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TECHNICAL REPORT

A SURVEY OF THE DOG RIVER WATERSHED

AN OVERVIEW OF LAND USE PRACTICES
AND AN ASSESSMENT OF THE
EFFECTS OF DEVELOPMENT ON
THE NATURAL RESOURCES OF THE BASIN

COASTAL PROGRAM

MAY 1994

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
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A SURVEY OF THE DOG RIVER WATERSHED

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EXECUTIVE SUMMARY

The Dog River Watershed, a basin located in a highly developed urban-suburban area, was surveyed for characterization of the land-use practices, soil types, topography, habitat and biological resources of the watershed. Some of the impacts of real estate development and non-point sources on habitat and biological resources are described. Although the basin possesses a minimal amount of industrial development, the effects of storm water runoff and other non-point sources were observed to have significant impacts on the aquatic habitats of the basin. The impacts were typical of non-point related problems, i.e. turbidity and siltation from erosion, trash and debris from urban storm water runoff, nutrient enrichment and enteric bacteria contamination.

The watershed also has experienced a significant amount of waterfront development, shoreline alteration and loss of wetlands. Most of the losses of wetlands are the result of the draining and filling of bottom land forest (swamp) and freshwater marsh during the 1950s and 1960s. Present and future development of waterfront property along the streams of the southwestern portion of the watershed have the potential to remove additional areas of wetlands. This would most likely occur through the cumulative impacts of the many small projects involving bulkheading of the shoreline, excavating for the construction of boat slips and activities involving the use of fill material.

INTRODUCTION

The coastal zone of Alabama has undergone the growth and development typical of the gulf coast states. The past decade has seen the developmental emphasis focus on the construction of large condominium and similar multiple unit projects on beach front property. These activities have been the primary interest of many developers and local governments and a major concern on the part of environmental managers and local residents. The actions of state and local regulators to control development in the coastal zone and the attention of both the public and the news media have largely been directed towards these highly visible projects.

However, bay front property, wetlands and the shorelines along the local tributaries and backwaters of Coastal Alabama have a much longer history of development than gulf beach property. Construction activity in such areas primarily tends to be residential along with an assortment of light commercial and recreational facilities. For a variety of reasons these categories of development in the coastal zone have not received the intense public scrutiny and regulatory attention of the more controversial oceanfront projects. Historically, regulation of such development has largely been controlled through local zoning ordinances and was simply viewed as a matter of designating property as residential, commercial etc. Little attention was paid in the past to the need to manage these construction activities so that impacts to aquatic resources were minimized (National Oceanic and Atmospheric Administration 1987, 1989; National Research Council 1990; U.S. Environmental Protection Agency 1991).

Due to the lack of regulatory oversight, a considerable amount of development in the Alabama coastal zone, particularly that which was constructed in the quarter century between 1950 and 1975, has occurred on former wetlands. Prior to enactment of wetlands protection statutes large areas of marsh and swamp were drained in order to provide expansive parcels of cheap land (Stout and LeLong 1981; Friend et al 1982; O'Neil and Mettee 1982). Although the present ordinances regulating wetlands development offer some degree of control over the loss of such land and the resultant degradation of aquatic resources, the impacts from existing land-uses might warrant additional measures such as controlling storm water runoff, more stringent restrictions on the use of septic tanks and other such impacts associated with these activities (Friend et al 1982; U.S. Environmental Protection Agency 1991).

As development within the Alabama coastal zone has progressed there has been a realization that even the developmental activities in upland habitats have the potential to significantly degrade water quality and impact aquatic resources. This has led environmental managers to extend the application of current practices and programs such as the best management plan (BMP) concept utilized for erosion control by mining and silviculture operations to land use and construction activities in upland as well as waterfront habitats.

Over the last quarter century significant progress has been achieved in the prevention and reversal of water quality degradation both in the state of Alabama and across the United States. The majority of this improvement has been realized through increasingly stringent standards imposed on industrial and municipal point source discharges. Although these measures have been effective in controlling the waste loads discharged from industrial facilities and municipal waste water treatment plants the National Pollutant Discharge Elimination System (NPDES) program which provided the regulatory mechanism for this has, until lately, failed to address the impacts from urban runoff and other non-point sources (U.S. Environmental Protection Agency 1991).

Recent awareness on the part of citizens, the academic community, environmental managers and government at all levels has led to the implementation of regulations controlling urban runoff and storm water discharges from construction activities. Enforcement of these regulations accompanied by an effective monitoring program has the potential to significantly reduce the impacts of development on aquatic resources (Alabama Department of Environmental Management, 1989; National Research Council 1990; U.S. Fish and Wildlife Service 1991)

In a similar manner organized studies of surface water quality have been directed either at surveys related to specific point sources and their receiving waters or routine monitoring of a broad network of fixed stations for long-term trends. Consequently, localized and/or short term but serious degradation to surface water quality from non-point sources has been overlooked and poorly studied, if not altogether ignored. (National Research Council 1990; U.S. Environmental Protection Agency 1991). Such oversights have "fallen through the cracks" of traditional water quality monitoring programs for a variety of reasons. One reason being that because a body of water in question was not receiving effluent from a point source discharge it was not perceived by resource managers as degraded. Another shortcoming has been that routine trends monitoring frequently fails to detect the ephemeral but significant degradation in water quality resulting from episodic events such as rainstorms (*ibid*).

Also, many routine monitoring programs neglect to integrate sediment chemistry, aquatic biota and other parameters into a comprehensive survey of a system. In general, water quality monitoring programs have often suffered from a general lack of correlating variations of water quality parameters with anthropogenic and natural factors (U.S. Environmental Protection Agency 1991).

In an effort to broaden the coverage of water quality management programs and analyze with greater resolution the impacts from developmental factors, regulatory agencies are exploring methods of improving their control of water pollution. This will require diversified programs that examine local land development, threats to biological resources, impairments to recreational uses of water and risks to human health (U.S. Environmental Protection Agency 1991). The findings of field surveys should also take into account natural factors (i.e. meteorology, soil morphology etc.) which may strongly influence water quality. The various aspects of development affecting surface waters must be reviewed via an integrated and multi-discipline approach for more effective management of aquatic resources (National Research Council 1990; U.S. Environmental Protection Agency 1991).

Acknowledging the need for more effective monitoring strategies environmental managers have focused their efforts towards programs encompassing entire drainage basins (U.S. Environmental Protection Agency 1991). Pursuing a basin-wide approach which accounts for the relationships between aquatic systems and the factors, both natural and developmental, effecting changes upon these systems offers a more thorough determination of the specific impacts to waters quality. Such methodologies offer a means to "tailor" control of land use and specifically "target" control measures for the prevention of water quality degradation (*ibid.*). The Environmental Protection Agency utilizes the term Watershed Protection Approach for the concept of monitoring and managing complete watersheds.

Realization of the shortcomings of its ambient monitoring program and the need for more effective management of coastal resources, the Alabama Department of Environmental Management (ADEM) has incorporated watershed surveys into the ADEM Coastal Resource Monitoring Strategy (ADEM 1993). The ultimate goal of the watershed surveys will be to provide the preliminary information necessary to assess the status of the basin and identify impairments of water use classifications or other related problems in a form which facilitates effective protection and management of coastal resources. Briefly, the main objectives of these surveys are:

1. Gather and review existing information on water/sediment quality, wetland communities, submerged aquatic vegetation, existing land use, impaired and/or potentially beneficial uses.

2. Identify critical data gaps and collect additional information as appropriate.

3. Describe the basin or sub-basin and current status of coastal resources to include existing impairments and major factors contributing to problems.

4. Identify and prioritize the basin's critical issues, use impairments and problem areas.

5. Develop indicators that will, through continued monitoring, be used to measure the success of the existing or future management/regulatory actions.

6. Prepare a basin characterization and status report for dissemination to, and use by, resource managers.

This survey is to serve as a "prototype" or demonstration of the above stated objectives. As such, the ADEM coastal program staff decided to utilize the department's existing data base of information regarding coastal resources, water quality, geology and development in the coastal zone. Additionally, it was decided to investigate a basin in an urbanized area where non-point sources would likely be the predominant impacts over those from wastewater point sources. This rationale will allow the survey to track the early progress of the recently implemented portions of the NPDES program regulating municipal storm water discharges. The potentials for shoreline development, water based recreational activities and critical habitat loss were also taken into consideration.

WATERSHED SURVEY

SURVEY PRINCIPLES

Utilization of the Watershed Protection Approach as a management strategy should be applied to a basin where pollution is a potential, significant threat to aquatic resources, human health and other beneficial uses of the water (U.S. Environmental Protection Agency 1991). Also this approach should employ a multifaceted method of investigation examining land use practices, soil types, sediment chemistry, aquatic biota and climatological factors. Finally, the results of the study should be developed into a plan for remediating existing degradation, managing the sources of degradation and avoiding additional degradation from future development (U.S. Environmental Protection Agency 1991; U.S. Fish and Wildlife Service 1991)

GENERAL DESCRIPTION OF THE WATERSHED

The coastal staff of the Alabama Department of Environmental Management selected the drainage basin of Dog River as the candidate for the watershed demonstration project. Located in Mobile County, Dog River is a tidally influenced stream some 8 miles in length that discharges to the western side of Mobile Bay south of the City of Mobile (Figure 1). The Dog River Watershed (DRW) encompasses an area of approximately 90 square miles receiving drainage from six sub-basins, (i.e., Eslava Creek, Robinson Bayou, Moore Creek, Halls Mill Creek, Rabbit Creek and Rattlesnake Bayou) all of which are navigable by small craft for significant portions of their lengths (Figures 2 and 3). This watershed has experienced extensive development for the past half century and is likely to undergo continued growth and development in the foreseeable future. The streams within the watershed serve as recreational sites for numerous residents of Mobile County. Fishing, swimming, water skiing and sailing are popular pursuits on the basin waters with one or more of these activities occurring at any time throughout the year (Chermock 1974; Friend et al 1982).

The lower reaches of Dog River from its mouth to the confluence with Halls Mill Creek are assigned a state water use classification of swimming and other whole body water-contact sports. The Department has assigned a water use classification of

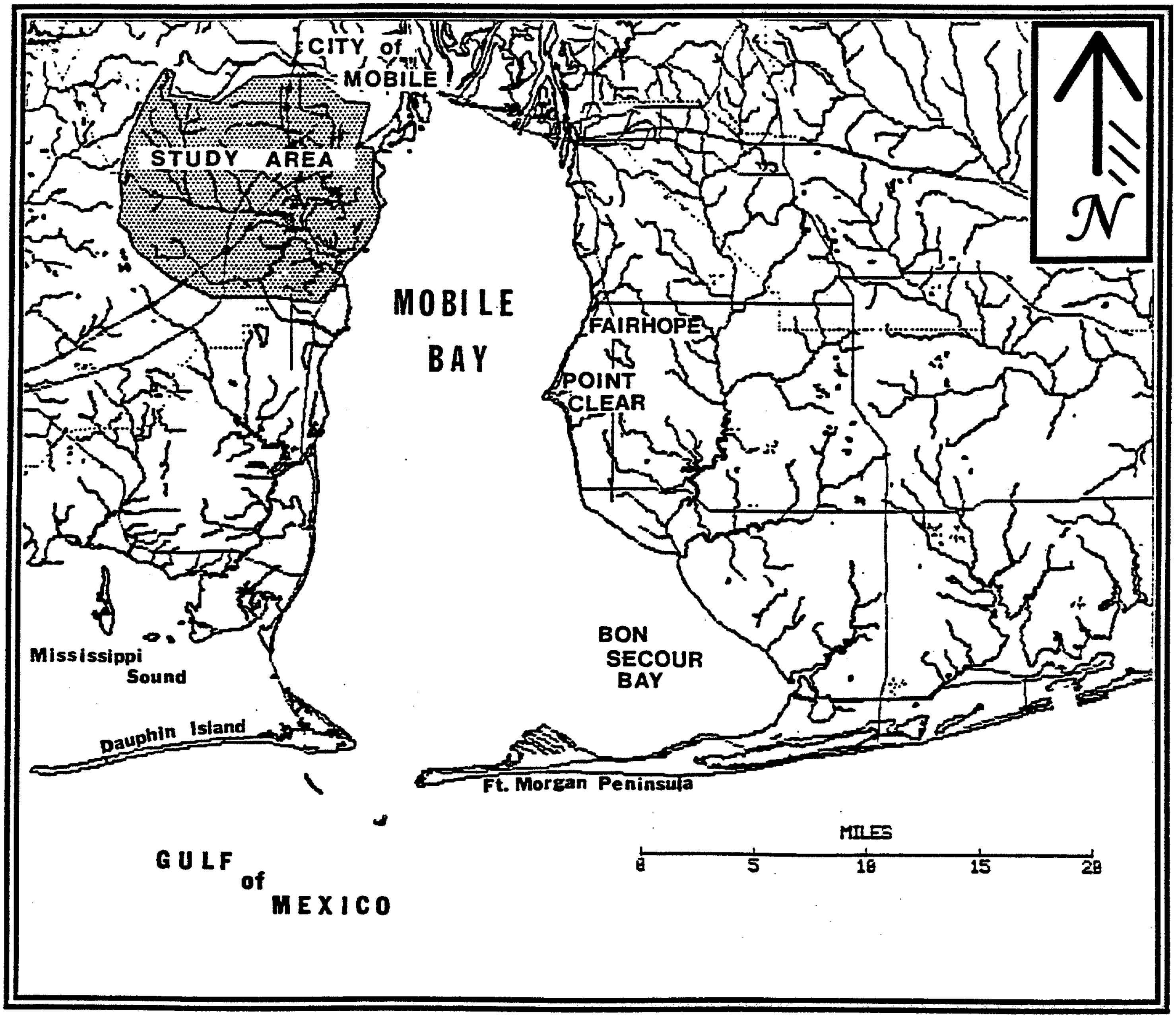

FIGURE 1

COASTAL ALABAMA
SHOWING THE DOG RIVER WATERSHED
(SHADED AREA)

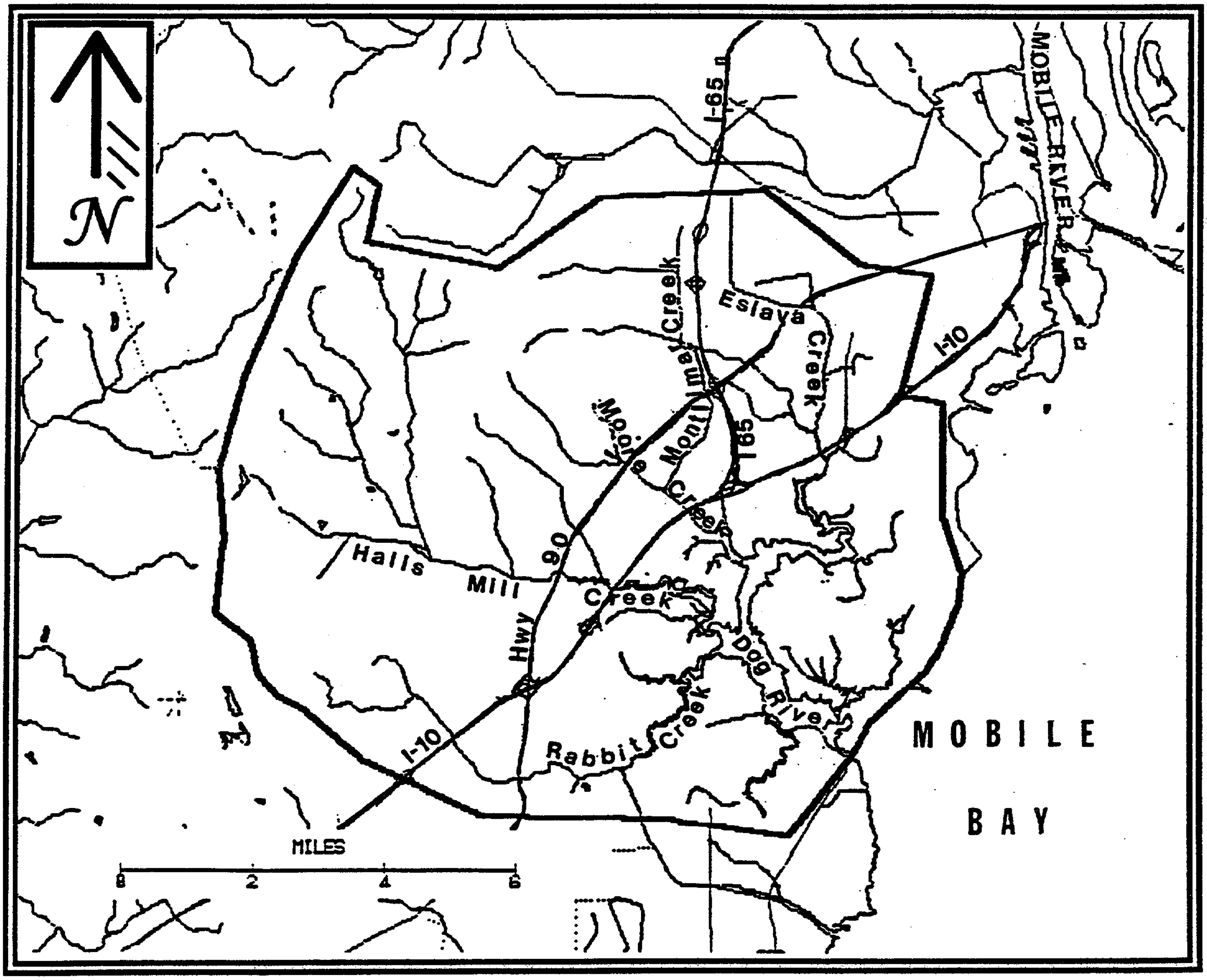

FIGURE 2

THE STUDY AREA
SHOWING MAJOR ROADS
AND SURVEYED STREAMS

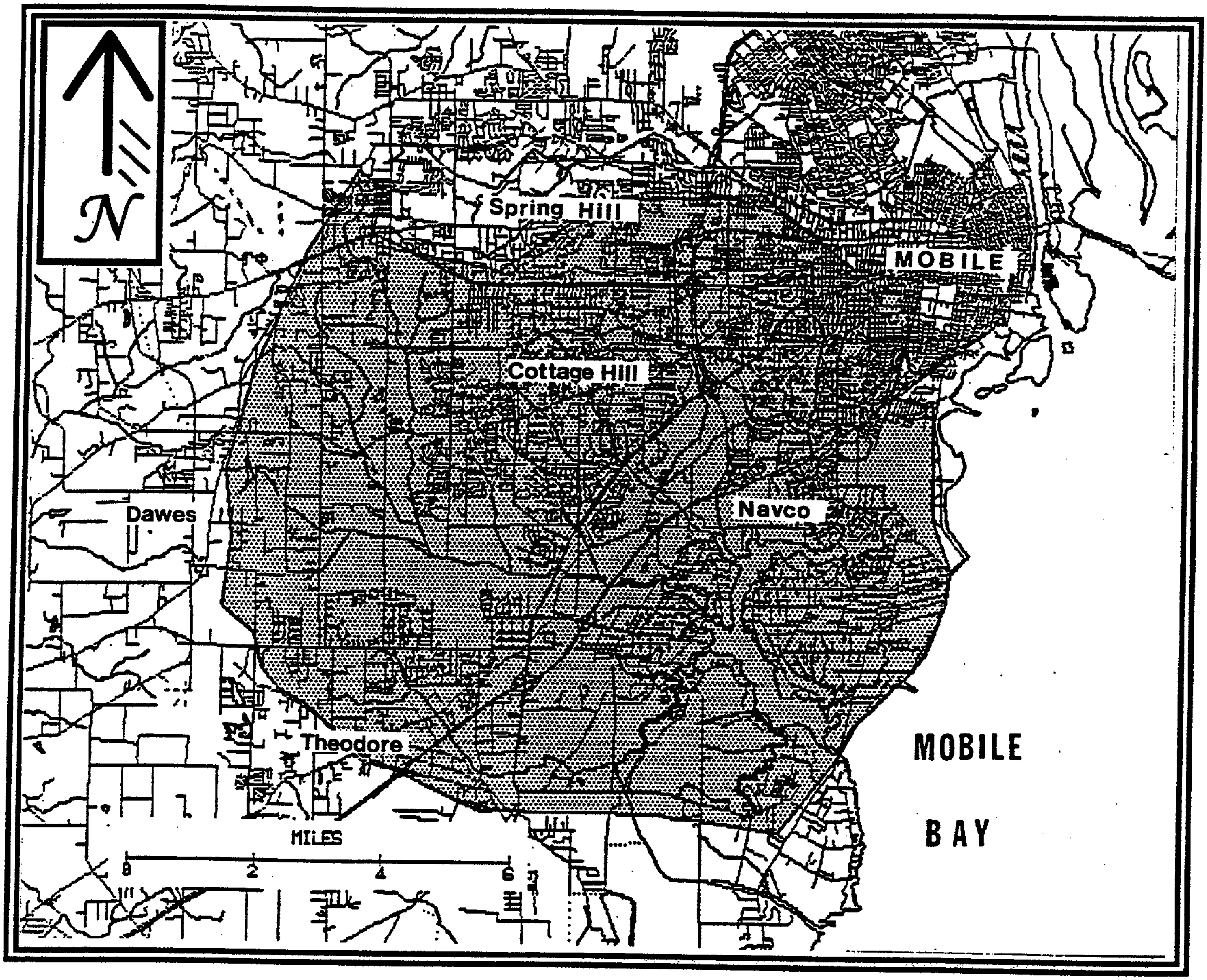

FIGURE 3

THE STUDY AREA
SHOWING DETAIL OF
CITY STREETS

fish and wildlife to the middle and upper reaches of the river and its tributaries Rabbit Creek, Rattlesnake Bayou, Halls Mill Creek and Robinson Bayou. Other streams within the watershed have not been assigned a specific use classification; however, those segments are considered as fish and wildlife waters pursuant to ADEM Administrative Code (335-6-11-.01(5)). For a summary of the water quality criteria applicable to these classifications please refer to Table A-1 in the appendix.

LAND USE IN THE WATERSHED

Historic development within the DRW primarily occurred in the upper reaches of the river and its headwaters, Eslava Creek. Initially, development of the area was both residential and light commercial (i.e. retail merchants, restaurants, etc.). Development over the past 25 years has been more directed towards larger commercial ventures (i.e. shopping malls and office parks), apartment complexes and subdivisions. The shoreline along the lower reaches of the river has experienced significant development of marina and docking facilities over the past four decades. More recently, development within the DRW has encompassed the western tributaries of the river and the lower reaches of the river. This development has primarily been residential but also has included significant development of recreational facilities (golf courses, ballparks and tennis courts) and retail businesses (shopping centers) (Friend et al 1982).

As is typical in the coastal zone, the vast majority of the waterfront along the river and navigable reaches of the tributaries has been developed. Most of this has been in the form of single unit residences although multiple unit residences (apartments and condominiums) and restaurants have been constructed. Future development within the watershed will likely concentrate on the construction of single unit dwellings in subdivisions, recreational facilities and retail business/office complexes typical of suburban residential areas (South Alabama Regional Planning Commission 1981; Friend et al 1982).

The DRW contains no major industrial facilities or municipal wastewater treatment plants. Although the city of Mobile previously operated a municipal wastewater treatment plant which discharged to Eslava Creek, this facility has been converted to a sewage lift station. At the time of this report there are seven businesses in the basin operating under the conditions of an NPDES permit, see Appendix A. All of these operations are classified as minor industrial facilities, only one (an automobile bumper plating works) is permitted to discharge process wastewater to tributaries of the DRW, the others are permitted only for discharge of storm water drainage and/or the discharge of non-contact cooling water, and boiler blowdown. Historically, a gravel and sand mining and washing facility operated along one of the tributaries (Halls Mill Creek); however, this facility has been shut down for several years. A brief description of these facilities is provided in the Appendix.

The absence of major industrial facilities, the small volumes of process wastewater discharged by permitted facilities, dense residential population, large areas of impermeable cover and active real-estate development make this watershed a good example for studying water quality degradation as primarily mediated by non-point sources.

SOIL CHARACTERISTICS OF THE WATERSHED

Aerial photographs from the Soil Survey of Mobile County published by the U.S. Soil Conservation Service (U.S. Department of Agriculture 1980) were examined by ADEM coastal program staff for determining soil types and categories of land development within the watershed. Soils in the upland portions of the watershed are primarily sandy loam type soils and the lowland areas of the basin are dominated by hydric soils with poor drainage properties. More specifically the Soil Conservation Service (SCS) classifies the soils in the lower areas of the watershed as either Bayou-Escambia-Harleston or Urban land-Smithton-Benndale. The soils of the higher, upland areas of the watershed are designated as Troup-Heidel-Bama and Notcher-Saucier-Malbis. Distribution of the soil types in the DRW is illustrated in Figure 4 and a description of soil characteristics is in Table 1.

The Bayou-Escambia-Harleston unit forms about 25 percent of the watershed and these soils are predominantly found along the middle to lower reaches of Dog River and the deeper, navigable stretches of Moore Creek, Halls Mill Creek, Rabbit Creek and Rattlesnake Bayou. The majority of the development in this area is residential and includes nearly all of the waterfront property along navigable waters. Soil scientists consider this unit to have poor potential for urban development with wetness being the main limiting factor (U.S. Department of Agriculture 1980).

The Urban land-Smithton-Benndale unit makes up about 30-35 percent of the area in the watershed. Urban land is defined by soil scientists as land with soil obscuring structures (U.S. Department of Agriculture 1980). The Smithton soils are poorly drained and are found in low flat areas and along streams, the well drained Benndale soils are found on upper slopes and ridge tops. This soil map unit includes a significant area of former wetlands (e.g. Wragg Swamp) that was drained for development. Most of this development has been in the form of shopping centers, apartment complexes and restaurants accompanied by their attendant large expanses of paved parking lots. A major portion of the land area along the upper reaches of Dog River and Eslava Creek is impervious due to such development. All of these factors combine to create a potentially significant urban storm water runoff problem in the watershed.

The Notcher-Saucier-Malbis association is found in approximately 10 percent of the watershed and is typified by broad, flat areas with gentle slopes (U.S. Department of Agriculture 1980). This soil association is found in the southwestern part of the Dog River Watershed and includes the wadeable, upper reaches of Rabbit Creek and Rattlesnake Bayou. Development in this area of the watershed is a mixture of residential, lodging, dining and other light commercial. A significant portion of this area is utilized for cultivated crops and pasture land.

The remaining 30-35 percent of the watershed area is made up of the Troup-Heidel-Bama unit. This soil map unit encompasses the majority of the western area within the basin including the wadeable, upper reaches of Moore Creek , Halls Mill Creek and their tributaries. The topography of this area is one of broad ridge tops and steep side slopes along natural drainage courses. Land of this soil unit classification has good potential for urban and agricultural development. Erosion and low water availability of the Troup soils are the limiting factors controlling development on these soils (U.S. Department of Agriculture 1980).

The western portion of the watershed is currently undergoing the most active development. This area contains a wide spectrum of structures from residential dwellings to large shopping and office complexes. In all likelihood the main emphasis of the near future for development in the DRW, and Mobile in general, will be directed towards the western uplands (South Alabama Regional Planning Commission 1981; Friend et al 1982).

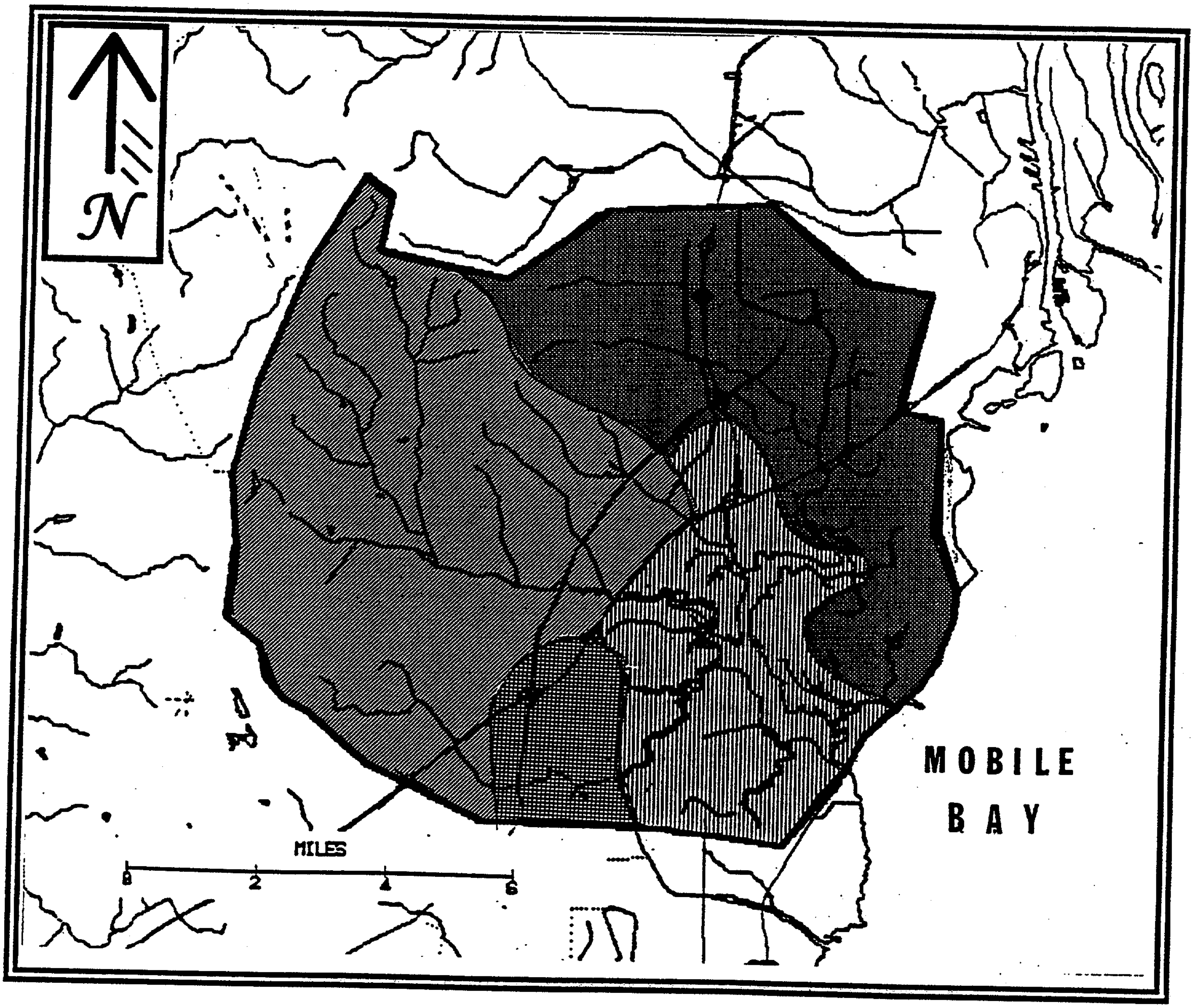

FIGURE 4

SOIL TYPES OF THE
DOG RIVER WATERSHED

LEGEND

- TROUP-HEIDEL-BAMA
- NOTCHER -SAUCER-MALBIS
- BAYOU-ESCAMBIA-HARLESTON
- URBAN LAND-SMITHTON BENNDALE

TABLE 1

GENERAL SOIL ASSOCIATIONS OF THE DOG RIVER WATERSHED

Troup-Heidel-Bama

Soils of this unit are well drained, have loamy subsoils and are formed in loamy marine sediments on nearly level to undulating uplands.

Troup soils are on side slopes and the more sloping ridgetops. Heidel and Bama soils are on the more level ridgetops. Troup soils have thick loamy sand surface layers; Heidel and Bama soils have sandy loam surface layers

This unit has good to fair potential for cultivated crops and pastures. Minimum tillage, contour farming and terracing are needed in the sloping areas. Erosion and the low available water capacity of Troup soils are the main limitations for farming. Potential for urban and woodland use is good. Potential for wildlife habitat is good to fair.

Notcher-Saucier-Malbis

Soils of this unit are moderately well drained, have loamy subsoils with plinthite and are formed in clayey and loamy marine sediments on nearly level to gently undulating uplands.

Notcher and Malbis soils are found on the higher elevations on broad, slightly convex ridges. Notcher soils are also on concave slopes around the heads of drainageways and on side slopes. Saucier soils are on broad flats along the lower elevations. All soils have sandy loam surface layers.

This unit has good potential for cultivated crops and pasture. Erosion on the more sloping ground is the main limitation. The potential of this unit for residential and urban development is good to fair. Wetness and the slow permeability of the plinthite layers are the limiting factors of this unit.

Bayou-Escambia-Harleston

These are poorly to moderately well drained soils with loamy subsoils; formed in riverine and marine sediments on uplands and terraces. These soils are found in nearly level to gently undulating areas.

Bayou soils are found along low, flat drainageways. Escambia and Harleston soils are on upland ridges.

The soils of this unit have poor potential for cultivated crops and pasture. Wetness is the limiting factor and the flat topography makes for few adequate drainage outlets. The potential for urban development is poor, wetness and poor drainage again are the main limitations. The potential for wildlife habitat development in this unit is good. The more upland Escambia and Harleston soils are suitable for both openland and woodland habitat while the lower, wetter Bayou soils have a fair potential for openland habitat only.

Urban land-Smithton-Benndale

Urban land areas on nearly level to gently rolling terrain intermingled with poorly drained to well drained soils with loamy subsoils. Found on upland areas and formed in riverine and marine loamy sediments. Where not altered by development, the landscape is one of broad flats surrounded by ridgetops.

The poorly drained Smithton soils are found along streams and on broad flat areas; the well drained Benndale soils are on upper side slopes and ridgetops. Urban land includes sidewalks, streets, parking lots, buildings and other structures that obscure the soil and impede natural drainage.

This unit has poor potential for most uses other than the continued urban development and its potential for urban use is only fair, the main limitation being the poorly drained Smithton soils.

SEDIMENT CHARACTERISTICS OF THE WATERSHED

A review of sediment chemistry data of this and other watersheds was conducted during the basin selection process. This review indicated that a potential exists for contaminated sediments in the DRW. Data for supporting this conclusion resulted from the sediment baseline survey conducted by the ADEM Coastal Program (Alabama Department of Environmental Management 1991). This survey revealed the presence of excessive concentrations of lead and cadmium as well as potential enrichment of sediments by chromium and copper. Taking into account the lack of industrialization in the watershed, a high degree of urbanization, significant motor vehicle traffic and the level of boating activity, the nature of sediment contamination would appear to implicate exhaust emissions, storm water runoff and the anti fouling/anti corrosive components of marine paints as the probable causative factors (Windom, et al. 1989; Baudau and Muntau 1990).

The general characteristics of the sediments in the watershed include aluminum rich clays mixed with silt and fine sand in the broader, deeper waters of the main river channel and in the deeper, tidally influenced streams and backwaters. The sediments near the mouth of Dog River, and in other stream segments subject to significant tidal currents, are somewhat coarser grained with more sand and less clay. The sediments of the upper reaches of the tributaries, where the streams have not been channelized, vary between silty sand and mud depending on depth and other aspects of stream morphology (U.S. Army Corps of Engineers 1985; ADEM, 1991).

WATER QUALITY OF THE WATERSHED

Existing water quality data for the DRW has been primarily limited to the ADEM trend station at Luscher Park on Dog River. Monitoring efforts have indicated a persistent long-term problem with fecal coliform bacteria and an apparent, although less severe, elevation of nutrient concentrations. Higher concentrations become more evident following heavy storm activity in the area, an indication that non-point sources significantly influence water quality in the basin (U.S. Fish and Wildlife Service 1991; U.S. Environmental Protection Agency 1991). Given this, it would appear that combined sewer overflows, septic tanks in hydric soils and urban runoff are potential contributors to these problems.

In addition to these matters there is a history of fish kills in Dog River which have been investigated by the ADEM Mobile Office. These fish kills usually have occurred in the late summer-early fall and apparently are the result of low dissolved oxygen during natural periods of low flow. The naturally occurring low flow conditions of area creeks and rivers in the late summer-early fall months also might be exacerbated in Dog River due to diversion of stream flow.

During the draining of Wragg Swamp for commercial property development and construction of Interstate Highway 65 a significant portion of the flow of the original headwaters of Eslava Creek were diverted south to form Montlimar Creek, which in turn was routed to Moore Creek. This diversion has removed a substantial but unquantified proportion of the flow originally entering the head of Dog River from Eslava Creek and transferred it to the lower reaches of Dog River. Such alterations of stream courses have the potential to increase the flushing time of tidally influenced waters such as Dog River possibly resulting in hypoxic conditions where such conditions might not have previously existed.

BIOLOGICAL RESOURCES

FLORA

The DRW contains a wide diversity of plant communities ranging from the submersed grassbeds and brackish marshes of Dog River and its tidially influenced tributaries to the pine forests of the upland tributaries and headwaters. (Chermock 1974; Sapp, Cameron and Stout 1976; Stout and LeLong 1981)

UPLANDS

The dominant plant association in the uplands of the DRW is the longleaf pine-oak community. Species abundant in this community include: longleaf pine (*Pinus palustrus*), southern red oak (*Quercus falcata*), laurel oak (*Quercus hemispherica*), dogwood (*Cornus florida*), southern magnolia (*Magnolia grandiflora*) and persimmon (*Diospyros virginiana*) (Stout and LeLong 1981). The understory of the upland forest includes the shrub species winged sumac (*Rhus copallinna*), sparkleberry (*Vaccinium arboreum*), blueberry (*Vaccinium elliottii*) and huckleberry (*Gaylussicia dumosa*). Some of the herbaceous species common to the upland woods of the study area are foxglove

(*Agalinis* spp.), milkweed (*Asclepias* spp.), sandhill lupine (*Lupinus diffusus*) and goldenrod (*Solidago* spp). Panic grasses (*Panicum* spp.), broomsedges (*Andropogon* spp) and windmill grass (*Gymnopogon ambiguus*) are some of the common grass plants of the basin.

In the lower elevations near wetlands and along the lower reaches of Dog River the forest canopy becomes more open. Slash pine (*Pinus elliottii*) becomes the dominant overstory species with an understory of saw palmetto (*Serenoa repens*), St. John's wort (*Hypericum fasciculatum*) and wax myrtle (*Myrica cerifera*). Low-lying, poorly drained areas in these pine woods contain shallow bogs and tannic ponds. The floral community of these special habitats include pitcher plants (*Sarricenia* spp.), sundew (*Drosera* spp.), butterworts (*Pinguicula* spp.) black titi (*Cliftonia monophylla*) and several species of orchid (*Pogonia ophioglossoides, Habenaria* spp and *Spiranthes* spp). Shrub communities also occur in the transition zones between uplands and wetlands of the DRW. Dominant species of the shrub communities are groundsel trees (*Baccharis halimifolia*), marsh elder (*Iva frutescens*) and yaupon (*Ilex vomitoria*) (Stout and LeLong 1981; U.S. Army Corps of Engineers 1984).

WETLANDS

The wetlands habitats of the DRW vary between the forested wetlands along the larger tributaries of the basin to the brackish marshes near the mouth of Dog River.

Along the upper reaches of the river and its upland tributaries the wetlands plant community largely is a freshwater marsh association. The dominant plant species of this community are sedges (*Cyperus* spp.), grasses (*Panicum* spp.), reeds (*Phragmites australis*), wild rice (*Zizania aquatica*), alligator weed (*Alternanthera philoxeriodes*), broad-leaved arrowhead (*Sagittaria latifolia*) and cattails (*Typha* spp.) (Stout and LeLong 1981; Sapp, Cameron and Stout 1976).

The lower reaches of Dog River and its tributaries are distinguished by areas of forested wetlands (swamps) occurring along streambanks and on low-lying, better drained flat terrain. The canopy of the forested wetlands is comprised of swamp tupelo (*Nyssa sylvatica*), red maple (*Acer rubrum* spp.), sweet gum (*Liquidamber styraciflua*) and bald cypress (*Taxodium distichum*). Dominant understory species of the forested wetlands are wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), green briar (*Smilax* spp.), muscadine (*Vitas rotundifolia*) and pepper bush (*Clethra alnifolia*) (Chermock et al. 1975; Sapp, Cameron and Stout 1976; Stout and LeLong 1981).

Near the mouth of Dog River transitional-brackish marshes occur. These wetlands are subjected to a variable salinity regime in addition to the stresses of flooding and exposure. Bulrush (*Scirpus* spp), sawgrass (*Cladium jamaicense*), wildmillet (*Echinochloa crusgalli*), torpedo grass (*Panicum repens*) and alligator weed are common in the lower salinity environments, whereas giant cordgrass (*Spartina cynosuroides*), spike grass (*Distichlis spicata*) and black needlerush (*Juncus roemerianus*) dominate in the higher salinity wetlands (*ibid*).

SUBMERGED GRASSBEDS

Scattered patches of submerged aquatic vegetation occur along the banks and shallow flats of Dog River and its tributary streams. Species common to the grassbeds of the DRW include water nymph (*Najas guadalupensis*), coontail (*Ceratophyllum demersum*), pondweed (*Potemogeton* spp.) and tapegrass (*Vallisneria americana*). Also common to the aquatic grassbeds of the basin are the floating plants including white waterlily (*Nymphaea odonata*), floating heart (*Nymphoides aquatica*) and bladderwort (*Utricularia* spp.) (Sapp, Cameron and Stout 1976; Stout and LeLong 1981).

FAUNA

INVERTEBRATES

Information on the invertebrate fauna of the DRW is sparse and primarily limited to studies of Mobile Bay in the immediate vicinity of the mouth of Dog River.

Surveys of the benthic infauna of Mobile Bay and the surrounding waters indicate that the lowland streams subjected to frequent or prolonged tidal incursions possess a community primarily composed of polychaete worms and amphipods (Parker 1960; Vittor 1973; Chermock 1974; U.S. Army Corps of Engineers 1978, Marine Environmental Sciences Consortium (MESC) 1980 and 1981, Heard 1982; Hopkins and Valentine 1989 and ADEM 1990). The coastal streams not subjected to salinity intrusions are populated primarily by aquatic insects, oligochaete worms, amphipods and isopods (Chermock 1974; O'Neil and Mettee 1982; Mettee et al 1983; Hopkins and Valentine 1989).

Organisms in a tidally influenced stream must either be adapted to a wide range of environmental variables (salinity, flow, exposure at low tide etc.) or they must be opportunists with the capability of rapidly colonizing disturbed habitats. The ability to tolerate low concentrations of dissolved oxygen is also an advantage because many tidially influenced streams of the area experience periods of hypoxia due to poor flushing characteristics and salinity stratification during times of low flow (Heard 1982; Williams 1984; Pennack 1989). The dominant species of the benthic habitats include the polychaetes *Mediomastus ambeseta, Streblospio benedicti, Ancistrosyllis* spp., *Cossura soyeri, Glycinde solitaria, Leitoscoloplos fragilis, L. robustus, Paramphinome pulchella, Hobsonia florida, Sigambra bassi* and *S. tentaculata* and the amphipods *Ampelesca* spp., *Corophium* spp, *Gammarus* spp. and *Melita nitida.* (Parker 1960; Vittor 1973; Chermock 1974; U.S. Army Corps of Engineers 1978; MESC 1980 and 1981; Heard 1982; Hopkins and Valentine 1989; ADEM 1990).

Those species inhabiting the upland streams avoid the stress imposed by salinity variations. However, the variable flows of coastal streams subject the community to rapidly occurring flood conditions and streambed scour during storm events, contrasted with prolonged periods of low water and its the stresses of habitat crowding and exposure (Chermock 1974; Mettee et al 1983; Pennack 1989). These factors tend to favor species with the ability to remain in or on the substrate, endure high current velocity, survive sudden displacement and transport downstream and tolerate exposure (Hynes 1972; Pennack 1989).

Dominant species of the upland coastal streams include midge fly larvae (*Chironomus* spp., *Cryptochironomus* spp., *Coleotanypus* spp., *Procladius* spp. and *Polypedilum* spp.), mayfly nymphs (*Stenonema* spp., *Baetis* spp., *Isonychia* spp. and *Hexigenia* spp.) crane fly larvae (*Tipula* spp.), stonefly nymphs (*Leuctra* spp. and *Perlesta* spp.), aquatic beetles (*Stenelmis* spp. and *Dubiraphia* spp.), caddis fly larvae (*Cheumatopsyche* spp. and *Hydropsyche* spp.), dragonfly nymphs (*Gomphus* spp. and *Progomphus* spp.), damselfly nymphs (*Agrion* spp. and *Ischnura* spp.), amphipods (*Gammarus* spp.) isopods (*Asellus* spp.), clams (*Sphaerium* spp.) and oligochaete worms (*Limnodrilus* spp.) (Chermock 1974; O'Neil and Mettee 1982; Mettee et al, 1983 and Hopkins and Valentine 1989).

Also abundant in some fresh/brackish water habitats of the area are several species of benthic mollusks. Some of the more common gastropod species are dove shells (*Anachis avara* and *A. obesa*), slipper shells (*Crepidula* spp.) wentle traps (*Epitonium* spp.) and bubble shell (*Haminoea succinia*). The marsh periwinkle (*Littorina irrorata*) is a frequent inhabitant of the brackish/saline marshes of coastal Alabama and is likely to occur in the patches of *Juncus* and *Spartina* along the lower reaches of Dog River. Pelecypod species likely to inhabit the streams of the basin include ark shells (*Anadara* spp.), dwarf surf clam (*Mulinia lateris* and *M. ponchatrainensis*), *Macoma mitchelli* and tellin clams (*Tellina* spp.) (ibid).

Several species of crayfish are known to occur in the streams and ponds of Mobile County; these are, *Orconectes immunis, Fallicambarus byersi, Cambarellus* (3 species) and *Procambarus* (7 species) (Hobbs 1974). Other crustacean species common to the streams and wetlands of Mobile County, and likely to occur in the DRW, are mud crabs (*Eurypanopeus depressus, Rithropanopeus harrissi* and *Panopeus* spp.), fiddler crabs (*Uca* spp.), blue crabs (*Callanectes sapidus*) and grass shrimp (*Palaemonetes pugio*) (Chermock 1974; Heard 1982; O'Neil and Mettee 1982; Hopkins and Valentine 1989; ADEM 1990).

Brown shrimp (*Penaeus aztecus*) and white shrimp (*Penaeus setiferus*) also may be found in the basin. These commercially important species spend the post larval and juvenile stages of their lives in the grassbeds and tidal marshes of Mobile Bay and its tributaries, including Dog River and its tributaries. Brown shrimp post larvae develop during the winter and spring months (Jan.-May), then the juveniles emigrate through the bay waters to the Gulf of Mexico during the summer. White shrimp mature in estuarine waters during the late spring and summer (May-Aug.) and return to the gulf beginning in August and continuing through October (Heath 1979; O'Neil and Mettee 1982).

FISH

Available information on the fish species of the DRW and surrounding waters primarily comes from studies of the fisheries of the Mobile Delta and Mobile Bay. These studies indicate that the dominant species occurring in the local streams are redear sunfish (*Lepomis microlophus*), bluegill (*L. macrochirus*), orange-spotted sunfish (*L. punctatus*), longear sunfish (*L. megalotis*), green sunfish (*L. cyanellus*), black and white crappie (*Pomoxis nigromaculatus* and *P. annularis*), catfish (*Ictalurus* spp.) and largemouth bass (*Micropterus salmoides*) (Boschung 1957; Swingle 1971; Chermock 1974; Tucker 1979). The southern flounder (*Paralichthys lethostigma*) and striped mullet (*Mugil cephalus*) also are abundant in local waters and are important recreational and commercial species (Chermock 1974; Tucker 1979).

Various smaller species of fish common to the area waters, and serving as a food base for many of the larger recreationally and commercially important species, include shiners (*Notropis* spp.), sheepshead minnow (*Cyprinodon variegatus*), topminnows and killifish (*Fundulus* spp) and tidewater silversides (*Menidia beryllinna*) (Boschung 1957; Smith-Vanez 1968; Swingle 1971; Chermock 1974; Tucker 1979).

REPTILES AND AMPHIBIANS

The varied habitats of the DRW allow for a diverse assortment of amphibian and reptilian life. The uplands of the basin serve as home for several species of toad (*Bufo* spp.) and treefrog (*Hyla* spp.), Gulf Coast box turtles (*Terrapene carolina major*), skinks

(*Eumeces* spp.), green anoles (*Anolis carolinensis carolinensis*), gray rat snakes (*Elaphe obsoleta spiloides*), southern black racers (*Coluber constrictor priapus*) and copperheads (*Agkistrodon contorix contorix*) are the common reptiles of the upland habitats of the watershed. Gopher tortoses (*Gopherus polyphemus*), once common in uplands habitats throughout the coastal area, are occasionally found in the hilly terrain of the western DRW (Chermock 1974; Mount 1975; O'Neil and Mettee 1982).

The moist pine flatwoods, swamps and marshes of the area are likely to contain cricket frogs (*Acris* spp.), bullfrogs (*Rana catesbeiana*) and salimanders (*Ambystoma* spp. and *Pseudotriton* spp) as an amphibian community. Reptiles common to the moist pinewoods and wetlands of the DRW are snapping turtle (*Chelydra serpentina serpentina*), Mississippi diamondback terrapin (*Malaclemys terrapin pileata*), cooters (*Pseudemys* spp.) water snakes (*Nerodia* spp) and cottonmouth (*Agkistrodon piscivorous leucostoma*). Alligators (*Alligator mississippiensis*) are likely inhabitants of the wider stretches of streams and bayous of the basin. The pigmy rattlesnake (*Sistrurus miliarius*), canebrake rattlesnake (*Crotalus horridus*) and diamondback rattlesnake (*Crotalus adamantus*) occur throughout the watershed but are most commonly found in swamps, marshes and pine flatwoods (*ibid*).

BIRDS

The DRW, as does coastal Alabama in general, possesses a rich and diverse avian fauna. The variety of habitats in the area allows for upland ground birds, raptorial species, songbirds, shore birds, wading birds and other waterfowl to inhabit the basin (Chermock et al, 1975, Imhof 1976 and Johnson 1979).

Among upland habitats of, and generally throughout, the DRW **permanent resident species** (i.e. those which nest and occur throughout the year) include the red-tailed hawk (*Buteo jamaicensis*), black vulture (*Coragyps atratus*), turkey vulture (*Cathartes aura*), bobwhite (*Colinus virginianus*), turkey (*Meleagris gallopavo*), American woodcock (*Philohela minor*), mourning dove (*Zenaida macroura*), Chuck-will's-widow (*Camprimulgus carolinensis*), screech owl (*Otus asio*), barred owl (*Strix varia*), Carolina chickadee (*Parus carolinensis*), Carolina wren (*Thyrothorus ludovicianus*), mockingbird (*Mimus polyglottus*), brown thrasher (*Toxostoma rufum*), red-winged blackbird (*Agelaius phoeniceus*), cardinal (*Cardinalis cardinalis*) rufus sided towhee (*Pipilo erythrophthalmus*) and killdeer (*Charadrius vociferus*) (Chermock et al, 1975 and Imhof 1976).

Also included as permanent residents of aquatic and shoreline habitats are the snowy plover (*Charadrius alexandrinus*), Forster's tern (*Sterna forsteri*), laughing gulls

(*Larus atracilla*), black skimmer(*Rynchops niger*), brown pelican(*Pelacanus occidentalis*), great blue heron(*Ardea herodias*), snowy egret (*Egretta thula*), black-crowned night heron (*Nycticorax nycticorax*) and clapper rail (*Rallus longiostris*) (Chermock 1974; Imhof 1976 and Johnson 1979).

The avian fauna of the DRW includes a significant number of species which occupy the area for only a portion of the year. These temporary residents may be grouped into the categories of winter resident, summer resident or migrant.

Winter residents are those species which nest in the north during the summer and overwinter in the coastal area. These primarily tend to be waterfowl, shorebirds and songbirds. The wintertime population of birds in the basin includes, in addition to the permanent residents, the yellow bellied sapsucker (*Sphyrapicus varius*), scissor-tailed flycatcher (*Muscivora forficata*), eastern phoebe (*Sayornis phoebe*), Bewick's wren (*Thryomanes bewickii*), house wren (*Troglodytes aedon*), winter wren(*Troglodytes troglodytes*), robin (*Turdus migratorius*), sharp-tailed sparrow (*Ammospiza caudacuta*) evening grosbeak (*Hesperiphona vespertina*) and whip-poor-will (*Caprimulgus vociferus*) (Chermock 1974; Imhof 1976; O'Neil and Mettee 1982).

Wetlands habitats and shorelines of the watershed are winter residences for the common loon (*Gavia immer*), horned grebe (*Podiceps auritus*), double-crested cormorant (*Phalacrocorax auritus*), hooded merganser (*Lophodytes cucullatus*), common merganser (*Mergus merganser*), pintail (*Anas acuta*), green-winged teal (*Anas crecca*), mallard (*Anas platyrhynchos*), American coot (*Fulica americana*), semipalmated plover (*Charadrius semipalmatus*), Caspian tern (*Hydroporgne caspia*), Bonaparte's gull (*Larus philadelphia*), white pelican (*Pelacanus erythrorhynchos*) and marsh hawk (*Circus cyaneus*) (Chermock 1974; Chermock etal, 1975; Imhof 1976).

Summer residents are those species which nest in the area for the summer and migrate south for the winter. Summer residents common throughout the DRW include the cattle egret (*Bubulcus ibis*), common nighthawk (*Chordiles minor*), chimney swift (*Chaetura pelagica*), Acadian flycatcher (*Empidonax virescens*), great-crested flycatcher (*Myiarchus crinitus*), barn swallow (*Hirundo rustica*), purple martin (*Progne subis*), wood thrush (*Hylocichla mustelina*), Swainson's warbler (*Limnothlypis swainsonii*) prothonotory warbler (*Protonotaria citrea*) and summer tanager (*Piranga rubra*). (Chermock 1975 and Imhof 1976).

In the wetlands habitats of the DRW during the summer are found the green heron (*Butroides virescens*), little blue heron (*Florida caerula*), Louisiana heron (*Hydranassa tricolor*), least bittern (*Ixobruchus exilis*), Yellow-crowned night heron

(*Nyctanassa violacea*) and osprey (*Pandion haliaetus*) (Chermock 1974, Chermock et al. 1975 and Johnson 1979).

Along the shorelines of the lower reaches of Dog River and around its mouth, are potential nesting locations for least tern (*Sterna albafrons*), royal tern (*Thalasseus maximus*) and sandwich tern (*Thalasseus sandvicenis*) (Johnson 1979). The stretch of Dog River in the vicinity of its confluence with Halls Mill Creek and Rabbit Creek has also been identified as the location of a nesting colony utilized by the great blue heron, little blue heron and cattle egret (ibid).

Migrant species are those which pass through the area as they move between the summer nesting grounds in more northern latitudes and overwintering habitats in the south. Typical migrant species occurring in the DRW during the spring and fall migration seasons are various warblers (*Dendroica* spp.), flycatchers (*Empidonax* spp.), cliff swallow (*Petrochelidon pryrronota*), blue grosbeak (*Guiraca caerulea*), bobolink (*Dolichonyx oryzivorus*) and ruby-throated hummingbird (*Archilochus colubris*) (Chermock et al, 1975 and Imhof 1976). In the marshes, mud flats and shore habitats of the DRW, the American bittern (*Botaurus lentigenosus*), perigrine falcon (*Falco perigrinus*), Canada goose (*Branta canadensis*), blue goose (*Chen caerulescens*), black rail (*Lateralis jamaicensis*), spotted sandpiper (*Actitis macularia*), stilt sandpiper (*Micropalama himantopus*), black tern (*Childonias niger*) and roseate tern (*Sterna dougalli*) are commonly occurring species (Chermock et al, 1975 and Johnson 1979).

<u>MAMMALS</u>

The literature reviewed regarding the biological resources of the DRW indicates that 48 species of non-domesticated, terrestrial mammals inhabit the area (Holliman 1963; Linzey 1970; Chermock et al. 1975; and Holliman 1979).

Mammalian species common throughout Mobile County and the DRW include the opossum (*Didelphis marsupialis pigra*), eastern cottontail rabbit (*Sylvilagus floridanus mallurus*), gray squirrel (*Sciurus carolinensis carolinensis*), striped skunk (*Spilogale putorius putorius*) and raccoon (*Procyon lotor varius*). The swamps and marshes of the basin are suitable habitat for the swamp rabbit (*Sylvilagus aquaticus littoralis*), beaver (*Castor canadensis carolinensis*), Louisiana muskrat (*Ondatra zibethicus rivalicius*), river otter (*Lutra canadensis canadensis*) and mink (*Mustella vison mink*). The white-tailed deer (*Odocoileus virginianus*), bobcat (*Lynx rufus floridanus*) and gray fox (*Urocyon cinereoargenteus floridanus*) are the only larger mammals likely to occur in the DRW and their presence is confined to relatively undeveloped, sparsely settled areas in the watershed (Linzey 1970; Chermock et al 1975 and Holliman 1979).

The Florida black bear (*Ursus americanus floridanus*), red wolf (*Canis niger*) and Florida panther (*Felis concolor coryi*) once were common to Mobile County. However, these species have gradually declined in numbers to the point where they have practically vanished from the area (Chermock 1957; Linzey 1970; and Chermock et al. 1975).

Five of the mammalian species common to Mobile County have been introduced from exotic lands. These are the nine-banded armadillo (*Dasypus novemcinctus mexicanus*), black rat (*Rattus rattus*), Norway rat (*Rattus norvegicus*), house mouse (*Mus musculus brevirostris*) and nutria (*Myocastor coypus bonariensis*) (O'Neil and Metee 1982).

Additionally, there are 9 species of marine mammals known to inhabit the north central gulf coast. Of these, only the bottlenose dolphin (*Tursiops truncatus*) and spotted dolphin (*Stenella plagiodon*) are regular inhabitants of the waters of coastal Alabama (Caldwell and Caldwell 1973). The Florida manatee (*Trichetus manatus latirostris*) also has been sighted in Alabama waters; however, these sightings have usually occurred in the higher salinity and clearer waters of the tidal passes in the lower bay (ibid).

ENDANGERED SPECIES

A review of literature describing the endangered and threatened species of Alabama discloses that fifty-eight species of plants found in Mobile County are classified as endangered, threatened or of special concern. For the most part, these are species associated with bogs and other wetlands habitats (U.S. Department of the Interior 1975; Freeman et al. 1979; O'Neil and Mettee 1982).

The DRW also is within the habitat range of some forty-six faunal species which are listed either as threatened or endangered (Boschung 1976; U.S. Department of the Interior 1980). Five species of crayfish, genera *Cambarellus* and *Procambarus*, listed as special concern by Bouchard (1976), have been collected from coastal Alabama. Two of these, *Cambarellus diminutus* (the smallest species of crayfish in the world) and *Procamberus evermanni* have been collected from Mobile County (O'Neil and Mettee 1982). The slow-flowing, low-gradient streams of the watershed provide suitable habitat for these species and others with similar requirements.

There are six species of fish considered as endangered, threatened or of special concern which have been collected from coastal Alabama (Ramsey 1976). One of these, the pigmy killifish (*Leptolucania omnata*) a species of special concern, is likely to inhabit the small streams of the DRW. The other five species either inhabit large rivers or are rare occurrences of displaced individuals (O'Neil and Mettee 1982).

Four rare species of amphibians, considered as threatened, endangered or of special concern, are known to inhabit the basin. The endangered flatwoods salamander (*Ambystoma cingulatum*) and the threatened dusky gopher frog (*Rana areolata sevosa*), inhabitants of moist pinewoods, have been collected from the DRW by Loding (1922) although no collections have occurred since then (O'Neil and Mettee 1982). The river frog (*Rana heckscheri*) and greater siren (*Siren lacertina*) are species of special concern which occur in Mobile County (*ibid*).

Nine species of reptiles listed as either endangered, threatened or of special concern are potential residents of the DRW (Boschung 1976; U.S. Department of the Interior 1980). The gopher tortoise (*Gopherus polyphemus*), indigo snake (*Drymarchon corais couperi*) and eastern diamondback rattlesnake (*Crotalus adamanteus*), once abundant in the area, are now classified as threatened, endangered and of special concern respectively (Mount 1976). Their decline in numbers is due, for the most part, to habitat destruction and the practice utilized by rattlesnake hunters of pouring gasoline into gopher tortoise holes for the purpose of driving snakes out of the burrows (O'Neil and Mettee 1982).

The black pine snake (*Pituophis melanoleucus*), listed as endangered, and the pine woods snake (*Rhadinea flavilata*), listed as of special concern, are inhabitants of the pine forest and flatwoods of Mobile County (Mount 1976). The Alabama red-bellied turtle (*Pseudomys alabamensis*) is considered threatened due to its small range and population (Mount 1976). This aquatic turtle is restricted to the lower Mobile River drainage and is a potential resident of the streams in the DRW. Also listed as of special concern and likely to reside in the basin are the Florida green water snake (*Nerodia cyclopion floridana*) and the Florida soft-shell turtle (*Trionyx ferox*) (Mount 1976).

However, not all of the species listed as either endangered or threatened are near their extinction. The most noteable recovery of such a species indigenous to the watershed is the American alligator (*Alligator mississippiensis*). Once hunted to such an extent that the population in coastal Alabama all but disappeared, their numbers are on the increase because of strict protective measures (O'Neil and Mettee 1982). This large reptile resides in the marshes and bayous of lower Dog River and tributaries.

Twenty-two species of birds considered as endangered, threatened or of special concern (Boschung 1976; U.S. Department of the Interior 1980) are known to occur in

Mobile County and the DRW at some time of the year, ten of these are breeding resident species.

The brown pelican (*Pelacanus occidentalis*) has experienced a "swing of the pendulum" with respect to its numbers in coastal Alabama. Once a historical common resident of the area, the pelican population declined through the 1950's, 1960's and 1970's resulting in its listing as endangered (Boschung 1976; U.S. Department of the Interior 1980). However, the numbers of this species have been on the increase over the past decade; it appears to have made a comeback and the population of coastal Alabama is no longer listed as either endangered or threatened (O'Neil and Mettee 1982).

Also known to the area and listed as endangered is the bald eagle (*Haliaeetus leucocephalus*) (Boschung 1976; U.S. Department of the Interior 1980). This species is a breeding resident of the gulf coast and nests along the shoreline of open water; their numbers have steadily declined throughout their range. Loss of nesting habitat, poaching and the effects of pesticides on reproduction are factors contributing to their diminished numbers. (Keeler 1976; O'Neil and Mettee 1982).

Avian species of the area listed as of special concern are the swallow-tailed kite (*Elanoides forficatus*), sharp-shinned hawk (*Accipiter striatus*), Cooper's Hawk (*Accipiter cooperi*) and red-shouldered hawk (*Buteo lineatus*) (Boschung 1976). These species have declined in numbers for the same reasons as the bald eagle and osprey.

Five mammalian species listed as either threatened or of special concern have been recorded from Mobile County, these are the Florida yellow bat (*Lasiurus floridanus*), southeastern myotis (*Myotis austroriparius austroriparius*), Bayou gray squirrel (*Sciurus carolinensis fuliginosus*), Florida panther (*Felis concolor coryi*) and black bear (*Ursus americanus floridanus*). The black bear and panther, both listed as endangered (Boschung 1976; U.S. Department of the Interior 1980), are unlikely residents of the DRW due to anthropogenic activity and a lack of suitable habitat. The Florida yellow bat and the southeastern myotis bat are classified as being of special concern (Boschung 1976). These species are seldom seen in the watershed but are potential inhabitants of wooded areas and old buildings. The bayou gray squirrel is found in the swamps and bayous of Mobile County (Dusi 1976).

BASIN SELECTION RATIONALE

Considering the information available on land use, soil types, sediment chemistry, water quality and biological resources, the ADEM coastal staff chose the DRW for this study of land use practices and their effects on water quality. Various portions of this basin display evidence of degraded water quality, contaminated sediments, poor land use planning, potential threats to aquatic life and impaired recreational use of some waters. Also taken into account were the potential for significant inputs of urban storm water drainage, the existing high population density and the trend towards large scale developments in the western part of the watershed.

From the review of available information, the apparent nature of the impacts to water and sediment quality within the basin would tend to implicate land-use practices and non-point sources as the primary anthropogenic factors influencing the environmental quality of the DRW. Conditions such as these lend themselves to corrective actions through implementation of the new storm water permitting requirements of the NPDES program and enforcement of land-use BMPs (e.g., erosion control).

NONPOINT SOURCE ASSESSMENT

LAND RECONNAISSANCE

Having reviewed the available information regarding land-use, soil characteristics, sediment chemistry, water quality and biological resources of the DRW, the next step was to conduct initial surveys of the topography of the watershed and current land-use practices within. Land reconnaissance of the watershed by motor vehicle was begun in January 1993 and continued through September 1993. These efforts were undertaken to ground truth and update the aerial photographic information from the SCS Soil Survey. The findings of these surveys indicate that the older developed portions of the watershed had changed little in the decade since the SCS report. The more recently developed areas of the basin are following the developmental trends that were underway at the time of the SCS survey (i.e., large residential subdivisions and office/shopping complexes). As appeared to be the case in the aerial photos from the SCS survey, significant expanses of the watershed are covered by parking lots, large commercial buildings, residential subdivisions, paved streets and other impervious cover. Also evident during the land reconnaissance was the proliferation of recreational facilities in the western portion of the basin. Notable developments being a golf course along Moore Creek, several softball/baseball diamonds in the Halls Mill Creek sub-basin, and numerous tennis courts at apartment complexes and public facilities throughout the western half of the DRW.

Considering the current land use patterns in the DRW, the non-point sources with the greatest potential for impacts to the aquatic resources of the basin include urban street refuse, oil, grease, dust and dirt from streets and parking lots, atmospheric deposition of airborne pollutants, leaks and overflows from sewers and erosion (U.S. Environmental Protection Agency 1991; National Oceanic and Atmospheric Administration 1987 and 1989; U.S. Fish and Wildlife Service 1991; Windom 1989). There also is a potential for impacts from faulty and improperly installed septic tanks in the residential areas not served by a sewer system. According to the SCS soil survey, some of the residential areas of the DRW are located on soils which are unsuitable for septic tank field lines (U.S. Department of Agriculture 1980). In addition, agricultural operations, golf course maintenance and residential lawn keeping activities all present potentials for excessive nutrient loads and pesticide runoff (U.S. Environmental Protection Agency 1991; U.S. Fish and Wildlife Service 1991).

There also is a history of citizens complaints regarding excessive turbidity and debris in streams of the DRW. These incidents have been investigated by the ADEM Field Office; results of the investigations have usually shown that the valid complaints occur following storm events and tend to be more frequent in Eslava Creek, Moore Creek and Halls Mill Creek than the other waters of the basin.

The categories of sources of potential impacts led to the decision to incorporate the sampling of storm events into the watershed survey. Analyses of storm water was directed towards the determination of nutrient concentrations, levels of enteric bacteria, suspended solids concentrations, turbidity and dissolved oxygen depletion (hypoxia). The parameters selected for the initial monitoring surveys are listed in Table 2.

TABLE 2

WATER CHEMISTRY PARAMETERS MONITORED

In situ measurements	Laboratory analyses
Water Temperature	Turbidity
pH	Nitrate
Dissolved Oxygen	Ammonia
Conductivity/Salinity	Total Kjeldahl Nitrogen
	Phosphate
	Fecal Coliform

AREA METEOROLOGY & STORM EVENTS

Three storm events were monitored as part of the watershed survey. These events occurred during three seasons (spring, summer and fall) and had representative characteristics of storms in their respective seasons.

Strong frontal systems are typical of the springtime weather in coastal Alabama. These systems move into the area from the plains states and Texas on the average of one every 5 to 7 days. These frontal systems have the potential for widespread, heavy rainfall often accompanied by violent thunderstorms and tornadoes. Rainfall from these systems is usually steady for several hours to a day but may become locally intense, sometimes depositing an inch of precipitation in less than an hour and daily precipitation may be as much as several inches. A daily record, for any 24 hour period in the watershed, of 13.36 inches was recorded at the National Weather Service station at Bates Field in April 1955 (O'Neil and Mettee 1982).

As is characteristic of the summer months in coastal Alabama, the DRW experiences convective-type thundershowers on an almost daily basis during the months of June through August. Data from the National Climatic Center shows that thunderstorms of 0.01" of precipitation or greater occur with an average frequency of one every 2.1 days during these months (O'Neil and Mettee 1982). These rain events usually occur between mid-afternoon and early evening and although some of the larger storms might encompass entire counties others are so localized in their effect that all of their precipitation load is deposited in areas of one square mile or less. Convective thunderstorms often have the potential to produce heavy rainfall and violent winds; indeed the smaller storms have the potential for dropping over one inch of rain in less than an hour. Such meteorological activity, even though somewhat small in the area of coverage, can cause significant increases in turbidity and suspended solids (National Research Council 1990; U.S. Environmental Protection Agency 1991; ADEM-FDER 1991).

The late-summer/early-fall period in coastal Alabama is typified by prolonged stretches of calm, relatively dry weather (O'Neil and Mettee 1982). The convective thunderstorms have all but vanished and the strong frontal systems of later autumn have yet to arrive. Precipitation during these weeks of calm weather is usually light to moderate and spread over a wide area.

Specific storm events incorporated into the watershed survey occurred on the following dates: March 30, 1993 approximately 3 inches of rain fell in a 12 hour period on Mobile and the DRW; July 12-14, 1993 localized thundershowers deposited one-half inch or more of precipitation on the watershed each day; and October 20-23, 1993 light to moderate rainfall intermittently occurred throughout Mobile County. All of these events were sufficient to cause noticeable increases of flow of the tributaries of the DRW.

STREAM AND SHORELINE SURVEYS

Having initiated land reconnaissance of the watershed and cursory examination of potential impacts to its waters, the next step was to survey the basin from the water for the purpose of determining the categories and extent of shoreline development and further identifying the nature of possible degradation in water quality.

ADEM personnel inspected the streams and shoreline of each sub-basins of the DRW. Eslava Creek, Robinson Bayou, Moore Creek, Halls Mill Creek, Rabbit Creek and Rattlesnake Bayou were surveyed to the upper limits of their navigable waters. The shallow upper stream reaches and otherwise non-navigable waters were examined at bridge crossings and, in some cases, by walking the stream course. During these surveys the types of development along the stream bank were noted, vegetation communities were categorized, gross characteristics of the stream were observed, *in situ* parameters were measured and water samples were collected. The stream/shoreline surveys and storm water sampling commenced on March 31$^{\underline{st}}$ following the storm of March 30$^{\underline{th}}$ and continued through October 1993. The locations of the sampling stations are shown in Figures 5 and 6; descriptions of the stations are given in Tables 3 & 4. A tabular summary of all water quality data is presented in the Appendix.

TABLE 3

LOCATIONS SURVEYED BY BOAT
DOG RIVER WATERSHED STORM SAMPLING

Station ID	Description of location
EC-1	Eslava Creek @ Holcombe Ave
EC-2	Eslava Creek south of I-10
RB	Robinson Bayou
MC-1	Moore Creek south of CSX trestle
MC-2	Moore Creek @ the Linksman Golf Course.
HMC-1	Halls Mill Creek approx. 0.5 km upstream of its mouth.
HMC-2	Halls Mill Creek approx. 200 meters upstream of I-10.
RC-1	Rabbit Creek approx. 0.5 km upstream of Ala. Hwy. 163.
RC-2	Rabbit Creek approx 200 meters upstream of its mouth.
RSB	Rattlesnake Bayou approx 0.5 km downstream of Ala.Hwy.163.

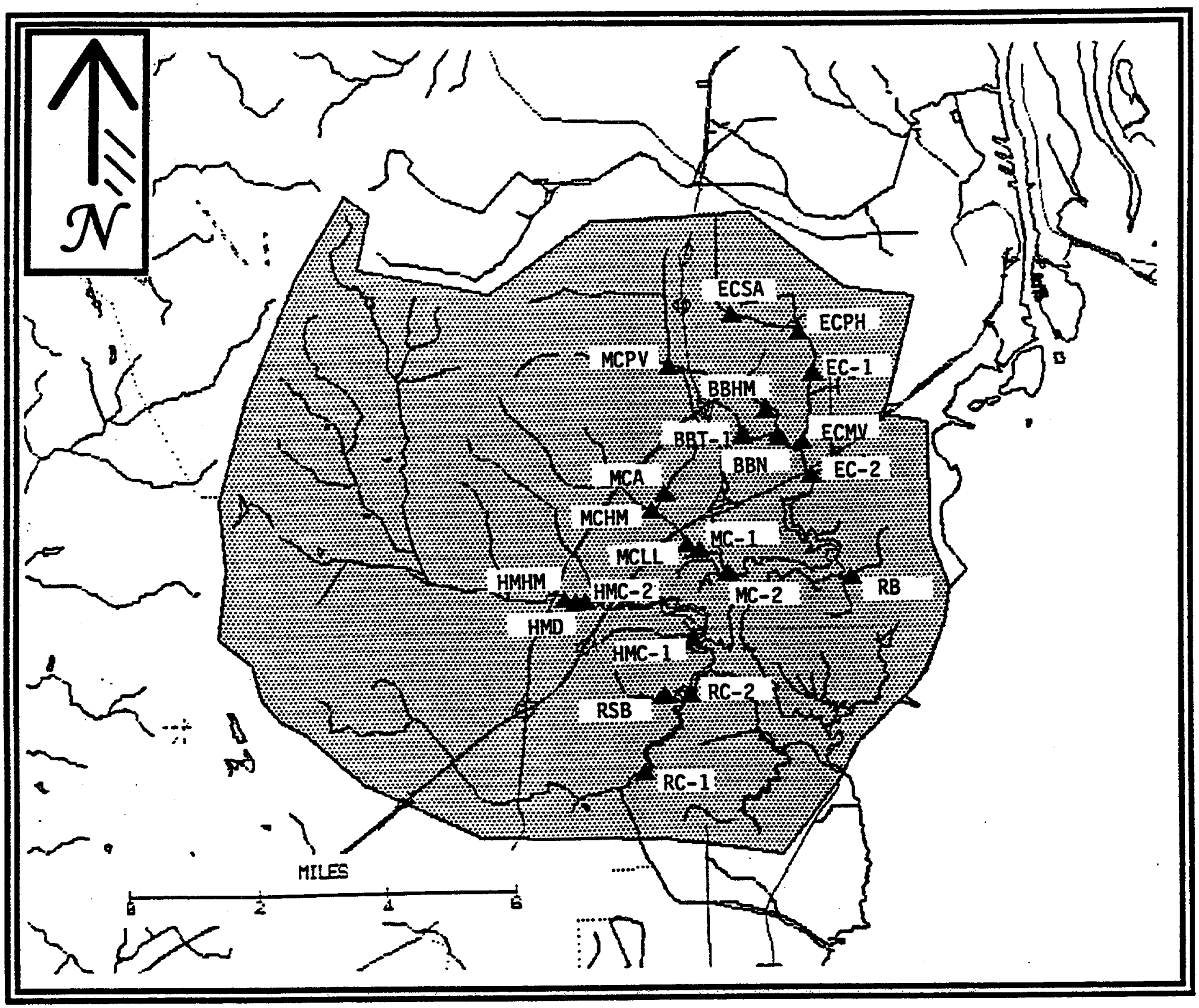

FIGURE 5

THE STUDY AREA
SHOWING THE LOCATIONS OF
STREAM SAMPLING STATIONS

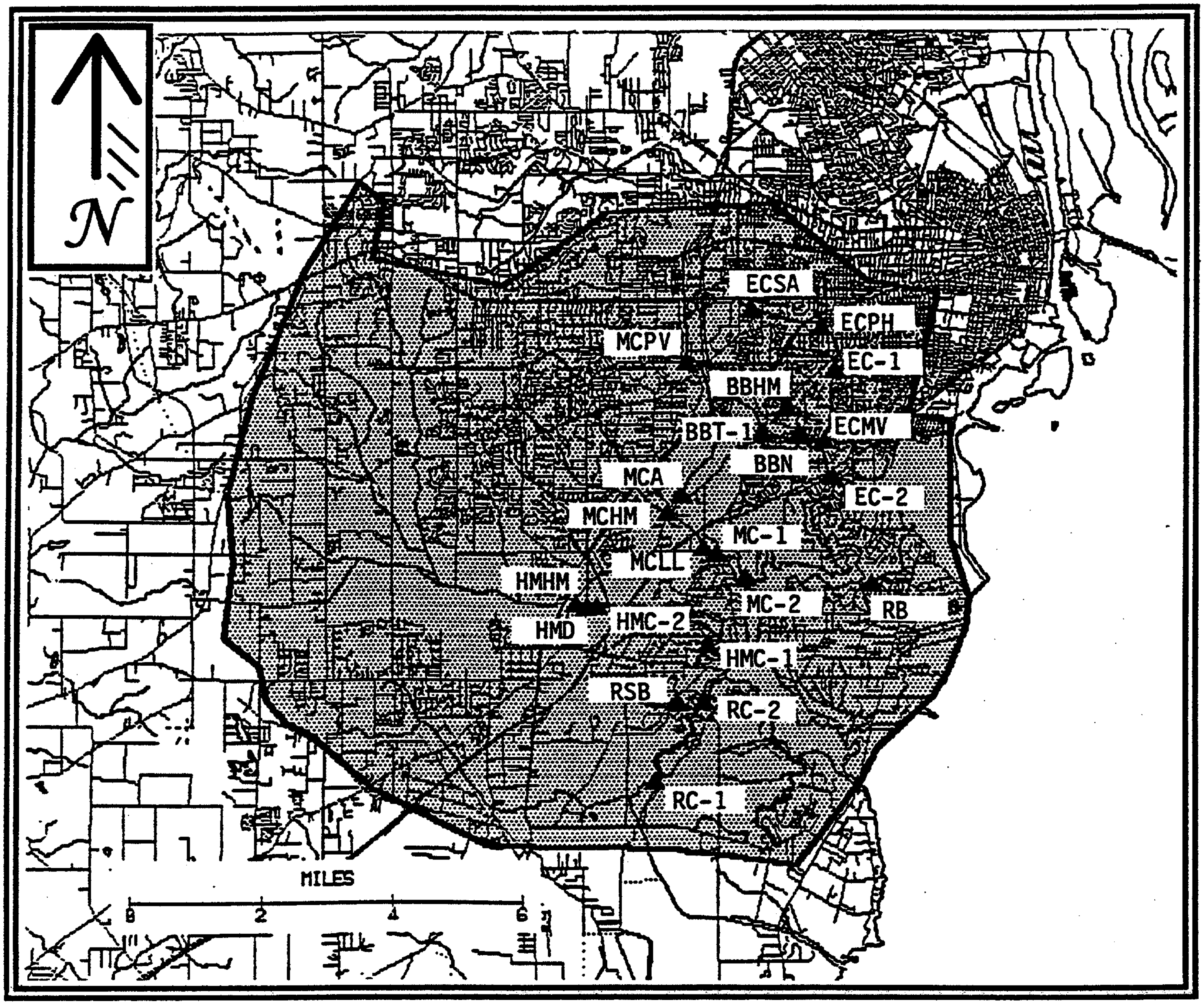

FIGURE 6

THE STUDY AREA
SHOWING THE LOCATIONS OF
STREAM SAMPLING STATIONS
(CITY STREETS ADDED)

TABLE 4

LOCATIONS OF STREAM CROSSINGS SURVEYED DOG RIVER WATERSHED STORM SAMPLING

Station ID	Description of location
ECSA	Eslava Creek at Sage Avenue, wadeable stream w/concrete bed and rip-rap lined banks.
ECPH	Eslava Creek at Pinehill Drive, wadeable stream w/ concrete bed and concrete sides.
ECMV	Eslava Creek at McVay Drive, non-wadeable stream w/ some channelization, vegetated banks and a silty bottom.
BBHM	Bolton Branch at Halls Mill Road, wadeable stream w/ rip-rap lined banks and bed.
BBN	Bolton Branch at Navco Road, non-wadeable stream w/ silty sand bed and vegetated banks.
BBMV	Bolton Branch at McVay Drive, drainage canal w/concrete banks and bed.
BBT-1	Unnamed tributary to Bolton Branch, wadeable stream with vegetated banks and sandy bottom.
HMD	Halls Mill Creek at Demotropolis Road, wadeable stream w/a natural stream course.
HMHM	Halls Mill Creek at Halls Mill Road, wadeable stream w/a natural stream course.
MCPV	Montlimar Creek at Pleasant Valley Road, channelized non-wadeable stream w/ silty sand bed and concrete banks.
MCA	Montlimar Creek at Azalea Road, drainage canal w/concrete banks and bed.
MCHM	Moore Creek at Halls Mill Road, wadeable stream w/ silt sand bed and rip-rap banks.
MCLL	Moore Creek at Lloyd's Landing, non-wadeable stream w/ a silty sand bed and some rip-rap for bank stabilization.

SUB-BASIN CHARACTERIZATIONS AND ASSESSMENTS

ESLAVA CREEK

Eslava Creek is an extensively channelized urban stream with numerous storm drains and culverts leading into it. The upper reaches of the creek have either a rip-rap or concrete revetment bank; the lower reaches, although channelized, have somewhat more natural and well vegetated banks. This entire sub-basin is highly developed and possesses large areas of impervious cover.

The development along the lower reaches of the stream bank is a mixture of residential dwellings and small businesses such as auto repair garages, retail merchants and restaurants. Most of the development in these neighborhoods is "older" construction having been built prior to 1960. The upper reaches of Eslava Creek are in what was once an extensive area of wetlands, locally known as Wragg Swamp. These wetlands were drained during the 1950s and 1960s for facilitating real estate development and highway construction. The development in these former wetlands is considerably "newer" than that of lower Eslava Creek and primarily consists of large commercial sites (i.e. shopping malls, office parks and motels) and multiple unit residential dwellings.

The natural vegetation of the Eslava Creek sub-basin is characteristic of bottom land hardwood forests. Common species observed throughout the sub-basin include water oak, swamp tupelo, red maple and sweet gum. Along the stream banks and in low places saw palmetto, wax myrtle and cinnamon fern were observed. Small patches of arrowhead, tapegrass and alligator weed were observed in the near bank shallows along the confluence of Eslava Creek and Bolton Branch. The vegetation of the higher ground of the Eslava Creek area has been extensively altered by landscaping; however, the remaining natural plant communities are composed of mixed pine-oak forest.

Eslava Creek was found to be littered with a significant amount of urban street refuse, litter, lawn clippings and other solid waste. Items frequently observed were plastic soda bottles, paper cups, empty oil containers, Styrofoam objects and packaging material such as plastic wrap and cardboard. Visible oil sheens were not observed in the stream; however, extensive patches of very fine particulate matter, or "scum" were observed.

Water clarity in Eslava Creek was fair and siltation was minimal. On most occasions visibility allowed for a gross qualitative identification of fish in the creek. Various small species, shiners (*Notropis* spp) and mosquito fish (*Gambusia affinis*), were observed swimming along the stream's upper reaches. Larger species, crappie (*Pomoxis* spp.) and bluegill (*Lepomis macrochirus*), were observed along the lower reaches of the creek. Quantitative collection of fish for determination of taxonomic and population characteristics was not an objective of the survey and therefore was not incorporated into the study plan. On most survey dates, residents of the neighborhoods along the lower creek were fishing. Conversations with some of these individuals indicated that they are pleased with their efforts and that fishing in the creek continues to be "good".

Analyses of water samples revealed enriched concentrations of nitrogenous materials and markedly elevated numbers of fecal coliforms when compared to data from coastal area streams of similar size and morphology monitored through the water quality trend network maintained by ADEM. The high concentrations of nitrate detected in Eslava Creek are the possible results of runoff from lawns, a golf course and landscaped grounds on commercial property. Leaks from sanitary sewer lines and septic tanks are likely contributors to the enteric bacteria problem. Whatever the source, bacterial concentrations in Eslava Creek indicate that sources of enteric waste contamination exist somewhere in the sub-basin.

BOLTON BRANCH

Bolton Branch is a small, tidially influenced, second order stream that joins with Eslava Creek to form Dog River. Draining a mixed commercial and urban residential section of the DRW, Bolton Branch is extensively channelized with rip-rap and concrete revetments along its upper reaches and a more natural stream course in its lower reaches. Similar to Eslava Creek, Bolton Branch also has many storm drains and culverts draining to it. The majority of the development in the community around Bolton Branch is older construction and only small areas of property suitable for development remains.

The native plant associations along Bolton Branch are identical to those described for Eslava Creek. The lower reach of this stream is densely wooded and a small community of arrowhead, alligator weed and other wetlands plants is located at the mouth of Bolton Branch.

The concentration of TKN and numbers of fecal coliforms in the storm water samples were elevated, relative to similar streams in the coastal area monitored by the Department, for all stations on Bolton Branch throughout the study. Water clarity, suspended solids and dissolved oxygen appeared to be minimally impacted from land-use and storm runoff.

ROBINSON BAYOU

Robinson Bayou is located in a primarily residential area which includes several schools, churches and small shopping centers. The stream is still in a somewhat unaltered condition relative to the channel morphology and drainage.

There is extensive development along the shore in the form of single unit residences. Most of the waterfront property is vegetated and the impact from storm water runoff appears to be far less than that to Eslava Creek. A significant number of the houses along Robinson Bayou have a pier, boat slip or boat house. Some of the boat slips and boat houses are fairly large and have resulted in an appreciable amount of shoreline alteration. The majority of these structures though, are built into sloping elevated stream banks and the wetlands habitats of Robinson Bayou appear to have been minimally affected by them.

The plant community of this sub-basin is typical of bottom land hardwood associations. Sweet gum, swamp tupelo, tulip tree and red maple are commonly found overstory species around Robinson Bayou. Wax myrtle, gallberry and black titi are abundant in the open areas along the stream banks. Bald cypress, palmetto, cinnamon fern and netted chain fern are common species in the wetter areas around the mouth of the bayou. At the confluence of Robinson Bayou with Dog River there is a significant stand of freshwater marsh. Sawgrass and cattails are the dominant emergent species in this marsh; fragrant water-lily, alligator weed and southern naiad are the dominant emersed/submersed plants.

Turbidity and nutrient concentrations were significantly lower in Robinson Bayou than in Eslava Creek; however, the bacterial levels of Robinson Bayou were sufficiently elevated to indicate potential source of enteric wastes. This might have been the result of line maintenance operations conducted in the area by the Mobile Water Service System. Robinson Bayou appeared to be relatively free of trash items throughout the study.

MOORE CREEK

Moore Creek is the outfall of a canal system draining a large area of western Mobile including a portion of the former Wragg Swamp. The confluence of Moore Creek with Dog River is located at river mile 3.8 on the river's west bank.

This stream is located in a suburban area comprised primarily of residential communities, schools and shopping centers. This portion of the DRW, like the upper reaches of Eslava Creek, is undergoing more active development than Robinson Bayou and the lower reaches of Eslava Creek which are located in "older" parts of Mobile. Also there are several light commercial "parks" and three golf courses in the drainage basin of Moore Creek.

The upper reaches of Moore Creek stretch into the extensively developed Cottage Hill community in Mobile. This area consists of numerous densely populated residential neighborhoods, shopping centers, schools, restaurants and other similar developments characterized by large areas of impervious cover. Moore Creek has undergone extensive alteration (i.e. bank stabilization, channelization, culverts etc.)

along its upper half but the lower half remains in a more natural condition and is significantly less densely developed than the upper. Most of the development in the area surrounding lower Moore Creek is single unit residential. A few small commercial developments are in this area but the amount of impervious cover and runoff associated with these facilities appears to be an insignificant portion of the watershed.

Lower Moore Creek has a moderate amount of property development along its waterfront; all in the form of single-unit residential dwellings. Most of the developed lots have a pier and/or a small boat house. Shoreline alteration and bank stabilization are somewhat minor and appear to have impacted little on marshlands along the creek.

The soils of the upper half of the Moore Creek sub-basin are the erosion prone Troup-Heidel-Bama unit. When exposed, these sandy loam soils are easily washed into drainage courses creating turbidity and siltation problems in the receiving waters. The dark humic soils of the lower half of Moore Creek are the less erosion prone, but poorly draining Bayou-Escambia-Harleston unit. These two soil associations have markedly contrasting physical appearances. This characteristic and the tendency for the eroded fines from upper Moore Creek drainage to remain in suspension, makes the turbidity and silt deposits in the lower creek quite noticeable.

The plant community of upper Moore Creek is, for the most part, the typical upland pine-oak association. This area has undergone considerable landscaping and altering of the native vegetation; however, longleaf pine, southern red-oak, dogwood and magnolia are still the dominant overstory species. Proceeding downstream to the lower elevations near the confluence with Dog River, this upland vegetation assemblage gradates to a bottom land forest intermixed with a mesic pinewoods community. At the mouth of Moore Creek is a significant stand of freshwater marsh. Sawgrass, duck potato, arrow-arum and alligator weed grow profusely in this area. Bald Cypress and black willow also are abundant along the banks of lower Moore Creek and its confluence with Dog River.

The waters of Moore Creek were found to have quite high turbidity and TSS values indicating a problem with runoff and erosion. This appears the result of poor erosion control practices in the residential, commercial and roadway development in the area. Numerous deposits or "bars" of reddish silt were noted along the bank and in the shallows of lower Moore Creek.

Concentrations of nitrogenous materials in the storm samples from Moore Creek were significantly higher than the levels usually observed and considered average for small coastal streams monitored by the Department. The numbers of fecal coliforms consistently exceeded the water quality criterion for its use classification of fish and wildlife. Runoff from lawns and other landscaped property present potentially significant sources of nutrient input; leaks and overflows from sewers and septic tanks are the likely causes of the excessive levels of enteric bacteria.

MONTLIMAR CREEK

Montlimar Creek is essentially an urban drainage canal, channelized throughout its entirety. Its banks are stabilized with concrete revetments and rip-rap along the length of the stream. Originally constructed to assist in the draining of Wragg Swamp, Montlimar Creek now serves as the main course of storm water drainage for a highly developed area. Beginning in a residential neighborhood, the stream receives drainage from several large apartment complexes, shopping center and office parking lots, an extensive area of warehouses and two golf courses. The flow from Montlimar Creek is discharged to Moore Creek on the southwest side of Mobile.

This stream, like the upper reaches of Eslava Creek, is in an area characterized by Smithton-Benndale soils. The poor drainage qualities of this soil unit are exacerbated by the accompanying large amounts of impervious cover in the area.

Due to the highly altered nature of Montlimar Creek and the surrounding land, there is little of a natural plant community. The vast majority of the land in the Montlimar Creek drainage has been cleared and developed leaving only a few patches of pine flatwoods. Wetlands which once existed in the Montlimar Creek area have all but disappeared.

Montlimar Creek was observed to have an accumulation of trash and debris comparable to Eslava Creek, although not as severe. The data from water analyses indicate an appreciable amount of nutrient enrichment in the creek. Some of the highest nitrate concentrations ever observed by the ADEM staff in coastal Alabama streams were detected in the samples from Montlimar Creek. Large areas of landscaped and maintained property, such as the golf course greens and numerous well manicured lawns of the area, are documented sources of nutrient over enrichment to surface waters (National Oceanic and Atmospheric Administration 1987; National Research Council 1990; U.S. Fish and Wildlife Service 1991; U.S. Environmental Protection Agency 1991; ADEM-FDER, 1991).

Additional data reveals elevated concentrations of fecal coliforms throughout Montlimar Creek. This is more evident in the upper reaches of this stream than in the lower reaches. Comparison of the different bacterial concentrations would appear to implicate the high density residential neighborhoods and commercial developments in the upper reaches of Montilmar Creek as sources of such contamination.

HALLS MILL CREEK

Halls Mill Creek has a fairly extensive drainage system in and of itself. This stream drains a sizable area of west Mobile and empties into Dog River 2.9 stream miles above the river's mouth. Although the creek drains heavily developed parts of Mobile County the stream's course is relatively unaltered compared to Eslava and Moore Creeks.

The wadeable, upper reaches of Halls Mill Creek are still somewhat natural, the banks are vegetated and the use of rip-rap and other bank stabilization methods is limited to bridge crossings. The banks of the lower reaches of Halls Mill Creek are extensively developed with residential housing along both sides. Even though the course of the stream is still relatively natural there is considerable alteration of the shoreline with numerous bulkheads, piers and excavated boat slips. A significant proportion of these structures appeared to have involved filling, dredging and draining of wetlands, primarily bottom land hardwood forest

Halls Mill Creek and its tributaries extend into the hilly uplands of west Mobile. This area is undergoing the most active development of any portion of the DRW. The soils of the western communities are, as previously discussed, somewhat prone to erosion. This characteristic and the rolling terrain present a potentially severe problem with development if proper control measures are not taken during construction. The Bayou-Escambia-Harleston soils of the lower elevations of the Halls Mill Creek sub-basin are much less prone to erosion; however these soils drain poorly and are easily flooded.

Because of the large area covered by this sub-basin, the extent of its penetration into upland habitats and contrasting soil types, the Halls Mill Creek system contains a wide variety of plant communities. The habitat around the tributaries of Halls Mill Creek and its headwaters contains a oak-pine association typical of the uplands of coastal Alabama. Unlike Montlimar Creek and Moore Creek, the Halls Mill Creek sub-basin still possesses significant acreage of somewhat natural upland forest. Proceeding downstream to lower elevations, the plant community gradually changes to a bottom land hardwood forest with a canopy of swamp tupelo, sweet gum, bay and red maple. These forests have a dense understory of wax myrtle, gallberry, saw-palmetto and ferns. Bald cypress and black willow are abundant along the lower reaches of Halls Mill Creek. The largest area of hardwood forest observed in the DRW is located along the middle reaches of Halls Mill Creek just south of Interstate Highway 10.

The Halls Mill Creek sub-basin also contains the largest area of freshwater marsh in the DRW. Large expanses of cattails, sawgrass and bulrushes are located along the middle and lower reaches of the creek. Intermingled with these dominant species are dense patches of duck-potato and waterlily. Floating and submerged aquatic vegetation also was noticed at several locations along Halls Mill Creek. Common species observed were bladderworts, spatterdock and musk-grass.

Approaching the mouth of Halls Mill Creek and its confluence with Dog River the shoreline vegetation begins to incorporate species characteristic of brackish/saline marshes. The habitats around the creek mouth are dominated by black needlerush, giant cordgrass and spikegrass. Water oak, slash pine and various shrubs are found on the slightly higher spots scattered among the marsh. Bald cypress also is abundant along most of the lower reaches of Halls Mill Creek.

The survey of the Halls Mill Creek sub-basin indicated that the impacts to the creek primarily were turbidity, siltation and enteric bacteria.

The waters of Halls Mill Creek, especially the segment above I-10, were consistently and noticeably turbid throughout the study. The stream bed was observed to have a significant amount of siltation, this too was most obvious in the upper reaches. Along the middle reaches of Halls Mill Creek numerous sand bars and silt deposits also were observed. The reddish color and sandy-silty texture of these deposits were in stark contrast to the darker sediments and soils characteristic of the middle-lower reaches of the creek. These reddish sediments were notably similar to those of the stream banks of upper Halls Mill Creek, its tributaries and the soils of the west Mobile area.

These sediment deposits might have partially resulted from the discharge of wash water from a gravel and sand processing facility that once operated in the Halls Mill Creek sub-basin. However; the majority of this material appeared to have been more recently deposited, possibly within the past year or so. This would appear to implicate roadway construction, subdivision development and other similar activities involving the clearing of significant acreage and/or the utilization of large amounts of fill material as the source. Identification of one of these sources was accomplished in September when the staff of the ADEM Mobile Field Office traced the source of a turbidity plume to a subdivision development on Milkhouse Creek, a tributary of Halls Mill Creek.

These waters also appear to be the recipients of significant inputs of enteric bacterial contamination from upstream sources. The fecal coliform counts of samples collected from Halls Mill Creek during the summer storm sampling (10,600/100ml and 13,000/100ml) are among the highest observed in area waters in recent years.

Development in the Halls Mill Creek sub-basin appears not to have impacted nutrient concentrations to the degree observed in the central and eastern portions of the DRW. The more natural drainage of the system might allow for some measure of nutrient removal as opposed to the culverts and channels of Eslava, Moore and Montlimar Creeks.

RABBIT CREEK-RATTLESNAKE BAYOU

The survey of these two bodies of water will be discussed together since they are closely interconnected. Their confluence with Dog River coincides closely with that of Halls Mill Creek at river mile 2.9.

Rabbit Creek and Rattlesnake Bayou were found to have the least amount of stream alteration and channelization of all the tributaries monitored in this study. Land development and area of impervious coverage within this portion of the DRW is the least of the streams surveyed. However, this sub-basin contains two minor industrial facilities operating under the conditions of NPDES permits; one of them, an automobile and truck bumper manufacturer, discharges treated process wastewater to Rattlesnake Bayou and the other facility, a paint and surface coating manufacturer, discharges storm water drainage from a solvent storage area to Rabbit Creek. Additionally, a soft drink bottling plant operating under the conditions of a state indirect discharge permit (SID) issued by the Department is located in the Rabbit Creek sub-basin, A brief description of these facilities may be found in the Appendix. A light commercial park consisting of warehouses, truck transport terminals and fabrication shops also lies within the confines of the Rabbit Creek-Rattlesnake Bayou basin.

The waterfront along Rabbit Creek east of Rangeline Road and along the navigable extent of Rattlesnake Bayou is extensively developed. All waterfront development along these streams is residential and a significant number of the residences have a bulkheaded shoreline and either a dock or boat slip. The waterfront along Rabbit Creek west of Rangeline Road was undeveloped at the time of the survey and the shoreline was in a more or less natural condition.

The abundance of piers, boathouses and the amount of shoreline alteration observed on Rabbit Creek and Rattlesnake Bayou would appear to represent a loss of some valuable submerged aquatic vegetation and brackish marsh.

The upper reaches of the Rabbit Creek-Rattlesnake Bayou system extend into the rolling terrain of west Mobile. The floral community of this area is the pine-oak association similar to the uplands of the Moore Creek and Halls Mill Creek systems. The pine-oak association gradually makes a transition to a pine savannah-bog community in the lower elevations. This sub-basin contains the largest expanse of pine savannah and tannic bog in the DRW. Near the deeper navigable waters, the savannah gradually changes into a swamp community containing numerous bald cypress and swamp tupelo. Along the undeveloped stream banks are sizable areas of freshwater marsh containing dense stands of sawgrass, bulrush and cattails. Farther downstream, shoreline development has disrupted most of the freshwater marsh except for that found on islands and in scattered patches. Waterfront development also has impacted on the brackish/saline marsh of the Rabbit Creek/Rattlesnake Bayou. Some of the brackish/saline marsh visible in the aerial photographs of the SCS soil survey appeared to have been filled by the time of this survey. Around the mouth of Rabbit Creek at the confluence with Dog River is a significant area of brackish/saline marsh with large dense stands of black needlerush and giant cordgrass. Numerous shrubs (wax myrtle and gallberry), slash pine and bald cypress are intermixed with the marshes.

There was no evidence of culverts or storm drains along either body of water. The neighborhoods of the Rabbit Creek/Rattlesnake Bayou sub-basin, including all waterfront property, are presently outside the service area of the City of Mobile's sewer system.

During the surveys of Rabbit Creek and Rattlesnake Bayou there was no evidence of oil sheens and floating scum. Plastics and other floating trash were present only in minimal amounts, nowhere near the quantities observed in Eslava Creek and upper Dog River. These waters possessed relatively good clarity during the study. The analyses of the samples for turbidity and TSS values in Rabbit Creek and Rattlesnake Bayou were within ranges considered average for coastal waters. Nitrogenous compounds were somewhat enriched relative to "pristine" waters; however this was considerably less than the enrichment observed in the upper reaches of Dog River, Eslava Creek and Moore Creek. The bacterial concentrations in Rabbit Creek and Rattlesnake Bayou were the lowest of all stations visited during the survey and were within the allowable limits for their use classification of fish and wildlife.

CONCLUSIONS AND DISCUSSION

REVIEW OF FINDINGS

The impacts of land use patterns and their related non-point sources on the waters of the DRW are clearly evident from the results of this survey. Although Dog River and its tributaries receive minimal inputs of wastewater effluent from point sources turbidity, the concentrations of nutrients and densities of enteric bacteria were observed to be as severely elevated, if not more, as in area streams which are receiving significant discharges of treated effluent from municipal and/or industrial facilities.

The land-use practices which appear to most significantly affect the basin are locating developments on soils with poor drainage characteristics, draining and filling of wetlands, channelization of streams, streets and parking lots not kept clean of trash and other debris, residences with septic tanks located in low lying areas near streams, poor erosion control practices during construction activities, lawn and golf course maintenance and in general, increasingly large areas of impervious cover forcing greater volumes of storm water runoff into heavily loaded drainage courses. Additionally, there appears to be a source of enteric bacteria (either undiscovered sewer line breaks or sanitary line ties to storm sewers) for the streams draining urbanized areas.

The specific impacts affecting a given tributary of the DRW appear to be highly characteristic of the land use within the individual sub-basin. Such associations of land use and water quality degradation have been observed during similar studies of the impacts of non-point sources on watersheds (National Oceanic and Atmospheric Administration 1989; National Research Council 1990; U.S. Environmental Protection Agency 1991).

The waters of the Eslava Creek sub-basin exhibit impacts related to extensive amounts of impervious cover and urban street debris (trash and litter). The Eslava Creek sub-basin also has experienced significant losses of wetland habitat, primarily due to the draining, filling and developing of Wragg Swamp.

The somewhat urban nature of this sub-basin with a high vehicular traffic activity and many commercial developments tends to result in significant accumulations of trash and debris which find their ways to Eslava Creek through storm water drains. The levels of fecal coliforms detected in this stream indicate the presence of sources of enteric wastes in both older and more recently developed areas. The nutrient enrichment in Eslava Creek is the likely result of runoff from landscaped properties and/or sewer overflows.

Robinson Bayou appears to exhibit impacts related more to enteric wastes than trash from urban runoff (Eslava Creek) and turbidity from erosion (Moore Creek and Halls Mill Creek). Robinson Bayou appears to have suffered only minor losses of wetland habitat relative to Eslava Creek and Halls Mill Creek. The water clarity and nutrient concentrations did not display signs of degradation related to development in the sub-basin. The concentrations of fecal coliforms might be explained by maintenance conducted on sanitary lines during the time of the survey.

Moore Creek displays various forms of water quality degredation and potential imparement to its use classification. The specific impacts are indicative of poor erosion control practices (i.e. turbidity), runoff from lawns and golf courses (i.e. nutrient enrichment) and inputs of enteric bacteria from its upper reaches. A significant amount of swamp and freshwater marsh along the middle to lower reaches appears to have been lost due to channelization and the construction of storm drainage. The waterfront development along the lower reaches has not caused significant losses of wetland habitat. However, the excessive turbidity and siltation observed in Moore Creek might pose a threat to the submerged aquatic vegetation and benthic infaunal communities of the stream.

The major tributary of Moore Creek, Montlimar Creek shows significant signs of impacts from enteric wastes(i.e. fecal coliforms and nutrients) and storm water runoff (i.e. turbidity and nutrients). The enteric bacterial problems and degraded clarity in Montlimar Creek appear to be more severe in the upper reaches than the lower reaches; however, the problem of nutrient enrichment appears to be an impact along the entirety of the stream.

Halls Mill Creek shows the most pronounced impacts from erosion and siltation of all streams within the DRW. Construction of residential subdivisions and roads appear to be the most significant activities affecting water clarity in this sub-basin. This stream displayed the most extensive shoreline alteration and potential loss of wetlands of all sub-basins of the DRW. Turbidity and siltation appear to present a threat to the aquatic vegetation and benthic fauna of this system.

Halls Mill Creek also contained the highest levels of fecal coliforms of all streams monitored in the watershed. Nutrient concentrations though were not particularly elevated compared to the conditions observed in the Eslava Creek and Moore Creek sub-basins in the eastern half of the DRW.

Rabbit Creek and Rattlesnake Bayou displayed the least amount of impact to water quality of all streams of the DRW. This might be the result of the less densely populated communities and the lesser amount of developed property in this portion of the watershed relative to the other sub-basins of the DRW. The lack of street drains, no large areas of impervious cover and a somewhat natural drainage course of Rabbit Creek and Rattlesnake Bayou appear to affect the water quality significantly less than the impacts of the more heavily developed and populated lands on the other sub-basins. The prevalence of excavated slips for water craft, extensive bulkheading and other shoreline alterations though, do indicate a potential for historical loss of marshland, submerged vegetation and other critical habitats along Rabbit Creek and Rattlesnake Bayou.

Although neither Eslava Creek, Montlimar Creek nor Moore Creek has been assigned a specific use classification, all waters of the state not assigned a specific use classification are to be considered as suitable for fish and wildlife unless water quality data indicates otherwise. The State of Alabama Water Quality Criteria specify that during the months of June through September "all waters, where attainable shall be suitable for recreation." In addition, those waters assigned a use classification of fish and wildlife should be acceptable for incidental water contact and recreation during June through September.

The criterion for bacteria of the fecal coliform group in waters classified for fish and wildlife is 200/100ml geometric mean density for June through September and 1000/100ml geometric mean density (2000/100 ml maximum for any single sample) for the rest of the year. The bacteriological data indicates a potential problem in meeting this standard. This is especially pertinent when taken into consideration with the fact that a segment of lower Moore Creek known as Lloyd's Landing is frequently utilized as a "swimming hole" and is located less than one mile downstream from the station sampled on Moore Creek

PLANS FOR THE SECOND YEAR OF THE SURVEY AND FUTURE RESEARCH NEEDS

There still exists a need to thoroughly examine the sediments of the DRW for the effects of urban non-point sources on the sediment chemistry of the basin. These efforts should be directed towards the analyses for metals, (especially those such as arsenic and lead which have been linked to urban runoff), petroleum hydrocarbons and pesticides. Such information would allow for a better quantitative assessment of the impacts to the aquatic biota of the DRW.

There is a general lack of information on the invertebrate communities of the streams of Coastal Alabama. This lack of information exists as data gap in the basic faunal descriptive sense as well as quantitative assessments of environmental impacts. The sediment chemistry also needs to be accompanied by a program for characterizing the benthic infauna of Dog River and its tributaries.

The extent of shoreline modification and waterfront development has led to a significant loss of wetland habitat and submersed aquatic vegetation. Although some of the losses have been examined in previous surveys (Sapp, Cameron and Stout 1976; Stout and LeLong 1981), this survey appeared to indicate a follow-up study might yield useful information on the more recent losses of wetland habitat and submersed vegetation.

The high concentrations of turbidity will be monitored to observe the effectiveness of the NPDES storm water management regulations and erosion control BMPs. Departmental staff also will continue to monitor fecal coliforms in the basin and will work with the Mobile County Health Department and the City of Mobile Water and Sewer Service towards the goal of lessening, and hopefully eliminating, the amounts of enteric wastes entering the waters of the DRW.

The surveys of sediment chemistry and the benthic infauna are within the capabilities of the ADEM coastal staff planned for the spring and summer of 1994. However, the survey of wetlands and submersed aquatic vegetation is beyond the scope of resources available for FY'94 and will have to be addressed in a separate survey.

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APPENDICES

APPENDIX A: NPDES PERMITTED FACILITIES IN THE WATERSHED

APPENDIX B: WATER QUALITY DATA FROM STORM SAMPLING

APPENDIX A

Businesses within the Dog River Watershed operating under the conditions of an NPDES permit

Facility: Cowin Equipment Co., Inc.
Location: 51 S. Schillinger Rd.
Mobile, Al
NPDES Permit No. AL 0041734
Receiving waters: Milkhouse Creek
Nature of wastewater: Stormwater runoff from vehicle parking and equipment maintenance areas. Uncontaminated stormwater from bulk petroleum storage areas.
Monitored parameters: TSS. flow, pH, oil & grease, naphthalene, total phosphorus,
lead, BOD-5 and COD.

Facility: GAF Building Material Corp.
Location: 2400 Emogene St.
Mobile, AL
NPDES Permit No. AL 0003506
Receiving waters: Woodcock Branch
Nature of wastewater: Non-contact cooling water and stormwater runoff from asphalt roofing and organic felt manufacturing facility.
Monitored parameters: Flow, temperature and oil & grease.

Facility: Mobile Paint Manufacturing Co., Inc.
Location: 4775 Hamilton Blvd.
Mobile, AL
NPDES Permit No. AL 0048941
Receiving waters: Rabbit Creek
Nature of wastewater: Drainage from solvent storage area.
Monitored parameters: Flow, pH, TOC, oil & grease, VOCs, xylene and toluene.

Facility: Petroleum Energy Products Co.

Location: US Hwy 90 at Higgins Rd.
Mobile, AL

NPDES Permit No. AL 0042612

Receiving waters: Halls Mill Creek

Nature of wastewater: Stormwater runoff from petroleum storage and handling areas.

Monitored parameters: Flow, pH, oil & grease, benzene, napthalene, BETX and lead.

Facility: Praxxair, Inc.

Location: 4077 Hamilton Blvd.
Mobile, AL

NPDES Permit No. AL 0027715

Receiving waters: Alligator Bayou

Nature of wastewater: Cooling tower blowdown, boiler blowdown, condensate, floor drainage and stormwater runoff.

Monitored parameters: Flow, pH, temperature, oil & grease, TSS, total residual chlorine and copper.

Facility: Quality Bumpers

Location: 5561 Todd Acres Blvd.
Mobile, AL

NPDES Permit No. AL 0050202

Receiving waters: Rattlesnake Bayou

Nature of wastewater: Facility process wastewaters and stormwater runoff from the manufactuing of automobile and truck bumpers.

Monitored parameters: Flow, pH, oil & grease, TSS, aluminum, arsenic, barium, cadmium, total chromium, hexavalent chromium, copper, mercury, silver, lead, zinc, fluorine, cyanide, total nitrogen, TOC, toxic organics and chronic toxicity.

Facility: Taylor-Wharton Cryogenics

Location: 4075 Hamilton Blvd.
Mobile, AL

NPDES Permit No. AL 0026247

Receiving waters: Alligator Bayou

Nature of wastewater: Hydrostatic test waters and stormwater runoff

Monitored parameters: Flow, oil & grease, TSS, total residual chlorine, TOC.

APPENDIX B: SURFACE WATER QUALITY DATA FROM STORM EVENTS

WATER QUALITY DATA
DOG RIVER WATERSHED STUDY
SURVEY OF 31 MARCH & 1 APRIL, 1993

STATION	DATE	AIR TEMP (DEG .C)	WATER TEMP (DEG. C)	pH (S.U.)	D.O. (mg/l)	SPECIFIC COND. (umhos/cm)	TURBIDITY (NTUs)	NITRATE NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)	KJELDAHL NITROGEN (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL SUSPENDED SOLIDS (mg/l)	FECAL COLIFORM (# /100ml)
EC-1	31-Mar	29	24	6.30	7.56	120	26	0.422	0.160	1.14	0.174	16	>2,400
EC-2	31-Mar	29	23	6.52	7.30	83	45	0.162	0.170	1.44	0.139	36	>2,400
RB-1	31-Mar	29	21	6.37	5.62	162	14	0.031	0.009	0.77	0.050	11	>2,400
MC-1	31-Mar	28	22	6.40	6.95	63	117	0.281	0.130	1.03	0.128	70	>2,400
MC-2	31-Mar	28	23	6.48	8.29	456	21	0.059	0.050	1.05	0.081	20	2,720
HMC-1	1-Apr	23	20	6.26	6.73	143	88	0.091	0.150	0.66	0.077	34	2,800
HMC-2	1-Apr	25	19	6.30	8.00	50	28	0.133	0.030	0.54	0.023	24	960
RC-1	1-Apr	25	21	6.31	6.15	79	22	0.092	0.100	0.55	0.043	10	960
RC-2	1-Apr	24	21	6.58	7.41	428	24	0.121	0.060	0.51	0.046	17	360
RSB	1-Apr	24	22	6.43	6.54	231	17	0.148	0.090	0.91	0.052	11	400

WATER QUALITY DATA
DOG RIVER WATERSHED STUDY
SURVEY OF 13 & 15 JULY, 1993

STATION	DATE	AIR TEMP (DEG .C)	WATER TEMP (DEG. C)	pH (S.U.)	D.O. (mg/l)	SPECIFIC COND. (umhos/cm)	TURBIDITY (NTUs)	NITRATE NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)	KJELDAHL NITROGEN (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL SUSPENDED SOLIDS (mg/l)	FECAL COLIFORM (# /100ml)
ECSA	13-Jul	31	27	7.39	6.91	90	35	0.244	0.060	0.50	0.095	29	>6,000
ECPH	13-Jul	29	26	7.12	7.01	100	44	0.319	0.220	0.15	0.294	35	>6,000
MCHM	13-Jul	31	27	7.19	7.54	62	65	0.277	0.150	0.90	0.112	55	>6,000
MCPV	13-Jul	31	27	7.10	7.14	44	48	0.294	0.080	0.30	0.084	42	>6,000
BBN	15-Jul	33	27	6.88	4.06	122	8	0.018	0.009	1.64	0.029	5	2,000
BBHM	15-Jul	33	INSUFFICENT DEPTH FOR MEASUREMENT				55	0.043	0.020	2.86	0.070	31	10,000
ECPH	15-Jul	34	30	6.85	9.41	134	8	0.108	0.009	2.36	0.044	15	1,530
MCA	15-Jul	33	29	6.83	6.69	63	12	0.322	0.080	0.95	0.022	5	930
MCHM	15-Jul	33	28	6.93	6.98	63	18	0.314	0.070	0.12	0.005	9	6,600
HMD	15-Jul	33	24	6.46	7.02	48	36	0.159	0.010	0.13	0.033	29	10,600
HMHM	15-Jul	33	24	6.50	7.01	49	74	0.162	0.060	0.19	0.054	58	13,000

WATER QUALITY DATA
DOG RIVER WATERSHED STUDY
SURVEY OF 21 & 23 OCTOBER, 1993

STATION	DATE	AIR TEMP (DEG .C)	WATER TEMP (DEG. C)	pH (S.U.)	D.O. (mg/l)	SPECIFIC COND. (umhos/cm)	TURBIDITY (NTUs)	NITRATE NITROGEN (mg/l)	AMMONIA NITROGEN (mg/l)	KJELDAHL NITROGEN (mg/l)	TOTAL PHOSPHATE (mg/l)	TOTAL SUSPENDED SOLIDS (mg/l)	FECAL COLIFORM (#/100ml)
MCPV	21-Oct	26	26	7.00	4.79	91	16	0.125	0.129	0.64	0.064	5	5,100
MCA	21-Oct	26	26	7.10	6.71	86	6	0.182	0.173	0.66	0.031	1	113
HMD	21-Oct	27	23	*NO DATA*	6.95	52	22	0.047	0.053	0.31	0.030	11	2,620
ECSA	21-Oct	27	26	7.00	4.73	138	18	0.052	0.190	0.66	0.073	3	1,800
ECPH	21-Oct	27	25	6.60	5.99	138	7	0.081	0.120	0.44	0.050	4	2,200
ECMV	22-Oct	16	23	6.37	0.97	9,100	9	0.047	0.177	0.78	0.109	6	>6,000
BBMV	22-Oct	18	*INSUFFICENT DEPTH FOR MEASUREMENT*				5	0.005	0.024	0.46	0.050	7	2,700
BBT-1	22-Oct	18	20	6.28	9.70	71	2	0.005	0.030	0.32	0.012	1	1,140
BBN	22-Oct	18	21	6.46	0.10	3,030	9	0.005	0.083	0.50	0.059	6	7,700
MCLL	22-Oct	*NO DATA DUE TO RAINSTORM*					11	0.488	0.332	0.73	0.037	10	3,350