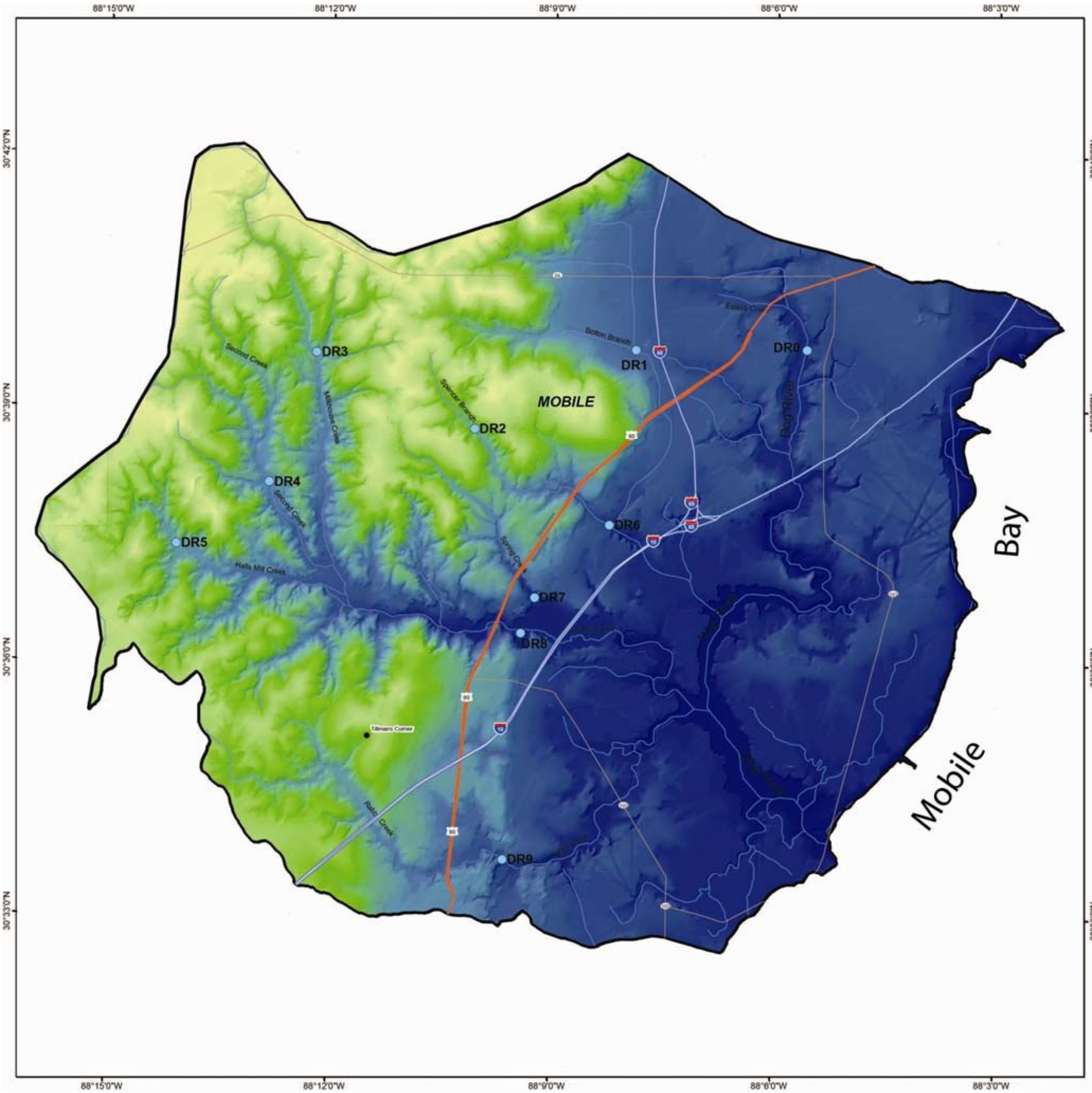
ANALYSIS OF DISCHARGE AND SEDIMENT LOADING RATES IN TRIBUTARIES OF DOG RIVER IN THE MOBILE METROPOLITAN AREA



GEOLOGICAL SURVEY OF ALABAMA

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ANALYSIS OF DISCHARGE AND SEDIMENT LOADING RATES IN TRIBUTARIES OF DOG RIVER IN THE MOBILE METROPOLITAN AREA

OPEN FILE REPORT 1214

By

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Partial funding for this project provided by the Mobile Bay National Estuary Program

Tuscaloosa, Alabama
2012

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INTRODUCTION

Beginning in 2006, the Geological Survey of Alabama partnered with the Mobile Bay National Estuary Program and other federal, state, and local agencies, universities, and private groups to systematically assess sediment transport to Mobile Bay from tributaries originating in Baldwin and Mobile Counties. One of these tributaries is Dog River, which drains the south part of the city of Mobile and flows southward into Mobile Bay about 3.5 miles south of Brookley Field (fig. 1).

Urban runoff can have tremendous deleterious impacts on water quality and biological habitat of streams. This is particularly true in watersheds where land use has been substantially changed and stream channels have been modified by channelization. Water quality in these urban streams is typically characterized by excessive nutrients, bacteria, and sediment. The northern part of the watershed includes part of downtown Mobile, which is almost completely urbanized, influencing runoff with impervious surfaces and urban contaminants. The western part of the watershed includes rapidly changing land uses from forested to urban and the southwestern part of the watershed includes interspersed commercial and forested landscapes.

This assessment is focused on documentation of land use in the watershed and resulting sediment transported into Mobile Bay from the city of Mobile. Data collected during this assessment are valuable in quantifying sediment loads and their related land uses so that limited regulatory and remedial resources may be employed where needs are greatest.

ACKNOWLEDGMENTS

Ms. Roberta Swann, Director, Mobile Bay National Estuary Program, Mr. Tom Herder, Watershed Protection Coordinator, Mobile Bay National Estuary Program, and Dr. Miriam (Mimi) Fearn, Associate Professor of Geography and Chairperson, Earth Science Department, University of South Alabama, were instrumental in the planning, funding, and facilitation of this project.

PROJECT AREA

The Dog River project is in the south Mobile metropolitan area of east-central Mobile County (fig. 1). The project consists of 9 monitoring sites on 8 tributaries of Dog River and contains an area of 55 square miles (mi^2) (plate 1).

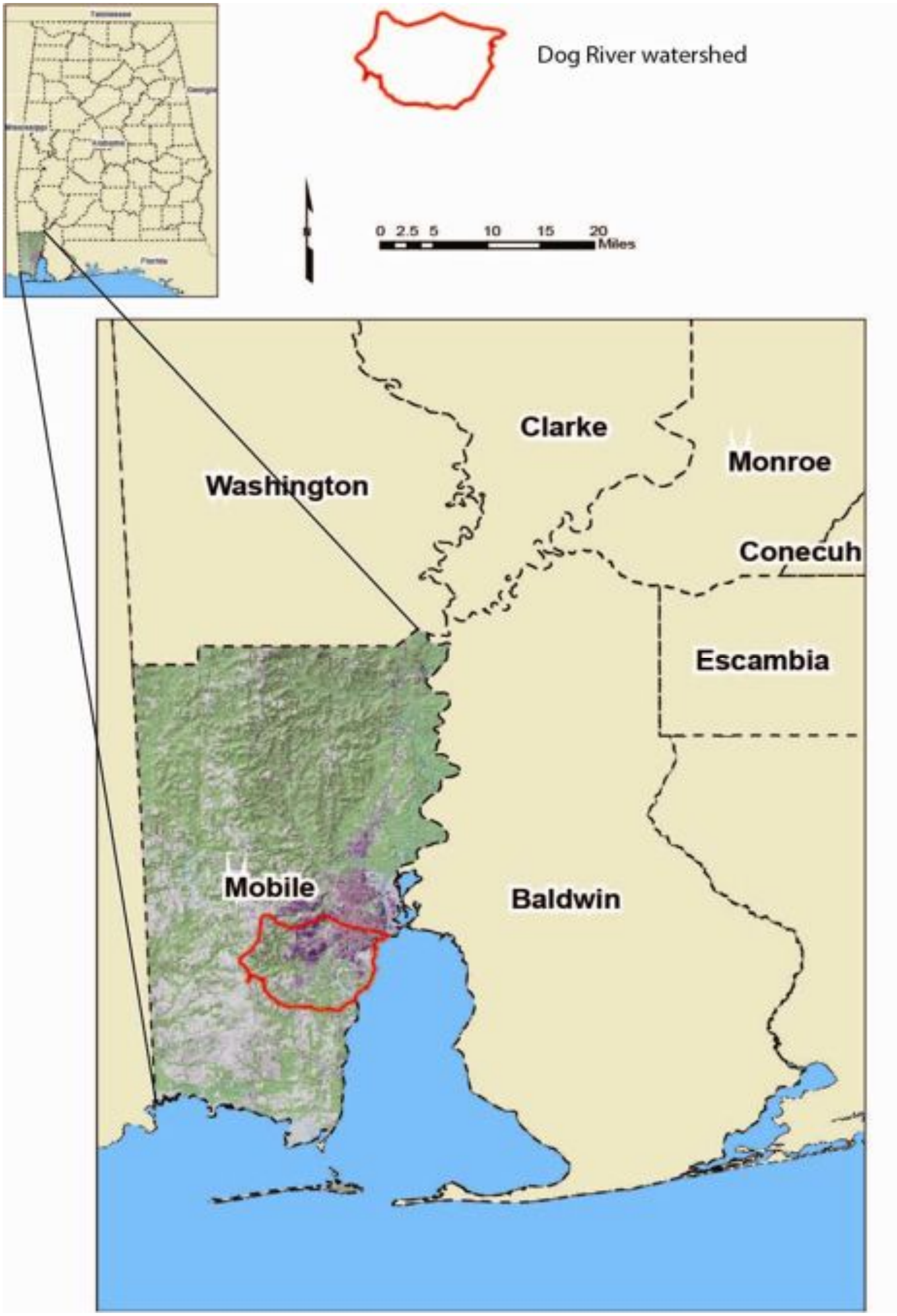

Figure 1.—Location of the Dog River watershed.

PROJECT MONITORING SITE CHARACTERISTICS

Site 1 is at latitude 30.66196^{o} north and longitude -88.13171^{o} west on Bolton Branch at Pleasant Valley Road, about 1600 feet west of Interstate 65. The stream channel is a concrete flume about 30 feet wide. The stream drains 3.6 mi^2 and has a gradient of 55 feet per mile upstream from the monitoring site (plate 2).

Site 2 is at latitude 30.64623 north and longitude -88.16788 west on Spencer Branch at Cottage Hill Road about 1.8 miles from the confluence with Moore Creek and about 7 miles from Mobile Bay (plate 2). The stream channel is a concrete flume about 30 feet wide (see appendix photograph) and the watershed upstream from the site drains 1.2 mi^2 and has a gradient of 62 feet per mile, upstream from the monitoring site.

Site 3 is at latitude 30.66106 north and longitude -88.20359 west on Milkhouse Creek at Grelot Road (plate 2). Milkhouse Creek upstream from the monitoring site drains 3.1 mi^2 and has a gradient of 44 feet per mile. Site 3 is 3.5 miles north of the confluence with Halls Mill Creek.

Site 4 is at latitude 30.63545 north and longitude -88.21401 west on Second Creek at Cottage Hill Road (plate 2). Second Creek upstream from the monitoring site drains 3.7 mi^2 and has a gradient of 44 feet per mile. Site 4 is 1.7 miles north of the confluence with Milkhouse Creek. The channel bed and banks are armored with limestone riprap.

Site 5 is at latitude 30.62319 north and longitude -88.23480 west on Halls Mill Creek at Schillenger Road (plate 2). Halls Mill Creek upstream from the monitoring site drains 2.2 mi^2 and has a gradient of 64 feet per mile. Site 5 is about 8 miles west of the confluence with Dog River. The stream channel upstream from the monitoring site is anastimosing with a thick sand and silt bed.

Site 6 is on Moore Creek near Halls Mill Road at latitude 30.6275 north and longitude -88.13737 west. The stream at this site is channelized and is highly impacted by several structures designed to control runoff. After several unsuccessful attempts to measure flow and bed sediment, the site was abandoned. Therefore, no data are available for site 6 (plate 2).

Site 7 is at latitude 30.61313 north and longitude -88.15405 west on Spring Creek at Maudelayne Drive, about 1.3 miles upstream from the Halls Mill Creek confluence (plate 2). Spring Creek upstream from the monitoring site drains 2.0 mi^2 and has a gradient of 58 feet per mile. The creek flows through residential developments for most of the reach. The channel is mostly natural with some limestone riprap armoring (see appendix photographs).

Site 8 is at latitude 30.60611 north and longitude -88.15712 west on Halls Mill Creek at Halls Mill Road, about 4.1 miles upstream from the Dog River confluence (plate 2). Halls Mill Creek upstream from the monitoring site drains 26.6 mi^2 and has a gradient of 26 feet per mile. Much of the floodplain is characterized as anastomosing and contains numerous wetlands (see appendix photograph).

Site 9 is at latitude 30.56153 north and longitude -88.16074 west on Rabbit Creek at Todd Acres Road, about 4.2 miles upstream from the Dog River confluence (plate 2). Rabbit Creek upstream from the monitoring site drains 6.2 mi^2 and has a gradient of 31 feet per mile. The downstream half of the monitored floodplain contains numerous wetlands. The monitoring site is characterized by riprap armoring and swift flow with pools upstream and downstream from the site (see appendix photograph).

Site 10 is at latitude 30.66221 north and longitude -88.09323 west on Eslava Creek at U.S. Highway 90 (Government Boulevard), about 2.4 miles upstream from the Dog River confluence (plate 2). Eslava Creek upstream from the monitoring site drains 6.5 mi^2 and has a gradient of 6 feet per mile. Eslava Creek drains the western part of downtown Mobile, east of Interstate 65. The floodplain is highly urbanized and the channel primarily consists of a concrete flume (see appendix photograph).

LAND USE AND STREAM FLOW CONDITIONS

Precipitation, stream gradient, geology, and land use are all important factors that influence sediment transport characteristics of streams. Sediment transport conditions in the Dog River watershed area are segregated by particular stream segments based on instream conditions that are influenced by the topography and soils of the watershed, impervious surfaces, construction activities, and associated erosion prevention and runoff detention efforts. Estimates of sediment loads are based on measured sediment and stream discharge. Therefore, a stream flow dataset composed of values ranging from base flow to flood is desirable. Average observed stream flow conditions are shown in table 1.

Stream flow characteristics for tributaries of Dog River vary widely due to the wide range of land forms, channel types and flow regimes influenced by urbanization, channel modifications, and floodplain structures designed to control runoff. Generally, streams that are farther away from downtown Mobile have received fewer modifications to floodplains and channels and have fewer impervious surfaces (plates 2, 3). Table 1 indicates that stream flow velocities are highest for those streams with extensive channelization and are not directly related to stream gradient. Halls Mill Creek upstream from site 5 has the highest gradient (64 feet per mile (ft/mi) but has the lowest flow velocity (0.60 feet per second (ft/s) due to a relatively natural anastomosing channel with meanders and numerous fallen trees and root wads that slow the flow velocity and prevent scour and erosion. The highest average flow velocity was measured at Bolton Branch (site 1) (3.3 ft/s). Eslava Creek (site 10) has the lowest stream gradient (6.0 ft/mi) but has a relatively high average flow velocity (2.1 ft/s) at monitoring site 10 due to channelization that creates an area of high velocity at the U.S. Highway 90 crossing.

Bolton Branch, Spencer Branch, Spring Creek, and Eslava Creek (sites 1, 2, 7, and 10, respectively) are channelized (concrete flumes) and have extensive commercial and residential development in the floodplains (plate 3). Milkhouse Creek has extensive, relatively recent development in the upstream part of the floodplain near site 3 (plate 3). The remaining monitored streams have relatively minimal development in floodplains and only minor modifications to stream channels, although relatively recent urbanization has occurred on the uplands along the drainage divides (plate 3). Second Creek (site 4) is primarily anastomosing but has extensive riprap channel armoring upstream and downstream from the monitoring site at the Cottage Hill Road crossing. Sites 5 and 8 are on Halls Mill Creek which has a relatively small amount of channel modification and floodplain development (plate 3). Rabbit Creek is the southern most tributary to Dog River and has relatively minimal development in the floodplain (plate 3). Agriculture in the Dog River watershed is minimal, although pasture and pecan orchards form a significant part of the land use in the headwaters of Halls Mill Creek and Rabbit Creek (plate 3).

Table 1. Stream flow characteristics for monitored sites in the Dog River watershed.

Monitored site	Average discharge (cfs[1])	Maximum discharge (cfs)	Minimum discharge (cfs)	Average flow velocity (ft/s[2])	Maximum flow velocity (ft/s)	Minimum flow velocity (ft/s)	Stream gradient (ft/mi[3])
1	58.9	268.0	2.7	3.3	9.00	0.72	55
2	26.8	83.4	0	2.70	7.50	0.00	62
3	12.0	23.2	3.0	n/a	n/a	n/a	44
4	46.1	150.0	7.4	n/a	n/a	n/a	44
5	30.6	120.0	4.5	0.60	1.00	0.07	64
7	20.5	65.4	1.2	2.40	5.45	0.61	58
8	72.8	107.0	44.5	1.20	1.50	1.08	26
9	53.0	200.0	12.1	n/a	n/a	n/a	31
10	99.7	318.0	4.4	2.1	3.00	1.10	6

[1]cfs- cubic feet per second
[2]ft/s- feet per second
[3]ft/mi- feet per mile

SEDIMENTATION

Sedimentation is a process by which eroded particles of rock are transported primarily by moving water from areas of relatively high elevation to areas of relatively low elevation, where the particles are deposited. Upland sediment transport is primarily accomplished by overland flow and rill and gully development. Lowland or flood plain transport occurs in streams of varying order, where upland sediment joins sediment eroded from flood plains, stream banks, and stream beds. Erosion rates are accelerated by human activity related to agriculture, construction, timber harvesting, unimproved roadways, or any activity where soils or geologic units are exposed or disturbed. Excessive sedimentation is detrimental to water quality, destroys biological habitat, reduces storage volume of water impoundments, impedes the usability of aquatic recreational areas, and causes damage to structures. Sediment loads in streams are composed of relatively small particles suspended in the water column (suspended solids) and larger particles that move on or periodically near the streambed (bed load). Seven of nine monitored sites in the Dog River watershed were assumed to have total sediment loads represented as suspended sediment due to stream channelization or stream bed armoring. Sediment in these streams was measured on hard surfaces where all sediment was suspended or saltating so that samples contained representative concentrations of all grain sizes transported downstream. Only Halls Mill Creek sites 5 and 8 had sand bed channels with clearly defined suspended and bed sediment.

SEDIMENT LOADS TRANSPORTED BY PROJECT STREAMS

The rate of transport of sediment is a complex process controlled by a number of factors primarily related to land use, precipitation runoff, erosion, stream discharge and flow velocity, stream base level, and physical properties of the transported sediment.

Changes in land use are the primary causes of excessive erosion and sedimentation in the Dog River watershed. Highly erodable soils formed from undifferentiated Miocene Series, Citronelle Formation, and Alluvial, Coastal, and Low Terrace Deposits sediments (plate 4) combined with relatively high topographic relief related to the formation of Mobile Bay can result in erosion and excessive sediment transport in areas where soils are cleared of vegetative cover and proper best management practices are not implemented. This situation can be aggravated in watersheds dominated by urban development, such as Dog River, where large upland areas of impervious surfaces increase runoff and cause accelerated stream flow velocities, flashy flows, and flooding.

Excessive sedimentation causes changes in base level elevation of streams in the watershed and triggers downstream movement of the material as streams reestablish base level equilibrium. The movement of this material is accelerated by periodic large precipitation events that cause increased stream flow and stream flow velocities. However, in urban watersheds like Dog River, impervious surfaces and armored, channelized streams prevent erosion and significantly reduce sediment loads.

SUSPENDED SEDIMENT

The basic concept of constituent loads in a river or stream is simple. However, the mathematics of determining a constituent load may be quite complex. The constituent load is the mass or weight of a constituent that passes a cross-section of a stream in a specific amount of time. Loads are expressed in mass units (tons or kilograms) and are measured for time intervals that are relative to the type of pollutant and the watershed area for which the loads are calculated. Loads are calculated from concentrations of constituents obtained from analyses of water samples and stream discharge, which is the volume of water that passes a cross-section of the river in a specific amount of time.

Suspended sediment is defined as that portion of a water sample that is separated from the water by filtering. This solid material may be composed of organic and inorganic particles that include algae, industrial and municipal wastes, urban and agricultural runoff, and eroded material from geologic formations. These materials are transported to stream channels by overland flow related to storm-water runoff and cause varying degrees of turbidity. Turbidity values for all monitoring sites are shown in table 2.

Annual suspended sediment loads were estimated using the computer regression model Regr_Cntr.xls (*Regression with Centering*) (Richards, 1999). The program is an Excel adaptation of the U. S. Geological Survey (USGS) seven-parameter regression model for load estimation (Cohn and others, 1992). The regression with centering program requires total suspended solids (TSS) concentrations and average daily stream discharge to estimate annual loads. Although average daily discharge for project streams was not available from direct measurement, it was estimated by establishing a ratio between periodic measured discharge in project streams and discharge values for the same times obtained from the USGS discharge station located on Chickasaw Creek near Kushla, Alabama (USGS site 02471001), about eight miles northwest from Mobile. Total suspended solids concentrations and estimated suspended sediment loads for each monitored site are shown in table 2 and figure 2. Eslava Creek, Spencer Branch,, and Spring Creek (sites 10, 7, and 2) had the largest loads with 10,803, 5,970, and 5,198 tons per year (t/yr), respectively. Figure 2 shows the correlation between suspended

Table 2—Total suspended solids (TSS) and suspended sediment loads measured in monitored streams.

Monitored site	Average Discharge (cfs)	Average turbidity (NTU)	Maximum turbidity (NTU)	Average TSS (mg/L)	Maximum TSS (mg/L)	Estimated suspended sediment load (t/yr)	Estimated normalized suspended sediment load (t/mi²/yr)
1	58.9	48	90	34	167	541	150
2	22.9	117	230	103	282	5,198	4,332
3	12.0	36	80	9	17	48	16
4	46.1	28	75	15	64	551	149
5	30.6	36	111	15	39	210	95
7	20.5	77	259	68	426	5,970	2,985
8	72.8	43	64	17	50	407	15
9	53.1	48	143	9	20	342	55
10	99.7	70	240	22	83	10,803	1,662

[1]Data were insufficient to estimate sediment loadings at site 6.

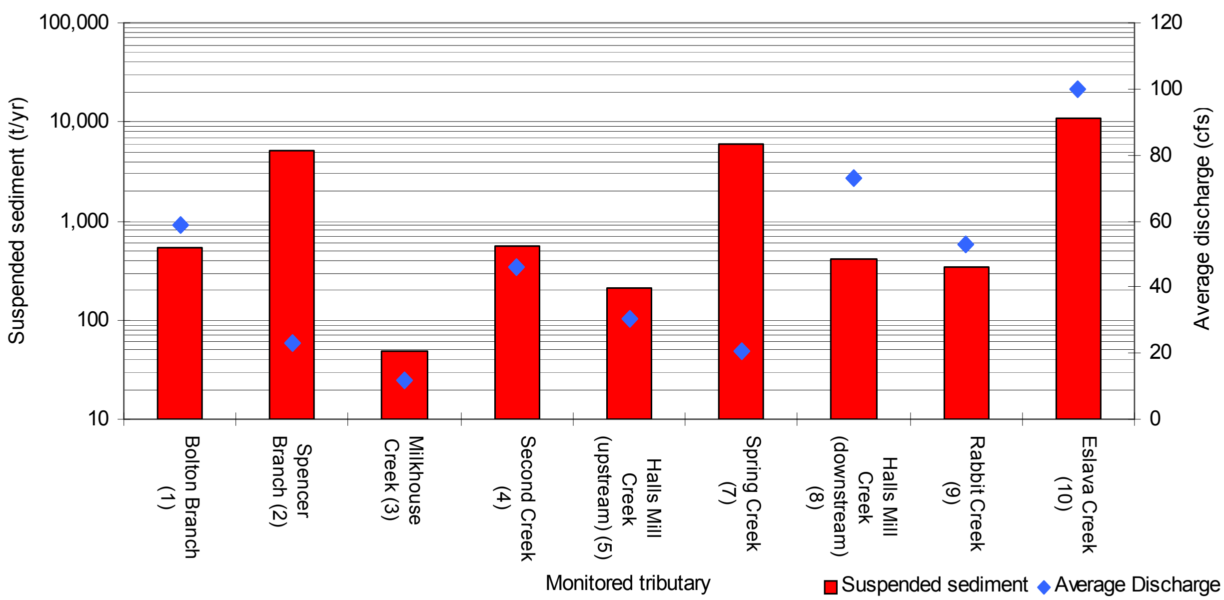

Figure 2.—Estimated suspended sediment loads and average discharge for monitored Dog River tributaries.

sediment loads and average stream discharge. Note the negative correlation for Spencer Branch (site 2) and Spring Creek (site 7) where relatively small discharge transports some of the largest loads (see appendix photograph). This is probably due to activities in the watershed that promote erosion and sedimentation in the stream. Figure 3 shows suspended sediment loads and average stream flow velocities for the monitored tributaries (velocity data was not available for sites 3, 4, and 9). Unlike figure 2, a positive correlation is seen for Spencer Branch (site 2) and Spring Creek (site 7), indicating that relatively large suspended sediment loads are transported by relatively small discharge due to high velocities that are a result of the highest stream gradients of the monitored streams (fig. 3, table 1). Bolton Branch (site 1) is the only negatively correlated stream, indicating that sediment available for transport by the highest average velocity is limited.

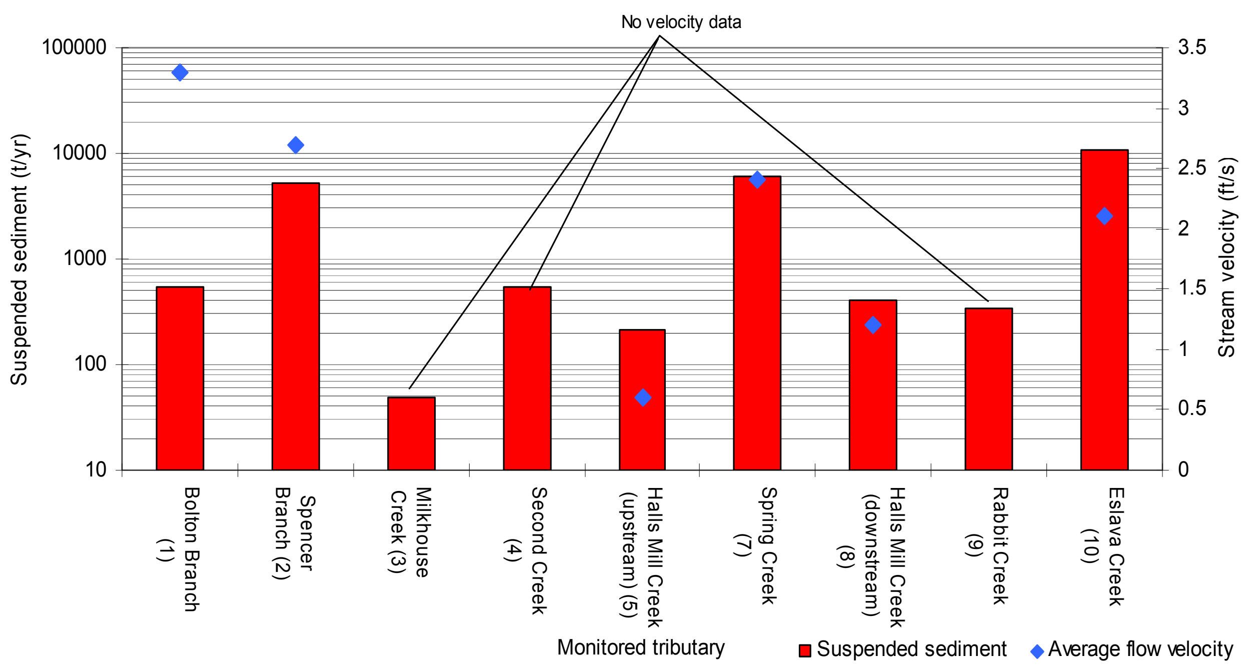

Figure 3.—Estimated suspended sediment loads and average stream flow velocities for monitored Dog River tributaries.

Normalizing suspended loads to unit watershed area permits comparison of monitored watersheds. Figure 4 shows normalized suspended sediment loads and indicates that Spencer Branch, Spring Creek, and Eslava Creek (sites 2, 7, 10) had the largest loads with 4,332 and 2,985, and 1,662 tons per square mile per year (t/mi^2/yr), respectively. When normalized suspended sediment loads are compared to monitored watershed area, it is clear that land use and hydrologic characteristics, not area, are the controlling factors that determine sediment load transport in the Dog River watershed (fig. 4). Spencer Branch (site 2) has the smallest monitored drainage area but has the largest suspended sediment load and normalized load, whereas Halls Mill Creek has the largest monitored drainage area and the smallest suspended sediment loads (fig. 4).

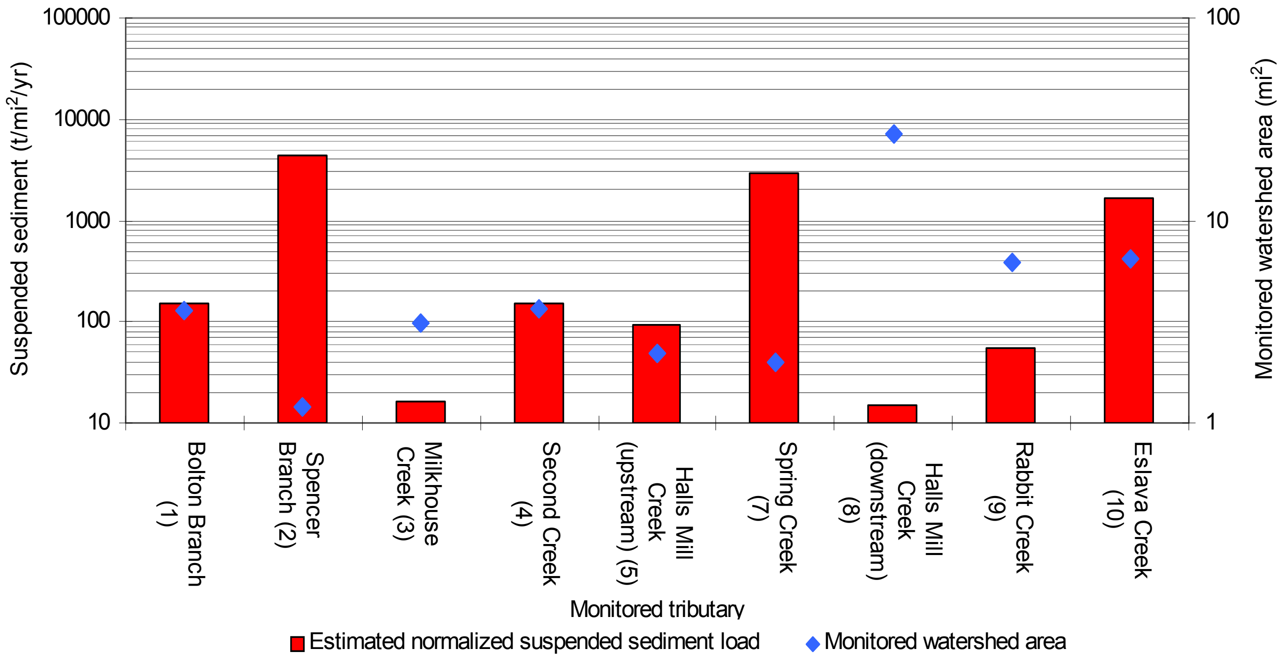

Figure 4.—Estimated normalized suspended sediment loads and monitored watershed areas for Dog River tributaries.

BED SEDIMENT

Transport of streambed material is controlled by a number of factors including stream discharge and flow velocity, erosion and sediment supply, stream base level, and physical properties of the streambed material. Most streambeds are in a state of constant flux in order to maintain a stable base level elevation. The energy of flowing water in a stream is constantly changing to supply the required power for erosion or deposition of bed load to maintain equilibrium with the local water table and regional or global sea level. Stream base level may be affected by regional or global events including fluctuations of sea level or tectonic movement. Local factors affecting base level include fluctuations in the water table elevation, changes in the supply of sediment to the stream caused by changing precipitation rates, and/or land use practices that promote excessive erosion in the floodplain or upland areas of the watershed.

Bed load sediment is composed of particles that are too large or too dense to be carried in suspension by stream flow. These particles roll, tumble, or are periodically suspended as they move downstream. Traditionally, bed load sediment has been difficult to quantify due to deficiencies in monitoring methodology or inaccuracies of estimating volumes of sediment being transported along the streambed. This is particularly true in streams that flow at high velocity or in streams with excessive sediment loads.

The Geological Survey of Alabama developed a portable bed load sedimentation rate-monitoring device to accurately measure bed sediment in shallow streams with sand or gravel beds (Cook and Puckett, 1998). The device was utilized during this project to measure bed loads periodically over a range of discharge events to calculate daily bed load sedimentation rates. However, Halls Mill Creek sites 5 and 8 were the only sites with stream bed conditions that permitted measurement of bed sediment. As mentioned previously, sediment volumes at all other sites were measured on hard surfaces so that total sediment volumes were assumed to be suspended. Table 3 shows measured average stream discharge and stream flow velocity and bed sediment loads for sites 5 and 8. Note that the bed sediment load at site 5 (265 t/yr) is greater than that at site 8 (242 t/yr) even though the drainage area for the watershed upstream from site 5 is less than 10 percent as large as the drainage area upstream from site 8. This is caused by two primary factors. First, plate 3 indicates that land uses in the headwaters of Halls Mill Creek upstream from site 5 are varied with both urban development and agriculture, whereas the floodplain between sites 5 and 8 is primarily forest and wetlands. Therefore, most of the bed sediment is sourced from the area upstream from site 5. Secondly, the floodplain of the creek between sites 5 and 8 expands significantly and contains numerous wetlands. The gradient of the stream decreases from 64 ft/mi upstream of site 5 to 15 ft/mi between sites 5 and 8. These factors indicate that there is significantly less erosion and greater sediment deposition in the watershed between sites 5 and 8 than upstream from site 5. This can also be seen on plate 4, which shows significant alluvium in the stream reach between sites 5 and 8.

As with suspended sediment, it is possible to use discharge/sediment relationships to develop regression models to determine mean daily bed load volumes and annual bed sediment loads, as shown in figure 5. Figure 6 shows the excellent correlation between measured stream flow velocity and corresponding bed sediment transport rates at Halls Mill Creek (site 8). Figure 6 also shows that almost no bed sediment is transported until the stream flow reaches 1.00 ft/s.

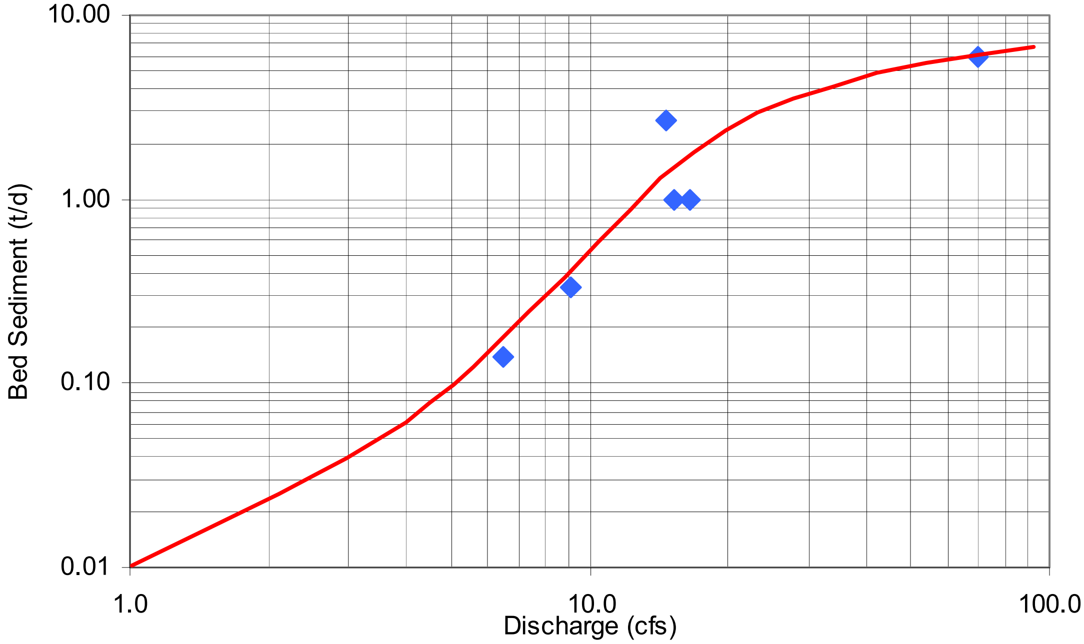

Figure 5.—Measured bed sediment loads in tons per day (t/d) and average stream discharge at Halls Mill Creek site 5.

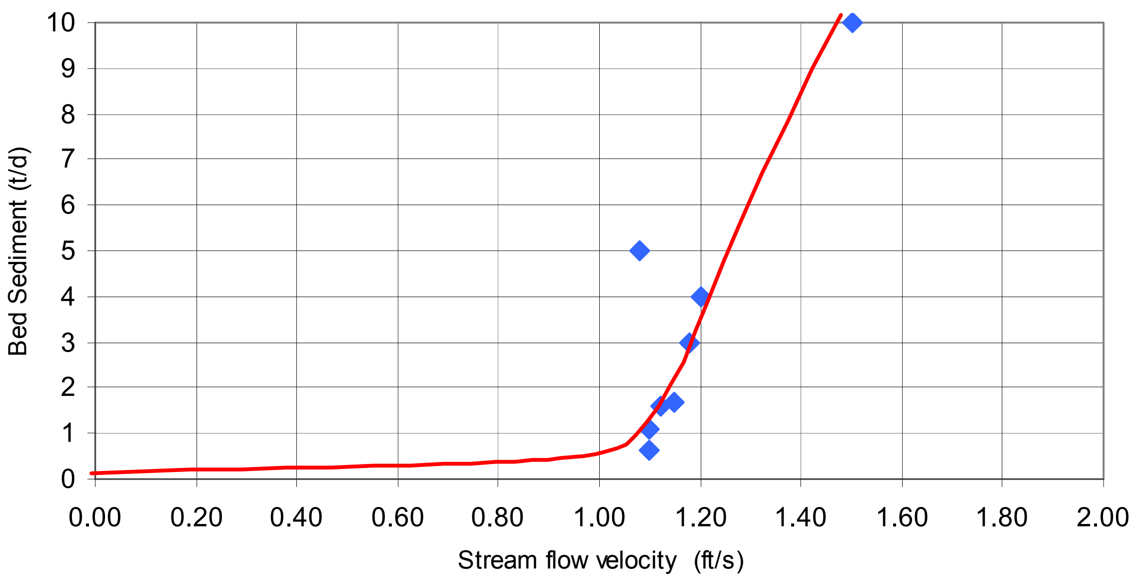

Figure 6.—Measured bed sediment loads in tons per day (t/d) and average stream flow velocities at Halls Mill Creek site 8.

Table 3 gives stream discharge, stream flow velocity, annual bed sediment loads, and normalized annual bed sediment loads for Halls Mill Creek sites 5 and 8. As discussed previously, site 5 had the largest bed sediment load (265 t/yr) and site 8 had a load of 242 t/yr. After normalization of bed sediment loads, site 5 had a load of 121 t/mi ^{2}/yr and site 8 had a load of 8.9 t/mi ^{2}/yr. This confirms the previously discussed fact that most of the bed sediment is contributed from the area upstream from site 5.

Table 3—Measured discharge, stream flow velocity, and estimated bed sediment loads for sites on monitored tributaries in the Dog River watershed.

Monitored site	Average discharge (cfs)	Average stream-flow velocity (f/s)	Estimated annual bed sediment loads (t/yr)	Estimated normalized annual bed sediment loads ($t/mi^2/yr$)
5	30.6	0.6	265	121
8	72.8	1.2	242	8.9

*Total sediment loads for sites 1-4, 6, 7, 9, and 10 were assumed to be suspended.

TOTAL SEDIMENT LOADS

Total sediment loads are composed of suspended and bed sediment. As noted previously, much of the erosion in the project watersheds is caused by human activity. Without human impact, erosion rates in the watershed, called the geologic erosion rate would be 64 $t/mi^2/yr$ (Maidment, 1993). The estimated geologic erosion rates for the project watersheds are shown in table 4. The largest total annual sediment load (10,803 t/yr) was estimated for Eslava Creek (site 10) (table 4, fig. 7). When the data are normalized, allowing comparison of sediment loads with respect to unit drainage areas, site 2 had the largest load (4,332 $t/mi^2/yr$) (table 4).

Table 4—Estimated total sediment loads for monitored Dog River tributaries.

Monitored site	Estimated geologic erosion rate total sediment load (t/yr)	Estimated total annual sediment load (t/yr)	Estimated normalized total annual sediment load ($t/mi^2/yr$)
1	230	541	150
2	77	5,198	4,332
3	192	48	16
4	237	551	149
5	134	475	226
7	128	5,970	2,985
8	1,734	649	24
9	398	342	55
10	416	10,803	1,662
Total	3,546	25,577	1,068 (average)

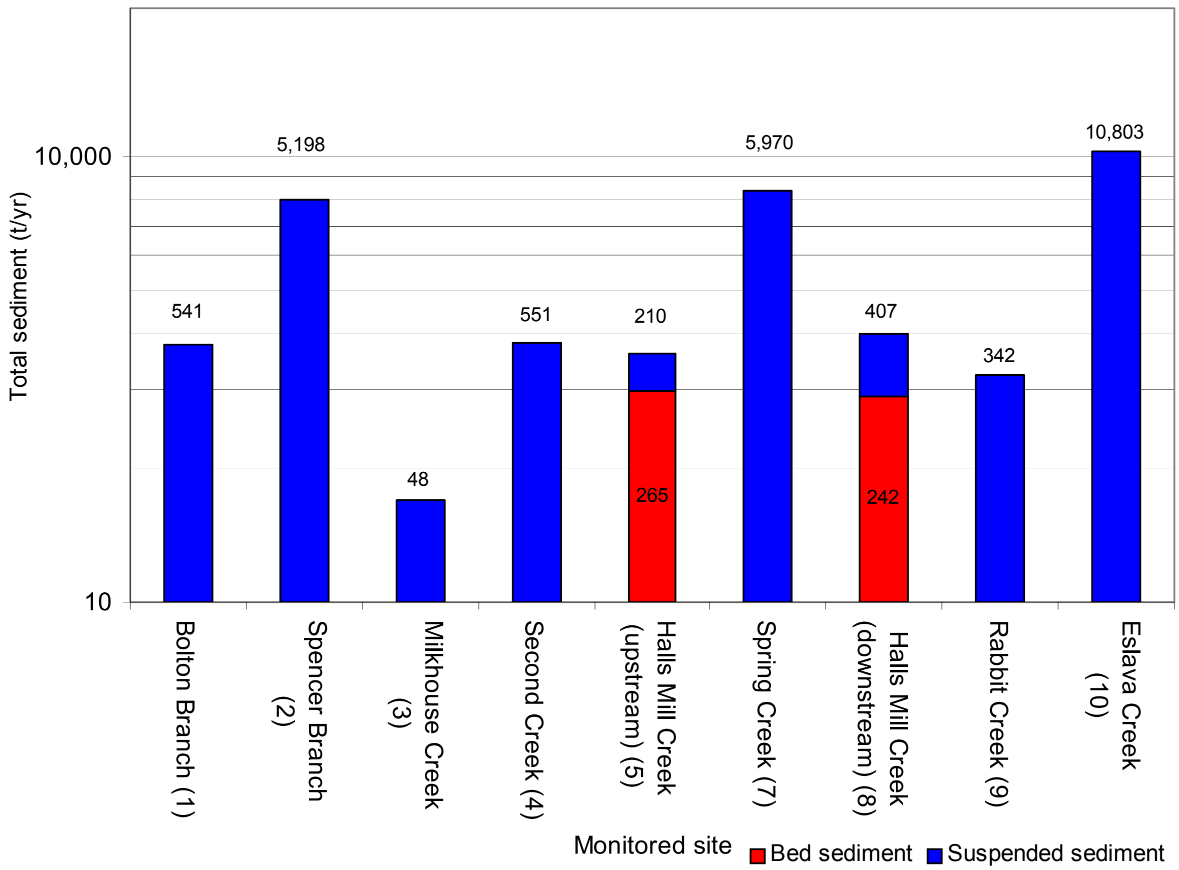

Figure 7.—Estimated total sediment loads for monitored tributaries in the Dog River watershed.

Comparisons of sediment loads from other watersheds are helpful in determining the severity of erosion problems in a watershed of interest. Estimates of sediment loads from Magnolia River site 4 (Magnolia River at U.S. Highway 98), D'Olive Creek site 3 (D'Olive Creek at U.S. Highway 90), and Tiawasee Creek site 7 (Tiawasee Creek upstream from Lake Forest), in Baldwin County, are compared to Dog River tributary loads in figure 8 (Cook and others, 2008, 2009). Figure 9 provides a comparison of sediment loads in selected streams throughout Alabama. It indicates that sediment loads estimated for Dog River sites 2, 7, and 10 are among the highest of about 55 streams assessed by GSA. Figure 9 also shows that sediment loads in the Dog River streams are comparable to watersheds with similar urban sediment sources, flow regimes, and erosional impacts. Figure 9 shows similar sediment loads in streams in the Choctawhatchee River watershed in southeast Alabama and the Bear Creek watershed in northwest Alabama (erosion primarily from row crop agriculture and timber harvesting).

Tributaries to the Gantt and Point A reservoirs in south-central Alabama have sediment primarily from eroding unpaved roads, and D'Olive Creek sediment is primarily from urban and developing urban areas of the watershed. Figure 9 also shows that sites with consistently higher sediment loads were from storm-water runoff in the more mature urban watersheds in the city of Tuscaloosa and Dog River. Yellow River exhibits the smallest loads due to the rural and forested character of the watershed (fig. 9).

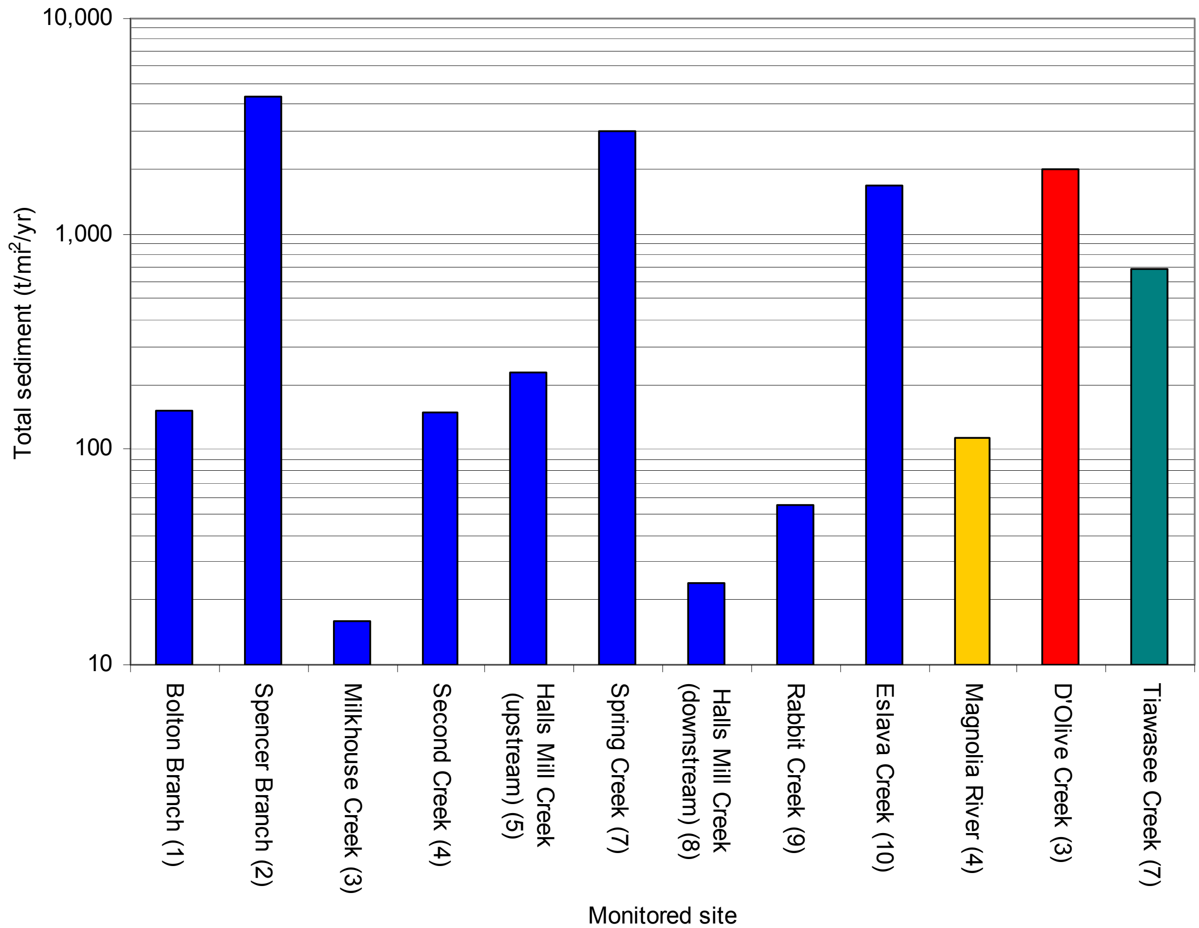

Figure 8.—Comparisons of estimated normalized total sediment loads from selected Baldwin County streams and monitored Dog River tributaries.

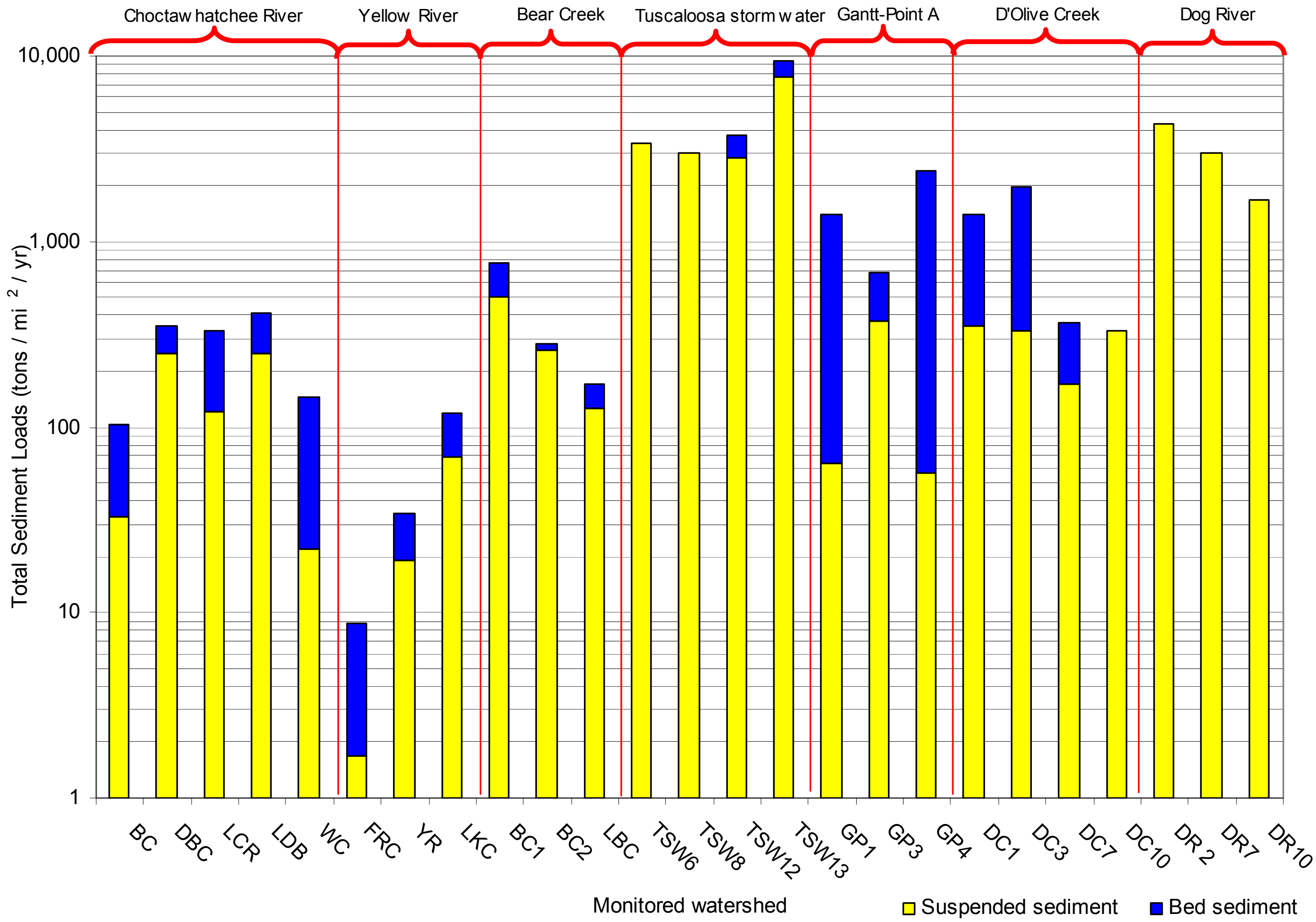

Figure 9.—Comparisons of estimated normalized total sediment loads from selected streams throughout Alabama and monitored Dog River tributaries.

SUMMARY

The purpose of this project is to assess sediment loads and sediment transport by tributaries of Dog River and to assess impacts of land-use on erosion and sediment loads in the watershed. These data will be useful to municipal and regional officials and agencies in the development of remediation plans to limit erosion and sediment transport into Dog River and Mobile Bay.

Urban runoff can have tremendous deleterious impacts on water quality and biological habitat of streams. This is particularly true in watersheds where land use has been substantially changed and stream channels have been modified by channelization. Water quality in these urban streams is typically characterized by excessive nutrients, bacteria, and sediment. The northern part of the watershed includes part of downtown Mobile, which is almost completely urbanized, influencing runoff with impervious surfaces and urban contaminants. The western part of the watershed includes rapidly changing land uses from forested to urban and the southwestern part of the watershed includes interspersed commercial and forested landscapes. Bolton Branch, Spencer Branch, Spring Creek, and Eslava Creek (sites 1, 2, 7, and 10, respectively) are channelized (concrete flumes) and have extensive commercial and residential development in the floodplains. Milkhouse Creek has extensive, relatively recent development in the upstream part of floodplain near site 3. The remaining monitored streams have relatively minimal development in floodplains and only minor modifications to stream channels, although relatively recent urbanization has occurred on the uplands along the drainage divides. Second Creek (site 4) is primarily anastomosing but has extensive riprap channel armoring upstream and downstream from the monitoring site at the Cottage Hill Road crossing. Sites 5 and 8 are on Halls Mill Creek which has a relatively small amount of channel modification and floodplain development. Rabbit Creek is the southern most tributary to Dog River and has relatively minimal development in the floodplain. Agriculture in the Dog River watershed is minimal, although pasture and pecan orchards form a significant part of the land use in the headwaters of Halls Mill Creek and Rabbit Creek.

Sediment loads were determined by direct measurement of suspended and bed sediment for a range of discharge events. These data were evaluated by regression models to determine annual sediment loads.

Sites 10 (Eslava Creek at U.S. Highway 98), 7 (Spring Creek at Maudelayne Drive), and 2 (Spencer Branch at Cottage Hill Road) had the largest suspended sediment loads with 10,803, 5,970, and 5,198 t/yr, respectively. When the data were normalized with respect to unit watershed area, sites 2, 7, and 10 had the largest loads with 4,332, 2,985, and 1,662 t/mi^2/yr, respectively. Halls Mill Creek sites 5 and 8 were the only sites with measurable bed sediment (265 and 242 t/yr, respectively) due to the fact that all other sites had hard surface stream beds so that all transported sediment was assumed to be suspended.

When compared to sediment loads previously estimated for Baldwin County streams-- D'Olive Creek (1,987 t/mi^2/yr), Tiawasee Creek (692 t/mi^2/yr), and Magnolia

River (112 t/mi^2/yr)-- Dog River tributary sites 2 (Spencer Branch) and 7 (Spring Creek) were larger with 4,332, and 2,985 t/mi^2/yr, respectively. Estimated total sediment transported to Dog River and Mobile Bay from the eight monitored streams is more than 25,000 t/yr or about 46,000 cubic yards of sediment.

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Appendix

Photographs

Spencer Branch monitoring site 2.

Spring Creek monitoring site 7.

Spring Creek near Halls Mills road, 3,000 feet downstream from site 7.

Rabbit Creek monitoring site 9.

Eslava Creek monitoring site 10.

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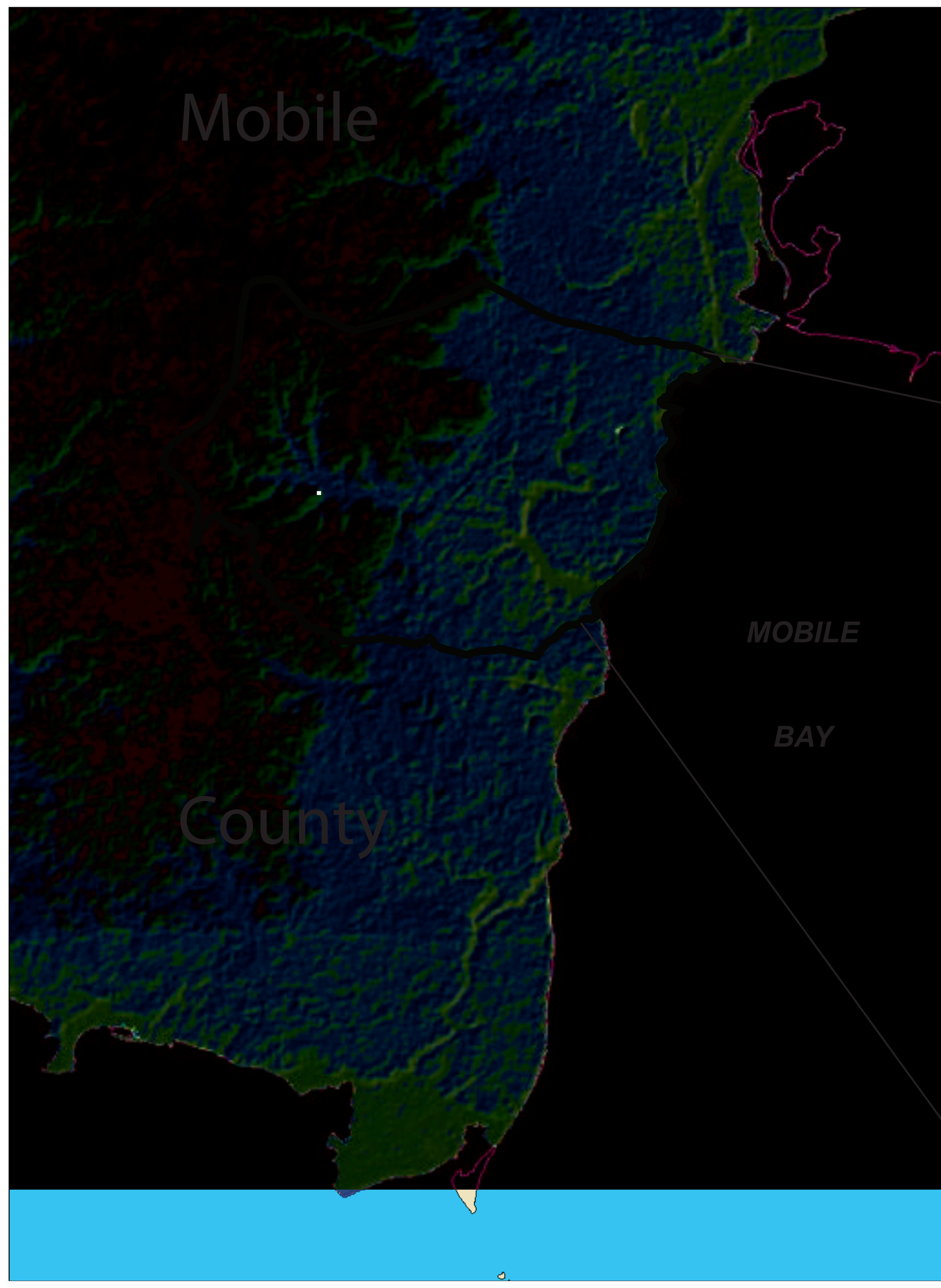
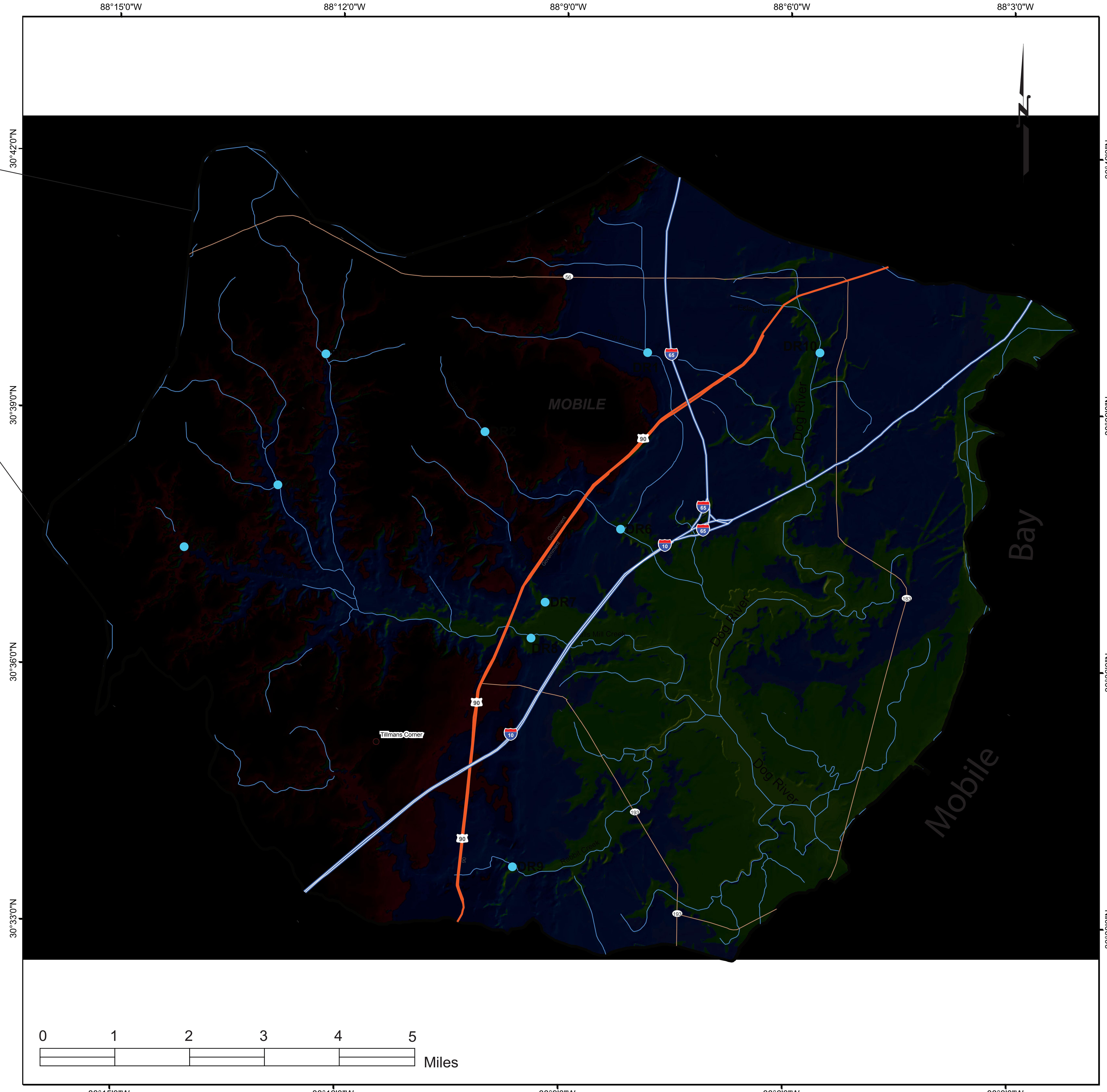




Explanation

Elevation in feet above NGVD 1929

High : 231

Low : -1

DR5 Site Location and Identification Number

City

Dog River Watershed Assessment Area

Rivers

Limited access interstate

Highway

Major road

85 Interstate highway

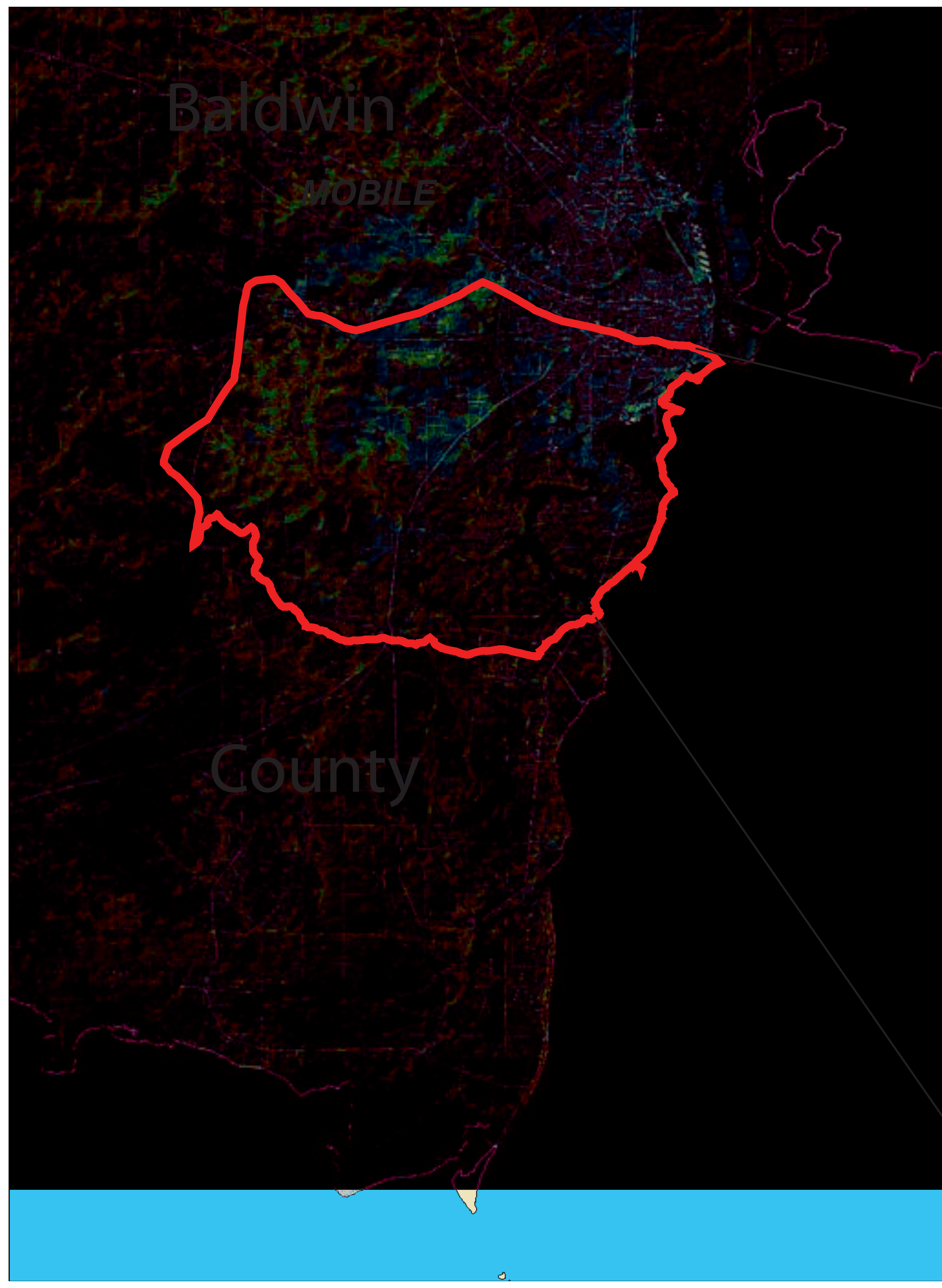
431 United States highway

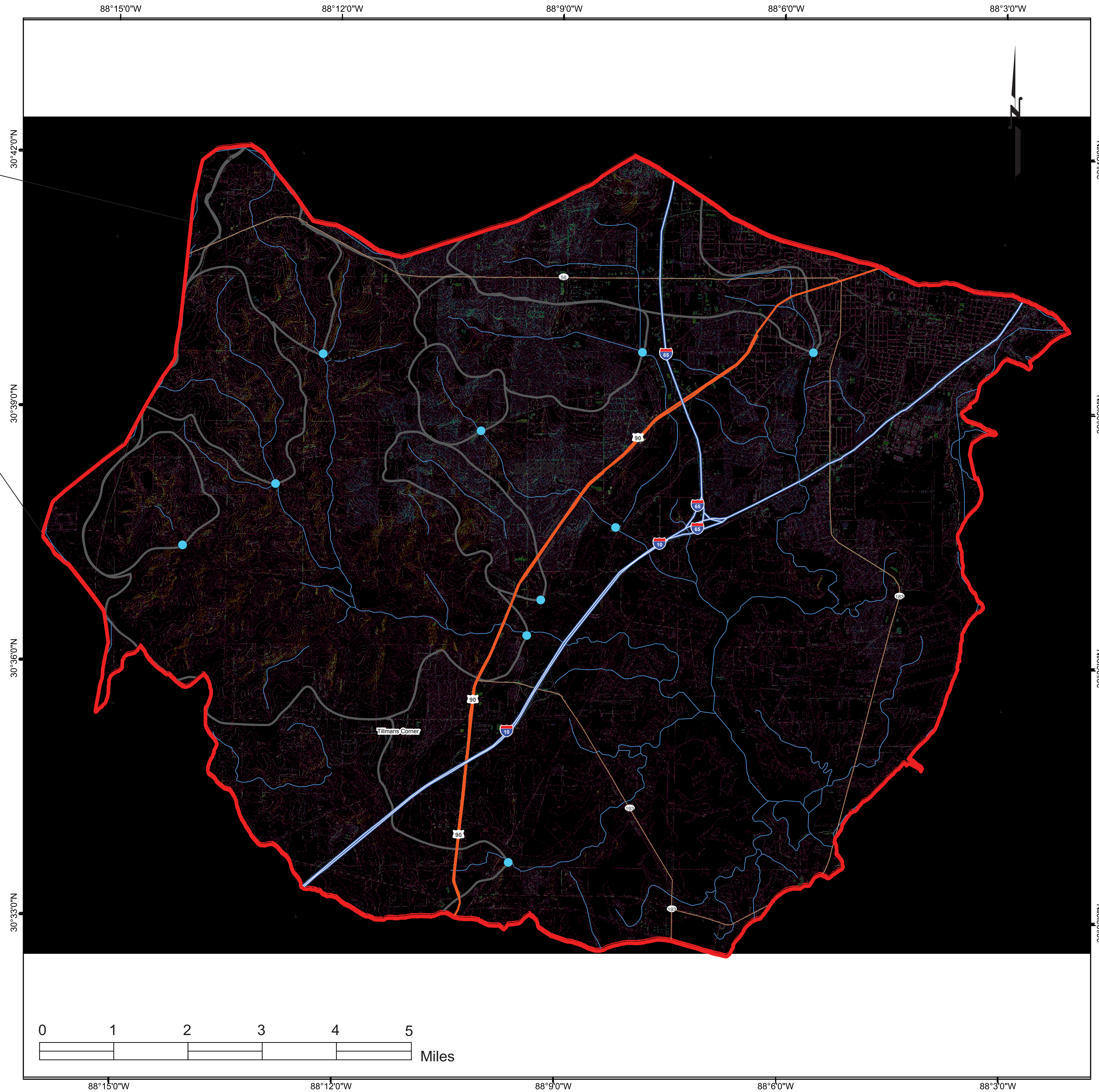
10 State highway

BERRY H. (NICK) TEW, JR.
State Geologist

TOPOGRAPHY AND LOCATIONS OF STREAMS AND MONITORING SITES IN THE DOG RIVER WATERSHED

By
Alana L. Rogers and Marlon R. Cook
2012





Explanation

- DR5 Site Location and Identification Number
- City
- Dog River Watershed Assessment Area
- Monitored Subwatersheds
- Rivers
- Limited access interstate
- Highway
- Major road
- 85 Interstate highway
- 431 United States highway
- 10 State highway

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TOPOGRAPHY, MONITORED SITES AND SUBWATERSHEDS IN THE DOG RIVER WATERSHED

By
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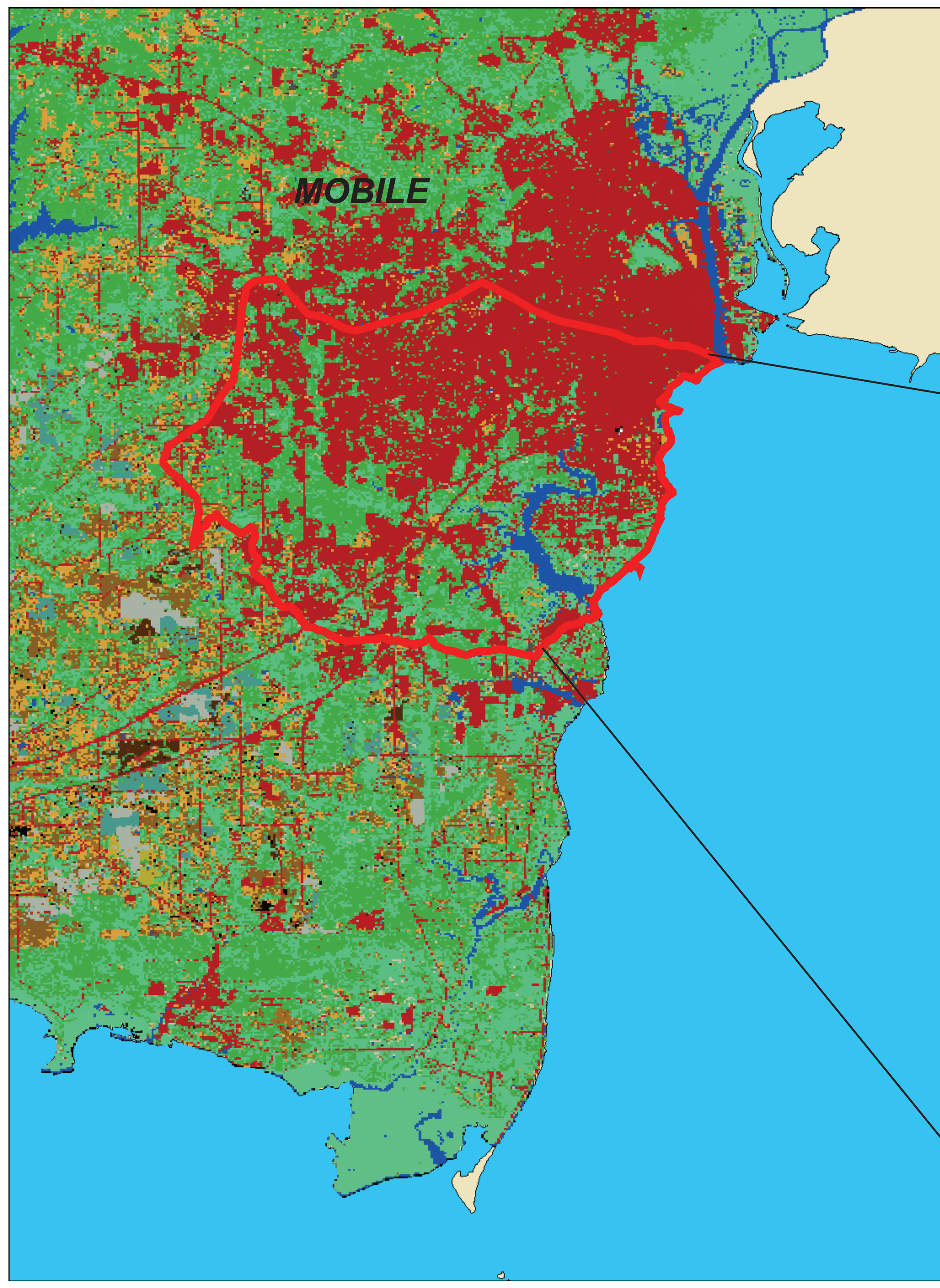
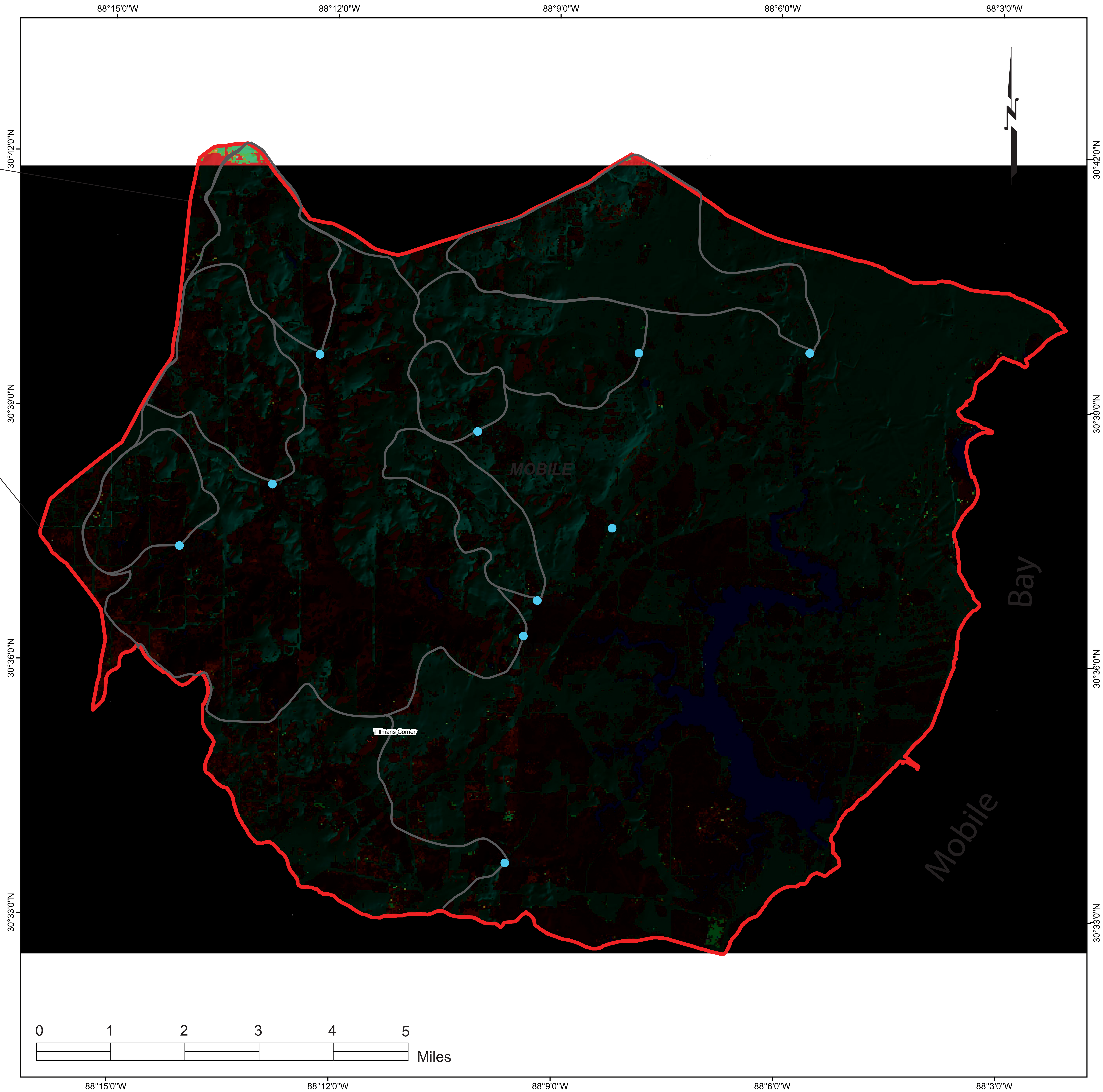


Explanation

- DR5 Site Location and Identification Number
- City
- Dog River Watershed Assessment Area
- Monitored Subwatersheds

LULC Classification

- Corn
- Cotton
- Soybeans
- Peanuts
- Other Crops
- Seed/Sod Grass
- Pasture/Hay
- Pecans
- Open Water
- Developed
- Barren
- Forest
- Grassland Herbaceous
- Wetlands



LAND-USE/LAND-COVER, MONITORED SITES AND SUBWATERSHEDS IN THE DOG RIVER WATERSHED

By:
Alana L. Rogers
2012

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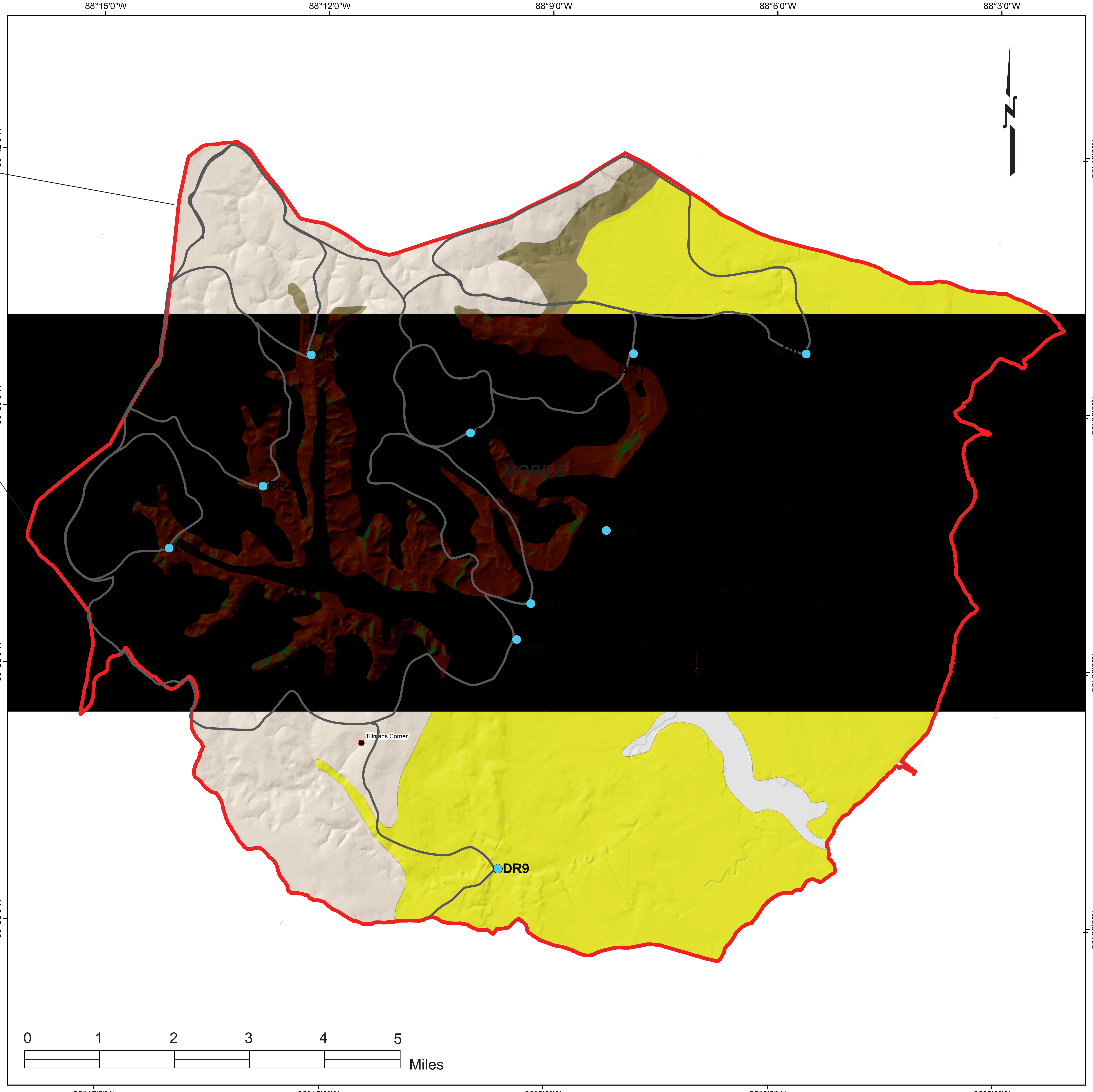

Explanation

DR5 Site Location and Identification Number

City

Dog River Watershed Assessment Area

Monitored Subwatersheds

Geology

Citronelle Formation

Alluvial, Coastal, and Low Terrace Deposits

Miocene Series Undifferentiated

Water

GEOLOGY, MONITORED SITES AND SUBWATERSHEDS IN THE DOG RIVER WATERSHED

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