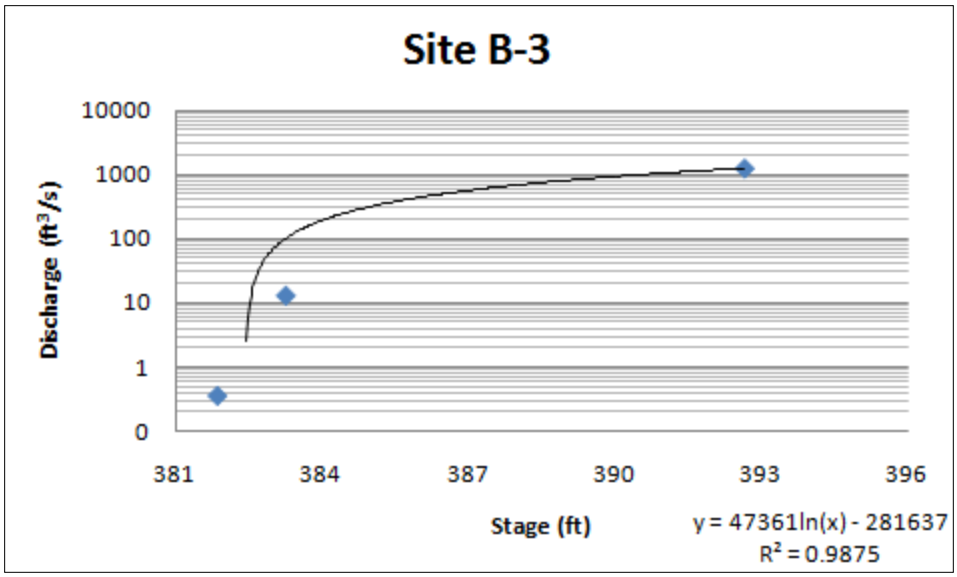
BORING LOG

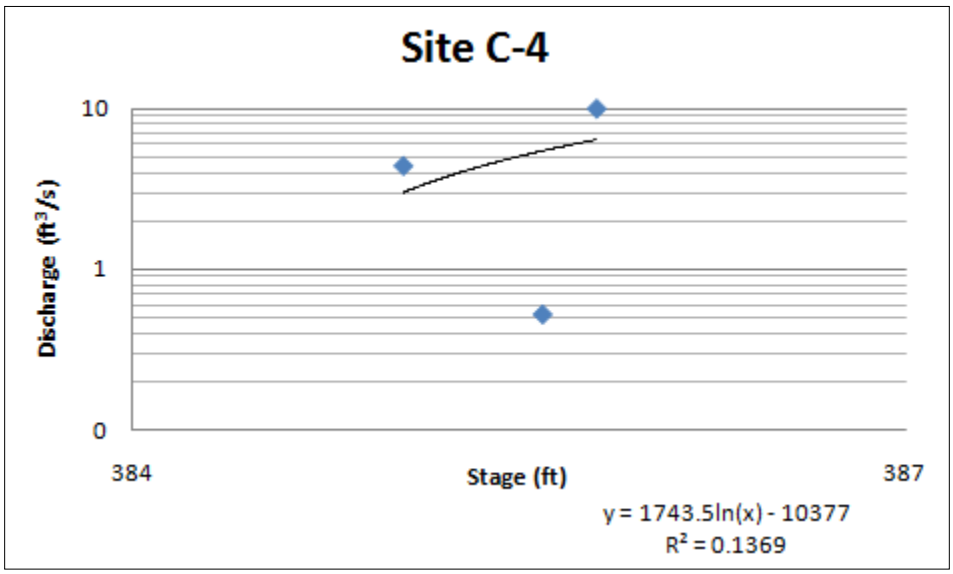
APPENDIX C

SURFACE WATER HYDROGRAPHS









APPENDIX D

LABORATORY ANALYSIS

ETC Environmental Testing & Consulting, Inc.
2700 Whitten Road Memphis, Tennessee 38133 (901) 213-2400 Fax (901) 213-2440
"A Laboratory Management Partner"

3/2/2011

Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU, MS, 39762

Ref: Analytical Testing
ETC Report Number: 11-048-0303
Client Project Description: Monitoring

Dear Dr. Darrel Schmitz:

Environmental Testing and Consulting, Inc. received 4 sample(s) on 2/17/2011 for the analyses presented in the following report.

The above referenced project has been analyzed per your instructions. The analyses were performed in accordance with the applicable analytical method.

The analytical data has been validated using standard quality control measures performed as required by the analytical method. Quality Assurance, instrumentation maintenance and calibration were performed in accordance with guidelines established by the analytical method(s) and NELAC. All results provided are in compliance with NELAC requirements unless otherwise indicated and/or narrated.

The results are shown on the attached Report of Analysis(s). Results for solid matrices are reported on an as-received basis unless otherwise indicated. This report shall not be reproduced except in full and relates only to the samples included in this report.

Please do not hesitate to contact me or client services if you have any questions or need additional information.

Sincerely,

Randall H. Thomas

Randy Thomas
Project Manager

Laboratory's liability in any claim relating to analyses performed shall be limited to, at laboratory's option, repeating the analysis in question at laboratory's expense, or the refund of the charges paid for performance of said analysis.

Alabama	#40750	Louisiana	#04015	Florida	#E87943	Texas	#T104704180-05-TX	Arkansas	#88-0650
Mississippi		California	#05240CA			Oklahoma	#9311	Virginia	#00106
Kentucky	#90047	Tennessee	#02027	EPA	#TN00012	Kentucky UST	#41	Kansas	#E-

10896

ETC ENVIRONMENTAL TESTING & CONSULTING, INC.

"A Laboratory Management Partner"

Non-Compliance Login Summary Report

Incident Date: 02-17-2011 04:50 pm
Report number: 11-048-0303 Lab Number(s): 86450-86453
Customer number: 03816
Customer Name: Department of Geo Sciences
Contact Name: Department of Geo Sciences
Project ID: Dept of Geosciences - Monitoring

This Non-Compliance Report has been generated because proper EPA protocol was not followed for the above referenced sample(s). This means that the data generated from the analysis of this project may not be suitable for Regulatory compliance.

This report should be included with any data submitted to a Regulatory Agency. The actual problems encountered are listed below.

Description of Login Non-Compliance

☐ **Sample Temperature Non-compliant**
Cooler Temperature: degrees Celsius
Required Temperature: degrees Celsius

☑ **Sample Received in Improper Container**
Analysis: Phenols
Received Container: Plastic
Required Container: Glass

☐ **Sample Improperly Preserved**
Analysis:
Received Preservative:
Required Preservative:

☑ **Sample Received Outside Holding Time** Date Received: 02-17-2011 00:00
Analysis: Fecal & Total Coliform
Sampled Date and Time: 2/16/11
Required Holding Time: 6 hours

Other:

Corrective Action

Client Notified: ● Yes ○ No Date Client Notified: 2/17/11 Contact Name: Will McBryde
Client Directive:
Approval to analyze samples out of compliance per Will McBryde/Nathan Pera.

Initiated By: Rebekah Ross Project manager: Nathan Pera QAO: Richard Medina

ETC ENVIRONMENTAL TESTING & CONSULTING, INC.
www.etcmemphis.com 2790 Whitten Road Memphis, Tennessee 38133 (901) 213-2400 Fax (901) 213-2440
"A Laboratory Management Partner"

03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86450**
Sample ID : **A-1**

Matrix: **Aqueous**
Sampled: **2/16/2011 10:29**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**99**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	02/22/11 10:25	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/17/11 12:30	TKM	5210-B
Carbon Dioxide (Estimate)	**1.7**	mg/L	0.1	1	03/02/11 14:38	JRF	4500-CO2
Chloride	**3.71**	mg/L	1.00	1	02/18/11 09:20	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	02/22/11 09:00	NRT	4500-CN-E
Total Coliform	**2**	cfu/100mL	1	1	02/17/11 16:50	LSK	9222-B
Fluoride (w/o distillation)	**0.130**	mg/L	0.100	1	02/18/11 09:20	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	02/18/11 09:20	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/18/11 09:20	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	02/18/11 09:20		EPA-300.0
pH	**8.0**	s.u.		1	02/17/11 17:01	MBS	4500-H-B
Total Dissolved Solids	**154**	mg/L	10	1	02/18/11 10:00	NRT	2540C
Total Phosphorus	<0.050	mg/L	0.050	1	02/21/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	02/24/11 11:21	DRG	EPA-420.1
Total Aluminum	**124**	µg/L	100	1	02/25/11 01:58	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/25/11 01:58	RQE	EPA-200.8
Total Arsenic	<0.500	µg/L	0.500	1	02/25/11 01:58	RQE	EPA-200.8
Total Barium	**39.2**	µg/L	1.00	1	02/25/11 01:58	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/25/11 01:58	RQE	EPA-200.8
Total Calcium	**43300**	µg/L	100	1	02/25/11 01:58	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/25/11 01:58	RQE	EPA-200.8
Total Chromium	<1.00	µg/L	1.00	1	02/25/11 01:58	RQE	EPA-200.8
Total Copper	**0.756**	µg/L	0.500	1	02/25/11 01:58	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**118000**	µg/L	100	1	02/25/11 01:58		EPA-200.8
Total Iron	**485**	µg/L	100	1	02/25/11 01:58	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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"A Laboratory Management Partner"

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86450**
Sample ID : **A-1**

Matrix: **Aqueous**
Sampled: **2/16/2011 10:29**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Lead	<0.500	µg/L	0.500	1	02/25/11 01:58	RQE	EPA-200.8
Total Magnesium	**2300**	µg/L	100	1	02/25/11 01:58	RQE	EPA-200.8
Total Manganese	**33.6**	µg/L	1.00	1	02/25/11 01:58	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	02/21/11 16:04	TDJ	EPA-245.1
Total Nickel	**0.612**	µg/L	0.500	1	02/25/11 01:58	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/25/11 01:58	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/25/11 01:58	RQE	EPA-200.8
Total Zinc	**6.34**	µg/L	5.00	1	02/25/11 01:58	RQE	EPA-200.8
Fecal Coliform	**200**	cfu/100mL	10	1	02/17/11 16:39	LSK	9222-D
Carbonate	<2	mg/L	2	1	02/22/11 09:05	EWB	2320B
Bicarbonate (as CaCO3)	**99**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Total Sulfate (SO4)	**14.4**	mg/L	1.00	1	02/18/11 09:20	KYS	EPA-300.0
Turbidity	**6.1**	NTU	1.0	1	02/18/11 10:10	NRT	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86451**
Sample ID : **A-3**

Matrix: **Aqueous**
Sampled: **2/16/2011 15:20**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**29**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	02/22/11 10:25	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/18/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**1.6**	mg/L	0.1	1	03/02/11 14:49	JRF	4500-CO2
Chloride	**12.0**	mg/L	1.00	1	02/18/11 09:38	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	02/22/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/17/11 16:50	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/18/11 09:38	KYS	EPA-300.0
Nitrate (NO3-N)	**1.23**	mg/L	0.100	1	02/18/11 09:38	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/18/11 09:38	KYS	EPA-300.0
Nitrate+Nitrite-N	**1.23**	mg/L	0.100	1	02/18/11 09:38		EPA-300.0
pH	**7.7**	s.u.		1	02/17/11 17:01	MBS	4500-H-B
Total Dissolved Solids	**114**	mg/L	10	1	02/18/11 10:00	NRT	2540C
Total Phosphorus	**0.134**	mg/L	0.050	1	02/21/11 08:40	TKM	4500-PE
Phenols (Total)	**0.052**	mg/L	0.050	1	02/24/11 11:21	DRG	EPA-420.1
Total Aluminum	**173**	µg/L	100	1	02/25/11 02:05	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/25/11 02:05	RQE	EPA-200.8
Total Arsenic	**1.09**	µg/L	0.500	1	02/25/11 02:05	RQE	EPA-200.8
Total Barium	**40.5**	µg/L	1.00	1	02/25/11 02:05	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/25/11 02:05	RQE	EPA-200.8
Total Calcium	**9950**	µg/L	100	1	02/25/11 02:05	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/25/11 02:05	RQE	EPA-200.8
Total Chromium	<1.00	µg/L	1.00	1	02/25/11 02:05	RQE	EPA-200.8
Total Copper	**1.57**	µg/L	0.500	1	02/25/11 02:05	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**37000**	µg/L	100	1	02/25/11 02:05		EPA-200.8
Total Iron	**1360**	µg/L	100	1	02/25/11 02:05	RQE	EPA-200.8

Qualifiers/ Definitions

* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
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Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86451**
Sample ID : **A-3**

Matrix: **Aqueous**
Sampled: **2/16/2011 15:20**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Lead	**0.599**	µg/L	0.500	1	02/25/11 02:05	RQE	EPA-200.8
Total Magnesium	**2960**	µg/L	100	1	02/25/11 02:05	RQE	EPA-200.8
Total Manganese	**143**	µg/L	1.00	1	02/25/11 02:05	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	02/21/11 16:07	TDJ	EPA-245.1
Total Nickel	**1.28**	µg/L	0.500	1	02/25/11 02:05	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/25/11 02:05	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/25/11 02:05	RQE	EPA-200.8
Total Zinc	**7.18**	µg/L	5.00	1	02/25/11 02:05	RQE	EPA-200.8
Fecal Coliform	**80**	cfu/100mL	10	1	02/17/11 16:39	LSK	9222-D
Carbonate	<2	mg/L	2	1	02/22/11 09:05	EWB	2320B
Bicarbonate (as CaCO3)	**29**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Total Sulfate (SO4)	**11.2**	mg/L	1.00	1	02/18/11 09:38	KYS	EPA-300.0
Turbidity	**11**	NTU	1.0	1	02/18/11 10:10	NRT	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86452**
Sample ID : **A-4**

Matrix: **Aqueous**
Sampled: **2/16/2011 15:44**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**20**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	02/22/11 10:25	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/18/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**3.0**	mg/L	0.1	1	03/02/11 14:50	JRF	4500-CO2
Chloride	**14.3**	mg/L	1.00	1	02/18/11 09:55	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	02/22/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/17/11 16:50	LSK	9222-B
Fluoride (w/o distillation)	**0.103**	mg/L	0.100	1	02/18/11 09:55	KYS	EPA-300.0
Nitrate (NO3-N)	**0.896**	mg/L	0.100	1	02/18/11 09:55	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/18/11 09:55	KYS	EPA-300.0
Nitrate+Nitrite-N	**0.896**	mg/L	0.100	1	02/18/11 09:55		EPA-300.0
pH	**7.1**	s.u.		1	02/17/11 17:01	MBS	4500-H-B
Total Dissolved Solids	**99**	mg/L	10	1	02/18/11 10:00	NRT	2540C
Total Phosphorus	**0.177**	mg/L	0.050	1	02/21/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	02/24/11 11:21	DRG	EPA-420.1
Total Aluminum	**276**	µg/L	100	1	02/25/11 02:13	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/25/11 02:13	RQE	EPA-200.8
Total Arsenic	**1.22**	µg/L	0.500	1	02/25/11 02:13	RQE	EPA-200.8
Total Barium	**40.1**	µg/L	1.00	1	02/25/11 02:13	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/25/11 02:13	RQE	EPA-200.8
Total Calcium	**4770**	µg/L	100	1	02/25/11 02:13	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/25/11 02:13	RQE	EPA-200.8
Total Chromium	<1.00	µg/L	1.00	1	02/25/11 02:13	RQE	EPA-200.8
Total Copper	**2.97**	µg/L	0.500	1	02/25/11 02:13	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**22800**	µg/L	100	1	02/25/11 02:13		EPA-200.8
Total Iron	**790**	µg/L	100	1	02/25/11 02:13	RQE	EPA-200.8

Qualifiers/ Definitions * Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

ETC ENVIRONMENTAL TESTING & CONSULTING, INC.

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"A Laboratory Management Partner"

03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86452**
Sample ID : **A-4**

Matrix: **Aqueous**
Sampled: **2/16/2011 15:44**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Lead	**0.781**	µg/L	0.500	1	02/25/11 02:13	RQE	EPA-200.8
Total Magnesium	**2640**	µg/L	100	1	02/25/11 02:13	RQE	EPA-200.8
Total Manganese	**76.9**	µg/L	1.00	1	02/25/11 02:13	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	02/21/11 16:08	TDJ	EPA-245.1
Total Nickel	**1.35**	µg/L	0.500	1	02/25/11 02:13	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/25/11 02:13	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/25/11 02:13	RQE	EPA-200.8
Total Zinc	**14.1**	µg/L	5.00	1	02/25/11 02:13	RQE	EPA-200.8
Fecal Coliform	**80**	cfu/100mL	10	1	02/17/11 16:39	LSK	9222-D
Carbonate	<2	mg/L	2	1	02/22/11 09:05	EWB	2320B
Bicarbonate (as CaCO3)	**20**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Total Sulfate (SO4)	**9.20**	mg/L	1.00	1	02/18/11 09:55	KYS	EPA-300.0
Turbidity	**9.9**	NTU	1.0	1	02/18/11 10:10	NRT	2130B

Qualifiers/ Definitions

* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
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Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86453**
Sample ID : **A-5**

Matrix: **Aqueous**
Sampled: **2/16/2011 17:10**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**17**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	02/22/11 10:25	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/18/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**4.0**	mg/L	0.1	1	03/02/11 14:51	JRF	4500-CO2
Chloride	**11.2**	mg/L	1.00	1	02/18/11 10:13	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	02/22/11 09:00	NRT	4500-CN-E
Total Coliform	**2**	cfu/100mL	1	1	02/17/11 16:50	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/18/11 10:13	KYS	EPA-300.0
Nitrate (NO3-N)	**0.785**	mg/L	0.100	1	02/18/11 10:13	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/18/11 10:13	KYS	EPA-300.0
Nitrate+Nitrite-N	**0.785**	mg/L	0.100	1	02/18/11 10:13		EPA-300.0
pH	**6.9**	s.u.		1	02/17/11 17:01	MBS	4500-H-B
Total Dissolved Solids	**102**	mg/L	10	1	02/18/11 10:00	NRT	2540C
Total Phosphorus	**0.202**	mg/L	0.050	1	02/21/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	02/24/11 11:21	DRG	EPA-420.1
Total Aluminum	**408**	µg/L	100	1	02/25/11 02:20	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/25/11 02:20	RQE	EPA-200.8
Total Arsenic	**1.40**	µg/L	0.500	1	02/25/11 02:20	RQE	EPA-200.8
Total Barium	**40.3**	µg/L	1.00	1	02/25/11 02:20	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/25/11 02:20	RQE	EPA-200.8
Total Calcium	**5200**	µg/L	100	1	02/25/11 02:20	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/25/11 02:20	RQE	EPA-200.8
Total Chromium	<1.00	µg/L	1.00	1	02/25/11 02:20	RQE	EPA-200.8
Total Copper	**3.05**	µg/L	0.500	1	02/25/11 02:20	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**23900**	µg/L	100	1	02/25/11 02:20		EPA-200.8
Total Iron	**2070**	µg/L	100	1	02/25/11 02:20	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/2/2011

Report Number : **11-048-0303**

REPORT OF ANALYSIS

Received : 2/17/2011

Lab No : **86453**
Sample ID : **A-5**

Matrix: **Aqueous**
Sampled: **2/16/2011 17:10**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Lead	**0.922**	µg/L	0.500	1	02/25/11 02:20	RQE	EPA-200.8
Total Magnesium	**2640**	µg/L	100	1	02/25/11 02:20	RQE	EPA-200.8
Total Manganese	**180**	µg/L	1.00	1	02/25/11 02:20	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	02/21/11 16:09	TDJ	EPA-245.1
Total Nickel	**1.44**	µg/L	0.500	1	02/25/11 02:20	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/25/11 02:20	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/25/11 02:20	RQE	EPA-200.8
Total Zinc	**9.04**	µg/L	5.00	1	02/25/11 02:20	RQE	EPA-200.8
Fecal Coliform	**130**	cfu/100mL	10	1	02/17/11 16:39	LSK	9222-D
Carbonate	<2	mg/L	2	1	02/22/11 09:05	EWB	2320B
Bicarbonate (as CaCO3)	**17**	mg/L	1	1	02/22/11 09:05	EWB	2320B
Total Sulfate (SO4)	**9.62**	mg/L	1.00	1	02/18/11 10:13	KYS	EPA-300.0
Turbidity	**13**	NTU	1.0	1	02/18/11 10:10	NRT	2130B

Qualifiers/ Definitions

* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Cooler Receipt Form

Customer Number: **03816**

Customer Name: **Department of Geo Sciences**

Report Number: **11-048-0303**

Shipping Method

○ FedEx ○ UPS ○ US Posta ○ Client ● LMP ○ Courier ○ Other:

Shipping container/cooler uncompromised?	● Yes	○ No	○ Not Present
Custody seals intact on shipping container/cooler?	○ Yes	○ No	● Not Required
Custody seals intact on sample bottles?	○ Yes	○ No	● Not Required
Chain of Custody present?	● Yes	○ No	
COC agrees with sample labels?	● Yes	○ No	
Samples in proper containers?	○ Yes	● No	
Sample containers intact?	● Yes	○ No	
Sufficient sample volume for indicated tests?	● Yes	○ No	
All samples received within holding time?	○ Yes	● No	
Container temperature in compliance?	● Yes	○ No	
Water - VOA vials free of headspace?	○ Yes	○ No	● N/A
Water - Preservation acceptable upon receipt?	● Yes	○ No	○ N/A
Samples screened for radioactivity (COE only)?	○ Yes	○ No	● N/A
Special precautions or instructions included?	○ Yes	● No	

Comments: Received a plastic container for Phenols testing.
Fecal & Total Coliform received out of holding time.
Approval to analyze per Will McBryde/Nathan Pera.
See Non-Compliance Report.

Any regulatory non-compliance issues will be recorded on non-compliance report.

Signature: Rebekah Ross

Date & Time: 02/17/2011 16:23:22

Environmental Testing & Consulting, Inc. Chain of Custody

Page _ of _

11-048-0303
03816
2011-02-17
16:20:11
Department of Geo Sciences
Monitoring

Client Name	Client Project Manager/Contact	Phone #
Mississippi State University	Will McBryde	334-467-7324
Project/ Site Location: USFS		email Address: wdm138@msstate.edu
Project Number	FID #	Purchase Order Number
Type of Event: Single Daily Weekly Monthly Quarterly Semi-Annual		Method of Shipment: Pick-up

- [ ] NPDES
- [ ] Wastewater
- [ ] UST
- [ ] Other Program:

- [ ] RUSH - Additional charges apply.

The following require a Statement of Work
- [ ] Special Report Requirements
- [ ] Special Detection Limit(s)
- [ ] Special Method Requirements

Environmental Testing & Consulting, Inc.
2790 Whitten Road
Memphis, TN 38133
(901) 213-2400 (phone)
(901) 213-2440 (fax)
www.etcmemphis.com

Date:	Time:	Sample Identification:	Number of Containers	Matrix	(G)rab or (C)omposite	Required Analysis: See Attached List. (initialed) 2/17/11
2/16/11	~~1520~~ 1064	A-1	6			
|	1520	A-3	6			
|	1544	A-4	6			
|	1710	A-5	6			

Approval to analyze FC+TC out of holding time per W. McBryde. (initialed) 2/17/11

Matrix
WW - Wastewater GW - Groundwater DW-Drinking Water S-Soil O-Oil L-Non-aqueous liquid
Other: ______

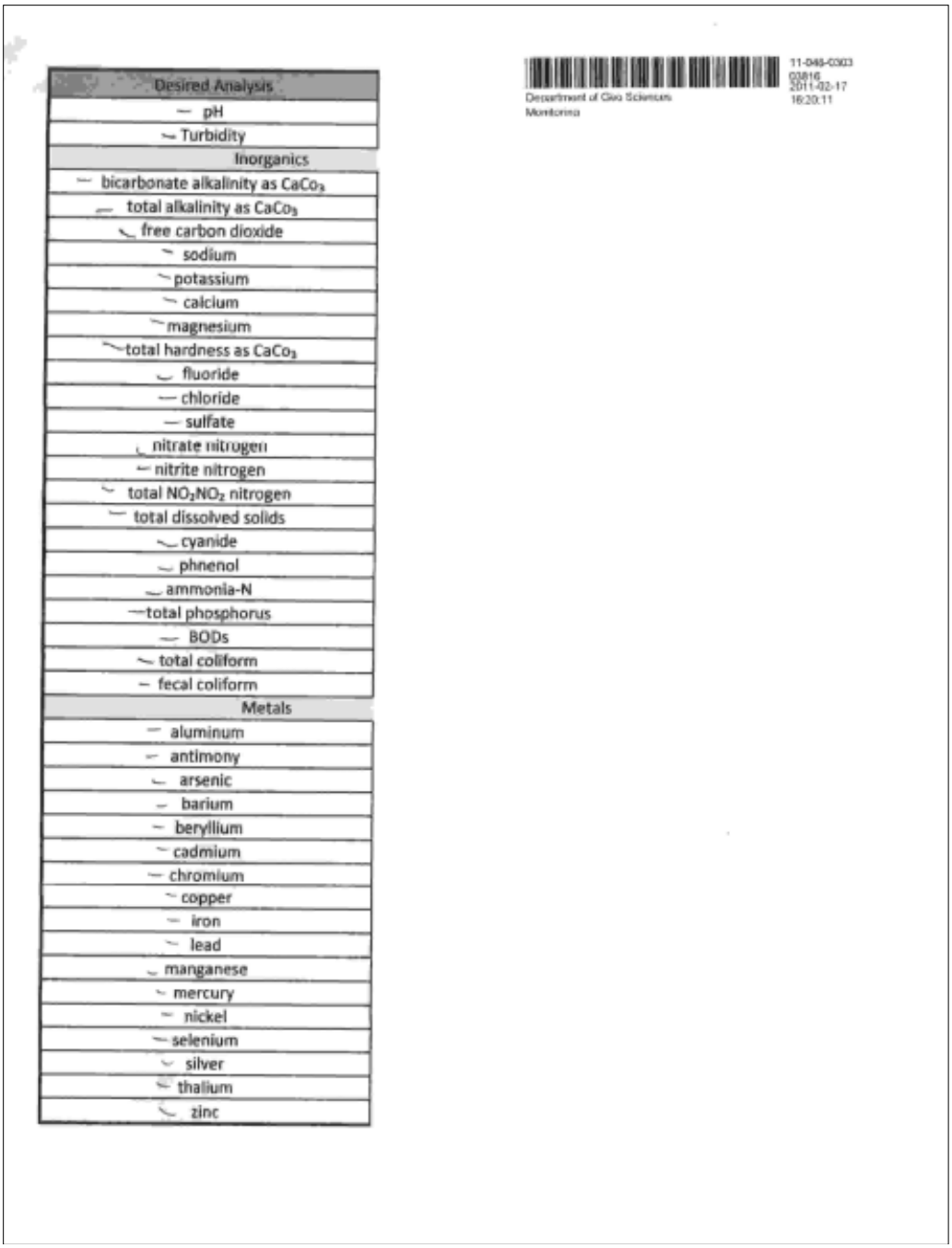
Sampled by (Name/Affiliation): (Print): [signature]

Client Remarks/Comments:

For Laboratory Use Only

Ice	Cooler Temp	Lab Comments
(Y) N	2.4°C	

Relinquished by: (SIGNATURE)	Date	Time	Received by: (SIGNATURE)	Date	Time
Will McBryde	2/17/11	1013	L.D. Buck	2/17/11	1013
Relinquished by: (SIGNATURE)	Date	Time	Received by: (SIGNATURE)	Date	Time
Relinquished by: (SIGNATURE) [signature]	2-17-11	1336	Received for lab by: (SIGNATURE) [signature]	2-17-11	1336



Desired Analysis
pH
Turbidity
Inorganics
bicarbonate alkalinity as $CaCo_3$
total alkalinity as $CaCo_3$
free carbon dioxide
sodium
potassium
calcium
magnesium
total hardness as $CaCo_3$
fluoride
chloride
sulfate
nitrate nitrogen
nitrite nitrogen
total NO_3NO_2 nitrogen
total dissolved solids
cyanide
phnenol
ammonia-N
total phosphorus
BODs
total coliform
fecal coliform
Metals
aluminum
antimony
arsenic
barium
beryllium
cadmium
chromium
copper
iron
lead
manganese
mercury
nickel
selenium
silver
thalium
zinc

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3/15/2011

Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU, MS, 39762

Ref: Analytical Testing
ETC Report Number: 11-056-0248
Client Project Description: Monitoring

Dear Dr. Darrel Schmitz:

Environmental Testing and Consulting, Inc. received 5 sample(s) on 2/25/2011 for the analyses presented in the following report.

The above referenced project has been analyzed per your instructions. The analyses were performed in accordance with the applicable analytical method.

The analytical data has been validated using standard quality control measures performed as required by the analytical method. Quality Assurance, instrumentation maintenance and calibration were performed in accordance with guidelines established by the analytical method(s) and NELAC. All results provided are in compliance with NELAC requirements unless otherwise indicated and/or narrated.

The results are shown on the attached Report of Analysis(s). Results for solid matrices are reported on an as-received basis unless otherwise indicated. This report shall not be reproduced except in full and relates only to the samples included in this report.

Please do not hesitate to contact me or client services if you have any questions or need additional information.

Sincerely,

Randall H. Thomas

Randy Thomas
Project Manager

Laboratory's liability in any claim relating to analyses performed shall be limited to, at laboratory's option, repeating the analysis in question at laboratory's expense, or the refund of the charges paid for performance of said analysis.

Alabama	#40750	Louisiana	#04015	Florida	#E87943	Texas	#T104704180-05-TX	Arkansas	#88-0650
Mississippi		California	#05240CA			Oklahoma	#9311	Virginia	#00106
Kentucky	#90047	Tennessee	#02027	EPA	#TN00012	Kentucky UST	#41	Kansas	#E-10396

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Non-Compliance Login Summary Report

Incident Date:	02-25-2011 01:47 pm		
Report number:	11-056-0248	Lab Number(s):	L87537-L87541
Customer number:	03816		
Customer Name:	Department of Geo Sciences		
Contact Name:	Department of Geo Sciences		
Project ID:	Dept of Geosciences - Monitoring		

This Non-Compliance Report has been generated because proper EPA protocol was not followed for the above referenced sample(s). This means that the data generated from the analysis of this project may not be suitable for Regulatory compliance.

This report should be included with any data submitted to a Regulatory Agency. The actual problems encountered are listed below.

Description of Login Non-Compliance

☐ **Sample Temperature Non-compliant**
Cooler Temperature: degrees Celsius
Required Temperature: degrees Celsius

☑ **Sample Received in Improper Container**
Analysis: Phenol
Received Container: Quart Plastic
Required Container: Quart Glass

☐ **Sample Improperly Preserved**
Analysis:
Received Preservative:
Required Preservative:

☑ **Sample Received Outside Holding Time** Date Received: 02-25-2011 13:30
Analysis: Total & Fecal Coliform
Sampled Date and Time: 2/24/11 Various
Required Holding Time: 6 Hours

Other:

Corrective Action

Client Notified: ○ Yes ● No Date Client Notified: Contact Name:
Client Directive:
Approval to always analyze samples out of compliance per Nathan Pera

Initiated By: Ms. Brooke Shoup Project manager: Mr. Nathan Pera QAO: Dr. Richard Medina

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03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87537**
Sample ID : **A7**

Matrix: **Aqueous**
Sampled: **2/24/2011 11:17**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**62**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/03/11 06:05	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/25/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**15.0**	mg/L	0.1	1	03/15/11 15:10	JRF	4500-CO2
Chloride	**7.03**	mg/L	1.00	1	02/25/11 15:08	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/01/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/25/11 14:30	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/25/11 15:08	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	02/25/11 15:08	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/25/11 15:08	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	02/25/11 15:08		EPA-300.0
pH	**6.8**	s.u.		1	02/25/11 14:55	JJP	4500-H-B
Total Dissolved Solids	**134**	mg/L	10	1	03/03/11 15:00	NRT	2540C
Total Phosphorus	<0.050	mg/L	0.050	1	03/01/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/02/11 13:07	DRG	EPA-420.1
Total Aluminum	**866**	µg/L	100	1	02/28/11 08:34	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/28/11 08:34	RQE	EPA-200.8
Total Arsenic	**1.35**	µg/L	0.500	1	02/28/11 08:34	RQE	EPA-200.8
Total Barium	**70.0**	µg/L	1.00	1	02/28/11 08:34	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/28/11 08:34	RQE	EPA-200.8
Total Calcium	**35400**	µg/L	100	1	02/28/11 08:34	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/28/11 08:34	RQE	EPA-200.8
Total Copper	**2.49**	µg/L	0.500	1	02/28/11 08:34	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**105000**	µg/L	100	1	02/28/11 08:34		EPA-200.8
Total Iron	**1300**	µg/L	100	1	02/28/11 08:34	RQE	EPA-200.8
Total Lead	**1.68**	µg/L	0.500	1	02/28/11 08:34	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
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Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87537**
Sample ID : **A7**

Matrix: **Aqueous**
Sampled: **2/24/2011 11:17**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**4060**	µg/L	100	1	02/28/11 08:34	RQE	EPA-200.8
Total Manganese	**760**	µg/L	1.00	1	02/28/11 08:34	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/02/11 10:18	TDJ	EPA-245.1
Total Nickel	**1.79**	µg/L	0.500	1	02/28/11 08:34	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/28/11 08:34	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	02/28/11 08:34	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/28/11 08:34	RQE	EPA-200.8
Total Zinc	**18.6**	µg/L	5.00	1	02/28/11 08:34	RQE	EPA-200.8
Fecal Coliform	**50**	cfu/100mL	10	1	02/25/11 13:50	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/09/11 08:40	EWB	2320B
Bicarbonate (as CaCO3)	**62**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Total Sulfate (SO4)	**43.9**	mg/L	1.00	1	02/25/11 15:08	KYS	EPA-300.0
Turbidity	**12**	NTU	1.0	1	02/25/11 15:00	NRT	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87538**
Sample ID : **A6**

Matrix: **Aqueous**
Sampled: **2/24/2011 11:50**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**26**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/03/11 06:05	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/25/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**8.0**	mg/L	0.1	1	03/15/11 15:10	JRF	4500-CO2
Chloride	**10.1**	mg/L	1.00	1	02/25/11 15:25	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/01/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/25/11 14:30	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/25/11 15:25	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	02/25/11 15:25	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/25/11 15:25	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	02/25/11 15:25		EPA-300.0
pH	**7.0**	s.u.		1	02/25/11 14:55	JJP	4500-H-B
Total Dissolved Solids	**70**	mg/L	10	1	03/03/11 15:00	NRT	2540C
Total Phosphorus	**0.206**	mg/L	0.050	1	03/01/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/02/11 13:07	DRG	EPA-420.1
Total Aluminum	**310**	µg/L	100	1	02/28/11 08:42	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/28/11 08:42	RQE	EPA-200.8
Total Arsenic	**1.81**	µg/L	0.500	1	02/28/11 08:42	RQE	EPA-200.8
Total Barium	**45.4**	µg/L	1.00	1	02/28/11 08:42	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/28/11 08:42	RQE	EPA-200.8
Total Calcium	**6700**	µg/L	100	1	02/28/11 08:42	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/28/11 08:42	RQE	EPA-200.8
Total Copper	**2.19**	µg/L	0.500	1	02/28/11 08:42	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**27100**	µg/L	100	1	02/28/11 08:42		EPA-200.8
Total Iron	**1900**	µg/L	100	1	02/28/11 08:42	RQE	EPA-200.8
Total Lead	**0.751**	µg/L	0.500	1	02/28/11 08:42	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87538**
Sample ID : **A6**

Matrix: **Aqueous**
Sampled: **2/24/2011 11:50**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**2520**	µg/L	100	1	02/28/11 08:42	RQE	EPA-200.8
Total Manganese	**251**	µg/L	1.00	1	02/28/11 08:42	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/02/11 10:19	TDJ	EPA-245.1
Total Nickel	**1.41**	µg/L	0.500	1	02/28/11 08:42	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/28/11 08:42	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	02/28/11 08:42	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/28/11 08:42	RQE	EPA-200.8
Total Zinc	<5.00	µg/L	5.00	1	02/28/11 08:42	RQE	EPA-200.8
Fecal Coliform	**70**	cfu/100mL	10	1	02/25/11 13:50	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/09/11 08:40	EWB	2320B
Bicarbonate (as CaCO3)	**26**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Total Sulfate (SO4)	**7.29**	mg/L	1.00	1	02/25/11 15:25	KYS	EPA-300.0
Turbidity	**11**	NTU	1.0	1	02/25/11 15:00	NRT	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87539**
Sample ID : **A8A**

Matrix: **Aqueous**
Sampled: **2/24/2011 15:46**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**37**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/03/11 06:05	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/25/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**4.0**	mg/L	0.1	1	03/15/11 15:10	JRF	4500-CO2
Chloride	**10.5**	mg/L	1.00	1	02/25/11 15:43	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/01/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/25/11 14:30	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/25/11 15:43	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	02/25/11 15:43	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/25/11 15:43	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	02/25/11 15:43		EPA-300.0
pH	**7.3**	s.u.		1	02/25/11 14:55	JJP	4500-H-B
Total Dissolved Solids	**119**	mg/L	10	1	03/03/11 15:00	NRT	2540C
Total Phosphorus	**0.154**	mg/L	0.050	1	03/01/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/02/11 13:07	DRG	EPA-420.1
Total Aluminum	**213**	µg/L	100	1	02/28/11 08:49	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/28/11 08:49	RQE	EPA-200.8
Total Arsenic	**1.84**	µg/L	0.500	1	02/28/11 08:49	RQE	EPA-200.8
Total Barium	**40.0**	µg/L	1.00	1	02/28/11 08:49	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/28/11 08:49	RQE	EPA-200.8
Total Calcium	**12800**	µg/L	100	1	02/28/11 08:49	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/28/11 08:49	RQE	EPA-200.8
Total Copper	**1.78**	µg/L	0.500	1	02/28/11 08:49	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**43700**	µg/L	100	1	02/28/11 08:49		EPA-200.8
Total Iron	**1620**	µg/L	100	1	02/28/11 08:49	RQE	EPA-200.8
Total Lead	**0.572**	µg/L	0.500	1	02/28/11 08:49	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87539**
Sample ID : **A8A**

Matrix: **Aqueous**
Sampled: **2/24/2011 15:46**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**2850**	µg/L	100	1	02/28/11 08:49	RQE	EPA-200.8
Total Manganese	**199**	µg/L	1.00	1	02/28/11 08:49	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/02/11 10:20	TDJ	EPA-245.1
Total Nickel	**1.28**	µg/L	0.500	1	02/28/11 08:49	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/28/11 08:49	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	02/28/11 08:49	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/28/11 08:49	RQE	EPA-200.8
Total Zinc	<5.00	µg/L	5.00	1	02/28/11 08:49	RQE	EPA-200.8
Fecal Coliform	**60**	cfu/100mL	10	1	02/25/11 13:50	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/09/11 08:40	EWB	2320B
Bicarbonate (as CaCO3)	**37**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Total Sulfate (SO4)	**9.82**	mg/L	1.00	1	02/25/11 15:43	KYS	EPA-300.0
Turbidity	**9.0**	NTU	1.0	1	02/25/11 15:00	NRT	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87540**
Sample ID : **A-9**

Matrix: **Aqueous**
Sampled: **2/24/2011 17:34**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**38**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/03/11 06:05	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/25/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**4.0**	mg/L	0.1	1	03/15/11 15:10	JRF	4500-CO2
Chloride	**9.21**	mg/L	1.00	1	02/25/11 16:35	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/01/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/25/11 14:30	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/25/11 16:35	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	02/25/11 16:35	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/25/11 16:35	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	02/25/11 16:35		EPA-300.0
pH	**7.2**	s.u.		1	02/25/11 14:55	JJP	4500-H-B
Total Dissolved Solids	**56**	mg/L	10	1	03/03/11 15:00	NRT	2540C
Total Phosphorus	**0.136**	mg/L	0.050	1	03/01/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/02/11 13:07	DRG	EPA-420.1
Total Aluminum	**175**	µg/L	100	1	02/28/11 08:57	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/28/11 08:57	RQE	EPA-200.8
Total Arsenic	**1.78**	µg/L	0.500	1	02/28/11 08:57	RQE	EPA-200.8
Total Barium	**38.4**	µg/L	1.00	1	02/28/11 08:57	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/28/11 08:57	RQE	EPA-200.8
Total Calcium	**10900**	µg/L	100	1	02/28/11 08:57	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/28/11 08:57	RQE	EPA-200.8
Total Copper	**1.63**	µg/L	0.500	1	02/28/11 08:57	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**37500**	µg/L	100	1	02/28/11 08:57		EPA-200.8
Total Iron	**1440**	µg/L	100	1	02/28/11 08:57	RQE	EPA-200.8
Total Lead	**0.548**	µg/L	0.500	1	02/28/11 08:57	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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MSU , MS 39762

Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87540**
Sample ID : **A-9**

Matrix: **Aqueous**
Sampled: **2/24/2011 17:34**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**2500**	µg/L	100	1	02/28/11 08:57	RQE	EPA-200.8
Total Manganese	**178**	µg/L	1.00	1	02/28/11 08:57	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/02/11 10:21	TDJ	EPA-245.1
Total Nickel	**1.30**	µg/L	0.500	1	02/28/11 08:57	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/28/11 08:57	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	02/28/11 08:57	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/28/11 08:57	RQE	EPA-200.8
Total Zinc	<5.00	µg/L	5.00	1	02/28/11 08:57	RQE	EPA-200.8
Fecal Coliform	**40**	cfu/100mL	10	1	02/25/11 13:50	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/09/11 08:40	EWB	2320B
Bicarbonate (as CaCO3)	**38**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Total Sulfate (SO4)	**8.77**	mg/L	1.00	1	02/25/11 16:35	KYS	EPA-300.0
Turbidity	**6.4**	NTU	1.0	1	02/25/11 15:00	NRT	2130B

Qualifiers/ Definitions
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MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87541**
Sample ID : **A-10**

Matrix: **Aqueous**
Sampled: **2/24/2011 18:20**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**31**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/03/11 06:05	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	02/25/11 13:00	TKM	5210-B
Carbon Dioxide (Estimate)	**5.0**	mg/L	0.1	1	03/15/11 15:10	JRF	4500-CO2
Chloride	**8.76**	mg/L	1.00	1	02/25/11 16:52	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/01/11 09:00	NRT	4500-CN-E
Total Coliform	<1	cfu/100mL	1	1	02/25/11 14:30	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	02/25/11 16:52	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	02/25/11 16:52	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	02/25/11 16:52	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	02/25/11 16:52		EPA-300.0
pH	**7.1**	s.u.		1	02/25/11 15:40	JJP	4500-H-B
Total Dissolved Solids	**100**	mg/L	10	1	03/03/11 15:00	NRT	2540C
Total Phosphorus	**0.131**	mg/L	0.050	1	03/01/11 08:40	TKM	4500-PE
Phenols (Total)	**0.134**	mg/L	0.050	1	03/02/11 13:07	DRG	EPA-420.1
Total Aluminum	**362**	µg/L	100	1	02/28/11 09:26	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	02/28/11 09:26	RQE	EPA-200.8
Total Arsenic	**1.63**	µg/L	0.500	1	02/28/11 09:26	RQE	EPA-200.8
Total Barium	**43.1**	µg/L	1.00	1	02/28/11 09:26	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	02/28/11 09:26	RQE	EPA-200.8
Total Calcium	**9400**	µg/L	100	1	02/28/11 09:26	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	02/28/11 09:26	RQE	EPA-200.8
Total Copper	**1.67**	µg/L	0.500	1	02/28/11 09:26	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**33400**	µg/L	100	1	02/28/11 09:26		EPA-200.8
Total Iron	**1910**	µg/L	100	1	02/28/11 09:26	RQE	EPA-200.8
Total Lead	**0.832**	µg/L	0.500	1	02/28/11 09:26	RQE	EPA-200.8

Qualifiers/ Definitions
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MQL Method Quantitation Limit
DF Dilution Factor

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MSU , MS 39762

Project Information : Monitoring

Report Date : 3/15/2011

Report Number : **11-056-0248**

REPORT OF ANALYSIS

Received : 2/25/2011

Lab No : **87541**
Sample ID : **A-10**

Matrix: **Aqueous**
Sampled: **2/24/2011 18:20**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**2400**	µg/L	100	1	02/28/11 09:26	RQE	EPA-200.8
Total Manganese	**306**	µg/L	1.00	1	02/28/11 09:26	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/02/11 10:22	TDJ	EPA-245.1
Total Nickel	**1.39**	µg/L	0.500	1	02/28/11 09:26	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	02/28/11 09:26	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	02/28/11 09:26	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	02/28/11 09:26	RQE	EPA-200.8
Total Zinc	<5.00	µg/L	5.00	1	02/28/11 09:26	RQE	EPA-200.8
Fecal Coliform	**90**	cfu/100mL	10	1	02/25/11 13:50	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/09/11 08:40	EWB	2320B
Bicarbonate (as CaCO3)	**31**	mg/L	1	1	03/09/11 08:40	EWB	2320B
Total Sulfate (SO4)	**7.62**	mg/L	1.00	1	02/25/11 16:52	KYS	EPA-300.0
Turbidity	**11**	NTU	1.0	1	02/25/11 15:00	NRT	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Cooler Receipt Form

Customer Number: **03816**
Customer Name: **Department of Geo Sciences**
Report Number: **11-056-0248**

Shipping Method

○ FedEx ○ UPS ○ US Postal ○ Client ● LMP ○ Courier ○ Other:

Shipping container/cooler uncompromised?	● Yes	○ No	○ Not Present
Custody seals intact on shipping container/cooler?	○ Yes	○ No	● Not Required
Custody seals intact on sample bottles?	○ Yes	○ No	● Not Required
Chain of Custody present?	● Yes	○ No	
COC agrees with sample labels?	● Yes	○ No	
Samples in proper containers?	○ Yes	● No	
Sample containers intact?	● Yes	○ No	
Sufficient sample volume for indicated tests?	● Yes	○ No	
All samples received within holding time?	○ Yes	● No	
Container temperature in compliance?	● Yes	○ No	
Water - VOA vials free of headspace?	○ Yes	○ No	● N/A
Water - Preservation acceptable upon receipt?	● Yes	○ No	○ N/A
Samples screened for radioactivity (COE only)?	○ Yes	○ No	● N/A
Special precautions or instructions included?	○ Yes	● No	

Comments: See non-compliance report.

Any regulatory non-compliance issues will be recorded on non-compliance report.

Signature: Brooke Shoup

Date & Time: 02/25/2011 13:37:29

Environmental Testing & Consulting, Inc. Chain of Custody

Page _ of _

Client Name	Client Project Manager/Contact	Phone #
Mississippi State Geosciences	Dr. Darrel Schmitz	601-916 1157

Project/ Site Location	email Address

Project Number	FID #	Purchase Order Number

Type of Event: Single Daily Weekly Monthly Quarterly Semi-Annual

Method of Shipment:

11-056-0248
03816
2011-02-28
13:35:15
Department of Geo Sciences
Monitoring

- [ ] NPDES
- [ ] Wastewater
- [ ] UST
- [ ] Other Program

- [ ] RUSH - Additional charges apply.

The following require a Statement of Work

- [ ] Special Report Requirements
- [ ] Special Detection Limit(s)
- [ ] Special Method Requirements

Environmental Testing & Consulting, Inc.
2790 Whitten Road
Memphis, TN 38133
(901) 213-2400 (phone)
(901) 213-2440 (fax)
www.etcmemphis.com

Required Analysis:

Date:	Time:	Sample Identification:	Number of Containers	Matrix	(G)rab or (C)omposite	Total Coliform Fecal	Alk, Turbidity, BOD, Cl, F, SO4	NO2/NO3, TDS pH	CN-T	Metals Hg Al, Sb, As, Ba, Be, Cd, Hardness	Phenol, NH3, Total P			
2/24/11	11:17	A7	6	H_2O	G									
2/24/11	11:50	A6	6	H_2O	G									
2/24/11	15:46	A8A	6	H_2O	G									
2/24/11	17:34	A-9	6	H_2O	G									
2/24/11	18:20	A-10	6	H_2O	G									

Matrix
WW - Wastewater GW - Groundwater DW-Drinking Water S-Soil O-Oil L-Non aqueous liquid
Other: ______

Sampled by (Name/Affiliation): (Print): Corey Lodner

Client Remarks/Comments

For Laboratory Use Only

Ice	Cooler Temp	Lab Comments
(Y) N	4°C	

Relinquished by: (SIGNATURE)	Date	Time	Received by: (SIGNATURE)	Date	Time
	2/25/11	1130	[signature]	2/25/11	1130
Relinquished by: (SIGNATURE)	Date	Time	Received by: (SIGNATURE)	Date	Time
[signature]	2/25/11	1330	Received for lab by: [signature]	2/25/11	1330

SAFEGUARD Form No. 811-2/WBCS000050 5/10

Page 14 of 14

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3/24/2011

Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU, MS, 39762

Ref: Analytical Testing
ETC Report Number: 11-069-0272
Client Project Description: Monitoring

Dear Dr. Darrel Schmitz:

Environmental Testing and Consulting, Inc. received 9 sample(s) on 3/10/2011 for the analyses presented in the following report.

The above referenced project has been analyzed per your instructions. The analyses were performed in accordance with the applicable analytical method.

The analytical data has been validated using standard quality control measures performed as required by the analytical method. Quality Assurance, instrumentation maintenance and calibration were performed in accordance with guidelines established by the analytical method(s) and NELAC. All results provided are in compliance with NELAC requirements unless otherwise indicated and/or narrated.

The results are shown on the attached Report of Analysis(s). Results for solid matrices are reported on an as-received basis unless otherwise indicated. This report shall not be reproduced except in full and relates only to the samples included in this report.

Please do not hesitate to contact me or client services if you have any questions or need additional information.

Sincerely,

Randall H. Thomas

Randy Thomas
Project Manager

Laboratory's liability in any claim relating to analyses performed shall be limited to, at laboratory's option, repeating the analysis in question at laboratory's expense, or the refund of the charges paid for performance of said analysis.

Alabama	#40750	Louisiana	#04015	Florida	#E87943	Texas	#T104704180-05-TX	Arkansas	#88-0650
Mississippi		California	#05240CA			Oklahoma	#9311	Virginia	#00106
Kentucky	#90047	Tennessee	#02027	EPA	#TN00012	Kentucky UST	#41	Kansas	#E-10396

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Non-Compliance Login Summary Report

Incident Date: 03-10-2011 04:53 pm
Report number: 11-069-0272 Lab Number(s): L89206, L89207, L89208, L89209
Customer number: 03816
Customer Name: Department of Geo Sciences
Contact Name: Department of Geo Sciences
Project ID: Dept of Geosciences - Monitoring

This Non-Compliance Report has been generated because proper EPA protocol was not followed for the above referenced sample(s). This means that the data generated from the analysis of this project may not be suitable for Regulatory compliance.

This report should be included with any data submitted to a Regulatory Agency. The actual problems encountered are listed below.

Description of Login Non-Compliance

☐ **Sample Temperature Non-compliant**
Cooler Temperature: degrees Celsius
Required Temperature: degrees Celsius

☐ **Sample Received in Improper Container**
Analysis:
Received Container:
Required Container:

☐ **Sample Improperly Preserved**
Analysis:
Received Preservative:
Required Preservative:

☑ **Sample Received Outside Holding Time** Date Received: 03-10-2011 14:00
Analysis: Total Coliform & Fecal Coliform
Sampled Date and Time: 3/9/11 Various
Required Holding Time: 6 Hours

Other:

Corrective Action

Client Notified: ○ Yes ● No Date Client Notified: Contact Name:
Client Directive:
Approval to always analyze coliform samples out of holding time.

Initiated By: Ms. Brooke Shoup Project manager: Mr. Nathan Pera QAO: Dr. Richard Medina

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03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89206**
Sample ID : **A-1**

Matrix: **Aqueous**
Sampled: **3/9/2011 7:26**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**12**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**19**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.03**	mg/L	1.00	1	03/10/11 16:36	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Total Coliform	**580**	cfu/100mL	10	1	03/10/11 16:00	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 16:36	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	03/10/11 16:36	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 16:36	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	03/10/11 16:36		EPA-300.0
pH	**6.1**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**93**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	**0.115**	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**9350**	µg/L	100	1	03/11/11 06:08	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:08	RQE	EPA-200.8
Total Arsenic	**3.40**	µg/L	0.500	1	03/11/11 06:08	RQE	EPA-200.8
Total Barium	**61.9**	µg/L	1.00	1	03/11/11 06:08	RQE	EPA-200.8
Total Beryllium	**0.583**	µg/L	0.500	1	03/11/11 06:08	RQE	EPA-200.8
Total Calcium	**6410**	µg/L	100	1	03/11/11 06:08	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:08	RQE	EPA-200.8
Total Copper	**5.08**	µg/L	0.500	1	03/11/11 06:08	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**21300**	µg/L	100	1	03/11/11 06:08		EPA-200.8
Total Iron	**7000**	µg/L	100	1	03/11/11 06:08	RQE	EPA-200.8
Total Lead	**6.57**	µg/L	0.500	1	03/11/11 06:08	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89206**
Sample ID : **A-1**

Matrix: **Aqueous**
Sampled: **3/9/2011 7:26**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**1290**	µg/L	100	1	03/11/11 06:08	RQE	EPA-200.8
Total Manganese	**241**	µg/L	1.00	1	03/11/11 06:08	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 14:24	TDJ	EPA-245.1
Total Nickel	**5.94**	µg/L	0.500	1	03/11/11 06:08	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:08	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:08	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:08	RQE	EPA-200.8
Total Zinc	**19.8**	µg/L	5.00	1	03/11/11 06:08	RQE	EPA-200.8
Fecal Coliform	**2800**	cfu/100mL	10	1	03/10/11 14:35	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**12**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**3.38**	mg/L	1.00	1	03/10/11 16:36	KYS	EPA-300.0
Turbidity	**150**	NTU	5.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89207**
Sample ID : **A-4**

Matrix: **Aqueous**
Sampled: **3/9/2011 8:20**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**7**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**13**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.44**	mg/L	1.00	1	03/10/11 16:54	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Total Coliform	**490**	cfu/100mL	10	1	03/10/11 16:00	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 16:54	KYS	EPA-300.0
Nitrate (NO3-N)	**0.428**	mg/L	0.100	1	03/10/11 16:54	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 16:54	KYS	EPA-300.0
Nitrate+Nitrite-N	**0.428**	mg/L	0.100	1	03/10/11 16:54		EPA-300.0
pH	**6.1**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**86**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	**0.485**	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**1080**	µg/L	100	1	03/11/11 06:16	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:16	RQE	EPA-200.8
Total Arsenic	**0.676**	µg/L	0.500	1	03/11/11 06:16	RQE	EPA-200.8
Total Barium	**24.7**	µg/L	1.00	1	03/11/11 06:16	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 06:16	RQE	EPA-200.8
Total Calcium	**2290**	µg/L	100	1	03/11/11 06:16	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:16	RQE	EPA-200.8
Total Copper	**6.39**	µg/L	0.500	1	03/11/11 06:16	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**10200**	µg/L	100	1	03/11/11 06:16		EPA-200.8
Total Iron	**1020**	µg/L	100	1	03/11/11 06:16	RQE	EPA-200.8
Total Lead	**1.81**	µg/L	0.500	1	03/11/11 06:16	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89207**
Sample ID : **A-4**

Matrix: **Aqueous**
Sampled: **3/9/2011 8:20**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**1080**	µg/L	100	1	03/11/11 06:16	RQE	EPA-200.8
Total Manganese	**127**	µg/L	1.00	1	03/11/11 06:16	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 14:25	TDJ	EPA-245.1
Total Nickel	**1.86**	µg/L	0.500	1	03/11/11 06:16	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:16	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:16	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:16	RQE	EPA-200.8
Total Zinc	**13.7**	µg/L	5.00	1	03/11/11 06:16	RQE	EPA-200.8
Fecal Coliform	**8600**	cfu/100mL	10	1	03/10/11 14:35	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**7**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**1.96**	mg/L	1.00	1	03/10/11 16:54	KYS	EPA-300.0
Turbidity	**48**	NTU	4.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89208**
Sample ID : **A-7**

Matrix: **Aqueous**
Sampled: **3/9/2011 8:44**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**5**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**7**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	<1.00	mg/L	1.00	1	03/10/11 17:46	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Total Coliform	**230**	cfu/100mL	10	1	03/10/11 16:00	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 17:46	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	03/10/11 17:46	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 17:46	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	03/10/11 17:46		EPA-300.0
pH	**6.1**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**79**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	<0.050	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**2180**	µg/L	100	1	03/11/11 06:23	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:23	RQE	EPA-200.8
Total Arsenic	<0.500	µg/L	0.500	1	03/11/11 06:23	RQE	EPA-200.8
Total Barium	**20.1**	µg/L	1.00	1	03/11/11 06:23	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 06:23	RQE	EPA-200.8
Total Calcium	**4600**	µg/L	100	1	03/11/11 06:23	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:23	RQE	EPA-200.8
Total Copper	**1.79**	µg/L	0.500	1	03/11/11 06:23	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**15000**	µg/L	100	1	03/11/11 06:23		EPA-200.8
Total Iron	**1180**	µg/L	100	1	03/11/11 06:23	RQE	EPA-200.8
Total Lead	**1.24**	µg/L	0.500	1	03/11/11 06:23	RQE	EPA-200.8

Qualifiers/ Definitions * Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89208**
Sample ID : **A-7**

Matrix: **Aqueous**
Sampled: **3/9/2011 8:44**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**865**	µg/L	100	1	03/11/11 06:23	RQE	EPA-200.8
Total Manganese	**51.1**	µg/L	1.00	1	03/11/11 06:23	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 13:49	TDJ	EPA-245.1
Total Nickel	**2.18**	µg/L	0.500	1	03/11/11 06:23	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:23	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:23	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:23	RQE	EPA-200.8
Total Zinc	**8.06**	µg/L	5.00	1	03/11/11 06:23	RQE	EPA-200.8
Fecal Coliform	**2100**	cfu/100mL	10	1	03/10/11 14:35	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**5**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**4.92**	mg/L	1.00	1	03/10/11 17:46	KYS	EPA-300.0
Turbidity	**28**	NTU	2.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89209**
Sample ID : **A-3**

Matrix: **Aqueous**
Sampled: **3/9/2011 9:04**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**7**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**6**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.40**	mg/L	1.00	1	03/10/11 18:03	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Total Coliform	**350**	cfu/100mL	10	1	03/10/11 16:00	LSK	9222-B
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 18:03	KYS	EPA-300.0
Nitrate (NO3-N)	**0.191**	mg/L	0.100	1	03/10/11 18:03	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 18:03	KYS	EPA-300.0
Nitrate+Nitrite-N	**0.191**	mg/L	0.100	1	03/10/11 18:03		EPA-300.0
pH	**6.3**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**86**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	**0.506**	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**3630**	µg/L	100	1	03/11/11 06:31	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:31	RQE	EPA-200.8
Total Arsenic	**2.40**	µg/L	0.500	1	03/11/11 06:31	RQE	EPA-200.8
Total Barium	**40.6**	µg/L	1.00	1	03/11/11 06:31	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 06:31	RQE	EPA-200.8
Total Calcium	**2830**	µg/L	100	1	03/11/11 06:31	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:31	RQE	EPA-200.8
Total Copper	**6.47**	µg/L	0.500	1	03/11/11 06:31	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**11500**	µg/L	100	1	03/11/11 06:31		EPA-200.8
Total Iron	**3470**	µg/L	100	1	03/11/11 06:31	RQE	EPA-200.8
Total Lead	**3.58**	µg/L	0.500	1	03/11/11 06:31	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Department of Geo Sciences
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108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89209**
Sample ID : **A-3**

Matrix: **Aqueous**
Sampled: **3/9/2011 9:04**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Magnesium	**1080**	µg/L	100	1	03/11/11 06:31	RQE	EPA-200.8
Total Manganese	**176**	µg/L	1.00	1	03/11/11 06:31	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 13:50	TDJ	EPA-245.1
Total Nickel	**3.21**	µg/L	0.500	1	03/11/11 06:31	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:31	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:31	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:31	RQE	EPA-200.8
Total Zinc	**16.6**	µg/L	5.00	1	03/11/11 06:31	RQE	EPA-200.8
Fecal Coliform	**9400**	cfu/100mL	10	1	03/10/11 14:35	LSK	9222-D
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**7**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**2.00**	mg/L	1.00	1	03/10/11 18:03	KYS	EPA-300.0
Turbidity	**95**	NTU	5.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89210**
Sample ID : **A-6**

Matrix: **Aqueous**
Sampled: **3/9/2011 10:11**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**4**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**5**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.24**	mg/L	1.00	1	03/10/11 18:21	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 18:21	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	03/10/11 18:21	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 18:21	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	03/10/11 18:21		EPA-300.0
pH	**6.1**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**75**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	**0.261**	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**2450**	µg/L	100	1	03/11/11 06:38	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:38	RQE	EPA-200.8
Total Arsenic	**1.04**	µg/L	0.500	1	03/11/11 06:38	RQE	EPA-200.8
Total Barium	**33.9**	µg/L	1.00	1	03/11/11 06:38	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 06:38	RQE	EPA-200.8
Total Calcium	**1970**	µg/L	100	1	03/11/11 06:38	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:38	RQE	EPA-200.8
Total Copper	**4.25**	µg/L	0.500	1	03/11/11 06:38	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**8230**	µg/L	100	1	03/11/11 06:38		EPA-200.8
Total Iron	**2090**	µg/L	100	1	03/11/11 06:38	RQE	EPA-200.8
Total Lead	**1.96**	µg/L	0.500	1	03/11/11 06:38	RQE	EPA-200.8
Total Magnesium	**803**	µg/L	100	1	03/11/11 06:38	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89210**
Sample ID : **A-6**

Matrix: **Aqueous**
Sampled: **3/9/2011 10:11**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Manganese	**147**	µg/L	1.00	1	03/11/11 06:38	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 13:51	TDJ	EPA-245.1
Total Nickel	**2.21**	µg/L	0.500	1	03/11/11 06:38	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:38	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:38	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:38	RQE	EPA-200.8
Total Zinc	**10.6**	µg/L	5.00	1	03/11/11 06:38	RQE	EPA-200.8
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**4**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**1.73**	mg/L	1.00	1	03/10/11 18:21	KYS	EPA-300.0
Turbidity	**56**	NTU	4.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89211**
Sample ID : **B-3**

Matrix: **Aqueous**
Sampled: **3/9/2011 12:18**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**5**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**9**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.24**	mg/L	1.00	1	03/10/11 18:38	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 18:38	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	03/10/11 18:38	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 18:38	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	03/10/11 18:38		EPA-300.0
pH	**5.9**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**71**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	<0.050	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**2080**	µg/L	100	1	03/11/11 06:46	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:46	RQE	EPA-200.8
Total Arsenic	<0.500	µg/L	0.500	1	03/11/11 06:46	RQE	EPA-200.8
Total Barium	**24.1**	µg/L	1.00	1	03/11/11 06:46	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 06:46	RQE	EPA-200.8
Total Calcium	**2800**	µg/L	100	1	03/11/11 06:46	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:46	RQE	EPA-200.8
Total Copper	**1.81**	µg/L	0.500	1	03/11/11 06:46	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**9940**	µg/L	100	1	03/11/11 06:46		EPA-200.8
Total Iron	**1220**	µg/L	100	1	03/11/11 06:46	RQE	EPA-200.8
Total Lead	**1.27**	µg/L	0.500	1	03/11/11 06:46	RQE	EPA-200.8
Total Magnesium	**715**	µg/L	100	1	03/11/11 06:46	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89211**
Sample ID : **B-3**

Matrix: **Aqueous**
Sampled: **3/9/2011 12:18**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Manganese	**107**	µg/L	1.00	1	03/11/11 06:46	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 13:52	TDJ	EPA-245.1
Total Nickel	**1.94**	µg/L	0.500	1	03/11/11 06:46	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:46	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:46	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:46	RQE	EPA-200.8
Total Zinc	**10.3**	µg/L	5.00	1	03/11/11 06:46	RQE	EPA-200.8
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**5**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**1.72**	mg/L	1.00	1	03/10/11 18:38	KYS	EPA-300.0
Turbidity	**26**	NTU	2.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89212**
Sample ID : **A-9**

Matrix: **Aqueous**
Sampled: **3/9/2011 12:55**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**8**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**6**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.16**	mg/L	1.00	1	03/10/11 18:55	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 18:55	KYS	EPA-300.0
Nitrate (NO3-N)	<0.100	mg/L	0.100	1	03/10/11 18:55	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 18:55	KYS	EPA-300.0
Nitrate+Nitrite-N	<0.100	mg/L	0.100	1	03/10/11 18:55		EPA-300.0
pH	**6.1**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**89**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	**0.188**	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	**0.052**	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**3520**	µg/L	100	1	03/11/11 06:53	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 06:53	RQE	EPA-200.8
Total Arsenic	**1.18**	µg/L	0.500	1	03/11/11 06:53	RQE	EPA-200.8
Total Barium	**37.6**	µg/L	1.00	1	03/11/11 06:53	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 06:53	RQE	EPA-200.8
Total Calcium	**3410**	µg/L	100	1	03/11/11 06:53	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 06:53	RQE	EPA-200.8
Total Copper	**3.51**	µg/L	0.500	1	03/11/11 06:53	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**12800**	µg/L	100	1	03/11/11 06:53		EPA-200.8
Total Iron	**2630**	µg/L	100	1	03/11/11 06:53	RQE	EPA-200.8
Total Lead	**2.32**	µg/L	0.500	1	03/11/11 06:53	RQE	EPA-200.8
Total Magnesium	**1050**	µg/L	100	1	03/11/11 06:53	RQE	EPA-200.8

Qualifiers/ Definitions * Outside QC limit DF Dilution Factor
MQL Method Quantitation Limit

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89212**
Sample ID : **A-9**

Matrix: **Aqueous**
Sampled: **3/9/2011 12:55**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Manganese	**205**	µg/L	1.00	1	03/11/11 06:53	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 13:54	TDJ	EPA-245.1
Total Nickel	**2.92**	µg/L	0.500	1	03/11/11 06:53	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 06:53	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 06:53	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 06:53	RQE	EPA-200.8
Total Zinc	**14.2**	µg/L	5.00	1	03/11/11 06:53	RQE	EPA-200.8
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**8**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**2.30**	mg/L	1.00	1	03/10/11 18:55	KYS	EPA-300.0
Turbidity	**52**	NTU	2.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

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Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89213**
Sample ID : **A-5**

Matrix: **Aqueous**
Sampled: **3/9/2011 18:13**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Alkalinity (as CaCO3)	**6**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Ammonia Nitrogen	<0.100	mg/L	0.100	1	03/14/11 02:40	EWB	4500-NH3D
Biochemical Oxygen Demand (5-day)	<5	mg/L	5	1	03/10/11 12:00	TKM	5210-B
Carbon Dioxide (Estimate)	**9**	mg/L	0.1	1	03/24/11 16:00	JRF	4500-CO2
Chloride	**1.32**	mg/L	1.00	1	03/10/11 19:13	KYS	EPA-300.0
Total Cyanide	<0.010	mg/L	0.010	1	03/18/11 09:05	GHD	4500-CN-E
Fluoride (w/o distillation)	<0.100	mg/L	0.100	1	03/10/11 19:13	KYS	EPA-300.0
Nitrate (NO3-N)	**0.282**	mg/L	0.100	1	03/10/11 19:13	KYS	EPA-300.0
Nitrite (NO2-N)	<0.100	mg/L	0.100	1	03/10/11 19:13	KYS	EPA-300.0
Nitrate+Nitrite-N	**0.282**	mg/L	0.100	1	03/10/11 19:13		EPA-300.0
pH	**6.2**	s.u.		1	03/10/11 16:35	JDW	4500-H-B
Total Dissolved Solids	**80**	mg/L	10	1	03/16/11 16:00	NRT	2540C
Total Phosphorus	**0.505**	mg/L	0.050	1	03/15/11 08:40	TKM	4500-PE
Phenols (Total)	<0.050	mg/L	0.050	1	03/15/11 11:30	DRG	EPA-420.1
Total Aluminum	**2120**	µg/L	100	1	03/11/11 07:00	RQE	EPA-200.8
Total Antimony	<1.00	µg/L	1.00	1	03/11/11 07:00	RQE	EPA-200.8
Total Arsenic	**0.586**	µg/L	0.500	1	03/11/11 07:00	RQE	EPA-200.8
Total Barium	**32.0**	µg/L	1.00	1	03/11/11 07:00	RQE	EPA-200.8
Total Beryllium	<0.500	µg/L	0.500	1	03/11/11 07:00	RQE	EPA-200.8
Total Calcium	**2250**	µg/L	100	1	03/11/11 07:00	RQE	EPA-200.8
Total Cadmium	<0.100	µg/L	0.100	1	03/11/11 07:00	RQE	EPA-200.8
Total Copper	**6.63**	µg/L	0.500	1	03/11/11 07:00	RQE	EPA-200.8
Hardness as CaCO3(SM-2340B)	**10100**	µg/L	100	1	03/11/11 07:00		EPA-200.8
Total Iron	**1660**	µg/L	100	1	03/11/11 07:00	RQE	EPA-200.8
Total Lead	**1.82**	µg/L	0.500	1	03/11/11 07:00	RQE	EPA-200.8
Total Magnesium	**1090**	µg/L	100	1	03/11/11 07:00	RQE	EPA-200.8

Qualifiers/ Definitions
* Outside QC limit
MQL Method Quantitation Limit
DF Dilution Factor

ETC Environmental Testing & Consulting, Inc.
www.etcmemphis.com
2790 Whitten Road Memphis, Tennessee 38133 (901) 213-2400 Fax (901) 213-2440
"A Laboratory Management Partner"

03816
Department of Geo Sciences
Dr. Darrel Schmitz
108 Hillbun Hall
MSU , MS 39762

Project Information : Monitoring

Report Date : 3/24/2011

Report Number : **11-069-0272**

REPORT OF ANALYSIS

Received : 3/10/2011

Lab No : **89213**
Sample ID : **A-5**

Matrix: **Aqueous**
Sampled: **3/9/2011 18:13**

Test	Results	Units	MQL	DF	Date / Time Analyzed	By	Analytical Method
Total Manganese	**139**	µg/L	1.00	1	03/11/11 07:00	RQE	EPA-200.8
Total Mercury	<0.0002	mg/L	0.0002	1	03/14/11 13:55	TDJ	EPA-245.1
Total Nickel	**2.24**	µg/L	0.500	1	03/11/11 07:00	RQE	EPA-200.8
Total Selenium	<2.00	µg/L	2.00	1	03/11/11 07:00	RQE	EPA-200.8
Total Silver	<0.100	µg/L	0.100	1	03/11/11 07:00	RQE	EPA-200.8
Total Thallium	<0.500	µg/L	0.500	1	03/11/11 07:00	RQE	EPA-200.8
Total Zinc	**15.3**	µg/L	5.00	1	03/11/11 07:00	RQE	EPA-200.8
Carbonate	<2	mg/L	2	1	03/18/11 08:35	EWB	2320B
Bicarbonate (as CaCO3)	**6**	mg/L	1	1	03/18/11 08:35	EWB	2320B
Total Sulfate (SO4)	**2.14**	mg/L	1.00	1	03/10/11 19:13	KYS	EPA-300.0
Turbidity	**42**	NTU	2.0	1	03/10/11 16:10	GHD	2130B

Qualifiers/ Definitions
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MQL Method Quantitation Limit
DF Dilution Factor

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Cooler Receipt Form

Customer Number: **03816**
Customer Name: **Department of Geo Sciences**
Report Number: **11-069-0272**

Shipping Method

○ FedEx ○ UPS ○ US Posta ○ Client ● LMP ○ Courier ○ Other:

Shipping container/cooler uncompromised?	● Yes	○ No	○ Not Present
Custody seals intact on shipping container/cooler?	○ Yes	○ No	● Not Required
Custody seals intact on sample bottles?	○ Yes	○ No	● Not Required
Chain of Custody present?	● Yes	○ No	
COC agrees with sample labels?	● Yes	○ No	
Samples in proper containers?	● Yes	○ No	
Sample containers intact?	● Yes	○ No	
Sufficient sample volume for indicated tests?	● Yes	○ No	
All samples received within holding time?	● Yes	○ No	
Container temperature in compliance?	● Yes	○ No	
Water - VOA vials free of headspace?	○ Yes	○ No	● N/A
Water - Preservation acceptable upon receipt?	● Yes	○ No	○ N/A
Samples screened for radioactivity (COE only)?	○ Yes	○ No	● N/A
Special precautions or instructions included?	○ Yes	● No	

Comments:

Any regulatory non-compliance issues will be recorded on non-compliance report.

Signature: Brooke Shoup

Date & Time: 03/10/2011 14:43:11

Environmental Testing & Consulting, Inc. Chain of Custody

Page 1 of 1

Client Name: Miss. State Univ.	Client Project Manager/Contact: D Schmitz	Phone #: 662-325-2904
Project/ Site Location: Smith Co. - USFS		email Address: schmitz@geosci.msstate.edu
Project Number:	PID #:	Purchase Order Number:
Type of Event: (Single) Daily Weekly Monthly Quarterly Semi-Annual		Method of Shipment: Hand delivered

11-069-0272
03510
2011-03-10
14:34:19
Department of Geo Sciences
Monitoring

☐ NPDES ☐ Wastewater ☐ UST ☐ Other Program

☐ RUSH - Additional charges apply.
The following require a Statement of Work
☐ Special Report Requirements
☐ Special Detection Limit(s)
☐ Special Method Requirements

Environmental Testing & Consulting, Inc.
2790 Whitten Road
Memphis, TN 38133
(901) 213-2400 (phone)
(901) 213-2440 (fax)
www.etcmemphis.com

Required Analysis:

Date:	Time:	Sample Identification:	Number of Containers	Matrix	(G)rab or (C)omposite	TC, FC	Total Alk, Chloride, Fluoride	NH3-N	BOD, Carbon Dioxide	CNT	ICPMS Metals, Hardness, Hg	NO3/NO2, pH	Total phenols, Total P	SO4, Turbidity	TDS
3/9/11	7:26	A-1	6	H_2O											
3/9/11	8:20	A-4	6	H_2O											
3/9/11	8:44	A-7	6	H_2O											
3/9/11	9:04	A-3	6	H_2O											
3/9/11	10:11	A-6	5	H_2O											
3/9/11	12:18	B-3	5	H_2O											
3/9/11	12:55	A-9	5	H_2O											
3/9/11	18:13	A-5	5	H_2O											

Matrix
WW - Wastewater GW - Groundwater DW-Drinking Water S-Soil O-Oil L-Non aqueous liquid
Other: ______

Sampled by (Name/Affiliation): (Print): D Schmitz, MSU
D. Schmitz

Client Remarks/Comments:

For Laboratory Use Only		
Ice	Cooler Temp	Lab Comments
(Y) N	14°C	

Relinquished by: (SIGNATURE)	Date	Time	Received by: (SIGNATURE)	Date	Time
D. Schmitz	3/10/11	1100	F. Lanang	3/10/11	1100
Relinquished by: (SIGNATURE)	Date	Time	Received by: (SIGNATURE)	Date	Time
Relinquished by: (SIGNATURE)	Date	Time	Received for lab by: (SIGNATURE)	Date	Time
F. Lanang	3/10/11	1400	F. Lanang	3/10/11	1400

SAFEGUARD Form No. 811-2/W03CS000060 6/10

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