# GEORGIA DEPARTMENT OF COMMUNITY AFFAIRS

# OCMULGEE RIVER WATERSHED MANAGEMENT PLAN

13 MARCH 2003

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Infrastructure, buildings, environment, communications

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# Ocmulgee River Watershed Management Plan

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# 1. Introduction

## 1.1 Purpose and Organization of the Plan

The Ocmulgee River Watershed Management Plan was developed to assist local and state agencies with comprehensive watershed planning efforts associated with specific study areas in the Ocmulgee River Basin. The primary objectives of the plan are to establish priorities for watershed protection measures and provide recommendations for water quality control and riparian and wetland restoration, protection, and enhancement. The information contained in the plan will provide a starting point for local interested parties in establishing specific watershed management strategies for the Ocmulgee River watershed study area.

The plan is organized into four primary sections. Section 1 provides a summary of the U.S. Environmental Protection Agency's (USEPA's) grant for the project as well as the public education/stakeholder involvement effort being implemented by the Georgia Department of Community Affairs (DCA). Section 2 provides an overall description of the watershed including physical characteristics and water quality. Section 3 details the evaluation of the watershed performed as part of the plan development. This discussion includes the water quality analyses, watershed health spatial model, soil loss assessment, and wetlands assessment. Section 4 describes recommended management measures that relate to water quality control and wetland/riparian restoration, protection, and enhancement. The organization of the plan provides a broad guideline intended to assist in the development of watershed protection strategies.

The project database and associated modeling tools will be housed and maintained at the Atlanta DCA offices for the purpose of providing planning information and technical assistance to other state agencies, the Regional Development Centers, local governments, and other parties involved with wetlands protection, watershed management, coordinated planning, and related activities in the project study area. Development and refinement of the database and tools will continue as needed, particularly if additional funding is made available to address specific project requests.

## 1.2 Summary of USEPA State Wetlands Protection Development Grant

The Ocmulgee River Watershed Management Plan Project was funded in part by a USEPA State Wetlands Protection Development Grant made available to DCA under Cooperative Agreement No. CD984515-98. The initial grant period began in June 1998 and was scheduled to end June 30, 2000. The grant received three time extensions: the first to March 31, 2002, the second to December 31, 2002, and the third to March 31, 2003. Several consulting firms were employed during the course of the project. Geonex, Inc., was contracted for the National Wetlands Inventory (NWI) digital mapping work. At the time the study began there were 44 NWI maps not yet in digital form. Geonex digitized these maps for the study area according to the National Wetlands Inventory program/contract guidelines. These digital maps were then added to the national database and are available at http://www.nwi.fws.gov. ARCADIS was contracted for assembly of the geographic information system (GIS) and water quality database, subsequent modeling work, and preparation of the Ocmulgee River Watershed Management Plan document.

The USEPA grant application was submitted by DCA at the suggestion of the Trust for Public Land (TPL), and continues earlier efforts to restore the vitality of the Ocmulgee River Basin, including Georgia's River Care 2000 program. Enhancement of the river corridor was also defined as a major objective of the Ocmulgee Heritage Greenway plan, and improvement of the watershed is a continuing objective of the Georgia Department of Natural Resources and DCA. The development of this particular watershed management plan represents an important step toward the protection and restoration of the river corridor, its wetlands, and aquatic resources. The resource protection goals continue the momentum already created within the Ocmulgee River corridor, including 1) TPL's acquisition of more than 2,000 acres of land upstream of Macon for the Oconee National Forest, 2) TPL's collection of approximately $4 million in land acquisition funds from multiple local, state, and federal partners, 3) a land acquisition strategy that will create and expand existing public land along the river from the Oconee National Forest south beyond Robins Air Force Base, 4) an extensive public outreach program facilitated by TPL, and 5) the development of a master plan for the Ocmulgee Heritage Greenway.

This project could also assist the Georgia Environmental Protection Division's (EPD's) River Basin Management Planning process for the Ocmulgee River Basin (to be developed in 2003) by providing water quality and GIS data and recommendations for river corridor protection and restoration in the central one-third of the basin. The project area includes the river corridor and major sub-basins from above Jackson Lake in Henry and Newton counties to below Robins Air Force Base, touching Dooly, Pulaski and Bleckley counties (see Section 2). The project area includes urban (residential and industrial) and rural sections, as well as areas managed by local, state, and federal resource protection agencies.

Major objectives of the watershed management plan are to define priorities for future land protection measures and make recommendations for riparian restoration and wetland enhancement. The grant objectives were met through a work scope that included data collection (including records search and field assessments), agency/partner input, GIS data assimilation and analysis, public outreach, and report preparation and management recommendations. In-kind match came from DCA and participating partners including the City of Macon Engineering Department, Bibb County Engineering Department, and the Macon Water Authority.

### 1.2.1 Objectives of the Grant

The watershed management plan provides a course of action to accomplish the following:

- Define priorities for future land acquisitions,
- Restore the riparian corridor,
- Enhance wetlands adjacent to the river and its tributaries,
- Improve and protect water quality,
- Facilitate the coordination of public, private, and nonprofit entities involved with river management, and
- Engage local stakeholders in a unified conservation ethic with respect to the river and the watershed management plan.

## 1.3 Stakeholder Involvement

Leading up to the project, DCA partnered with the EPA Office of Water and hosted a water quality monitoring training workshop on November 15 –19, 1999. A total of 50 students attended, including planners and GIS personnel from all 16 of Georgia's Regional Development Centers, as well as scientists from the Georgia Department of Natural Resources – Environmental Protection Division. In 2000, a second full workshop was held in Atlanta to accommodate the demand for training.

The first Stakeholders/Match Partners meeting for the project was held at the Middle Georgia Regional Development Center (RDC) in Macon, Georgia, on March 22, 2001.

The meeting was attended by four of the five original match partners (only Community Foundation of Central Georgia did not attend), EPD, EPA Region 4, three RDCs, and some local government representatives. DCA, ARCADIS, and Wetland and Ecological Consultants (WEC) (the wetland subcontractor for ARCADIS) gave PowerPoint presentations on the project, and questionnaires were distributed to the attendees to determine interest and possible data contributions to the project. ARCADIS followed up on this information with letters to interested parties regarding data submissions for the project.

On June 12, 2001, DCA and ARCADIS held the first of a series of stakeholder and public information meetings for the Ocmulgee project, at the Music Hall of Fame in Macon, Georgia, from 9:30 a.m. to 12:30 p.m. The meeting was widely advertised by DCA with newspaper and radio station coverage, and was well attended by about 40 interested stakeholders. Presentations by DCA, ARCADIS, and WEC initiated the discussion portion of the meeting. DCA also set up a display booth and maps of the project area. Stakeholders provided comments on areas of particular concern in the watershed, as well as many suggestions for additional data sources.

In June 2001, DCA began posting information of the Ocmulgee River project on the DCA website at http://www.dca.state.ga.us, under its Environmental heading. Initial postings included DCA and ARCADIS PowerPoint presentations, a fact sheet, comment forms, and a map of the study area. The final report and other project information will be published at http://wwww.GeorgiaPlanning.com.

On August 1, 2001, DCA held the first educational drop-in meeting at the Jackson-Butts County Library in Jackson, Georgia. The meeting was held from 2:00 p.m. to 7:30 p.m., to allow people to attend after regular working hours. The purpose of the meeting was to educate the general public and local governments about the project, answer questions, and receive comments. In addition, the meeting was designed to provide general education on water quality issues through ongoing PowerPoint and videotape presentations and the distribution of free brochures, total maximum daily load (TMDL) videotapes, and copies of DCA's *ArcExplorer Watersheds of Georgia* CDs and *PowerPoint Tools to Educate the Public* CDs. Everyone on the Ocmulgee project contact list was also invited to set up educational displays. Displays were set up by the Georgia Stream Buffer Initiative, Georgia Forestry Commission, Alcovy River Watershed Team (through the DCA Office of Coordinated Planning), and Lamar County Livestock and Agricultural Exposition Authority, which set up and demonstrated DCA's Wetlands Enviroscape model. The meeting was attended by about 35 people, and a number of interested individuals spent several hours discussing water quality issues with the project team.

On October 30, 2001, DCA attended the Ocmulgee River Environmental Forum in Macon, Georgia, sponsored by the Ocmulgee River Initiative, Inc., and met with a number of existing partners in our project and discussed the project with citizens and other parties. DCA also discussed the availability of additional water quality data for the project with Dr. Brian Rood of Mercer University and Brian Wyzalek of the Macon Water Authority. About 40 copies of the Watershed and PowerPoint CDs were distributed.

On December 10, 2001, DCA held the third public drop-in meeting for the project at the Perry Public Library in Perry, Georgia. Since previous public meetings had been held in the upper portion of the watershed study area (Jackson-Butts County) and the middle portion (Macon), this meeting was held in the lower portion of the study area to provide information to these area residents. The weather was stormy this day and the meeting was lightly attended, but did provide some good dialogue with interested parties. The PowerPoint CDs, as well as the new *Water Resources Toolkits for Local Governments* CDs, were distributed. Examples of meeting notices, press releases, and a summary of the initial stakeholder comments are included in Appendix A.

Beginning in August 2001, DCA contracted with Rawson Clipping Service, 175 Gwinnett Drive, Lawrenceville, Georgia 30045, to collect newspaper clippings from statewide sources that may contain information of interest to the Ocmulgee project. The key words "Ocmulgee River or Basin, Ocmulgee Watershed, and Altamaha River or Basin" were applied for this effort. These clippings were sent to DCA at least monthly (and sometimes weekly) to be scanned by the project staff for relevant watershed information and to document DCA and other public outreach activities related to the project.

### 1.3.1 Involvement in Macon Blueprints and Ocmulgee Heritage Greenway Program

The Georgia Conservancy's Macon Blueprints project is a vision planning process that will help determine the suitability and feasibility of pursuing a National Heritage Area designation for the river corridor in the Macon area through a partnership with the Ocmulgee Heritage Greenway Program. This project also offered an opportunity to expand the contacts and public outreach opportunities for the Ocmulgee River Watershed Management Plan project. DCA was invited to participate on the Macon Blueprints Steering Committee and attended the initial start-up meeting on March 14,

2001. DCA then assisted with the project by providing water quality and GIS mapping information to Randall Roark and his students at the Georgia Institute of Technology (GT), who were assisting with the project.

On April 4, 2002, DCA attended the second meeting of the Macon "Blueprints for Successful Communities" Steering Committee. New Town Macon and the Georgia Conservancy led a discussion of the assets and challenges in the proposed National Heritage Area, including current activities, priorities, and time frames for action. The GT students working on a Macon Community Design Workshop project presented Volume 2 of a Briefing Book, addressing issues and Comprehensive Development Plan items. This book discusses land use, historic preservation, neighborhoods, economic development, open space, recreation, and environmental and transportation issues. Water quality and GIS information collected for the Ocmulgee River Watershed Management Plan project was used in development of the book.

On June 10, 2002, DCA participated in the third Macon Blueprints Steering Committee meeting and led a discussion of water quality issues in the Macon area, using information derived from the Ocmulgee Watershed Management Plan. The discussion also encompassed aesthetic considerations in the Ocmulgee River Heritage Greenway area, some of which could be addressed through the activities of the Keep Macon-Bibb Beautiful, Rivers Alive, and other programs with DCA involvement. The steering committee decided to create four subcommittees, including the environmental education subcommittee, to examine various aspects of the project in more detail.

On August 1, 2002, DCA participated in an environmental education subcommittee meeting. During the meeting, members discussed how environmental education, and in particular, water-related education, could be integrated into the Ocmulgee Heritage Greenway project and other area programs. Members sought to list all existing environmental education activities, groups, and facilities that were known to them in the area, and discussed a variety of possibilities to expand environmental education.

### 1.3.2 Distribution of Education Tools to the Public

As part of DCA's efforts to provide local governments and citizens in the Ocmulgee study area and throughout Georgia with resources to address water management issues, DCA developed three useful products on CD: *PowerPoint Tools to Educate the Public*, *ArcExplorer Watershed of Georgia*, and a *Water Resources Toolkit for Local Governments.*

DCA's *PowerPoint Tools to Educate the Public* contains a public education PowerPoint presentation called "Water: Our Planet's Most Precious Resource," with information on the hydrologic cycle, how we use our water, the impact of land use and impervious surfaces on water quality, and how individual actions can reduce nonpoint source pollution. There is also a prepared script for this presentation. The CD also contains other presentations on local government water management issues, TMDLs, and nonpoint source pollution control and water conservation, with an Excel spreadsheet showing the water and cost savings of various water conservation tools for local governments. Several thousand of these CDs have been distributed statewide.

The *ArcExplorer Watersheds of Georgia* is a two-volume CD set that uses free ArcExplorer GIS viewing software to provide interactive maps of Georgia's 52 large watersheds. These maps show the cities, counties, rivers, streams, lakes, and other water bodies within each watershed boundary, as well as the locations of 305(b)/303(d) impaired waters, water intakes and wastewater discharges, landfills, recycling centers, schools and colleges, Keep Georgia Beautiful programs, urbanized areas, and various other features. Users can easily learn how to view areas of interest, zoom in and out, measure distances, query the database for certain information, print maps, and perform other basic GIS tasks. The CD is designed to provide citizens, watershed groups, local government staff, and school and environmental educators with an introduction to GIS technology, as well as specific watershed information for their area. The CDs have been updated periodically to include more current information such as Georgia Hazardous Site Index locations, Census 2000 Urbanized Areas, and the most recent locations of Georgia's 305(b)/303(d) impaired waters.

The *Water Resources Toolkit for Local Governments* CD was prepared by DCA in partnership with the Georgia Water Management Campaign, Association County Commissioners of Georgia, Georgia Municipal Association, and Water Systems Council. This CD contains a wealth of water management information for local government officials and staff, including guidance on drinking water supply and water conservation, wastewater, stormwater, watershed planning and protection, wetlands, funding sources, public education, best management practices, and much more. It also contains two videos prepared by the Georgia Water Management Campaign on nonpoint source pollution and TMDLs, and a variety of PowerPoint presentations useful for public outreach.

The latter two CDs have also been packaged into a small bound booklet titled *Tools for Protecting Georgia's Water Resources*. DCA did an initial printing of 5,000 of the Watershed and Toolkit CDs and distributed them through various methods, including a series of water resource education workshops sponsored by the 16 Georgia RDCs. The CDs have been distributed at public meetings for the Ocmulgee watershed project, and the *Tools for Protecting Georgia's Water Resources* booklets were mailed out statewide (including the Ocmulgee study area) to county commissioners by the Association of County Commissioners of Georgia (ACCG) and to mayors and city councilpersons for cities with more than 3,500 persons by the Georgia Municipal Association (GMA).

These CDs have been widely praised by users at all levels, and DCA considers them to be valuable tools for educating local governments and citizens about a wide variety of water issues. Some Ocmulgee project funds were used to help cover costs of printing CDs distributed directly to city and county officials in the 18 counties in the Ocmulgee study area, as well as those given out at public meetings and workshops for the Ocmulgee project itself.

DCA will continue to make water resources management and watershed protection information available through the distribution of written information and CDs, and also by posting such information on its web sites, including www.dca.state.ga.us and www.georgiaplanning.com. Information specific to the Ocmulgee River Watershed project is posted on the latter site under Water Resources.

### 1.3.3 Presentation of the Ocmulgee River Draft Watershed Management Plan to Stakeholders and the Public

DCA presented some initial information on the Draft Plan at the Georgia Water Stewardship Conference at the University of Georgia on September 6, 2002. Joe Krewer and Terry Jackson of DCA made a combined presentation to water resource students and professionals on the history of the project and details of the data collection, analysis, and modeling effort.

On November 22, 2002, the DCA and ARCADIS project team conducted a partner/stakeholder meeting at the Middle Georgia Regional Development Center in Macon. The meeting was designed to provide attendees with a hard copy of the November 15, 2002 draft of the Ocmulgee River Watershed Management Plan, and to present and discuss the Draft Plan. Approximately 130 people on the Ocmulgee stakeholders' contact list were notified of the meeting by email, fax or regular mail on or about November 12. The Draft Plan information was also posted on November 15 to the Georgia Planning web site at www.georgiaplanning.com, along with comment forms and other information, so that stakeholders could look at it before the meeting or if they could not attend.

Joe Krewer and Terry Jackson from DCA and Dan Harris from ARCADIS represented the project team, and approximately 22 local government, RDC, state agency, and EPA personnel attended the meeting. DCA and ARCADIS project team members gave presentations providing an overview of the Plan, GIS database and modeling, and project recommendations, and a discussion of how the database and modeling tools will be housed and used at DCA to provide information for more detailed studies in the future. Attendees were provided with written comment forms and asked to provide feedback by December 6, 2002.

DCA noted that the final Plan would include an additional Resources section as an appendix or separate document to provide information on how to address some of the actual recommendations. DCA also noted that a number of useful items are already on the *Water Resources Toolkit for Local Governments* CD, which was provided in the copy of the Draft Plan notebook given to each attendee, along with the *Watersheds of Georgia* CDs.  DCA also announced tentative plans to hold a public education event addressing the final Plan, water quality, wetlands protection, and land conservation in the project area in December 2002 (later revised to early 2003).

The final Plan document will be distributed to the public and local governments upon completion, and the project database and modeling tools will be housed at DCA for continuing use in local and regional planning activities.

## 2. River Basin Characteristics

The Ocmulgee River Basin is located in the middle of the state of Georgia. It begins southeast of the Atlanta metropolitan area and is formed by the confluence of the Yellow River, South River, and Alcovy River at Jackson Lake. The main stem extends approximately 255 river miles and flows southeast past the city of Macon to join the Oconee River. Together, the Oconee River and the Ocmulgee River form the Altamaha River near Lumber City. The confluence of these two rivers into the Altamaha comprises the largest river system entirely contained within the state of Georgia. This system has an average annual flow of 12,000 cubic feet per second (cfs) discharging to the Atlantic Ocean.

The Ocmulgee River Basin is one of 14 major river basins defined in the state of Georgia. The basin encompasses all or portions of 34 counties, with a drainage area of approximately 6,071 square miles. The geological fall line located near Macon separates the upper Ocmulgee Basin, situated in the Piedmont Physiographic Region, from the lower Ocmulgee Basin located in the upper Coastal Plain. The upper Ocmulgee Basin has more than 2,590 perennial river and stream miles while the lower Ocmulgee Basin has almost 1,150 perennial stream miles.

### 2.1 River Basin Description

The project area for this study consists of the middle one-third of the Ocmulgee Basin (hereinafter referred to as the Ocmulgee River watershed), as shown on Figure 2-1. This area includes approximately 2,420 square miles, extending from above Jackson Lake in Newton and Henry counties to below Robins Air Force Base, touching Pulaski, Dooly, and Bleckley counties. Approximately 55 percent of this area is in the Piedmont Physiographic Region, and 45 percent is in the Coastal Plain. Areas of special interest include the large floodplains that have developed below the fall line as the river encounters the soft sediments of the upper Coastal Plain. These forested wetland areas make up more than 8 percent of the Ocmulgee River watershed, or almost 194 square miles, and are especially significant to aquatic and wetland-dependent wildlife. Water quality within the Ocmulgee River watershed is generally good, although there are a number of streams and lakes listed as not meeting their designated uses, as discussed in Section 2.1.5. The river has a moderate current with a gradient of approximately 1 foot per mile.

### 2.1.1 River Basin Boundary Limits

The Ocmulgee River watershed study area comprises approximately 2,420 square miles spanning 18 counties from Newton and Henry counties at the northern limits to Pulaski, Dooly, and Bleckley counties at the southern limits (see Figure 2-1). The watershed drains all or portions of these counties, and numerous cities are also drained by this portion of the Ocmulgee River. Table 2-1 lists the counties and larger cities that drain to this reach of the river.

Figure 2-1

**Table 2-1. Ocmulgee River Boundary Limits**

| County | City |
|---|---|
| Newton | Mansfield |
| Henry | Hampton |
| | Locust Grove |
| Spalding | Sunny Side |
| | Griffin |
| | Orchard Hill |
| Butts | Jenkinsburg |
| | Jackson |
| | Flovilla |
| Jasper | N/A |
| Lamar | Milner |
| | Barnesville |
| Monroe | Forsyth |
| | Culloden |
| Jones | Gray |
| Upson | Yatesville |
| Crawford | N/A |
| Bibb | Payne City |
| | Macon |
| Peach | Byron |
| | Fort Valley |
| Houston | Centerville |
| | Warner Robins |
| | Perry |
| Twiggs | N/A |
| Macon | Marshallville |
| Dooly | Unadilla |
| Pulaski | N/A |
| Bleckley | N/A |

N/A – No large cities within the county are draining to this section of the Ocmulgee River.

Upson, Macon, Dooly, Pulaski, and Bleckley counties contain relatively small portions of the watershed. The cities of Macon and Warner Robins represent the two largest municipal areas within the watershed. In addition, Robins Air Force Base—considered the largest industrial complex in Georgia—is located adjacent to Warner Robins.

### 2.1.2 Soils

The Ocmulgee River watershed is divided into two major land resource areas (formerly known as soil provinces) including the Southern Piedmont and the Southern Coastal Plain areas. The soils underlying the river basin are significant to the overall physical characteristics of the river basin. They are essential elements that determine land use, surface water and groundwater resources, and vegetation.

#### 2.1.2.1 Southern Piedmont

The Southern Piedmont extends into many of the southeastern states including Alabama, Georgia, North Carolina, South Carolina, and Virginia with a total area of approximately 62,330 square miles.

This land resource area is usually found at elevations ranging from 100 meters (328 feet) to 400 meters (1,312 feet). The topography is primarily narrow to relatively broad upland ridge tops, short sloping terrain adjacent to major streams, and narrow valley floors that make up 10 percent or less of the land area.

The Southern Piedmont is dominated by the Udults soils. The Udults are characterized by having a clayey or loamy subsoil, a thermic temperature regime, a udic moisture regime, and kaolinitic, mixed, or oxidic mineralogy. Several soils and soil series comprise the Southern Piedmont (see Table 2-2).

**Table 2-2. Southern Piedmont Soils**

| Soil | Soil Series | Description/Comments |
|---|---|---|
| Hapludults | Cecil, Madison, Appling | Well drained, very gently sloping to gently sloping. |
| | | Well drained, steeper slopes. |
| Paleudults | Davidson | Well drained, very gently sloping to gently sloping. |
| Rhodudults | | Well drained, steeper slopes. |
| Dystrochrepts | | Well drained, steeper slopes. |
| | Chewalca | Alluvial deposits |
| Hapludalfs | Pacolet, Cecil, Gwinnett, Louisa, Louisburg, Wilkes | Well drained, steeper slopes. |
| Udifluvents | Congaree, Cartecay | Alluvial deposits |
| Fluvaquents | Wehadkee | Alluvial deposits |

#### 2.1.2.2 Southern Coastal Plain

The Southern Coastal Plain extends into several states including Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia with a total area of approximately 110,060 square miles, making it the largest of the three land resource areas.

This land resource area is usually found at elevations ranging from 25 meters (82 feet) to 200 meters (656 feet). Elevations tend to increase from the lower Coastal Plain northward. The topography may be characterized as nearly level and gently undulating valleys and gently sloping to steep uplands. Stream valleys tend to be narrow in the upper areas and become broad as they near the coastal areas.

The Southern Coastal Plain is dominated by the Udults soils, which is the same as the Southern Piedmont. Several soils and soil series comprise the Southern Coastal Plain (see Table 2-3).

**Table 2-3. Southern Coastal Plain Soils**

| Soil | Soil Series | Description/Comments |
|---|---|---|
| Paleudults | Bama, Bowie, Dothan, Malbis, Norfolk, Orangeburg, Red Bay, Ruston | Well drained and moderately well drained, nearly level to strongly sloping, upland areas. |
| | Clarendon, Goldsboro | Moderately well drained and somewhat poorly drained, less sloping. |
| | Angie, Faceville, Greenville, Marlboro, Shubuta | Well drained to moderately well drained, clayey. |
| | Darco, Fuquay, Lucy, Troup, Wagram | Well drained, nearly level to steep, upland areas. |
| Hapludults | Cahaba, Cuthbert, Kirvin, Luberne, Saffell, and Sweatman in the south, and Suffolk, Emporia, Rumford, Kenansville, and Craven in the north | Well drained, gently sloping to steep, upland areas. |
| Fragiudults | Ora, Bourne, Pheba, Savannah | Moderately well drained and somewhat poorly drained, less sloping. |
| | Dulac, Providence | Moderately well drained and somewhat poorly drained, less sloping. |
| Quartzipsamments | Alaga, Kershaw, Lakeland | Nearly level to moderately steep, upland areas (mostly in the south). |
| Paleudalfs | Atwood, Boswell, Millwood, Susquehanna | Nearly level to moderately steep, upland areas (mostly in the southwest). |
| | Lexington | Loess-capped hilltops in the north-central areas. |
| Glossaqualfs | Aldine, Caddo, Guyton, Mollville, Waller, Wrightsville | Nearly level to moderately steep, upland areas (mostly in the southwest). |
| Ochraquults | Amy, Myatt, Rembert, Weston | Nearly level on low wetlands. |
| Albaquults | Cantey, Leaf | Nearly level on low wetlands. |
| Paleaquults | Byars, Coxville, Pantego, Plummer | Nearly level on low wetlands. |
| Udifluvents | Colling, Iuka, Ochlockonee | Bottomlands. |

| Soil | Soil Series | Description/Comments |
|---|---|---|
| Fluvaquents | Bibb, Falaya, Mantachie, Waverly | Bottomlands. |
| Dystrochrepts | Chenneby, Ouchita | Bottomlands. |

### 2.1.3 Surface Water Characterization

The Ocmulgee River within the study area extends from Jackson Dam to Bleckley County and drains 2,420 square miles. Many tributaries are located along this portion of the river system including all or portions of Big Creek, Echeconnee Creek, Indian Creek, Rocky Creek, Tobesofkee Creek, and Yellow Water Creek. These tributaries and many others combine to form the Ocmulgee River. At the confluence of the Ocmulgee River and Oconee River, the Altamaha River is formed, which discharges to the Atlantic Ocean.

The overall characteristics of the Ocmulgee River are very dependent on the land resource area. The city of Macon sits along the fall line that separates the Piedmont and Coastal Plain. The section of the river above Macon in the Piedmont tends to have shoals and islands with a rocky bottom, narrow floodplain with steep hillsides, low wooded banks along straight river stretches, high wooded bluffs along meanders, and bedrock dominating the river bottom. After the river flows past Macon, the river characteristics change. The bottom becomes sandier in slower waters, banks tend to be high and steep comprised of grasses and shrubs, and the river tends to have a wide floodplain.

#### 2.1.3.1 Precipitation

Precipitation is a major influence on the flow of the Ocmulgee River and its tributaries. Rainfall varies throughout the system, but generally ranges from 3.4 inches to 5.0 inches in the Southern Coastal Plain. Each land resource area is associated with a different climate and produces varying rainfall (see Table 2-4).

**Table 2-4. Precipitation Within Varying Land Resource Areas**

| Land Resource Area | Precipitation (inches) | Average Temperature (°F) | Comment |
|---|---|---|---|
| Southern Piedmont | 3.8 – 4.6 | 57.2 – 64.4 | Precipitation is evenly distributed throughout the year with lowest being in the fall. Snowfall is minimal. |
| Southern Coastal Plain | 3.4 – 5.0 | 60.8 – 68.0 | Minimal precipitation is seen during the fall throughout. Maximum rainfall occurs in midsummer in the east and in winter and spring in the west. |

#### 2.1.3.2 Hydrology

The northern approximate three-fourths of the Ocmulgee River watershed encompasses much of the drainage area designated by the U.S. Geologic Survey (USGS) as Hydrologic Unit Code (HUC) 03070103. The balance of the study area is made up of portions of HUC 03070104. Sixty subareas (12-digit HUCs) were selected to provide an optimal representation of hydrology in the middle Ocmulgee River basin.

Two active USGS gages are located within the study area. One is located near Macon (USGS 02213000) and the other is located near Jackson (USGS 02210500). River flows are measured at both and are summarized in Table 2-5.

**Table 2-5. Ocmulgee River Flow Summary**

| Gage | Flow (cfs) | | |
|---|---|---|---|
| | Minimum | Mean | Maximum |
| USGS 02213000 | 280 | 1,193 | 7,500 |
| USGS 02210500 | 305 | 893 | 8,700 |

### 2.1.4 Vegetation

Vegetation varies slightly along the river depending on the land resource area. The Piedmont area typically consists of hardwood, white oak, red oak, yellow poplar, sycamore, and pine forests of loblolly pine and slash pine. Dogwoods, honeysuckle, pinehill bluestem, briars, and other grasses and forbs dominate the understory. The Coastal Plain is similar to the Piedmont, comprised predominantly of mixed oak-pine forests including loblolly, longleaf, slash, and shortleaf pines; sweetgum; yellow poplar; and red and white oaks. Dogwood, gallberry, and farkleberry dominate the understory along with common sweetleaf, American holly, greenbrier, southern bayberry, little bluestem, Elliot bluestem, and native lespedezas. Much of the vegetation along the river in the swampy areas is dominated by bald cypress, black tupelo, and other hydrophytic trees.

### 2.1.5 Water Quality

A number of stream segments within the watershed are included in the Georgia Section 303(d) List of impaired waters by EPA under the Clean Water Act. As shown on Figure 2-2, the majority of stream segments within the watershed are either listed as fully supporting their designated use or have not been monitored at all. Approximately 388 miles of streams are listed as partially supporting or not supporting their designated use. This total does not include Jackson Lake or High Falls Lake, which are also listed as not supporting. As summarized in Table 2-6, the majority of these segments have been identified with biota deficiencies; a few of these also include violations of fecal coliform bacteria, pH, dissolved oxygen, and toxicity levels. Both Jackson Lake and High Falls Lake are listed for fish consumption guidance due to PCBs. Jackson Lake is also listed for fecal coliform violations. Appendix C includes the Georgia EPD 305(b)/303(d) listings of impaired waters for the entire Ocmulgee Basin, from both the 20002001 and 2002 data releases.

Only a relatively small portion of the drainage area into Jackson Lake is included within the study area. The proposed Tussahaw Reservoir would be located on Tussahaw Creek, upstream of Jackson Lake. Much of the Jackson Lake drainage area, both within and upstream of the study area, is undergoing increasing development pressures. This has resulted in a corresponding increase in water quality impacts to the lake, which has been discussed in earlier studies by others.

Table 2-7 lists the most current TMDLs finalized for the Ocmulgee study area at this writing. TMDLs are developed by the Georgia EPD or EPA on a set schedule for certain waters found on Georgia’s 303(d) list of impaired waters. Although some TMDLs were issued for the study area earlier, the last round of TMDLs for the Ocmulgee, Oconee, and Altamaha basins was issued in 2001. Once a TMDL has been developed and finalized, a TMDL implementation plan must be developed and implemented. To date, most implementation plans have been prepared by Georgia’s 16 RDCs. Most of the Ocmulgee study area is included in the Middle Georgia RDC area, with smaller portions within the Atlanta Regional Commission (Henry County), Northeast Georgia RDC area (in Jasper and Newton counties), McInstosh Trial RDC area (in Butts, Spalding, Lamar, and Upson counties), and Heart of Georgia RDC (Bleckley County). The individual RDCs should be contacted for information on the development and implementation of TMDL implementation plans in their areas, which may be on various schedules and include a wide variety of activities and stakeholders to address the pollutants of concern for each TMDL.

Figure 2-2

Table 2-6

Table 2-7

## 2.2 Population and Land Use/Land Coverage

### 2.2.1 Population

Based on 2000 census data, the range of population densities throughout the Ocmulgee River watershed is somewhat diverse, as shown on Figure 2-3 (U.S. Census Bureau Summary File-1, 2000). The highest densities are located within a corridor that includes Macon and Warner Robins in the central portion of the watershed, and in the northwestern areas that can be associated with the Atlanta metropolitan area fringe. A higher population density is also found to the west of Jackson Lake, primarily associated with increased residential development in that area. The balance of the watershed contains primarily rural and undeveloped population densities. A summary of densities by subarea is provided in Table 2-8.

**Table 2-8. Population Density by HUC**

| Subarea ID | Population | Pop. Density, persons/ac | Subarea ID | Population | Pop. Density, persons/ac |
|---|---|---|---|---|---|
| 30701030305 | 12,968 | 0.43 | 30701031403 | 1,048 | 0.07 |
| 30701030803 | 3,939 | 0.18 | 30701031404 | 1,510 | 0.06 |
| 30701030804 | 3,705 | 0.30 | 30701031405 | 8,852 | 0.41 |
| 30701030902 | 8,896 | 0.40 | 30701031406 | 87,509 | 1.45 |
| 30701030903 | 5,530 | 0.27 | 30701031501 | 1,398 | 0.06 |
| 30701031001 | 7,385 | 0.36 | 30701031502 | 1,107 | 0.05 |
| 30701031002 | 1,234 | 0.08 | 30701031503 | 2,172 | 0.08 |
| 30701031003 | 1,277 | 0.05 | 30701031504 | 3,728 | 0.19 |
| 30701031004 | 4,548 | 0.23 | 30701031505 | 9,301 | 0.26 |
| 30701031005 | 2,222 | 0.13 | 30701031506 | 28,973 | 0.82 |
| 30701031006 | 2,234 | 0.08 | 30701031601 | 13,039 | 0.45 |
| 30701031101 | 8,241 | 0.42 | 30701031602 | 41,239 | 2.10 |
| 30701031102 | 8,062 | 0.34 | 30701031603 | 5,635 | 0.21 |
| 30701031103 | 5,024 | 0.28 | 30701031604 | 19,697 | 0.61 |
| 30701031104 | 19,183 | 0.89 | 30701031605 | 25,129 | 0.39 |
| 30701031105 | 7,955 | 0.25 | 30701040101 | 19,886 | 0.70 |

| Subarea ID | Population | Pop. Density, persons/ac | Subarea ID | Population | Pop. Density, persons/ac |
|---|---|---|---|---|---|
| 30701031106 | 7,404 | 0.26 | 30701040102 | 68,991 | 2.00 |
| 30701031201 | 6,476 | 0.28 | 30701040103 | 1,283 | 0.05 |
| 30701031202 | 1,605 | 0.09 | 30701040104 | 1,511 | 0.04 |
| 30701031203 | 2,178 | 0.13 | 30701040106 | 1,170 | 0.04 |
| 30701031204 | 1,998 | 0.07 | 30701040107 | 4,555 | 0.11 |
| 30701031301 | 1,193 | 0.06 | 30701040201 | 12,990 | 0.30 |
| 30701031302 | 426 | 0.03 | 30701040202 | 14,319 | 0.56 |
| 30701031303 | 405 | 0.02 | 30701040203 | 1,561 | 0.08 |
| 30701031304 | 377 | 0.03 | 30701040204 | 5,030 | 0.19 |
| 30701031305 | 1,066 | 0.05 | 30701040205 | 8,377 | 0.20 |
| 30701031306 | 2,526 | 0.12 | 30701040206 | 16,204 | 0.33 |
| 30701031307 | 5,308 | 0.20 | 30701040207 | 1,805 | 0.06 |
| 30701031401 | 5,750 | 0.24 | 30701040401 | 1,684 | 0.06 |
| 30701031402 | 5,937 | 0.19 | 30701040402 | 3,895 | 0.11 |

Graphs of county-level population projections through the year 2025 for the Ocmulgee study area are provided in Appendix C for reference purposes. This information has also been included in the project database and can be accessed as needed for future projects.

Figure 2-3

### 2.2.2 Land Use/Land Cover

Land use within the watershed varies significantly, ranging from deep woodlands in the more rural areas to industrial near some of the larger cities. In general, as mentioned in previous sections, the dominant land resource area is a factor determining land use. Typically, the Southern Piedmont is predominantly agricultural use and woodland areas. However, land adjacent to major cities is dominated by residential and urbanizing development. The Southern Coastal Plain is dominated by woodland areas and agriculture.

Existing land cover also varies significantly across the watershed. An evaluation of the 1992 USGS National Land Cover map (see Figure 2-4) showed that land coverage ranges from undeveloped wetlands and forests through dense urban areas. As summarized in Table 2-9, the majority of the watershed is made up of undeveloped forested land (70.2 percent), followed by agricultural use (20.2 percent). Residential, commercial, industrial, and urban land uses are shown in only 8.4 percent of the watershed. The balance of the area (1.2 percent) is listed as open water (see Table 2-9).

Projected land use conditions for the study area have been compiled by the Atlanta Regional Commission and the Middle Georgia, Macintosh Trail, Middle Flint, and Northeast Georgia RDCs as part of their comprehensive plans. A map of the projected conditions is provided in Figure 2-5.

The Comprehensive Plan Land Use Element provides regional development centers the following opportunities:

- Inventory existing regional land use patterns and trends.
- Identify preferred future patterns of growth based on regional needs and desires.
- Explore the possibility of regional approaches to land use problems.
- Develop goals, policies, and strategies to guide patterns of land development in their respective region throughout the planning period.

The four generalized land use categories are defined as follows:

- Developed: Areas where urban services (e.g., water, sewer, etc.) are already being provided at the time of plan preparation.
- Developing: Areas that will require provision of new urban services during the planning period.
- Rural: Areas not expected to require provision of urban services during the planning period.
- Conservation: Areas to be preserved in order to protect an important resource or environmentally sensitive area.

The results of the regional land use analysis are used to create a regional conceptual development plan and are factored into the identification of target areas within the region where special management or allocation of governmental resources will be needed (e.g., environmentally sensitive areas facing development pressure, areas of intense development or redevelopment where urban services will need to be expanded, etc.). The locations of the target areas must be indicated on the map of projected land use patterns developed in the above land use analysis. For each of these target areas, needs, goals, and a strategy for achievement of the goals must be developed. The strategy must identify major public actions needed to address the particular land use issues in each target area (DCA Rules, Chapter 110-12-6-.03).

Figure 2-4

Figure 2-5

**Table 2-9. Land Use/Land Cover Summary Within the Ocmulgee River Study Area**

| Land Use/Class Name | Area (square miles) | Percent of Study Area |
|---|---|---|
| Emergent Herbaceous Wetlands | 1.5 | 0.06% |
| Bare Rock/Sand/Clay | 2.8 | 0.11% |
| Quarries/Strip Mines/Gravel Pits | 8.1 | 0.32% |
| Urban/Recreational Grasses | 13.8 | 0.55% |
| High Intensity Residential | 16.9 | 0.67% |
| Commercial/Industrial/Trans. | 27.7 | 1.10% |
| Open Water | 30.8 | 1.22% |
| Low Intensity Residential | 51.9 | 2.05% |
| Transitional | 94.5 | 3.74% |
| Woody Wetland | 179.0 | 7.08% |
| Pasture/Hay | 246.2 | 9.74% |
| Row Crops | 263.4 | 10.42% |
| Mixed Forest | 334.6 | 13.24% |
| Evergreen Forest | 530.6 | 20.99% |
| Deciduous Forest | 725.8 | 28.71% |
|  | 2,527.6 | 100 % |

Source: 1992 USGS National Land Cover Dataset.

# 3. River Basin Assessment

## 3.1 Assessment Overview

The Ocmulgee River watershed study area consists of approximately 2,420 square miles, incorporating 60 subareas and spanning 18 counties, from Newton and Henry counties at the northern limits, and south to Bleckley, Pulaski, and Dooly counties (see Figure 2-1). The TARGET and ASSESS modules from the EPA Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) model were used to evaluate water quality conditions within the study area. The primary focus of the analyses was to assess wetland conditions and water quality trends during the period of 1990 to 2001, with the objective of identifying watershed subareas that may contain water quality concerns. These results could then be applied in the development of generalized management scenarios addressing potential problem areas.

BASINS is an integrated GIS, data analysis, and modeling system developed for watershed evaluation and TMDL development (see Figure 3-1). It is an extensive compilation of several water quality and quantity models, such as Hydrological Simulation Program – FORTRAN (HSPF), Nonpoint Source Modeling (NPSM), Enhanced Stream Water Quality Model (Qual-2e), Pollutant Loading Application (PLOAD), Soil and Water Assessment Tool (SWAT), and a pollutant routing model (TOXIROUTE), along with defensible background data that includes the USEPA's Permit Compliance System (PCS) and Storage and Retrieval (STORET) databases. Most BASINS operations are integrated into GIS applications.

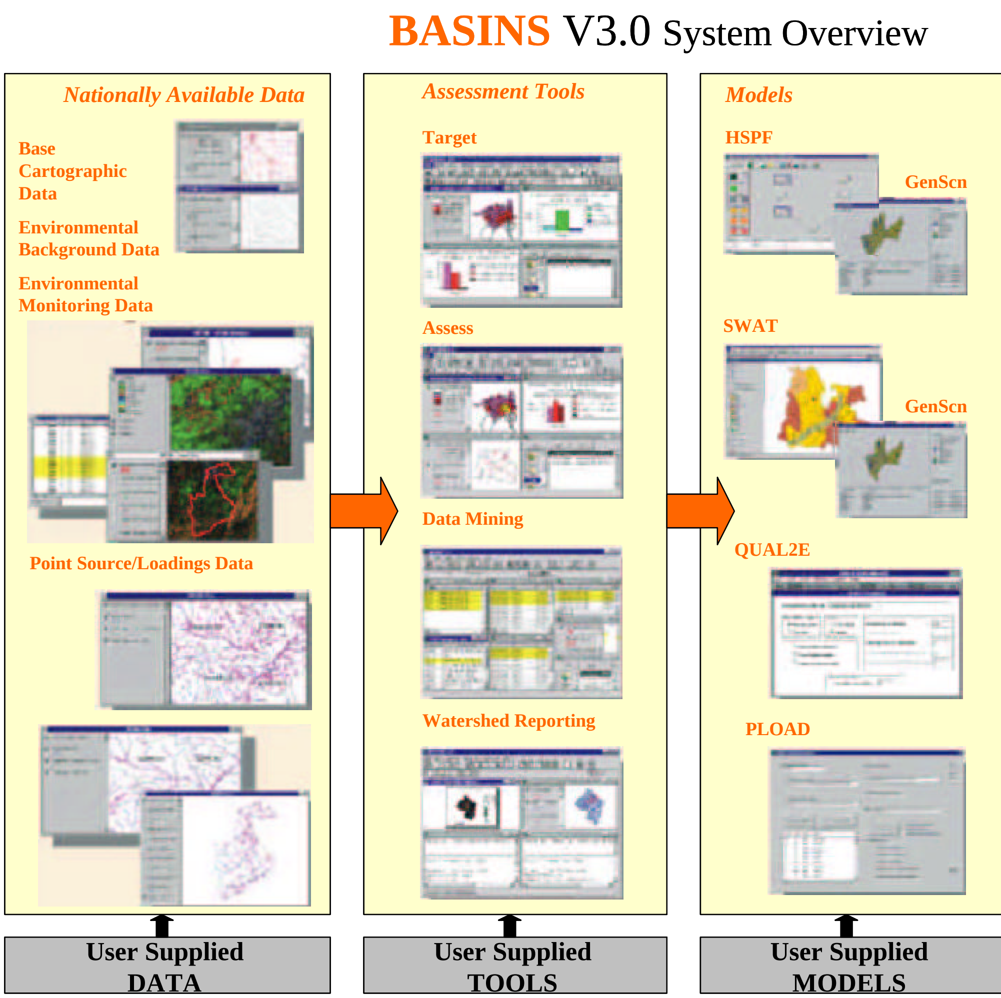
BASINS may be separated into two general sections:

- Assessment Tools
- Watershed and Water Quality Modeling

Assessment Tools includes the modules TARGET, ASSESS, and Data Mining, and allows the user to delineate watersheds, set up reports, and import site-specific data. The Watershed and Water Quality Modeling section includes all available models. For the Ocmulgee River watershed, only the Assessment Tools, specifically TARGET and ASSESS, were used for the evaluation of water quality data.

**Figure 3-1**

**Basins Overview**




Source: USEPA, BASINS, Version 3.0 User's Manual.

The TARGET module is used to evaluate water quality data and point source loadings within a watershed on a basin scale. It processes site-specific water quality data and/or permitted discharges to produce data summaries for the basin. Module output includes a thematic map of the watershed with subareas shaded according to monitoring results, a bar chart showing the statistical distribution of water quality monitoring results by subareas, and another bar chart showing the distribution of average pollutant concentrations throughout the study area.

The ASSESS module is used to evaluate water quality conditions of a watershed. It enables the analysis of water quality trends across a watershed and over a specified time period. ASSESS output includes a map of the water quality stations ranked according to concentrations of selected pollutants, and a bar chart indicating the distribution of results.

Figure 3-2

### 3.2 Database and GIS Development

GIS data application was an integral part of the water quality assessment for the study area. It enabled information to be processed and evaluated according to spatial distribution and water quality conditions in the most accurate manner possible.

The study area was comprised of 60 subareas. As shown on Figure 3-2, these subareas were based on 12-digit HUCs, as opposed to the eight-digit HUCs applied within the existing BASINS database. The 12-digit HUCs allowed the study area to be evaluated on a more refined scale. Site-specific data were then collected from various sources and added to the database. Data sources compiled for this project are summarized in Appendix C.

In order to augment the BASINS database with local water quality data, sampling locations, and the refined subareas, it was necessary to make several modifications to the BASINS program itself. This required revisions to the program code and tables so that the existing software could read and process the new information and produce valid results.

To enable BASINS to process the HUC-12 subarea delineations, revisions to the program table structure were required so that the revised tables mimicked characteristics of the existing tables. An identical match had to be made between the field width and type within each table. However, this was not the case regarding the basin identification numbers. Standard BASINS HUCs required an eight-digit field width, whereas the 12-digit HUCs required an additional four digits. These additional digits were added to the existing data, thereby extending the basin identification numbers. This, in turn, allowed the original BASINS software to read the new HUC values. Once the HUC identification numbers were revised, other software and table modifications were needed so that all water quality-affiliated tables would also be able to link with the new HUCs. Modified software code and data tables are shown in Appendix B for the benefit of experienced BASINS users.

The modified HUC identification numbers also affected the input of water quality data. The water quality observation stations, water quality stations, and water quality tables had to be edited to reflect the new HUC units being utilized. The water quality observation stations table contains information regarding the location, agency, type of station, cataloging unit, and stream segment location. The water quality stations table is similar to the water quality observation stations table; however, this table is linked with the water quality table to access the monitoring data summaries. Once the existing

BASINS data was amended to facilitate analysis at the HUC-12 level, the supplemental data collected could then be incorporated.

Incorporating and evaluating the local, site-specific data required several steps within the BASINS program. First, monitoring sites were physically located by latitude and longitude. The mean parameter value concentrations for each location were then entered for each year, parameter, and monitoring period. The water quality tables were then amended with mean values for each monitoring station and for the HUC-12 basin in which each station was located. In order to facilitate data more recent than 1997, the software code of the TARGET and ASSESS modules was edited. A new monitoring year period extending from 1998 to 2001 had to be developed. This revised year range included only the new data sets collected through the Ocmulgee Watershed Study, allowing selection of the 1998 to 2001 monitoring period for data analyses. No STORET data could be incorporated into this range since none existed for that period. Ultimately, 66 new monitoring locations were added to the BASINS water quality stations, bringing the total to 224 stations within the study area. These new stations required the addition of 742 records to the water quality data tables. Once the existing data was modified and the new data were incorporated, the TARGET and ASSESS modules could be run. The final monitoring stations are shown on Figure 3-3.

Because of the extensive modifications to the BASINS software, any local water quality data can now be incorporated into the GIS databases, including any parameter, sampling location, and HUC. These revisions have allowed expanded access to BASINS that may now be utilized extensively for the project area. Using the completed modifications, any water quality data from 2002 and earlier can be loaded into the project database at the HUC-12 level using standard techniques. Information dated post-2002 or at a greater detail than HUC-12 will require additional script and data table modifications.

Figure 3-3

### 3.3 Water Quality Assessment

The water quality assessment of the Ocmulgee River study area was based on the evaluation of sampled water quality concentrations of selected pollutants. These data were compiled through monitoring programs conducted by others from 1990 to 2001. This assessment sought the identification of subareas (HUC-12s) that have the potential for water quality impairments and subsequently, the development of relevant alternative management measures. The initial steps in this process involved selecting pollutants for analysis, obtaining local water quality data, and applying the BASINS TARGET and ASSESS modules. It should be noted that this methodology is not intended to address all possible regulatory standards or to replicate other existing water quality information such as EPD's 303(d) list of impaired waters for this area, which is discussed elsewhere in the Plan.

#### 3.3.1 Water Quality Parameters

Water quality parameters were selected for analysis based on their significance to watershed stream quality, along with their accessibility and distribution within the available monitoring data. The original list of parameters within the BASINS database included 33 parameters. Twenty of these would ultimately be selected for the study area evaluation.

A careful analysis was performed to identify which parameters would best represent water quality conditions throughout the study area. All of the data were reviewed, including the STORET and more recent water quality data, along with their relationship to physical watershed characteristics such as land use and hydrology. This review assisted in the development of the most comprehensive parameter list that best depicted potential water quality conditions within the study area and allowed for an accurate and valid analysis throughout the study period. The final parameters selected were as follows:

- Total Alkalinity (as $CaCO_3$)
- Unionized Ammonia
- Biochemical Oxygen Demand (BOD), 5-day, $20^o$ Celsius
- Total Hardness

- Total Nitrite and Nitrate
- Nitrite Nitrogen
- Nitrate Nitrogen
- Total Kjeldahl Nitrogen
- Ammonia Nitrogen
- Dissolved Oxygen
- Total Phosphorus
- Total Nonfilterable Residue (TSS)
- Specific Conductance
- Total Chromium (as Cr)
- Total Copper (as Cu)
- Total Nickel (as Ni)
- Total Zinc (as Zn)
- Chemical Oxygen Demand (COD)
- pH
- Fecal Coliform

### 3.3.2 Surface Water Quality Monitoring Data

The water quality data used for the analyses were from a range of sources. The majority of historical data came from the national databases, primarily STORET, that are provided in the BASINS software. STORET is made up of water quality monitoring data from various state and federal agencies, including the EPA, USGS, and Georgia EPD. Along with the national databases, local, site-specific water quality data were obtained for use in the study. The local data generally were found to be more current, having been collected as recently as 2001 by several organizations and local governments within the study area (see Table 3-1).

**Table 3-1 Surface Water Quality Data (through 2001)**

| Organization/Local Government | Data Description |
|---|---|
| Macon Water Authority | EPA ICR and Ocmulgee Watershed Study data from three sampling locations.<br>Water quality monitoring data for the city of Macon watershed assessment. |
| USGS/EPD | Water quality monitoring data along the Ocmulgee River collected during 1998, 1999, 2000, and 2001. |
| | |
| EPA* | STORET monitoring data of samples collected from 1970 to 1997. |
| EPD | 303(d) list of streams. |
| Northeast Georgia RDC | Monitoring data along the Alcovy River for the watershed assessment and protection plan. |
| Butts County | Raw water testing data from the Ocmulgee River Water Plant for January 1994 to July 2001. |
| Ocmulgee River Initiative* | Seasonal water quality data from 45 sampling locations along the Ocmulgee River from summer 1996 to spring 2001. |
| Bibb County Engineering* | NPDES stormwater monitoring data. |
| City of Macon Engineering* | NPDES stormwater monitoring data. |
| Robins Air Force Base* | NPDES stormwater monitoring data and in-house river monitoring data at 12 sampling locations along the Ocmulgee River from 1993 to 1998. |

*Used in BASINS analyses.

A variety of other information was also collected to assist in the development of the project database. This included GIS coverage for soils, threatened and endangered species, land use, national wetlands inventory, greenspace programs, topography/elevation, hydrology, infrared orthophotos, the EPD's 303(d) list of streams, and the EPA's Southeastern Ecological Framework (see Appendix C). Each agency and/or organization that provided data was contacted through a variety of methods, including telephone conversations, public meetings, handouts, and letters. An initial public meeting was held by Georgia DCA to discuss the project with the many stakeholders within the study area. Each stakeholder was asked to submit information relevant to water quality land use and hydrologic conditions within the study area. DCA was then able to establish a list of contacts that were willing to assist in data development for the project. The agencies and organizations that provided information included:

- Macon Water Authority
- City of Macon Engineering
- Bibb County Engineering
- Macon-Bibb County Parks and Recreation Department
- Robins Air Force Base
- Georgia Forestry Commission
- Georgia EPD
- Georgia DCA
- USEPA
- McIntosh Trail Regional Development Center
- Northeast Georgia Regional Development Center
- Trust for Public Lands
- Ocmulgee River Initiative
- Butts County Water and Sewer Authority

The data were received in various formats, including GIS coverage, hard copies, and electronic spreadsheets. For GIS applicability and BASINS analysis, the water quality data had to be converted into a compatible electronic format. Data available only in hard copy format were input into electronic databases and summarized based on mean concentrations before being processed into the BASINS database. Along with the water quality data input, DCA also compiled the sampling locations with spatial distribution into electronic format. These files were then incorporated into the project. If no compatible electronic format could be compiled for a data set and/or if sampling locations could not be verified, the data set could not be used in the TARGET and ASSESS analyses. However, all appropriate water quality data sets are included in the project database and can be accessed to provide additional information on conditions within any project subarea and for other site-specific studies.

### 3.3.3 Data Analysis (BASINS TARGET/ASSESS)

The BASINS TARGET module was used to evaluate water quality trends from 1990 to 2001 within the Ocmulgee Watershed by subarea. The selected water quality pollutants were analyzed for the discrete monitoring periods 1990 to 1994, 1995 to 1997, and 1998 to 2001. These results were evaluated according to a predetermined threshold value (concentration). These threshold values are concentrations that are input for comparison of the water quality monitoring data in BASINS. Where applicable, the threshold values were based on EPD in-stream water quality standards (see Table 3-2). However, if standards were not applicable for certain pollutants, an average Event Mean Concentration (EMC) was input. The average EMC used for analysis was an average of land use concentrations published by the Atlanta Regional Commission (ARC) and included within their Water Management Model Database (see Table 3-3). However, not all parameters could be assigned an EMC by this method; therefore, values were also developed from a number of other literature sources, as summarized in Table 3-4. These criteria were primarily based on technical guidance and recommendations from agencies such as the EPA and the American Water Works Association (AWWA).

The threshold values were not exceeded within some subareas. In those cases, a somewhat lower value was entered so that graphical representation of the water quality concentrations for that subarea could be generated. These values were not based on regulatory criteria. For example, the TARGET evaluation for fecal coliform during the monitoring period 1995 to 1997 initially began with a threshold value of 200 colonies/100 milliliters (mL). However, without any exceedance of the standard, no results could be plotted. Therefore, a lower threshold value of 100 colonies/100 mL was input, which was found to enable a more useful plot of concentrations.

The BASINS ASSESS module applies a method that simplifies organization of water quality data and presents a wide range of information about the specific monitoring locations. Example ASSESS results are presented in Appendix D. The module was used to evaluate subarea water quality conditions and view water quality data statistically in a report format. Specific monitoring locations were selected within the study area, and a statistical report was generated for each water quality parameter. The water quality data were also inventoried to include a description of the location, source, agency, county, watershed, and number of observations.

**Table 3-2 EPD Water Quality Standards**

| Parameter | Standard |
|---|---|
| Dissolved Oxygen | No less than 4.0 mg/L for water supporting warm water species of fish |
| Chromium (Dissolved)* | Freshwater – 16 ug/L (Acute), 11 ug/L (Chronic) |
| Nickel (Dissolved)* | Freshwater – 790 ug/L (Acute), 88 ug/L (Chronic) |
| pH | 6.0 – 8.5 |
| Fecal coliform | 200/100 mL (Primary Standard used for modeling purposes. Other standards based on seasonal maximums and geometric means for designated uses also exist.) |

* Assumes a total hardness of 50 mg/L as $CaCO_3$.

The threshold value for total hardness was set at 25 mg/L in relation to the minimum criteria for metals concentration calculations set forth by the EPD.

**Table 3-3 Water Quality Pollutant Event Mean Concentrations**

| | | Event Mean Concentrations (mg/L) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Land Use | Percent Imperviousness | BOD | TDS | COD | TSS | Total Phosphorus | Total Kjeldahl Nitrogen | Nitrite plus Nitrate | Total Copper | Total Zinc | Ammonia Nitrogen |
| Forest/Open | 0.50 | 8 | 100 | 51 | 216 | 0.09 | 0.46 | 0.25 | 0.00 | 0.00 | 0.00 |
| Agriculture | 0.50 | 4 | 678 | 72 | 400 | 0.40 | 209 | 0.50 | 0.04 | 0.10 | 0.001 |
| Large Lot Single Family (>2 ac) | 10.00 | 10.1 | 91 | 58 | 235 | 0.19 | 0.66 | 0.34 | 0.01 | 0.04 | 0.00 |
| Low-Density Single Family (1 – 2 ac) | 12.00 | 11 | 100 | 190 | 280 | 0.67 | 0.20 | 2.85 | 0.03 | 0.22 | 0.004 |
| Low- to Medium-Density Single Family (0.5 – 1 ac) | 19 | 15 | 71 | 75 | 279 | 0.47 | 1.37 | 0.69 | 0.04 | 0.12 | 0.004 |
| Medium-Density Single Family (0.25 – 0.50 ac) | 26.00 | 10.80 | 100 | 83 | 140 | 0.47 | 2.36 | 0.96 | 0.05 | 0.12 | 0.003 |
| Townhouse/Apartment | 48.00 | 10.8 | 51 | 70 | 109 | 0.19 | 1.24 | 0.69 | 0.02 | 0.14 | 0.003 |
| Commercial | 85.00 | 9.71 | 100 | 190 | 248 | 0.66 | 3.2 | 1.18 | 0.04 | 0.28 | 0.005 |
| Office/Light Industrial | 70.00 | 15 | 58 | 77 | 93 | 0.66 | 3.2 | 1.18 | 0.04 | 0.19 | 0.003 |
| Heavy Industrial | 80.00 | 9.7 | 100 | 61 | 91 | 0.24 | 1.28 | 0.63 | 0.04 | 0.19 | 0.001 |
| Average | 35.10 | 10.41 | 145 | 92.7 | 209 | 0.36 | 22.1 | 0.87 | 0.03 | 0.14 | 0.0024 |

Source: Watershed Management Model User's Manual, Atlanta Regional Commission, 1998.

**Table 3-4 Literature Based Threshold Values**

| Parameter | Concentration/Value |
|---|---|
| Total Alkalinity | 20 mg/L (Kentucky Natural Resources and Environmental Protection) |
| Unionized Ammonia | 0.002 mg/L (EPA, 1991c) |
| Nitrite Nitrogen | 1 mg/L – Drinking water designation (AWWA, 1990) |
| Nitrate Nitrogen | 10 mg/L – Drinking water designation (AWWA, 1990) |
| Specific Conductance* | 235 umhos/cm (Illinois EPA) |

* Specific conductance can be a good indicator of Total Dissolved Solids (TDS) concentration. It has been determined that TDS correlates to approximately 60 percent of conductivity (Illinois EPA). With an average EMC for TDS of 145 mg/L, an average specific conductance measurement of approximately a 235 umhos/cm would result.

### 3.3.4 Water Quality Trends

The BASINS TARGET module was run for each selected parameter. Results are provided below for the overall study period (1990 to 2001). The initial threshold value used in module evaluation was based on regulatory and literature values. However, for graphical representation, the lowest concentration for each parameter in the database was used. **Anything less than the lowest parameter concentration on each graph indicates that no data was available for the parameter during a specific time period.** Graphical plots of these results are provided in Appendix E. The figure numbers given below reference the Appendix E plots.

#### Total Alkalinity

The initial threshold value for total alkalinity was set at 20 milligrams per liter (mg/L). This value was based on documentation from the Kentucky Natural Resources and Environmental Protection Cabinet, which indicated that the buffering capacity should be at least 20 mg/L for increased aquatic viability. Overall, no significant water quality problems for total alkalinity were identified. Concentrations ranged from less than 14 mg/L to 92 mg/L. A few elevated concentrations were identified, located predominantly within the center and northernmost portions of the study area. See Figures E-1 through E-3 for a graphical representation of the extent of total alkalinity concentrations. Possible sources of the increased concentrations may be from limestone deposits or soils rich in calcium carbonate.

### Unionized Ammonia

The initial threshold value for unionized ammonia was set at 0.002 mg/L, based on the EPA criteria for aquatic life in freshwater. Based on these criteria, there appear to be some water quality problems and/or concerns within the study area. Concentrations ranged from 0.00001 mg/L to 0.75mg/L. The higher concentrations were predominantly located in the southernmost subareas. See Figures E-4 through E-6 for a graphical representation of the extent of unionized ammonia concentrations. Possible sources of the high concentrations are organic material decomposition within the natural system, along with animal and human excrement, and fertilizers from agricultural, residential, and urban use.

### BOD, 5-Day

The initial threshold value for BOD, 5-day was set at 10.41 mg/L based on ARC EMCs. Overall, there appears to be some indications of water quality problems for BOD, 5-day within the study area; however, no trends can be established. Concentrations ranged from less than 2 mg/L to as high as 9,000 mg/L. The higher concentrations were predominantly located in the south-central areas. See Figures E-7 through E-9 for a graphical representation of the extent of BOD, 5-day concentrations. Possible sources of the higher concentrations may be from industrial and municipal discharges, urban runoff, agricultural runoff, and natural oxygen demanding processes.

### Total Hardness

The initial threshold value for total hardness was set at 25 mg/L to correspond with the minimum criteria for water quality standard calculations for metals. The total hardness within the Piedmont physiographic region of Georgia tends to be fairly low, as demonstrated by the monitoring data. There appear to be no water quality concerns regarding total hardness within the study area, and no trends were identified. Concentrations ranged from less than 2 mg/L to 78 mg/L. See Figures E-10 and E-12 for a graphical representation of the extent of total hardness concentrations. Total hardness is a function of the amount of calcium and magnesium in the soils. The documented concentrations are typical for this region.

### Total Nitrite Plus Nitrate

The initial threshold value for total nitrite plus nitrate was set at 0.87 mg/L based on ARC EMCs. There appear to be no significant water quality problems related to this parameter within the study area; however, there may be indications of increasing concentrations over time. Concentrations ranged from less than 0.027 mg/L to 1.04 mg/L over the entire study period. While these are not significantly high, there appear to be consistently increasing concentrations within the south-central portion of the study area. See Figures E-13 through E-15 for a graphical representation of the extent of total nitrite plus nitrate concentrations. Possible sources of the higher concentrations may be from municipal and industrial wastes, as well as runoff from agricultural, forest, urban, and suburban areas.

#### Nitrite Nitrogen

The initial threshold value for nitrite nitrogen was set at 1 mg/L based on AWWA's recommended limit for water bodies primarily designated for human consumption. There appear to be no significant water quality problems within the study area. See Figures E-16 and E-17 for a graphical representation of the extent of nitrite nitrogen concentrations. Concentrations ranged from less than 0.0069 mg/L up to 0.0324 mg/L.

#### Nitrate Nitrogen

The initial threshold value for nitrate nitrogen was initially set at 10 mg/L based on AWWA's recommended limit for water bodies primarily designated for human consumption. There appear to be no significant water quality problems within the study area and the initial threshold value was not exceeded. See Figures E-18 through E-20 for a graphical representation of the extent of nitrate nitrogen concentrations. Concentrations ranged from less than 0.00056 mg/L to 6.063 mg/L.

#### Total Kjeldahl Nitrogen

The initial threshold value for Total Kjeldahl Nitrogen was initially set at 22.1 mg/L based on ARC EMCs. Overall, there seem to be varying concentration levels within the study area although none exceed the EMC. Concentrations range from 0.11 mg/L to 2.3 mg/L. There appears to be a minor trend within the central portion of the watershed. See Figures E-21 through E-23 for a graphical representation of the extent of Total Kjeldahl Nitrogen concentrations.

#### Ammonia Nitrogen

The initial threshold value for ammonia nitrogen was set at 0.0024 mg/L based on ARC EMCs. Overall, there appear to be no significant water quality problems within the study area for this parameter although one subarea indicates a trend of increasing concentrations. See Figures E-24 through E-26 for a graphical representation of the extent of ammonia nitrogen concentrations. Concentrations ranged from less than 0.001 mg/L to 1.12 mg/L. The concentrations at or above 1.0 mg/L should be considered above the normal range. Possible sources of the higher concentrations may be municipal and industrial wastes, as well as runoff from agricultural, forest, urban, and suburban areas.

#### Dissolved Oxygen

The initial threshold value for dissolved oxygen was set at 4.0 mg/L. This value was based on EPD water quality standards. There appear to be some subareas that may have dissolved oxygen concentrations below the standard. A trend for low concentrations is apparent within the central portion of the study area. See Figures E-27 through E-29 for a graphical representation of the extent of dissolved oxygen concentrations. Concentrations ranged from 2.0 mg/L to 11.0 mg/L. Possible sources that may decrease dissolved oxygen concentrations include municipal and industrial waste discharges, sediment oxygen demand in the water body, and respiration by aquatic plants.

#### Total Phosphorus

The initial threshold value for total phosphorus was originally set at 0.36 mg/L based on ARC EMCs. There appear to be no significant water quality problems within the study area and no relative trends within the subareas. See Figures E-30 through E-32 for a graphical representation of the extent of total phosphorus concentrations. However, some locations do indicate relatively higher concentrations. Overall, concentrations ranged from less than 0.01 mg/L to 2.02 mg/L. Possible sources of the higher concentrations may be municipal and industrial wastes, as well as runoff from agricultural, forest, urban, and suburban areas.

#### Total Nonfilterable Residue (TSS)

The initial nonfilterable threshold value for TSS was set at 209 mg/L based on ARC EMCs. Some locations in the study area exhibit significantly high TSS concentrations. A few of the subareas are associated with increased concentrations throughout the study period. See Figures E-33 through E-35 for a graphical representation of the extent of TSS concentrations. Concentrations ranged from less than 5 mg/L to

376,000 mg/L. High TSS concentrations are often attributed to soil erosion from agricultural areas, construction sites, unvegetated soils, and stream banks.

#### Specific Conductance

The initial threshold value for specific conductance was set at 235 umhos/cm, which was based on Illinois EPA documentation. The specific conductance of a water body can be an indirect measure of total dissolved solids (TDS) within that sample. Through research, it has been concluded that approximately 60 percent of the conductivity measurement is typically associated with TDS (Illinois EPA). The ARC EMC for TDS is 145 mg/L, which establishes an approximate value for specific conductance of 235 umhos/cm. There appear to be a few locations within the study area that indicate relatively high specific conductance. Three subareas within the central portion of the study area show a trend toward higher concentrations. See Figures E-36 through E-38 for a graphical representation of the extent of specific conductance. Concentrations within the overall study area ranged from less than 39 umhos/cm to 996 umhos/cm. Dissolved solids may include chloride, nitrate, sulfate, phosphate, sodium, magnesium calcium, and iron. These parameters can originate from natural soils, agricultural runoff, and urban runoff.

#### Total Chromium

The initial threshold value for total chromium was set at 0.011 mg/L based on EPD water quality standards. Although the standards are for the dissolved fraction of chromium in a water column, they were applied as the total chromium threshold for the assessment of the monitoring values. However, a total concentration will typically be somewhat higher than the dissolved fraction above. Not many sample results exceed the threshold; however, there are a few sampling locations that exceed the threshold. These stations are located in the northernmost, southernmost, and central portions of the study areas; however, there do not appear to be water quality problems related to chromium in the study area. See Figure E-39 for a graphical representation of the extent of total chromium concentrations. Concentrations ranged from 0.0056 mg/L to 0.034 mg/L. Elevated chromium levels may be attributed to naturally occurring ores, industrial discharges, and automobiles.

#### Total Copper

The initial threshold value for total copper was initially set at 0.03 mg/L, based on ARC EMCs. There do not appear to be any significant water quality problems associated with total copper within the study area; however, there are a few sampling locations that exceeded the threshold value. See Figures E-40 through E-42 for a graphical representation of the extent of total copper concentrations. Concentrations ranged from less than 0.005 mg/L to 0.061 mg/L. Elevated copper concentrations may be attributed to industrial smelting operations and municipal incineration.

#### Total Nickel

The initial threshold value for total nickel was initially set at 0.088 mg/L based on EPD water quality standards for dissolved fraction nickel in the water column. There do not appear to be any water quality problems associated with total nickel within the study area, and all concentrations appear to be within standards and below the initial threshold value. See Figures E-43 through E-45 for a graphical representation of the extent of total nickel concentrations. Concentrations ranged from less than 0.005 mg/L to 0.0205 mg/L.

#### Total Zinc

The initial threshold value for total zinc was set at 0.14 mg/L based on ARC EMCs. There do appear to be locations within the study area that exhibit water quality problems, with higher concentrations identified within the central portion of the study area. See Figures E-46 through E-48 for a graphical representation of the extent of total zinc concentrations. Some samples were recorded as above the threshold as well as the EPD water quality standard, with concentrations ranging from less than 0.001 mg/L to 0.322 mg/L. The EPD water quality standard for the dissolved fraction of zinc is 0.058 mg/L (chronic), with a total hardness of 50 mg/L as $CaCO_3$. Possible sources of increased concentrations include industrial and municipal discharges, soils high in zinc content, and runoff from urban areas, especially high-traffic/transportation areas.

#### Chemical Oxygen Demand (COD)

The initial threshold value for COD was originally set at 92.7 mg/L based on ARC EMCs. There appear to be high concentrations of COD within some of the subareas, particularly those within the central portion of the study area. See Figures E-49 through E-51 for a graphical representation of the extent of COD concentrations. Concentrations ranged from less than 7 mg/L to 62,333 mg/L. High concentrations of COD can be associated with municipal and industrial discharges and urban runoff.

### pH

The initial threshold value for pH was set at 6.0 based on EPD water quality standards, which established an acceptable pH range of 6.0 to 8.5. There do not appear to be significant water quality problems related to pH in the study area. See Figures E-52 through E-54 for a graphical representation of the extent of pH concentrations. Most of the recorded measurements are close to neutral (pH around 7.0); however, a few stations indicated lower levels of pH within the south-central portion of the study area. Overall concentrations ranged from 5.4 pH units to 7.85 pH units. Concentrations below the standard may be due to industrial and municipal discharges.

### Fecal Coliform

The initial threshold value for fecal coliform was originally set at 200 colonies/100 mL based on the EPD primary water quality standard. There appear to be several locations within the study area that have exhibited above-standard fecal coliform concentrations. These are predominantly within the central and southern portions of the watershed. See Figures E-55 through E-57 for a graphical representation of the extent of fecal coliform concentrations. Colony counts ranged from less than 2.5/100 mL to 12,473/100 mL. Typical sources of fecal coliform include industrial and municipal waste discharges, residential septic systems, and human and animal excrement (including farm, domestic, and wild animals).

Overall, there are no significant trends related to the selected water quality parameters in comparison to established standards. However, there are specific locations that exhibit higher concentrations than others within the study area. These areas have the greatest potential for water quality problems. Management measures are recommended to provide water quality control within the study area. Potential measures are discussed in Section 4.

The DNR Wildlife Resources Division provides the following disclaimer:

> "The data collected by the Georgia Natural Heritage Program comes from a variety of sources, including museum and herbarium records, literature, and reports from individuals and organizations, as well as field surveys by our staff biologists. In most cases the information is not the result of a recent on-site survey by our staff. Many areas of Georgia have never been surveyed thoroughly. Therefore, the Georgia Natural Heritage Program can only occasionally provide definitive

> information on the presence or absence of rare species on a given site. Our files are updated constantly as new information is received. Thus, information provided by our program represents the existing data in our files at the time of the request and should not be considered a final statement on the species or area under consideration."

### 3.3.5 Soil Loss Assessment

Although not considered within the water quality spatial analysis for the study area, an assessment of estimated sediment loads was completed for future comparison. To evaluate sediment loads from within the study area, the Revised Universal Soil Loss Equation (RUSLE) was used. RUSLE is an erosion prediction model that predicts long-term average annual soil loss resulting from raindrop splash and runoff from specific field slopes within selected cropping and management systems and from rangeland (Mitasova and Mitas 1999). RUSLE is a replacement for the Universal Soil Loss Equation (USLE) and retains the six factors in that equation. These factors represent the following:

- Rainfall and runoff factor (R)
- Soil erodibility factor (K)
- Slope length and steepness factors (LS)
- Cover and management factor (C)
- Support practices factor (P)

Developed by the U.S. Department of Agriculture (USDA)-Agricultural Research Service, and first released in 1993, this technology has been implemented in field offices of the USDA-Natural Resources Conservation Service and is being used nationally and internationally for prediction of rill and interrill erosion on cropland, rangeland, and other land uses.  RUSLE uses the same empirical principles as USLE, but it also includes modifications such as monthly factors, influences of convexity/concavity of nonuniform slopes and complex terrain, and improved equations for LS factor computation (Foster and Wischmeier 1974, Renard et al. 1991).

The fundamental equation is summarized as:

A = R * K * LS * C * P

Where:

A = Average annual soil loss in tons per acre per year
R = Rainfall/runoff erosivity
K = Soil erodibility
LS = Hillslope length and steepness
C = Cover-management
P = Support practice

For purposes of this study, the project GIS was applied as the basis for a computational assessment of sediment loss from the watersheds. The analysis was performed using ArcGIS 8.1 with the Spatial Analyst extension to incorporate the empirical factors described above. The factors applied for this analysis are summarized in Table 3-5.

**Table 3-5. RUSLE Empirical Factors**

| Factor | Parameter | Value |
|---|---|---|
| R | | 300 |
| K[1] | | |
| LS | Dependent on HUC topography | |
| C[2] | Agriculture | 0.337 |
| | Commercial | 0.330 |
| | Woods, good cover | 0.003 |
| | Woods, fair cover | 0.003 |
| | Impervious | 0.0001 |
| | Pasture, range land | 0.004 |
| | Open space, fair condition | 0.004 |
| | Surface water | 0.0001 |
| | Residential (2-acre lots and more) | 0.013 |
| | Residential (1/3-acre lots) | 0.013 |
| | Dirt roads | 0.60 |
| | Gravel roads | 0.45 |
| P | | 1.0 |

[1]K-values taken from the Georgia STATSGO GIS coverage.
[2]C-values were derived from the 1995 MRLC GIS coverage.

The R factor is a measure of rainfall erosivity and is based on a statistical analysis of the rainfall intensity and frequency. The R factor was found to be between 275 and 300 for the Ocmulgee Basin.

The K factor is a measure of the soil erosivity. The values for this study were taken from the Georgia State Soil Geographic (STATSGO) Database. The values for the Ocmulgee Basin ranged from 0.12 to 0.27.

The LS factor is based on the land slope and cumulative drainage area. The computation of this factor changed from the USLE procedures. The main difference is that the slope length variable in the USLE is replaced by the accumulated drainage area in the RUSLE. First, the ground surface elevation coverage (TIN) for the basin was used to calculate slope and flow accumulation grids. Then, the LS factor was calculated using the following expression:

$$LS = \left( \left( \frac{[FLOWACC]*(Grid\_Size)}{(22.1)} \right)^{0.6} \right) * \left( \left( \frac{(\sin([SLOPE]*0.01745))}{(0.09)} \right)^{1.3} \right)$$

The C factors were estimated using the Multi-Resolution Land Characteristics (MRLC) dataset prepared by the U.S. Geologic Survey.

Once these values were run in the GIS computation, a sediment load was estimated for each HUC within the study area, as summarized on Figure 3-4. As shown in Table 3-6, the results ranged from less than 1 ton/acre/year to around 21 tons/acre/year. It should be noted that results are highly dependent on small variations within the input data and within base information. These results are estimates based on available data for the watershed. More site-specific information will provide more accurate sediment loading for a specific subarea.

The majority of the watershed was simulated to produce low to moderate soil loss rates in comparison to typical national rates. The soil loss is estimated to be generally high (4 to 6 lb/acre/yr) in the southwestern portion of the watershed. This can be attributed to a higher amount of agricultural land than found in the other parts of the watershed. In the northwestern portion of the watershed, two subbasins south of Locust Grove were also simulated to have high soil loss rates. These subbasins are affected by a higher percentage of commercial and agricultural land use. The highest values were simulated for the area between Macon and Warner Robbins. These values can be attributed to the higher density of developed land in these subbasins, along with an elevated soil erodibility factor.

BMPs directed toward construction site erosion and sediment control, post-development stormwater management, and agricultural practices could significantly improve the soil loss experienced within the Lower Ocmulgee Watershed. Post-development stormwater management that includes water quality controls, in addition to the traditional peak flow attenuation requirements, should be implemented. The Georgia Stormwater Management Manual provides detailed calculations and design requirements that address water quality and quantity issues from developed sites. The Georgia Soil and Water Conservation Commission has been working with NRCS field and Farm Services Bureau offices to develop agricultural BMPs that are directed at improving water quality in Georgia’s streams. Many of the BMPs have been implemented on a voluntary basis and when they are expected to provide an additional monetary benefit to the farmer. Additional public education efforts, in concert with the other efforts of these agencies, could increase the use of agricultural practices that reduce sediment loads to the streams and rivers in the Ocmulgee Watershed.

Although this analysis did not take construction activities into consideration, improper erosion and sediment controls are often the cause of large quantities of sediment entering local streams. The state has developed adequate BMPs and requirements for construction activities. Implementation of these BMPs should be emphasized within the watershed. More specific BMPs are described in Section 4.

Table 3-6

Figure 3-4

### 3.4 Wetlands Assessment

A primary focus of the Ocmulgee River Watershed Management Plan was the assessment of wetlands within the study area. This assessment was concerned with both the evaluation of current wetland health and with the potential role of wetlands in the management of basin water quality. Working with DCA, the ARCADIS-WEC team established the following major goals for the evaluation of wetlands:

- Review existing data to include National Wetland Inventory (NWI) maps, land cover maps, soils maps, aerial photography, and other existing data to determine if discrepancies occur between the available sources.

- Develop a site-specific wetland functionality and condition criteria along with a checklist for potential wetland and riparian mitigation sites.

- Utilize the criteria for a field inspection of selected wetland areas.

- Identify potential sites suitable for wetland and riparian restoration, and develop general mitigation prescriptive methodologies.

- Relate threatened and endangered species data as provided by DCA to the potential role of wetlands in the study area.

The 2,420-square-mile study area is known to include very diverse vegetative and thus, wetland communities. This diversity can primarily be attributed to soil differences, being that the study area includes portions of the Piedmont, Sand Hills, and Coastal Plain physiographic regions. Although functionality and condition criteria focused on wetland areas, streams were also evaluated based on stream morphology, as well as on impairment associated with sedimentation or other pollutants. The ARCADIS-WEC team produced an intermediate “Wetland and Stream Assessment” document through this effort (see Section 5 for full reference).

#### 3.4.1 Methodology

The initial objective of the wetlands assessment was to develop a means for evaluating wetland functionality and value. The selected approach was based in part on a system that classifies wetlands according to hydrogeomorphic (HGM) characteristics. This approach considers topographic position, source of water, and hydrodynamics of a wetland. The HGM divides wetlands into five broad categories or classes:

- Riverine
- Fringe
- Slope
- Flat
- Depressional
- It was anticipated that most if not all wetlands encountered within the project area would fall within the riverine class, with some flat and depressional wetland types identified. Therefore, the criteria developed focused on riverine systems.

In addition to consideration of the HGM approach, ARCADIS-WEC incorporated an ecological component (HGM considers physical characteristics of a wetland only) consisting of an evaluation of the vegetative communities and associated wildlife habitat. As a result, four main wetland functions were considered in the assessment:

- Forest ecology
- Wildlife habitat
- Hydrology/flood storage
- Water quality (related to the potential for sediment/toxicant removal)

In order to compile a basin-wide assessment, field evaluation/verification consisted of the examination of representative wetland sites selected from throughout the basin. As shown in Table 3-7 and in the sample data form provided in Appendix F, three to five criteria were developed to evaluate each wetland function. An area observed to be in the best or most pristine condition was assigned a value of 1.0 for the relevant criterion, while areas that were noted at highly degraded conditions were assigned a value of 0.0. Intermediate values were assigned as indicated on the data form. The criteria applied for the forest ecology and wildlife habitat parameters consider wetland functions only. For hydrology/flood storage and water quality, the criteria also include parameters related to existing wetland values (proximity to impervious surfaces and land uses). Although the assignment of values for each of the criteria was necessarily somewhat subjective, the values should be considered accurate for relative comparison purposes among the study area wetlands.

**Table 3-7**

**Evaluation Criteria for Wetlands and Riparian Areas**
**Ocmulgee River Watershed Management Plan**

| Function | Criteria | Options | Functional Index* |
|---|---|---|---|
| Forest Ecology | Species Composition | Late-Successional | 1.0 |
| | | Mid-Successional | 0.5 |
| | | Early Successional | 0.1 |
| | Stand Age (Years) | 80+ | 1.0 |
| | | 40–80 | 0.7 |
| | | 20–40 | 0.5 |
| | | 10–20 | 0.3 |
| | | 2–10 | 0.1 |
| | | 0–1 | 0.0 |
| | Regeneration | Natural | 1.0 |
| | | Planted | 0.1 |
| | Canopy Coverage | 90+ | 1.0 |
| | | 70–90 | 0.7 |
| | | 50-70 | 0.4 |
| | | <50 | 0.1 |
| | Exotic Species (% of Area Affected) | 0 | 1.0 |
| | | 1–25 | 0.5 |
| | | 25–50 | 0.2 |
| | | 50–75 | 0.1 |
| | | 75–100 | 0.0 |
| Wildlife | Protected Species** Habitat | Preferred | 1.0 |
| | | Suitable | 0.7 |
| | | Marginal | 0.3 |
| | | Common | 0.0 |
| | General Wildlife Habitat Quality | Excellent | 1.0 |

**Table 3-7**

**Evaluation Criteria for Wetlands and Riparian Areas
Ocmulgee River Watershed Management Plan**

| **Function** | **Criteria** | **Options** | **Functional Index*** |
|---|---|---|---|
| | | Moderate | 0.5 |
| | | Poor | 0.0 |
| | Habitat Conversion*** | None | 1.0 |
| | | Change Structure | 0.5 |
| | | Change stand | 0.2 |
| | | Change type | 0.0 |
| | Fragmentation | 100 acres+ | 1.0 |
| | | 50–100 acres | 0.7 |
| | | Corridor 300'+ width and 10–50 acres | 0.5 |
| | | Corridor 100'–300' width and 10–50 acres | 0.3 |
| | | Corridor 50'–100' width and < 10 acres | 0.2 |
| | | Corridor < 50' width | 0.0 |
| Hydrology/Flood Storage | Proximity to hydrologic source (e.g., overbank flooding) | Within 100-year floodplain with no obstructions | 1.0 |
| | | Direct contact with other surface flow | 0.3 |
| | Size | Same as acreage for fragmentation | See above |
| | Adjacent land use % impervious surface within 300 meters of wetland and/or 0.5 mile upstream | 50%+ | 1.0 |
| | | 25–49% | 0.5 |
| | | 5–24% | 0.2 |
| | | 0–4% | 0.0 |
| | Water Regime | Seasonally saturated | 1.0 |
| | | Seasonally inundated | 0.7 |
| | | Semipermanently inundated | 0.2 |
| | | Permanently inundated | 0.0 |

**Table 3-7**

**Evaluation Criteria for Wetlands and Riparian Areas**
**Ocmulgee River Watershed Management Plan**

| Function | Criteria | Options | Functional Index* |
|---|---|---|---|
| Sediment, Nutrient, Toxicant Removal | Soil Type% Fine Particles Clay, Silt, O.M. | Sandy clay loam, clay loam, clay | 1.0 |
| | | Sand, sandy loam | 0 |
| | Water Regime | See hydrology | See above |
| | Adjacent Land Use | Row cropping, golf course | 1.0 |
| | | Industrial | 0.5–0.7 |
| | | Retail/commercial | 0.3–0.5 |
| | | Residential/roads | 0.1–0.2 |
| | | Forested | 0.0 |

Notes:

*Overall index = average; value of 1.0 indicates ideal condition.

**Presence of a protected species will be a "red flag," habitat evaluation will be further classified depending on the rarity of the species as indicated by the federal and/or state listing; early successional habitats common to the area will receive a 0 index value.

***Change structure = forested wetland to shrub or herbaceous wetland.

Change stand = bottomland hardwood to pine conversion.

Change type = hydrology alteration such as draining.

Change type areas will be considered for restoration.

Upon development of the criteria, existing data were reviewed to identify potential wetland sites for field evaluation. The most extensive wetland classification system currently available is based on the U.S. Fish and Wildlife Service's NWI maps (see Figure 3-5). These NWI maps are based on interpretation of 1979 and 1988 aerial photographs for potential wetland sites, identifying potential wetlands according to a classification hierarchy based on the Cowardin system. The NWI maps were initially applied under the current evaluation to identify potential wetland sites for field evaluation. The threatened and endangered (T&E) species coverage as provided by EPD included only sparse data broken out to the taxonomic group without a definition of affected areas. A plot of the coverage is provided in Figure 3-6.

Figure 3-5

Figure 3-6

The NWI maps were found to classify the majority of wetlands within the study area as palustrine forested, followed by palustrine emergent and palustrine shrub/scrub. It was estimated that a total of 36 individual apparent wetland sites could be field evaluated as part of the project. Specific sites were selected based on a random, stratified process intended to provide a sample set that was representative of the watershed physiographic regions (Piedmont and Coastal Plain), wetland types (Palustrine forested, Palustrine shrub/scrub, and Palustrine emergent), wetland sizes, and spatial distribution. The locations of the selected 36 sites are shown on Figure 3-7.

During the field survey, each of the above criteria were evaluated, along with the following:

- Vegetative composition
- Approximate stand age
- Wildlife habitat
- Protected species habitat
- Soil parameters (based on a shovel test for the presence of wetland characteristics and texture, with particular focus on silt and clay content)
- Fundamental site characteristics were also noted, including:
- Overall wetland size
- Connectivity to hydrologic source
- Evidence of sedimentation and/or potential pollutants
- Surrounding land uses

Field survey data were then applied in conjunction with digital orthographic infrared (IR) quadrangles (USGS 1999) and existing digital soil survey data to assign final index values to each evaluated wetland. An example IR quadrangle plot with soils data is shown on Figure 3-8.

Streams located adjacent to a surveyed wetland were documented according to:

- Stream morphology
- Potential for mitigation
- Apparent sedimentation problems

However, stream criteria were not developed nor were they assigned index values.

### 3.4.2 Field Reconnaissance Findings

Of the 36 wetland sites evaluated, 22 were identified as palustrine forested and nine as palustrine shrub/scrub or emergent areas. The remaining five areas (Sites 9, 12, 21, 25, and 30) were found to be upland sites that were incorrectly shown on the NWI maps as wetland areas. A total of 21 sites were adjacent to riverine areas, nine of which are listed by the Georgia Department of Natural Resources, EPD as 303(d) impaired waters (see Appendix C). In addition, three wetland sites were noted to have been incorrectly typed by NWI (forested areas mapped as shrub/scrub or wetland, and vice versa). Photographs from each of the 36 sites are provided in Appendix G.

Among all sites evaluated, a total of 105 plant species, consisting of 47 tree and shrub species and 58 herbaceous and vine species, were observed. Tables 3-8 and 3-9 list the plant species noted at each site.

Exotic species, or evidence thereof, were also noted at several sites:

- Feral swine (*Sus scrofa*) – located on eight sites
- Chinese privet (*Ligustrum sinense*) – located on 12 sites
- Microstegium (*Microstegium vimineum*) – located on four sites
- Japanese honeysuckle (*Lonicera japonica*) – located on nine sites
- Kudzu (*Pueraria lobata*) – located on three sites

Figure 3-7

Figure 3-8

Table 3-8, page 1

Table 3-8, page 2

Table 3-9

### 3.4.3 Wetland Functionality

Figure 3-9 provides a summary of index values developed for each of the wetland sites. These values were calculated by averaging the index value for each of the criteria within the four functional components (forest ecology, wildlife habitat, hydrology/flood storage, and water quality). An overall wetland index value was then calculated as the average of all criteria for each site. The overall wetland index values range from 0.34 to 0.72. Forest ecology values range from 0.30 to 0.94; wildlife habitat values range from 0.0 to 0.75; hydrology/flood storage values range from 0.32 to 0.75; and water quality values range from 0.07 to 0.90. These ranges do not include land areas mislabeled by NWI as wetland, which were assigned an index value of 0.0 for all indices.  A summary of index values is provided in Table 3-10. Detailed values for each functional component are provided in Appendix F.

Although the stream assessment was not factored into the wetland indices, tabulated basic stream morphology information, sediment loads, and potential for restoration are provided in Table 3-11. Sediment loading was noted within the substrates of seven out of the 21 documented streams. In general, the riparian zones were noted to be intact; however, there is potential for restoring the riparian zone at evaluation Sites 1 and 13 through planting of native vegetation.

Figure 3-9

Table 3-10

Table 3-11

### 3.5 Integrated Assessment/Spatial Analysis

A watershed health spatial model for the study area has been constructed using the Model Builder Tools of the Spatial Analyst extension of ArcView version 3.2a. The model was developed to incorporate relevant data collected through the project and to then evaluate spatial relationships within the data and rate geographic areas according to selected criteria. This model incorporates land cover, population, water quality results, and NWI wetland classifications. These parameters are compiled within the customized spatial model algorithms to help evaluate the overall health of subareas as well as alternative best management practices (BMPs) (although alternative BMPs were not evaluated as part of the spatial analysis under this study). The model is also very scalable and parameters can be changed easily to examine a range of scenarios. The major categories of model input data are described below, along with processes used to prepare the data for use in the model.

*Imperviousness* levels within a watershed have been shown to directly impact water quality. Imperviousness estimates for each subarea were generated using satellite imagery from the 1992 MRLC land cover data. This value was assigned a 30 percent weight to the overall health of the subarea. Once the data was compiled for the study area, it was clipped to the watershed boundary (see Section 2.2.2). The HUC-12 subareas were then unioned to the MRLC data to estimate imperviousness. The MRLC land cover classifications were next converted to standard Soil Conservation Service (SCS) classifications (SCS 1986). These classifications were weighted based on the percentage of area covered relative to the total subarea. Imperviousness was then assigned according to the SCS TR-55 method (SCS 1986). Each subarea's imperviousness level was then translated into a value between 0 and 9, with 0 representing very little impact, and 9 representing a high level of impact. These values have not been related to any national or state standards. Modeled imperviousness scores are summarized in Table 3-12.

*Population density* has also been commonly associated with a range of water quality issues and was therefore selected by ARCADIS as a key model parameter. It was assigned a weight of 30 percent toward overall subarea (HUC) health. Population density was derived from the Census 2000 block-level population count as provided in the Census 2000 GIS Block. The Census Blocks and the HUC-12 subareas were merged using a map overlay union to allow population to be summed for each specific subarea. The total population of each subarea was divided by its total acreage to produce a unit population value (see Section 2.1.1). All density values were converted to a 0–9 scale for compilation with the other model parameters, with 0 representing the lowest relative density and 9 representing an extremely high density. These values are not intended to reflect relative population densities on a national or state scale. Modeled population density scores are summarized in Table 3-13.

*Wetland conditions* within each subarea was selected as another parameter significant to water quality. This parameter was assigned an overall model weight of 25 percent. The ARCADIS-WEC team developed wetland condition layers based on field reconnaissance findings calibrated to wetland functionality indices (see Section 3.4). The scores developed were assigned on a HUC-10 basis with that score reassigned to all subareas (HUC-12s) within that HUC-10. If more than one wetland reconnaissance site was located within a HUC-10, the average score from those sites was used. Three primary types of wetland sites were identified:

- Palustrine emergent wetlands (PEM) – five sites identified.
- Palustrine forested wetlands (PFO) – 22 sites identified.
- Palustrine shrub/scrub wetlands (PSS) –four sites identified.

Insert Table 3-12

- Insert Table 3-13

- Weight assignments were then compiled to integrate subarea wetland conditions to the model. Wetlands were ranked according to successional maturity. PFO wetlands were assumed to typically represent the more mature wetlands and were therefore assigned the highest weight (50 percent). PSS wetlands were generally considered to be less evolved than those identified as PFO, and were therefore assigned a lower weight of 30 percent. As the least evolved type, PEM wetlands were assigned a weight of 20 percent within the spatial model. Wetland scores for the spatial model are shown in Table 3-14 and on Figure 3-10.

**Table 3-14**
**Wetland Conditions Scoring Summary**
**Ocmulgee River Watershed Management Plan**

| | Score Per Type | | | **Combined** |
|---|---|---|---|---|
| **HUC-10** | **PFO** | **PSS** | **PEM** | **Score** |
| 307010303 | 0 | 0 | 0 | 0 |
| 307010308 | 0 | 0 | 0 | 0 |
| 307010309 | 0 | 0 | 0 | 0 |
| 307010310 | 5 | 0 | 0 | 3 |
| 307010311 | 0 | 0 | 4 | 1 |
| 307010312 | 0 | 0 | 5 | 1 |
| 307010313 | 3 | 5 | 0 | 3 |
| 307010314 | 3 | 0 | 0 | 2 |
| 307010315 | 4 | 5 | 0 | 4 |
| 307010316 | 4 | 5 | 0 | 4 |
| 307010401 | 3 | 0 | 5 | 3 |
| 307010402 | 3 | 4 | 0 | 3 |
| 307010404 | 5 | 0 | 6 | 4 |

Note:

Score Values: 0 = Excellent
9 = Poor

- Insert Figure 3-10

*Water quality results* from the BASINS TARGET module output (for years ranging from 1998 to 2001) were also applied within the spatial model (see Section 3.3). An overall weight of 15 percent was assigned to the water quality score toward the modeled subarea health. The following 10 water quality constituents were input from the TARGET results:

- Total Suspended Solids (TSS)
- Fecal Coliform
- Phosphorus
- pH
- Dissolved Oxygen
- Chemical Oxygen Demand (COD)
- Biochemical Oxygen Demand (5-Day) (BOD-5)
- Total Kjeldahl Nitrogen
- Nitrite Nitrogen
- Nitrate Nitrogen

These constituents were selected based primarily on their known effects to water quality conditions relative to wetlands and aquatic communities, as discussed in Section 3.3.4.

The model was input with a weighted value for each constituent. These values were developed based on the potential degree of degradation each constituent can be expected to have on aquatic systems and/or human health. The weighted values are summarized in the following table:

| Rank | Weighted Value | Ecological Impacts |
|---|---|---|
| Low | 0% – 5% | Minimal or no ecological impacts |
| Moderate | 6% – 15% | Ecological impact is potential at excess concentrations |
| High | 16% – 25% | Ecological impact is probable at excess concentrations |

- TSS – Weighted Value = 15 percent

- TSS was assigned a moderate weighted value. In the short-term, TSS does not typically promote degradation of wetlands. Flow within the wetland systems generally does not provide for a means of significant transport and/or suspension. Over a period of time, TSS may be deposited into the system to a point where it becomes excessive, which can lead to storage decreases and aquatic community degradation.

- Fecal Coliform – Weighted Value = 15 percent

  Fecal coliform was assigned a moderate weighted value. It is typically not a main component in the degradation of wetlands, but is a key indicator species for the evaluation of water quality for human consumption.

- Phosphorus – Weighted Value = 20 percent

  Phosphorus was given a high weighted value. Phosphorus is considered a primary limiting agent in the growth and development of plants, including algae. In excess this constituent may cause detrimental effects within an aquatic system such as a wetland.

- pH – Weighted Value = 5 percent

  pH was assigned a low weighted value. pH is the measure of the acidity or alkalinity of a water body. Wetlands often have a greater tolerance to moderate pH fluctuations.

- Dissolved Oxygen – Weighted Value = 5 percent

  Dissolved oxygen was given a low weighted value. In some cases, wetlands exhibit anaerobic conditions and, therefore, can tolerate low oxygen levels.

- COD – Weighted Value = 10 percent

  COD was given a moderate weighted value. It is primarily a measure of the strength of industrial wastewaters that can inhibit biological activity and/or are not readily biodegradable. High-strength wastewaters are often associated with wetland degradation.

- BOD-5 – Weighted Value = 10 percent

  BOD-5 was assigned a moderate weighted value. This constituent is also a measure of the strength of untreated and treated wastewaters within an aquatic system. Wetland degradation can result from high concentration of wastewaters.

- Total Nitrogen – Weighted Value = 20 percent

  Total nitrogen was given a high weighted value. As with phosphorus, nitrogen is considered a key element in the growth and development of aquatic plants. In excess, nitrogen may contribute to the degradation of an aquatic ecosystem. The individual nitrogen species that make up total nitrogen were assigned internal weights as follows:

  Total Kjeldahl Nitrogen – Weighted Value = 50% (Total Nitrogen)

  Nitrite Nitrogen – Weighted Value = 25% (Total Nitrogen)

  Nitrate Nitrogen – Weighted Value = 25% (Total Nitrogen)

Wetland condition scores developed for the spatial model are shown in Table 3-15.

A summary of the final model structure is shown on Figure 3-11. As discussed above, the weights assigned to the modeled subarea categories (population density, imperviousness, wetland conditions, and water quality results) were based in part according to the strength of the datasets and their relevance to the project objectives. Block level population was one of the more up-to-date and detailed datasets used in the model and was therefore assigned a greater weight. Both population and imperviousness typically have a substantial interrelational impact on water quality. To account for that relationship, as well as the comprehensive level of data available for the watershed, imperviousness was assigned a higher weight. A weakness of this dataset is the age of much of the data. The wetland data was compiled at a local level and would have carried a heavier weight if there were more wetlands documented throughout the study area. The BASINS TARGET modeling results were also given somewhat lower scores due to their inconsistent data coverage within the watershed.

Table 3-15

Figure 3-11

After the model was run, an overall HUC (subarea) health was assigned. Each HUC health value ranged from 9 (poorest) to 1 (excellent). In general, overall HUC health results tended to be directly proportional to population density and imperviousness, with the overall HUC health decreasing as the two factors increased. Therefore, the results of the model indicated the poorest health scores for subareas within the Macon, Georgia area, which have the highest population density and imperviousness levels. Overall HUC health results are summarized in Table 3-16 and on Figure 3-12.

Figure 3-12

Table 3-16

# 4. General Management Strategies

## 4.1 Watershed Issues and Recommended Management Measures

The Ocmulgee River watershed will continue to change with increasing development. As with many watersheds that are experiencing development pressures, the need to control water quality while preserving and protecting natural habitat is essential. The ability to maintain the quality of life for human health, plants, and animals is a necessity for present and future conditions. The following sections discuss issues and recommendations for maintaining, enhancing, restoring, improving, and protecting water quality and ecological health within the watershed. These recommendations are based on the evaluation findings developed under this project.

### 4.1.1 Watershed Issues

As described in previous sections, a number of analyses and assessments were completed as part of this study, including:

- BASINS TARGET and ASSESS
- GIS Watershed Health Spatial Model
- Soil Loss Assessment (RUSLE)
- Wetlands Assessment

Each of these evaluations provided an indication of a different aspect of the overall health of the 60 subareas within the watershed.

The water quality evaluation using BASINS TARGET and ASSESS identified watershed subareas with trends of stream monitoring results that are outside of predetermined threshold values (see Sections 3.3.1 to 3.3.4). The BASINS model results indicate that severe water quality problems are not currently present on a watershed scale. However, some subareas, particularly those in the more urbanized and developing areas, show trends of increasing concentrations for various pollutants (see Appendix E).

The soil loss assessment using the RUSLE model resulted in estimates of sediment loads for each HUC (see Section 3.3.5). Although the results were based on watershed scale data, general trends can be seen based on land uses exhibiting high loading rates. Areas around urbanizing (transitional) zones indicate the highest loading rates and loads tend to be higher within the Coastal Plain land resource area.

The wetland assessment was performed using various functional components:

- Forest ecology,
- Wildlife habitat,
- Hydrology/flood storage, and
- Water quality.

These components were applied to develop an overall wetland index value (see Section 3.4). This assessment indicated that overall, wetlands and riparian zones within the watershed are in relatively good health, although there are locations that may be suitable for restoration and/or enhancement.

The GIS watershed health spatial model provided an overall health score for each subarea within the Ocmulgee River watershed. Land cover, population, water quality modeling results, and wetland conditions were all considered in this process (see Section 3.5). The results generally indicated a need to restore, protect, and/or enhance water quality and ecological features in subareas associated with developed and developing areas.

As shown on Figure 3-12, relative trends for subarea health within the Ocmulgee River watershed have closely followed patterns of development. The poorest estimated health levels are associated with the two subareas located in the most urbanized areas – the northern portion of the city of Macon and most of the city of Warner Robins (subareas 3071031602 and 3071040102, respectively). The next-lowest health levels are associated with the broad development corridor between these two urbanized areas, which extends across the western and eastern boundaries of the watershed between those cities. As a result, nearly all of Bibb County is projected to include subarea health rated as moderate, moderate to poor, and poor (the three lowest rankings). These lower health levels are also projected to extend along a corridor generally lying from Macon north to Forsyth, roughly following State Routes 23 and 18, and including Lake Juliette. It should be noted that all rankings within this study are based solely on a relative comparison of results from within the watershed, and are not referenced to any regulatory or other established guideline.

A somewhat lowered health level has been associated with the subarea that includes the cities of Perry and Fort Valley (30701040202), as well as with two nearby subareas. A more detailed evaluation would be required to determine whether this is related to conditions within one city or the other, or within the corridor between the two municipalities. While all other subareas within the watershed are projected with very good to excellent subarea health, results may be elevated in some cases due to insufficient data. The best health levels are most often associated with subareas that are predominantly forested (the Oconee National Forest and the Piedmont National Wildlife Refuge are located south of Jackson Lake). Subarea issues and projected trends are discussed in greater detail below.

### 4.1.2 Recommended Management Measures (BMPs)

The Ocmulgee River watershed is changing daily as a result of the rapid pace of development. It is becoming more important to implement measures that will minimize water quality pollutants (from point and nonpoint sources) reaching the Ocmulgee River and its tributaries. Management measures or BMPs are recommended to maintain water quality under existing conditions and/or alleviate possible pollutant problems in the future.

Two general categories of management measures, structural and nonstructural, have been developed. Most of these are intended to address multiple problems, while a few also address specific problems.

*Nonstructural BMPs* do not require physical construction of a water quality control device, but are program- and/or policy-oriented actions. Nonstructural BMPs may include:

- Public education
- Volunteer programs
- Incentive programs
- Riparian buffers

- Dedicated greenways
- Federal, state, and local policies and regulations

Nonstructural BMPs tend to provide a more economical and long-term solution to water quality control, attributable mostly to enhanced public awareness and involvement.

*Structural BMPs* involve the utilization of constructed stormwater facilities that are designed for water quality and water quantity control. While all of these are not necessarily applicable to the Ocmulgee River watershed, examples of structural BMPs are listed below:

- On-site and regional detention and retention basins
- Constructed, restored, and enhanced wetlands
- Sand filters
- Oil and grease separators
- Precast stormwater drainage system units
- Grassed swales
- Stream bank restoration
- Porous pavement
- Energy dissipaters

Alternative BMPs (structural and nonstructural) were evaluated as recommendations for the Ocmulgee River watershed in light of the evaluation findings and according to eight general categories of management measures:

- Post-construction runoff controls/Land development provisions
- Public education and outreach

- Public participation/involvement
- Illicit discharge detection and elimination
- Construction site runoff
- Pollution prevention and housekeeping for municipal operations
- Riparian area and wetland protection, enhancement, and restoration
- Other related activities/volunteer activities

Any stormwater planning and related activities should be coordinated with existing regional programs. For example, the Georgia Community Greenspace Program coordinates grants and other incentives for the establishment of greenspace statewide. Counties within the study area that are currently participating in this program are Henry, Newton, Butts, Monroe, Crawford, Bibb, Houston, and Pulaski.

Detailed elements of the eight categories are described in Table 4-1. It should be noted that these measures are not intended to be all-inclusive, and many may not be applicable or feasible within a specific subarea, location or municipality. The intention is to provide useful alternatives that will allow flexibility in the management decision process and provide general direction for watershed protection, management, and enhancement. The measures relevant to the specific watershed subareas (based on the evaluation results) are discussed in the following sections.

Table 4-1

### 4.2 Recommended Management Alternatives

Examination of the results summarized in Tables 3-12 through 3-16 indicates the highest scoring subareas (those with the poorest relative health) exhibited a few common characteristics within their model scoring. While each included the highest levels of imperviousness (to varying degrees), an even more consistent commonality between these subareas was exceptionally poor scores in wetland conditions (see Figure 3-10). More specifically, nearly all of these subareas (with the exception of one) were associated with the lowest concentrations of mature wetlands (PFO and PSS).

Trends related to water quality scores are less apparent. However, higher levels of fecal coliform, total suspended solids (TSS), and chemical oxygen demand (COD) were identified with three subareas within the Macon area (30701031602, 30701031406, and 30701031605). These parameters are most commonly associated with developed and developing areas. Often, elevated fecal coliform levels are identified with poorly functioning septic systems or sanitary sewage facilities, while TSS levels are identified both with new construction and with eroded stream banks serving highly impervious areas. The limited amount of available analytical data from the watershed hampers a more detailed discussion of stream water quality.

In accordance with the evaluation findings, recommended management measures for the Ocmulgee River watershed will emphasize the subareas associated with the greatest development pressures:

| Area | Associated Subarea(s) |
|---|---|
| Macon | 30701031405, 30701031406, 30701031505, 30701031506, 30701031601, 30701031602, 30701031604, 30701031605, 30701040101 |
| Warner Robins | 30701040102, 30701040103 |
| Forsyth | 30701031301, 30701031307 |
| Perry | 30701040202 |

When one of the above four areas is referenced within the discussion of recommendations below, it is implied that the associated subareas are included. Recommended BMPs are more fully described in Section 4.1 and are listed below:

1. Post-construction runoff controls/land development provisions

2. Public education and outreach
3. Public participation and involvement
4. Illicit discharge detection and elimination
5. Construction site runoff control
6. Pollution prevention/good housekeeping at municipal operations
7. Riparian area and wetland protection, enhancement, and restoration
8. Other related activities/volunteer activities

In regard to urban stormwater management, it should be noted that the city of Macon and Bibb County maintain National Pollutant Discharge Elimination System (NPDES) Phase I Municipal Separate Storm Sewer System (MS4) Permits, which were originally issued by the Georgia EPD in 1995 and are reissued every 5 years. The county and city are considered to be medium-sized MS4s and are co-permittees, but with separate MS4 Permits and Stormwater Management Programs, which require that certain best management practices and stormwater monitoring programs be implemented.

The NPDES Phase II Stormwater Permitting Program for small municipalities will become effective in 2003, with certain cities, counties, and other government entities in Georgia required to apply for EPD's General NPDES MS4 Permit by March 10, 2003. In the Ocmulgee study area, small MS4 permittees may include the cities of Byron, Centerville, Griffin, Hampton, Payne City, and Warner Robins, as well as parts of Henry, Houston, Jones, Newton, Peach and Spalding counties (although some counties may not have permitted areas within the study area). These local governments will be required to obtain MS4 permit coverage and develop and implement stormwater management programs during the course of the first five-year permitting period.

More specific recommendations have been presented under each of the above BMPs in Section 4.1; these will be highlighted as appropriate. Reference numbers for BMPs are indexed in Table 4-1.

While each of the recommended management measures is applicable to virtually all of the subareas to some degree, this discussion seeks to highlight BMPs that should be emphasized in each specific subarea. For example, while nearly all aspects of land development provisions (BMP 1) should be practiced at some level throughout the watershed, it is listed below as a recommendation only for subareas currently experiencing development pressures and where these practices should be particularly emphasized. In any case, the extensive use of the *Georgia Stormwater Management Manual* (Atlanta Regional Commission) and the *Manual for Erosion and Sedimentation Control in Georgia* (State Soil and Water Conservation Commission) should be emphasized within all subareas of the watershed.

Each major area identified as experiencing development pressures within the watershed is discussed in Table 4-2 below.

**Table 4-2. Recommended BMPs for Urbanized Areas**

| Area | Recommended BMPs | Comments |
|---|---|---|
| Macon | 1, 2, 3, 4, 5, 6, 7, 8 | As the most densely developed area, emphasis should be placed on increasing greenspace and wetlands restoration. BMPs should also seek to address fecal coliform (point and nonpoint sources should be investigated) and TSS levels. Land management and public education will be important for future improvements to subarea health. |
| Warner Robins | 1, 2, 3, 6, 7, 8 | While experiencing many of the same pressures as Macon, problems with water quality are not as apparent. Poor wetland functionality should be a priority. Public education should point out fertilizer management to address identified nitrate levels. |
| Forsyth | 1, 2, 3, 7 | Enhancement of greenspace and wetlands should be a priority since this area received the highest score in imperviousness levels. HUC 30701031307 impervious score is skewed by predominance of Lake Juliette. |
| Perry | 1, 2, 3, 7 | While exhibiting relatively low population density, this area showed a high level of imperviousness and degraded wetland quality. Emphasis should be placed on greenspace and wetland enhancement. |

Specific BMPs for the remaining subareas are presented in Table 4-3. While these areas have not yet experienced the levels of development pressure discussed above, some degree of land development provisions (BMP 1) and riparian area and wetland protection (BMP 7) should be initiated in each. Emphasis on these measures should be increased to keep pace with increasing development so that subarea health can be preserved or even improved. In particular, local governments must enact and enforce local ordinances in compliance with the Georgia Department of Natural Resources Rules for Environmental Planning Criteria, especially those pertaining to river corridors and wetlands. These two BMPs are additionally listed as a recommendation below where more intense implementation is currently indicated. Specific sites recommended for wetland restoration and enhancement are described in Section 4.3.

In the many subareas dominated by agriculture and forestry, land owners and operators should be encouraged to incorporate appropriate best management practices into their land management. Extensive guidance materials and assistance with these practices are provided by County Extension Agents, local offices of the USDA Farm Service Agency, Natural Resources Conservation Service and Forestry Service, the Georgia Forestry Commission, and various other agencies and university-sponsored programs.

**Table 4-3. Recommended BMPs for Nonurbanized Areas**

| Subarea/HUC | Recommended BMPs | Comments |
|---|---|---|
| 30701030305 | 2f, 5, 7d | Predominantly forest, very little agriculture or other development. Emphasize wetland protection. |
| 30701030803 | 2f, 5, 7d, 7f | Predominantly forest, significant agricultural uses in eastern half. Emphasize wetland protection. |
| 30701030804 | 2f, 5, 7b, 7d | Elevated imperviousness score likely due to inclusion of northeast branch of Jackson Lake. Otherwise predominantly forest with very little agricultural. Buffers and greenspace should be emphasized. |
| 30701030902 | 2f, 5, 7d, 7f | Includes significant levels of woody wetlands and forested lands. Predominantly agricultural uses in western portions. Emphasize wetland protection. |
| 30701030903 | 2f, 5, 7b, 7d, 7f | Elevated imperviousness score likely due to inclusion of most of Jackson Lake. Forested lands and woody wetlands predominate. Some agricultural use in western portion. No identified problems. Buffers and greenspace should be emphasized. |
| 30701031001 | 2f, 2g, 5, 7 | Elevated wetland score, with agricultural uses predominant. Minor residential development in southwest area associated with city of Jackson. Emphasize coordination with agricultural community, wetland protection. |
| 30701031002 | 2f, 5, 7d, 7f | Elevated wetland score, with some agricultural uses in southern and eastern portions. Predominantly forest. Emphasize wetland protection. |
| 30701031003 | 2d, 2f, 5, 7d, 7f | Elevated wetland score, with significant transitional area and widely scattered agricultural uses. Predominantly forested. Emphasize wetland protection. |
| 30701031004 | 2d, 2f, 5, 7d | Elevated wetland score, with scattered transitional areas and some residential use associated with city of Jackson. Predominantly forested, with small remaining area of woody wetland. Emphasize coordination with development community, wetland protection. |

**Table 4-3. Recommended BMPs for Nonurbanized Areas**

| Subarea/HUC | Recommended BMPs | Comments |
|---|---|---|
| 30701031005 | 2d, 2f, 5, 7d, 7f | Elevated wetland score, with minor transitional areas, some agricultural use. Predominantly forested, with small remaining area of woody wetland. Emphasize coordination with development community, wetland protection. |
| 30701031006 | 2f, 5, 7f | Elevated wetland score, with scattered agricultural areas. Predominantly forested with significant areas of woody wetland in central portion. Emphasize coordination with agricultural community, wetland protection. |
| 30701031101 | 2f, 5, 7f | Significant levels of emergent and woody wetlands. Coverage evenly divided between agricultural uses and forested. Emphasize coordination with agricultural community, wetland protection. |
| 30701031102 | 2f, 5, 7d, 7f | Predominantly forested, with some minor development associated with Griffin. Scattered agricultural areas. |
| 30701031103 | 2f, 5, 7f | Predominantly forested with scattered agricultural areas. Coordination with agricultural community advised. |
| 30701031104 | 2d, 2f, 5, 7d, 7f | Slightly elevated imperviousness and population, with western portion dominated by Griffin development. Majority of HUC evenly divided between agricultural uses and forested. Emphasize coordination with both development and agricultural communities. |
| 30701031105 | 2f, 5, 7f | Coverage evenly divided between agricultural uses and forested. Scattered woody wetlands. Emphasize coordination with agricultural community. |
| 30701031106 | 2f, 5, 7b, 7d, 7f | Coverage evenly divided between agricultural uses and forested. Scattered woody wetlands. Small lake in western portion. Emphasize buffers. |
| 30701031201 | 2f, 5, 7d, 7f | Predominantly forested with significant areas of agricultural use. Southern area includes development associated with Barnesville. |
| 30701031202 | 2f, 5, 7f | Predominantly forested with scattered areas of agricultural use. Includes significant area of woody wetlands. Emphasize coordination with agricultural community, wetland protection. |
| 30701031203 | 2f, 5, 7f | Predominantly forested with scattered areas of agricultural use. |
| 30701031204 | 2d, 2f, 4, 5, 7d, 7f | Predominantly forested with small transitional areas, small and scattered agricultural areas. Some fecal coliform monitored, source assessment may be appropriate. Emphasize coordination with development community. |
| 30701031302 | 2f, 5, 7d | Elevated wetland score likely associated with Macon HUC-10. Coverage almost entirely forested. |
| 30701031303 | 2f, 5, 7d | Elevated wetland score likely associated with Macon HUC-10. Coverage almost entirely forested. |
| 30701031304 | 2f, 5, 7d | Elevated wetland score likely associated with Macon HUC-10. Coverage almost entirely forested. |

**Table 4-3. Recommended BMPs for Nonurbanized Areas**

| Subarea/HUC | Recommended BMPs | Comments |
|---|---|---|
| 30701031305 | 2d, 2f, 5, 7d, 7f | Elevated wetland score likely associated with Macon HUC-10. Slightly elevated imperviousness score possibly associated with narrow corridor of transitional use. Otherwise almost entirely forested. Emphasize coordination with development community. |
| 30701031306 | 2d, 2f, 5, 7d, 7f | Elevated wetland score likely associated with Macon HUC-10. Slightly elevated imperviousness score, possibly associated with small and scattered transitional areas. Predominantly forested with some agricultural areas in western portion. Emphasize coordination with both development and agricultural communities. |
| 30701031401 | 2d, 2f, 5, 7d, 7f | Predominantly forested, with small scattered transitional areas. Minor development associated with Barnseville in western area. Emphasize coordination with development community. |
| 30701031402 | 2d, 2f, 5, 7d, 7f | Predominantly forested with scattered agricultural areas. Some development and transitional areas in northeast associated with Forsyth. Significant area of woody and emergent wetlands in south-central portion. Emphasize coordination with development community and wetland protection. Emphasize coordination with agricultural community. |
| 30701031403 | 2f, 5, 7f | Coverage evenly divided between agricultural and forested areas. Emphasize coordination with agricultural community. |
| 30701031404 | 2d, 2f, 5, 7d, 7f | Predominantly forested, with small scattered transitional areas. Emphasize coordination with development community. |
| 30701031501 | 2f, 5, 7f | Elevated wetland score likely associated with Macon HUC-10. Predominantly forested with significant agricultural areas. Emphasize coordination with agricultural community. |
| 30701031502 | 2d, 2f, 5, 7d, 7f | Elevated wetland score likely associated with Macon HUC-10. Predominantly forested with scattered agricultural and transitional areas. Corridor of woody wetlands in central portion. Emphasize coordination with both agricultural and development communities, wetland protection. |
| 30701031503 | 2f, 5, 7d | Elevated wetland score likely associated with Macon HUC-10. Predominantly forested with woody wetlands in eastern portion. |
| 30701031504 | 2d, 2f, 5, 7d, 7f | Elevated wetland score likely associated with Macon HUC-10. Predominantly forested with some agricultural areas and scattered transitional areas. Emphasize coordination with both agricultural and development communities. |
| 30701031603 | 2d, 2f, 5, 7d, 7f | Elevated wetland score likely associated with Macon HUC-10. Slightly elevated imperviousness from isolated transitional areas (proximity to Macon) and development around Gray. Predominantly forested with some agricultural areas. Emphasize coordination with both agricultural and development communities. |
| 30701040103 | 1, 2, 3, 5, 7 | Significantly elevated imperviousness level associated with large transitional areas. Balance is predominantly forested with some agricultural areas. Elevated overall score warrants accelerated planning and BMP implementation focused on retrofit and planning. |

**Table 4-3. Recommended BMPs for Nonurbanized Areas**

| Subarea/HUC | Recommended BMPs | Comments |
|---|---|---|
| 30701040104 | 2d, 2f, 5, 7d, 7f | Somewhat elevated imperviousness level associated with scattered transitional areas. Predominantly forested with significant area of woody wetlands in southwest. Emphasize coordination with development community and wetland preservation. |
| 30701040106 | 2d, 2f, 5, 7d, 7f | Elevated wetland score likely associated with Warner Robins HUC-10. Predominantly forested with some woody wetlands in southwest, scattered transitional areas. Emphasize coordination with development community and wetland preservation. |
| 30701040107 | 1, 2, 3, 5, 7 | Elevated wetland score, with development impacts from Warner Robins. Predominantly forested, with agricultural areas in northwest and large area of woody wetlands through central portion (Ocmulgee River). Some elevated nitrate levels monitored. Emphasize coordination with both agricultural and development communities and wetland preservation. |
| 30701040201 | 2d, 2f, 5, 7f | Elevated wetland score. Coverage almost entirely agricultural uses with only very isolated forested or wetland areas. Development from Fort Valley in northwest. Emphasize coordination with agricultural community. |
| 30701040202 | 1, 2, 3, 5, 7 | Elevated wetland and imperviousness score, with development associated with Fort Valley and Perry, including some industrial uses. Balance of coverage is predominantly agricultural with small isolated forested areas. Emphasize coordination with both agricultural and development communities and wetland preservation. |
| 30701040203 | 2d, 2f, 5, 7 | Elevated wetland score. Coverage predominantly agricultural with some forested areas and isolated transitional areas. Scattered wetlands through central portions. Emphasize coordination with both agricultural and development communities and wetland preservation. |
| 30701040204 | 2d, 2f, 5, 7 | Elevated wetland score. Coverage predominantly agricultural with some forested areas and isolated transitional areas. Scattered wetlands through central portions. Emphasize coordination with both agricultural and development communities and wetland preservation. |
| 30701040205 | 2d, 2f, 5, 7d, 7f | Elevated wetland score. Coverage predominantly agricultural with some forested areas and isolated transitional areas. Emphasize coordination with both agricultural and development communities and wetland preservation. |
| 30701040206 | 2d, 2f, 5, 7d, 7f | Elevated wetland score. Coverage predominantly agricultural. Some forested and wetland areas through central portion. Scattered transitional and urban/recreational areas. Emphasize coordination with both agricultural and development communities and wetland preservation. |
| 30701040207 | 2d, 5, 7d, 7f | Elevated imperviousness and wetland scores, with scattered transitional areas. Predominantly forested coverage with significant areas of agricultural use. Some woody wetlands through central area. Emphasize planning, coordination with both agricultural and development communities, and wetland preservation. |

**Table 4-3. Recommended BMPs for Nonurbanized Areas**

| Subarea/HUC | Recommended BMPs | Comments |
|---|---|---|
| 30701040401 | 1, 2d, 5, 7 | Elevated imperviousness and wetland scores, with scattered transitional areas. Predominantly agricultural areas, isolated forested areas. Emphasize planning, coordination with both agricultural and development communities, and wetland preservation. |
| 30701040402 | 2d, 2f, 5, 7f | Elevated wetland score. Predominantly agricultural areas, isolated forested areas, and scattered woody wetlands through central portion. Emphasize coordination with agricultural community and wetland preservation. |

### 4.3 Potential Wetland Restoration and Enhancement Sites

Of the 31 wetland sites documented, eight have been deemed suitable for wetland mitigation:

- Four sites noted as impacted by silviculture and in various stages of regeneration (Sites 20, 24, 29, and 35 – although Site 35 was apparently cut for agricultural purposes)
- Two sites noted as impacted by cattle (Sites 1 and 10)
- Two sites noted as impacted by agriculture (Sites 13 and 34)

Only Site 13, located along Echeconnee Creek, appeared to have been drained in addition to having vegetation removed for agricultural purposes. Therefore, this site is the only one assessed as suitable for full wetland restoration (restoring both hydrology and vegetation). The remaining seven sites (1, 10, 20, 24, 29, 34, and 35) are nevertheless considered suitable for enhancement (restoring vegetation only).

Native vegetation could be restored at each of the eight sites listed above. It is recommended that the revegetation plan emphasize mass-producing bottomland hardwoods. In addition, those sites noted as shrub/scrub or emergent may also be suitable for enhancement. However, sites 17 and 26 are located within a utility line right-of-way and would not be eligible for revegetation. While these shrub/scrub and emergent sites are currently functional wetlands, it may be desirable to restore them to forested wetlands, following coordination with stakeholders.

Hydrology can be easily restored at Site 13 by placing two water control structures (such as bags of concrete mix staked with rebar) within the ditch along the eastern portion of the site. One water control structure each should be placed at the midpoint (measured from the road east to the end of the agricultural field) and at the easternmost limit of the field. However, it should be noted that soil types will be an important consideration when attempting to restore hydrology at any site. The majority of soils within Site 13 are listed by the Monroe County Soil Survey (unpublished) as Toccoa. These soils are characterized as well-drained sandy loams, which can be problematic when attempting to maintain sufficient surface hydrology for wetland restoration. On-site observations indicated that soils, particularly around the western portion of the site (away from Echeconnee Creek), are predominantly clay loams, which are more suitable for wetland restoration. More intensive soil survey work would be needed at this site to determine the extent to which hydrology can be restored.

#### 4.3.1 Future Detailed Wetland Analyses

As discussed in Section 3, the Ocmulgee River watershed evaluation included two primary assessments:

- Water Quality Assessment (Section 3.3), and
- Wetlands Assessment (Section 3.4)

The Integrated Assessment/Spatial Analysis (Section 3.5) incorporated the findings of these two assessments with other watershed conditions? such as population and land use. The results of this effort provide a framework for future evaluations employing greater detail. As additional information and/or more intense evaluation techniques are brought to bear, this foundational work is intended to assist experienced individuals and agencies with further study of wetland issues throughout the watershed. The wetlands assessment methodology described in Section 3.4 and the forms provided in Appendix F can also be used by persons with wetlands assessment experience to derive wetland functionality indices for additional wetlands in the study area. These results could then be incorporated into the project database.

In order to evaluate potential wetland conditions within a HUC or more specific area, it will be important to understand the correlation between each of the analyses performed and their relevance to the area being evaluated and the issues at hand. For example, imperviousness is an important hydrologic characteristic that is known to have a significant impact on the functionality of downstream wetlands. Higher imperviousness typically leads to higher pollutant levels, more frequent bankfull stages, greater flow velocities and peak discharges, and increased in-stream erosion (soil loss). Some general guidelines exist that may be applied in a wetlands evaluation where imperviousness is a potential issue:

- Imperviousness levels greater than 20 percent are considered as high and therefore may signify an overall need for restoration and/or protection of wetland areas.

- Imperviousness levels between 10 and 20 percent are generally considered as moderate, and it may be necessary to begin protection efforts and possibly restoration at specific locations.

- Imperviousness levels less than 10 percent are considered to be low, and there will likely not be an immediate need for wetland protection and restoration, although conditions should continue to be tracked.

Imperviousness has also been directly linked to development levels, and indirectly to population densities. Increased development is typically related to an increase in population, with more people moving into an area to live and work. Increasing development and population density within an area typically results in a decline in water quality from point and non-point sources, and hence a decline in wetland quality. Looking at each of these issues can be very useful in evaluating potential wetland protection and/or restoration areas at a more detailed level.

The overall watershed health score (Table 3-14) can serve as the starting point for evaluating potential wetland degradation and identifying specific alternatives. Listed HUC health values that can be considered as moderately high, in comparison to other scores, will likely warrant additional investigation. Questions regarding the subarea that should be asked through this process include:

- Where is it located relative to urban areas?

    - Is it near a major city?
    - Will development likely increase because of its location?

- Where is it located with respect to primary surface waters (e.g., reservoirs, major rivers and tributaries, major wetland areas)?

    - Is there a primary surface water within the HUC?

- How does the existing land use compare with projected future land use?

- Will development likely increase significantly, moderately, or at a minimal rate?
- Are conserved lands present or planned within or nearby the subarea?
- Can wetland preservation and/or enhancement be tied to conserved lands?

- Are there any known water quality problems that may affect wetlands?

The answers to these questions should provide essential information that will help determine priority locations for wetland protection and/or restoration.

A theoretical examination of HUC 030701040207 is presented below as one example of this more detailed process. This subarea is located at the southern boundary of the study area, as shown on Figure 3-2. The subarea is made up predominantly of agricultural and forested land uses, and includes a variety of inventoried wetland systems (Figure 3-5). The subarea receives drainage from much of Houston and Peach counties, including developing areas associated with the cities of Perry and Fort Valley, which are located upstream. For this example, an objective has been set to identify optimal wetland preservation and/or rehabilitation areas.

As discussed in Section 3.5, spatial analysis showed somewhat elevated scores for this subarea in imperviousness and wetland health. Combined scoring for the HUC showed an overall health score of "good," although some ongoing wetland degradation may be indicated. The scores for this HUC are detailed in Table 4-4. Given these results, the establishment of additional wetland preservation and/or rehabilitation sites could be warranted for this subarea in order to stem further degradation. A first step in examining this issue would be to take a closer look at the data on hand, as summarized in Figure 4-1.

**Table 4-4. HUC 030701040207 Integrated Analyses Results**

| Description | Result |
|---|---|
| Imperviousness | 6 |
| Population | 1 |
| Wetland | 3 |
| Water Quality | 0 |
| Overall HUC Health | 3 |
| Soil Loss | 1.90 tons/acre/year (relatively low) |

As shown in frame A of Figure 4-1, the majority of inventoried wetland systems are located in the northern portion of the subarea, which is also shown to include primarily forested areas. The southern portion of the subarea is dominated by agricultural uses. The elevated health scores could therefore be associated with agricultural impacts within the HUC and with upstream development pressures (see upstream areas in Figure 3-5). Although the Threatened & Endangered (T&E) Species database is very coarse, it can nevertheless be seen that two groups of listed plant species (monocotyledons and dicotyledons) have been identified in the general vicinity north and east of the HUC, suggesting additional benefits to preservation efforts in this area. An examination of Table 2-7 shows that EPA has developed a TMDL for fecal coliform for the segment of Big Indian Creek running northwest to southeast through the subarea. The 2002 Georgia 303(d) listing shows this segment as partially supporting its designated use of fishing. Any management practices planned for the subarea should therefore be coordinated with any efforts related to the TMDL for the stream.

Frame B of Figure 4-1 shows an overlay of the inventoried wetland systems with the T&E species and projected land use coverages for the HUC. It can be seen that a large area of conserved land is projected for the northern portion of the subarea, corresponding with the locations of NWI systems, and in accord with the current forested land uses. Optimal wetland preservation/rehabilitation areas could likely be identified within, and coordinated with, the projected conserved lands, and more precisely within or near the designated NWI systems.

Frame C of Figure 4-1 presents a detailed image of conserved lands in this area of the HUC. The NWI systems are overlaid to the infrared orthophotos for the area, along with the T&E species coverage. A close examination of these images will identify a number of existing wetland areas that could be set aside for preservation and/or rehabilitation as part of the establishment of conserved lands already planned. Once potential sites have been identified, field evaluations and discussions with relevant agencies, land owners and other stakeholders would be conducted so that final sites can be established and wetland health is improved within the HUC.

Figure 4-1

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# Appendix A

Public Education and Stakeholder Involvement Materials

## Appendix B

Modified Basins Code and Tables

# Appendix C

Water Quality, Population Projections, and Related Data Sources

## Appendix D

BASINS ASSESS Results

# Appendix E

BASINS TARGET Results

# Appendix F

Wetlands Assessment Survey Forms and Data

# Appendix G

Wetland Site Photographs