FINAL

Environmental Impact Statement

Enhanced Evaluation of Cumulative Effects Associated With US Army Corps of Engineers Permitting Activity For Large-Scale Development in Coastal Mississippi

AUGUST 2005

VOLUME I

Prepared for

US Army Corps of Engineers
Mobile District

Prepared by

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COOPERATING AGENCIES

Environmental Protection Agency—Region 4 • U.S. Fish and Wildlife Service • National Marine Fisheries Service
National Aeronautics and Space Administration—John C. Stennis Space Center • National Oceanic and Atmospheric Administration
Federal Highway Administration • Mississippi Department of Environmental Quality • Mississippi Department of Marine Resources
Mississippi Department of Transportation • Mississippi Secretary of State • Mississippi Department of Archives and History
Mississippi Department of Wildlife, Fisheries & Parks • Gulf Regional Planning Commission • Hancock County Port and Harbor Commission
Jackson County Board of Supervisors • Hancock County Board of Supervisors • Harrison County Economic Development Commission
Mississippi Gulf Coast Chamber of Commerce

CERTIFICATION CONCERNING CONFLICTS OF INTEREST

No person involved in the preparation of this Environmental Impact Statement stands to profit from the findings of the document, any decision made based on the findings, or the results of any such decision.

Signature:	Date:
Kristin J. Shields	August 2005

Kristin Shields,
Tetra Tech, Inc.

FINAL
ENVIRONMENTAL IMPACT STATEMENT

***LEAD AGENCY*:** U.S. Army Corps of Engineers, Mobile District

***COOPERATING AGENCIES*:** U.S. Environmental Protection Agency, Region 4; U.S. Fish and Wildlife Service; National Marine Fisheries Service; National Aeronautics and Space Administration, John C. Stennis Space Center; National Oceanic and Atmospheric Administration; Federal Highway Administration; Mississippi Department of Environmental Quality; Mississippi Department of Marine Resources; Mississippi Department of Transportation; Mississippi Secretary of State; Mississippi Department of Archives and History; Mississippi Department of Wildlife, Fisheries and Parks; Gulf Regional Planning Commission; Hancock County Port and Harbor Commission; Jackson County Board of Supervisors; Hancock County Board of Supervisors; Harrison County Economic Development Commission; Mississippi Gulf Coast Chamber of Commerce

***TITLE*:** Environmental Impact Statement for Enhanced Evaluation of Cumulative Effects Associated with U.S. Army Corps of Engineers Permitting Activity for Large-Scale Development in Coastal Mississippi

***DESIGNATION*:** Final EIS for Public Review

***PROPOSED ACTION*:** Develop and implement an enhanced methodology that would provide consistent and objective consideration of regional cumulative effects and mitigation in environmental impact analyses associated with permit evaluations for future large-scale development projects in coastal Mississippi for which a Corps individual permit is required.

***AFFECTED JURISDICTION*:** Harrison County, Hancock County, and western Jackson County, Mississippi.

***POINT OF CONTACT*:** Dr. Susan I. Rees, Technical Representative, U.S. Army Corps of Engineers, Mobile District, 109 St. Joseph Street, Mobile, AL 36602-3605

***ABSTRACT*:** This EIS is a hybrid document with a scope that departs in several notable ways from a traditional analysis under the National Environmental Policy Act. The scope is twofold: (1) to produce a comprehensive analysis of recent and reasonably foreseeable development trends and associated environmental conditions, and (2) to consider the effects of putting into place a tailored method for evaluating and mitigating regional cumulative effects in environmental impact evaluations associated with future permit applications for large-scale development projects in coastal Mississippi. The trends analysis associated with the EIS evaluates relevant planning documents and projects coastal Mississippi development trends and their cumulative effects spanning the period from 1992 to 2020 using geographic information systems (GIS) and econometric forecasting models.

The EIS evaluates long-term (20-year) regional cumulative effects of Corps permitting actions in the coastal Mississippi area under various development scenarios and regulatory frameworks. For the proposed action, the EIS assesses the environmental and socioeconomic effects of developing and implementing a consistent methodology for conducting cumulative effects analyses that would rely on the results of the trends analysis in future Corps permit decisions

regarding applications for large-scale development projects in coastal Mississippi that require individual Corps permits. Under the no action alternative, the Corps would continue to perform cumulative effects analysis for permits on an ad hoc basis, and regional growth would continue to be managed as in the past. Essentially, the no action alternative represents the status quo and serves as a benchmark against which the proposed action can be evaluated. The results of the trends analysis and the effects of the no action alternative and proposed action are summarized below.

Trends Analysis Growth Scenarios and Projections. Four growth scenarios were evaluated to assess the future environmental and socioeconomic conditions of the coastal Mississippi area. The population of the three coastal counties is projected to grow by 17 percent (in the absence of further gaming expansion, i.e., the low-growth scenario) to more than 50 percent (if the rate of gaming expansion for the period from 2000 to 2020 were to remain the same as during the 1990s (i.e., the high-growth scenario). Under the high-growth scenario, the populations of Harrison and Hancock Counties are projected to increase by 68 percent and 60 percent, respectively, during the period from 2000 to 2020. Under the high-growth scenario, population growth in Jackson County would also accelerate, but at a lower rate than the other two counties (a 32 percent increase by the year 2020). Although Jackson County is assumed not to build any gaming facilities during the study period from 2000 to 2020, development projects in Harrison County would likely spur economic and population growth in the western portion of Jackson County. In the absence of further gaming development, Hancock County and Jackson County would likely to experience modest growth (26 percent and 24 increase in population by the year 2020, respectively), while Harrison County would likely experience relatively low growth (a 10 percent increase by 2020). The projected growth under the low- and high- growth scenarios would likely result in a loss of 1 to 3 percent (9,000 to 27,000 acres) of natural habitat across the three-county area to increased development. Impervious surface is projected to increase by 19 to 73 percent as compared with current levels, and high-density development would likely double under the high-growth scenario.

No Action Alternative. The conditions of resources described in this EIS for each growth scenario reflect the range of possible conditions that may occur under the no action alternative under varying economic conditions. As compared with current (2000) conditions, continued growth under the no action alternative would likely result in minor to potentially significant adverse impacts on several natural resources, including water quality, wetlands, and federally listed species. With respect to socioeconomic conditions, minor to potentially significant adverse impacts would be expected for public safety, protection of children from risk, and transportation, relative to current conditions. In addition, significant beneficial effects would be expected for economic conditions.

Proposed Action. A comprehensive trends analysis that identified the principal regional cumulative effects associated with induced development from Corps permitting actions was conducted. The results of the analysis were integrated into a special-purpose permit evaluation methodology for enhanced consideration and mitigation of regional cumulative effects associated with large-scale development projects. Under the proposed action, enhanced consideration of regional cumulative effects during permitting and implementation of mitigation strategies (termed Regional Conservation Practices [RCPs] in the EIS) to reduce these effects would result in minor to significant beneficial effects relative to the no action alternative. It should be noted that most of these mitigation strategies (RCPs) are beyond the regulatory authority of the Corps of Engineers. Thus, many RCPs would need to be adopted voluntarily by state, local, and/or private developers; others might be included as special permit conditions by the Corps for large-scale development projects, on a case-by-case basis. The principal strategies for minimizing regional

cumulative effects identified through the trends analysis included enhanced storm water control measures; enhanced management strategies and new technology for reducing septic tank failures; enhanced wetland creation and mitigation tracking; and increased intervention for the protection of federally listed species, such as the Mississippi gopher frog. Relative to current (2000) conditions, implementation of the proposed action might mitigate significant adverse effects on most resources, even under high-growth conditions.

***REVIEW COMMENT DEADLINE*:** The Final EIS is available for review and comment for 60 days, beginning August 26, 2005, through October 24, 2005. The Final EIS is being made available for review at each of the libraries in Hancock, Harrison, and Jackson Counties. It will also be posted on the Corps's website at www.sam.usace.army.mil. Public comments should be provided to Dr. Susan Rees at the Corps of Engineers, Mobile District, P.O. Box 228, Mobile, AL 36682-0001; by telephone at (251) 694-4141; by fax at (251) 690-2605; or by e-mail at susan.i.rees@sam.usace.army.mil. The deadline for submitting written comments on the Final EIS is October 24, 2005.

EXECUTIVE SUMMARY

BACKGROUND

This Environmental Impact Statement (EIS) has been prepared by the U.S. Army Corps of Engineers (the Corps) to address the environmental and socioeconomic consequences of implementing a cumulative impacts-based permitting methodology in coastal Mississippi. Cumulative effects are defined as the environmental effects that result from the incremental impact of various past, present, and reasonably foreseeable future actions. The methodology uses a trends-based analysis to provide consistent and objective consideration of cumulative effects in environmental impact analyses. The methodology would be used to help evaluate permits for development projects in the coastal Mississippi region for which an individual Corps permit is required and for which the Corps prepares an environmental assessment or a third party prepares an EIS. The methodology would improve the evaluation of the cumulative effects of development projects that require Corps permits, especially in environmentally sensitive areas of coastal Mississippi. The EIS was undertaken in accordance with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 et seq.), *Council on Environmental Quality Regulations Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR Parts 1500–1508), and Corps regulations for implementing NEPA (33 CFR Parts 230 and 325).

The Corps envisions that future, project-specific NEPA analyses in the study area could, as appropriate, incorporate by reference applicable portions of this EIS.

NEED

For several decades prior to 1992, development in coastal Mississippi occurred on a relatively small scale and was concentrated in the areas near the Mississippi Sound. In the 1990s, however, coastal Mississippi experienced significant growth and development. Pursuant to Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972, developers are required to obtain a Corps permit when a proposed project would directly, indirectly, or cumulatively affect jurisdictional waters of the United States. From 1992 to 2000, the Corps issued permits for a number of large-scale development projects.

In the permitting process, consideration of potential environmental effects has historically focused on the direct and indirect effects of individual projects. Recently, because of increased concerns over the effects of induced growth and the incremental loss of sensitive resources such as wetlands and other coastal habitats, there is an increased need to understand the regional cumulative effects of all proposed actions for which permits are required, as well as those of other, unrelated, development activities in the region.

Accurate evaluation of cumulative effects is a task that relies on the gathering of substantial amounts of information. Although the permitting process during the past decade has attempted to take cumulative impacts into account, the Corps believes there is a need for a better, more comprehensive approach and understanding of cumulative effects. This need could be met if a comprehensive regional trends analysis could be made available to local and regional planners, developers, the Corps, other regulatory agencies, and the public.

A major limitation of traditional cumulative effects analysis is that individual permit applicants typically assess only those cumulative effects closely related to their projects. Activities or projects

not related to a proposed action or which would not occur near a proposed project are often ignored or only superficially evaluated. The reason for this is twofold: First, individual applicants are reluctant to extend their cumulative effects consideration to areas not directly affected by or adjacent to their project because of the increased costs of conducting such an analysis. Second, because the actual impact of a proposed project is usually quite limited in terms of spatial and temporal impact, imposition of a regional-scale analysis for such projects could seem unreasonable and overly burdensome. This limitation, together with the rapid and significant economic and environmental changes in the Mississippi coastal region, has prompted the Corps to develop a specific methodology that could be replicated and that could more fully capture the cumulative effects of proposed development projects.

DOCUMENT DEVELOPMENT

Several federal and state agencies joined the Corps in preparation of the EIS. The Corps is the lead agency, and the other agencies are participating in cooperating agency roles. These other agencies have brought information and experience in resource-specific areas to the NEPA process, as well as an interest in identifying and analyzing the relevant issues. Federal agencies that participated in preparation of this EIS are the U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Federal Highway Administration (FHWA), and National Aeronautics and Space Administration (NASA). Participating state and local agencies are the Mississippi Secretary of State; Mississippi Department of Marine Resources (MDMR); Mississippi Department of Environmental Quality (MDEQ); Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP); Mississippi Department of Archives and History (MDAH); Mississippi Department of Transportation (MDOT); Hancock County Port and Harbor Commission; Gulf Regional Planning Commission (GRPC); Jackson County Board of Supervisors; Hancock County Board of Supervisors; Harrison County Economic Development Commission; and Mississippi Gulf Coast Chamber of Commerce.

DOCUMENT CONTENT

The EIS is a hybrid document with a scope that departs from a traditional NEPA analysis. The scope is twofold: (1) to produce a comprehensive analysis of recent and reasonably foreseeable development trends and associated environmental conditions in coastal Mississippi, and (2) to consider the effects, in the context of environmental impact analyses, of implementing a tailored method for evaluating cumulative effects for development projects in coastal Mississippi that require a Corps permit.

Based on relevant data and studies, the trends analysis underlying the proposed methodology projects coastal Mississippi development trends and their cumulative effects spanning the period from 1992 to 2020. The EIS does not analyze the effects of any particular proposal for which an applicant has sought or might seek a permit. Rather, in order to provide a more informed understanding of cumulative effects, the EIS considers actions in the study area since 1992, known pending actions, and postulated future actions. The effects of adopting the proposed special-purpose methodology are compared with the effects that could be expected if the Corps did not adopt such a methodology.

Study Area and Regions of Influence

The primary region of influence (ROI) considered in the EIS encompasses the coastal counties of Mississippi, which are Hancock, Harrison, and Jackson Counties. Because most of the development that can be linked to Corps permitting actions has occurred along the coast, a more focused

assessment of cumulative impacts was conducted for what is referred to in the EIS as the "Coastal Study Area." The Coastal Study Area encompasses an area from the coastline to 2 miles north of Interstate10 in Hancock and Harrison Counties and the western portion of Jackson County. Note, however, that for some resource areas the geographical coverage of the trends analysis extends to portions north of the three ROI counties. Certain natural resources, such as surface water, for example, were more appropriately analyzed in terms of watershed boundaries, because water quality is influenced by the cumulative effects of all actions that occur within the watershed. For other resources, such as socioeconomics, the data necessary for conducting the analysis were not readily available on a subcounty basis, and analyses were performed at the county level. Thus, although the impacts analyzed in the EIS in Jackson County are primarily concentrated in the western part of the county, all of Jackson County was considered in the socioeconomic analysis because of the impracticality of modeling economic impacts at the subcounty level.

Trends Analysis

Given the uncertainty associated with predicting the condition of natural resources and socioeconomic conditions over a 20-year period, a comprehensive trends analysis was conducted to evaluate changes that could occur under different growth scenarios. Major features of the technical approach for conducting the trends analysis in the EIS are described below.

Temporal scope. The Corps employed two principal time frames for the trends analysis. The first time frame runs from 1992 to 2000, which was used to measure the past rate of growth in the coastal area. The second time frame runs from 2000 to 2020. The year 2000 was the baseline year for the study because the most recent analytical data used in the trends analysis date, to a large extent, from the year 2000. The year 2020 is the endpoint for which trends and cumulative effects are projected.

Simulation of change. The key indicators of growth simulated in the EIS are changes in land cover, socioeconomic parameters (e.g., economic output, population), and resource conservation strategies used within defined areas for the year 2020. Simulations of changes in these indicators are used as inputs for various resource-specific predictive models to characterize resource conditions in 2020.

Four growth scenarios. The trends analysis relies on four growth scenarios: *low growth* (relative to historical trends), *baseline (most likely) growth* (based on average growth over the past 30 years), *high growth* (continuation of growth rates calculated to have occurred between 1992 and 2000), and *medium growth* (between the baseline and high-growth scenarios).

Evaluation of conditions. The trends analysis examines two variants for each growth scenario. The first variant assumes growth proceeds in the presence of existing conservation, resource management, and infrastructure conditions and practices. The second variant assumes growth proceeds with enhanced conservation, resource management, and infrastructure conditions and practices. In this case, it is assumed that localities impose and enforce an optimal regime of controls and other measures benefiting the natural and human environments. Although the majority of these control measures are beyond the regulatory authority of the Corps, the measures are provided as recommendations to assist other groups in selecting management strategies for conserving coastal resources.

Spatial scope. The spatial scope of the trends analysis depends on the resource being evaluated. Generally, the three-county area was used, with an emphasis given to areas within the Coastal Study Area. As mentioned earlier, certain resource areas were assessed at a larger scale.

Special-Purpose Methodology

The Corps's proposed special-purpose methodology builds on existing local permit application and review procedures and the Corps's regulations for NEPA compliance in performing regulatory program functions (33 CFR Parts 230 and 325). The Corps's adoption of this methodology is not intended to change or lengthen the permit application process. Rather, these procedures should significantly enhance the cumulative effects analyses provided in environmental documentation for large-scale development projects, thereby effectively reducing the potential for delays in permit decisions (as well as project implementation, if approved). Furthermore, the methodology developed in the EIS will provide a conduit for advice on resource management measures that other groups may adopt for reducing the adverse environmental effects of regional development. The new methodology, as proposed, is outlined below.

- Conduct a comprehensive regional cumulative effects analysis using trends analysis and available studies (from the Mississippi Department of Marine Resources [MDMR] under the Coastal Resource Management Planning effort and other groups) in order to better understand the long-term, regional cumulative effects from past, present, and potential future growth, particularly as it relates to Corps permitting actions.

- Provide data, results, and methods so that future permit applicants and Corps permit writers and evaluators can use the results of the trends analysis as part of the cumulative effects section of future NEPA analyses and documentation (either Corps-generated environmental assessments [EAs] or third-party EISs). It is not the Corps's intention that permit applicants be required in the future to conduct a detailed analysis of regional cumulative effects that replicates the level of analysis and detail presented in this EIS. On the contrary, one of the objectives of developing the special-purpose methodology is to provide a means for permit applicants to quickly link their site-specific actions to the trends analysis in the EIS. It is hoped that this would help to address difficult regional cumulative effects issues in future NEPA documentation.

- Based on the results of the trends analysis, develop and identify regional conservation practices (RCPs) that are being or could be used for the management and conservation of coastal resources and avoid and reduce the adverse cumulative effects of development. As part of the special-purpose methodology, RCPs can be used and implemented in the following two ways:

    1. *Formulate site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects*. When reviewing a proposed development project, the Corps could formulate site-specific permit conditions based in part on applicable RCPs to avoid and reduce adverse environmental effects.

    2. *Foster adoption of RCPs that non–Corps entities (e.g., federal, state, and local agencies, and private entities) could elect to use to enhance ongoing programs, develop new requirements and regulations, initiate planning studies, or implement mitigation and control measures to reduce cumulative effects*. Based on the results of the trends analysis, most of the RCPs needed to reduce cumulative effects are beyond the regulatory authority of the Corps and thus fall into this category. These RCPs may be implemented in the following ways:

- State and local regulatory authorities could elect to formulate new regulations based in part on these RCPs to manage coastal resources and reduce environmental and/or socioeconomic effects of development.

- Federal, state, and local regulatory authorities, as well as nongovernmental organizations, could elect to conduct studies based in part on these RCPs to better understand the effects of development on coastal resources.

- Federal, state, and local regulatory authorities, as well as nongovernmental organizations, could elect to incorporate RCPs, in whole or in part, into ongoing and new coastal planning initiatives for the conservation of coastal resources.

- Private entities could elect to formulate mitigation measures and best management practices (BMPs) based in part on these RCPs to reduce adverse environmental and socioeconomic effects of specific development projects.

In addition, in the case of wetlands, a third type of RCP has been identified: Regional studies and management approaches could be implemented through an interagency cooperative effort for the conservation of coastal resources (pending the availability of funds).

ALTERNATIVES CONSIDERED

Three alternatives are considered in the EIS. First is the proposed action, implementation of a special-purpose permit evaluation methodology based on use of a comprehensive trends analysis. Second is deferral[1] on development trends and cumulative effects matters to appropriate state, regional, and local agencies within the constraints of the law. Such deferral would include passage of any enabling legislation that might be required. This alternative could include preparation of the trends analysis by the Corps, or it could omit preparation of a trends analysis by the Corps. Third is the no action alternative, required by regulations of the Council on Environmental Quality (CEQ). The no action alternative consists of the Corps continuing to evaluate cumulative effects on an ad hoc basis. No trends analysis would be developed under the no action alternative.

Proposed Action: Permit Review Methodology and Comprehensive Trends Analysis

The Corps's preferred alternative is the proposed action. It consists of implementing a special-purpose methodology based on the results of a comprehensive trends analysis for considering cumulative effects in environmental impact analyses or development projects in coastal Mississippi.

Deferral to State/Local Agencies

Coastal Mississippi applicants for permits for activities subject to Section 10 of the Rivers and Harbors Act of 1899 or Section 404 of the Clean Water Act of 1972 submit a *Joint Application and Notification* to the Corps.[2] In evaluating each permit application, the Corps invites public and agency comment on all individual permit applications. Agency views are accorded due weight because they reflect the expert opinion of officials who have both subject matter expertise and responsibility for the types of actions at issue. Under this alternative, the Corps would provide trends analysis

[1] In common usage, *defer* means either "to put off to another time" or "to yield in judgment or opinion." The Corps intends that only the latter use of the word pertain in this document.
[2] Copies of applications are provided to the MDMR and MDEQ, Bureau of Pollution Control.

information to state and local agency officials or to a state-empowered and jointly staffed regional agency and solicit their views on whether permits should be issued based on their evaluation of cumulative effects.

Three principal factors render this alternative impracticable. First, it is reasonable that, based on the same data, various state and local agencies and their federal counterparts could arrive at opposing or conflicting conclusions concerning cumulative effects. In such a case, the Corps would have to decide among the agencies' recommendations in a process little different from the approach currently used. Second, no state-empowered regional development authority or environmental protection authority currently exists that can override other state and local agencies on development decisions. Third, the Corps ultimately has sole decision-making authority on permit applications. Absent congressional action granting such authority to another entity, acceptance of state and local recommendations as binding on Corps decisions could be an impermissible compromise of the independent responsibility and judgment entrusted to the Corps. Because of these factors and the time that would be required to change them, adoption of an alternative predicated on deferral to state and local agency judgment is not feasible and, therefore, is not examined further in this EIS.

No Action Alternative

Under the no action alternative, the Corps would not implement the proposed methodology nor use the trends analysis. The Corps would continue to perform cumulative effects analysis for permits on an ad hoc basis. Inclusion of the CEQ-required no action alternative in the EIS also serves as a benchmark against which the proposed action is evaluated.

SUMMARY OF ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

Table ES–1 is a summary of the environmental and socioeconomic consequences of the alternatives analyzed in this EIS for each resource area considered.

Table ES–1

Summary of Environmental and Socioeconomic Effects

No Action Alternative (Baseline)	Proposed Action
Socioeconomics: Economics	
• Minor to significant beneficial effects on economics might occur relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. • Population Growth (2020): 431,000–565,000 (368,000 in 2000). • Population % Growth (2020): 17–54 percent. • GRP (2020): $14.5–$18.5 billion ($10 billion in 2000). • Employment (2020): 252,000–336,000 (227,000 in 2000). • Under the low-growth scenario (zero growth in casino sector), Hancock and Jackson Counties projected to still have robust growth (about 25 percent growth by 2020) from other sectors, while only 10 percent growth is projected for Harrison County by 2020. • Under the high-growth scenario, Harrison and Hancock Counties would grow by more than 60 percent; 85 percent of this growth would be directly associated with casino development. • About 8 percent of casino growth would spill into Jackson County, accounting for 25 percent of the county's overall growth under the high-growth scenario.	• Similar to no action alternative.
Socioeconomics: Public Services and Safety	
• Minor adverse effects on public services might occur relative to current (2000) conditions. • Significant adverse effects on public safety might occur relative to current conditions under the medium- and high-growth scenarios, assuming that casino development would drive future growth. • Growth scenarios reflect future conditions under the no action alternative. Adverse effects include potential increases in crime and social problems, as cited in the *National Gambling Impact Study Commission Report* (1999).	• Long-term minor beneficial effects on public services might occur from implementing RCPs relative to the no action alternative. RCPs include enhanced regional planning and implementation of action items in the *National Gambling Impact Study Commission Report*. • No effect to minor adverse effects on public services might occur relative to current conditions (2000). • Public safety might continue to deteriorate relative to current (2000) conditions even with implementation of RCPs.
Socioeconomics: Environmental Justice	
• Minor adverse effects on environmental justice might occur relative to current (2000) conditions under the high-growth scenario. • Growth scenarios reflect future conditions under the no action alternative. Adverse effects include increased potential for encroachment and displacement of environmental justice neighborhoods.	• Long-term minor beneficial effects on environmental justice neighborhoods might occur from implementing RCPs (e.g., enhanced regional planning and consideration of environmental justice issues) relative to the no action alternative. • No effect to minor adverse effects might occur relative to current (2000) conditions.

Table ES–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Socioeconomics: Protection of Children	
• Minor to significant adverse effects on children might occur under the medium- and high-growth scenarios relative to current (2000) conditions assuming casino development would drive future growth. • Growth scenarios reflect future conditions under the no action alternative. Potential adverse effects associated with gambling activities cited in the *National Gambling Impact Study Commission Report* include family disintegration, substance abuse, and increased criminal activity.	• Long-term minor beneficial effects on children might occur relative to the no action alternative from implementing RCPs (e.g., implementing action items in the *National Gambling Impact Study Commission Report*). • However, risks to children might continue to increase relative to current (2000) conditions even with the implementation of RCPs, assuming casino development would continue to drive future growth.
Land Use/Land Cover	
• No conflict effects relative to current (2000) conditions would occur because all development would be subject to relevant state, county, and community land use zoning, comprehensive plans, and subdivision regulations. • Growth scenarios reflect future conditions under the no action alternative. Substantial land cover changes are projected for the entire area relative to current (2000) conditions. Specific impacts are addressed in other resource sections. • Development in the Coastal Study Area would increase by 8 percent to 31 percent, and impervious surface would increase by 19 percent to 73 percent relative to 2000. High-density growth is projected to double under the high-growth scenario. • Loss of natural area cover in the three counties would range from 9,000 to 27,000 acres, or 1 percent to 3 percent, of available natural habitat. • Demands for office, retail, and wholesale space in the three coastal counties are projected to grow 31 percent to 47 percent relative to current conditions (2000) under the medium- and high-growth scenarios.	• Long-term minor beneficial effects (on other resources) might occur, relative to the no action alternative, from implementing RCPs that advocate low-impact development methods, habitat conservation, and enhanced regional planning. Land cover changes, however, would still be similar to those under the no action alternative.

Table ES–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Water Resources	
• Minor to moderate adverse effects on water quality might occur under the most-likely and low-growth scenarios. • Minor to significant adverse effects on water quality might occur under the medium- and high-growth scenarios. Primary impacts due to increased pathogen, nutrient, and BOD_5 loadings, particularly during storm events. Sedimentation would not be a significant adverse impact on water quality, relative to other stressors. Inadequate storm water controls (due to serious wetland loss and increased impervious surface) and septic tank failures would continue to be the major cause of water quality impairments along the coast. • Growth scenarios reflect future conditions under the no action alternative. Many water bodies in the region are included on the state's 303(d) list, primarily as a result of pathogens, nutrients, and BOD_5 loadings. Subwatersheds that would likely experience the most significant decline in water quality relative to current conditions due to increased loadings of these parameters include De Lisle, Lower Wolf River, Rotten Bayou, Tuxachanie Creek, and (to a lesser extent) Biloxi River. Subwatersheds that would change little relative to current conditions include Bayou La Croix, Upper Jourdan River, and Upper Wolf River. Turkey Creek–Old Fort Bayou is already significantly impaired and would not experience dramatic changes in loadings. However, significant increases in impervious surface under the high-growth scenario, along with minor increases in loadings, would result in additional impairments in Turkey Creek–Old Fort Bayou.	• Long-term minor to significant beneficial effects on water quality might occur relative to the no action alternative from implementing RCPs. RCPs focus on controlling storm water peak flows containing nutrients and pathogens, and reducing sources (septic tank failures). RCPs are summarized below: – Require latest technology and BMPs for new septic tank installations – Enact inspection and maintenance requirements, as well as public outreach initiatives, to enhance existing septic tanks – Expand sewer systems in areas with septic tank failures – Implement MS4 program requirements – Implement BMPs for nonpoint source controls (agriculture) and construction (including riparian buffers) – Implement low-impact development landscape design approaches for storm water control – Create wetlands and bioretention facilities for storm water control • Minor adverse to significant beneficial effects might occur relative to current (2000) conditions depending on the location and extent of RCP implementation.
Geology, Soils, and Groundwater	
• Negligible to minor adverse effects on soils might occur under all growth scenarios. Soil loss might be reduced in some subwatersheds due to loss of agricultural land cover, whereas soil loss might increase to a minor extent in other subwatersheds. • Improper installation or maintenance of septic tanks located in hydric soils has caused septic tank failures, which have resulted in significant adverse impacts on water quality. • There are insufficient data to quantify the carrying capacity of groundwater aquifers in the region. Lowering of the groundwater table and saltwater intrusion might occur in the future. It is unclear, however, whether the carrying capacity of these aquifers would be reached in 20 years. Data suggest infrastructure is sufficient to address future needs.	• Long-term minor beneficial effects on soils and groundwater might occur relative to the no action alternative from enhanced regional planning and implementation of RCPs. • Minor adverse effects on soils and groundwater might occur relative to current (2000) conditions.

Table ES–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Biological Resources: Terrestrial Life (Vegetation and Wildlife)	
• Minor adverse effects on vegetation cover and wildlife populations might occur south of I-10; only negligible adverse effects are likely to occur north of I-10 relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. Loss of natural area cover within the three counties might range from 9,000 acres (most-likely growth scenario) to 27,000 acres (high-growth scenario), or 1 percent to 3 percent, of available natural habitat. Loss of wet pine savanna and bottomland hardwood forests would be expected.	• Long-term minor beneficial effects might occur from implementing RCPs that advocate prescribed burning (where practical), clustered development, wildlife corridors, riparian habitat conservation, monitoring, and enhanced management of sensitive habitat. • Minor adverse effects would still likely occur relative to current (2000) conditions under both the medium- and high-growth scenarios.
Biological Resources: Wetlands	
• Minor adverse effects on wetlands might occur relative to current (2000) conditions under the most-likely and low-growth scenarios. • Significant adverse effects on wetlands might occur relative to current (2000) conditions under the medium- and high-growth scenarios. • Growth scenarios reflect future conditions under the no action alternative. Loss of emergent wetlands in the Coastal Study Area would range from 1,000 acres (most-likely growth scenario) to 5,000 acres (high-growth scenario), or 5 percent to 21 percent, of available emergent wetland habitat. Cumulative losses over a 50-year period would range from one-third to nearly one-half of emergent wetlands in the Coastal Study Area. Loss of wetlands in bottomland hardwood and pine savanna forests would also occur. However, data are insufficient to quantify potential losses.	• Long-term minor to significant beneficial effects might occur from implementing RCPs relative to the no action alternative. RCPs include instituting a functional value assessment study and tracking system, implementing watershed-based mitigation decision making, conducting a detailed study of wetland stressors, implementing ecosystem restoration/creation projects, implementing a robust mitigation tracking system, and requiring wetland creation for storm water management (where practical). • Minor adverse to minor beneficial effects might occur relative to current (2000) conditions depending on the extent of RCP implementation.
Biological Resources: Aquatic Life	
• Minor adverse effects on aquatic life might occur relative to current (2000) conditions as a result of increased development. However, significant cumulative adverse effects on aquatic life from human activities and natural causes have occurred, particularly on sea grass beds, over the past several decades. • Growth scenarios reflect future conditions under the no action alternative. Significant deterioration of aquatic life habitat has occurred, including adverse fluctuations in salinity levels, erosion due to severe weather events, nutrient loadings, and direct loss due to development and shoreline protection measures.	• Long-term minor beneficial effects from implementing RCPs would occur relative to the no action alternative. RCPs include bulkhead and seawall design modifications, wetland mitigation, modification to navigation channel maintenance procedures, ecological restoration and monitoring (sea grass beds), salinity monitoring, and storm water management. • Minor adverse to minor beneficial effects might occur relative to current (2000) conditions depending on the extent of RCP implementation.

Table ES–1

Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Biological Resources: Rare, Threatened and Endangered (RTE) Species	
• Minor to significant adverse effects on RTE might occur relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. Federally listed species would not be expected to reach recovery goals with continuation of historical growth and current management approaches. Of particular note is the possible extinction of the Mississippi gopher frog in the absence of significant intervention.	• Long-term minor to potentially significant beneficial effects from implementing RCPs might occur relative to the no action alternative. RCPs include RTE species research, monitoring, and mapping; implementation of water quality RCPs; control of invasive species and natural predators; use of prescribed burning for forest management (where practical); initiation of habitat conservation plan and intervention efforts to protect the Mississippi gopher frog, as appropriate; public outreach and involvement initiatives; restriction and control of mining activities that impact RTE species; conservation of riverine habitat; protective buffers for RTE species; and restrictions on recreational activities as appropriate to protect beach RTE species' habitat. • Minor adverse to significant beneficial effects might occur relative to current (2000) conditions depending on the extent of RCP implementation.
Cultural Resources	
• Minor adverse effects on cultural resources might occur relative to current (2000) conditions, particularly under the medium- and high-growth scenarios. • Growth scenarios reflect future conditions under the no action alternative. Increased potential for high-intensity development to encroach upon historic structures. Increased potential to disturb yet-undiscovered archaeological sites. •	• Long-term minor beneficial effects on cultural resources might occur relative to the no action alternative from enhanced regional planning. • However, unavoidable minor adverse effects might occur relative to current (2000) conditions even with the implementation of RCPs.
Air Quality	
• Negligible to minor adverse effects on air quality might occur relative to current (2000) conditions under the low- and most-likely growth scenarios, while minor to significant adverse effects might occur under the medium- and high-growth scenarios. • Growth scenarios reflect future conditions under the no action alternative. Increases in mobile sources might result in increased ozone precursor emissions that might in turn result in increased ozone levels. Limited historical trends suggest that increases in mobile sources have not directly resulted in increases in ozone levels; in fact, ozone levels have decreased slightly. Significant growth, however, might ultimately result in the area's being designated in nonattainment for ozone, particularly under the medium- and high-growth scenarios.	• Long-term minor beneficial effects on air quality might occur relative to the no action alternative from enhanced regional planning and control of ozone precursor emissions. • Minor adverse effects on air quality might occur relative to current (2000) conditions even with the implementation of RCPs.

Table ES–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Noise	
• Overall, minor adverse effects on noise levels might occur under all growth scenarios relative to current (2000) conditions. Significant adverse effects might occur if high-intensity development and unacceptable noise levels encroach upon sensitive land uses (e.g., hospitals, schools, nursing homes, churches). • Growth scenarios reflect future conditions under the no action alternative. Increases in high-density development might result in increased levels of noise, particularly along transportation corridors and from construction activities. High-density development is expected to increase by 10,000 to 24,000 acres in the coastal counties. This increase is expected to occur primarily in medium-density areas, where average noise levels might increase by 10 to 20 dB compared with current conditions.	• Long-term minor beneficial effects on noise levels might occur relative to the no action alternative from enhanced regional planning (that minimizes noise near sensitive areas) and implementation of noise abatement measures (e.g., noise barriers along highway corridors, use of noise-reducing technology for construction machinery and aircraft). • Minor beneficial to minor adverse effects on noise levels might occur relative to current (2000) conditions depending on the extent of RCP implementation and location. Significant adverse effects should be avoided.
Utilities	
• Minor to moderate adverse effects on infrastructure might occur relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. Overall, levels of service should be maintained through adaptive management. Adverse effects that are likely to occur include increased potential for flooding due to inadequate storm water control measures and increases in impervious surface, and septic tank failures.	• Long-term minor to moderate beneficial effects on infrastructure and the environment might occur relative to the no action alternative from implementing RCPs. Infrastructure RCPs include upgrading storm water control measures (inflow and infiltration corrective action, wetland creation, bioretention facilities); applying LID planning methods; expanding wastewater treatment system coverage; expanding water supply systems; evaluating alternative water supply approaches; implementing septic tank BMPs (implementing maintenance, stricter permitting regulations, use of alternative treatment technology); and expanding recycling programs. • Minor beneficial to minor adverse effects on infrastructure might occur relative to current (2000) conditions depending on the extent of RCP implementation.
Transportation	
• Negligible to minor adverse effects might occur on all transportation modes, with the exception of auto traffic. Significant adverse impacts on auto traffic would be expected under all growth scenarios, but particularly under the medium- and high-growth scenarios and along major transportation corridors (e.g., US 90, I-10, Popps Ferry Road, Pass Road, and other corridors and interchanges). Also, significant public safety risks would continue to increase at railroad crossings, particularly under the medium- and high-growth scenarios. • Growth scenarios reflect future conditions under the no action alternative. Overall, levels of service (LOS) during peak hours would reach severe congestion levels with LOS values ranging from D to F.	• Long-term minor to significant beneficial effects on transportation might occur relative to the no action alternative from implementing RCPs. Transportation RCPs include updating regional comprehensive transportation plans as appropriate, developing east/west and north/south connectors, relocating CSX mainline tracks north of I-10, enhancing Coastal Transit Authority coverage, and evaluating and implementing transportation management strategies (e.g., regional synchronized traffic signals, Intelligent Transportation System, carpooling, multimodal systems). • Minor beneficial to minor adverse effects on infrastructure might occur relative to current (2000) conditions depending on the extent of RCP implementation and location.

Table ES–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Visual and Aesthetic Resources	
• Minor to potentially significant adverse effects on visual and aesthetic resources might occur relative to current (2000) conditions depending on the nature of future projects and the intensity of growth. • Growth scenarios reflect future conditions under the no action alternative. High-density development is expected to increase by 30 to nearly 100 percent by 2020, depending on the growth scenarios. High-density development might encroach on historic structures and natural areas, which could adversely affect visual and aesthetic vistas in the region.	• Long-term minor beneficial effects on visual and aesthetic resources might occur relative to the no action alternative from enhanced regional planning and application of landscape planning measures that minimize adverse visual and aesthetic impacts associated with large-scale development projects. • However, unavoidable adverse effects might occur relative to current (2000) conditions even with the implementation of RCPs.

As part of the proposed action, RCPs were developed to enhance regional resource management and conservation efforts, principally undertaken by local and state agencies for the reduction of adverse effects associated with development. RCPs consist of a wide range of best management practices, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. These RCPs were developed to reduce specific cumulative effects from development as identified through the EIS process, particularly through the trends analysis. As part of the special-purpose methodology, RCPs might be used and implemented in two primary ways:

1. ***Formulate site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects***. Upon the review of proposed large-scale development projects, the Corps of Engineers might formulate site-specific permit conditions based in part on these RCPs (identified in Table 5.15–2 under this first heading) for the reduction of environmental and/or socioeconomic effects.

2. ***By conducting the trends analysis and providing the results of this EIS, foster adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects***.

    - State and local regulatory authorities might elect to formulate new regulations based in part on these RCPs to conserve coastal resources and reduce environmental and/or socioeconomic effects from development.

    - Federal, state, and local regulatory authorities, as well as nongovernmental organizations might elect to conduct studies based in part on these RCPs to provide a better understanding of the effects of development on coastal resources.

    - Federal, state, and local regulatory authorities, as well as nongovernmental organizations might elect to incorporate, in whole or in part, RCPs as part of ongoing and/or new coastal planning initiatives for the conservation of coastal resources.

- Private entities might elect to formulate mitigation measures and BMPs based in part on these RCPs in order to reduce environmental and/or socioeconomic effects associated with specific development projects.

In the case of wetlands, a third way of implementing RCPs was identified: Regional studies and management approaches could be implemented through an interagency cooperative effort for the conservation of coastal wetland resources (subject to the availability of funds).

Unavoidable Adverse Environmental Effects

Both the no action alternative and the proposed action would result in some unavoidable adverse environmental effects. Although the magnitude, extent, or duration of these impacts would be reduced through mitigation, certain adverse effects would be unavoidable. The principal unavoidable adverse effects on the environment are summarized below.

- ***Water Resources.*** Issuance of additional permits for large-scale developments under the no action alternative would have direct and indirect minor to significant adverse effects on water quality, as discussed in Section 5.3, depending on the extent of future growth in the region. Under the proposed action, these impacts would be reduced. However, unavoidable adverse effects would occur under both alternatives, because increases in impervious surface under each growth scenario would likely continue to stress stream geomorphology and aquatic habitat. Implementation of RCPs to reduce these impacts under the proposed action might result in only minor adverse impacts on water quality and geomorphology even under high-growth conditions. In particular, enhanced application of RCPs for controlling storm water peak flows, particularly the use of created wetlands and bioretention units, might improve conditions even beyond current conditions.

- ***Biological Habitat/Wildlife.*** Induced growth, particularly under the high-growth scenario, would result in unavoidable loss of terrestrial habitat in the region. This loss of habitat would in turn result in adverse effects on wildlife and sensitive species. Of particular concern is the significant cumulative loss of wetlands in the Coastal Study Area due to anthropogenic and natural causes. Implementation of RCPs to enhance wetland function, create wetlands, and closely manage and track wetland loss and mitigation efforts would reduce and could reverse these negative trends.

- ***Visual and Aesthetic Resources.*** Some loss of scenic attractiveness and loss of scenic integrity would be associated with implementing either of the alternatives. Implementing the no action alternative, however, would have greater visual and aesthetic impacts than implementing the proposed action.

- ***Groundwater Resources.*** Projected population growth would continue to place increased demands and unavoidable adverse impacts on aquifers of the region under both the no action and proposed action alternatives. In the long term, additional growth might ultimately lead to a need to ensure alternative sources of water using reservoirs.

TABLE OF CONTENTS

SECTION 1.0:
INTRODUCTION, PURPOSE, AND NEED 1-1

1.1 INTRODUCTION 1-1
1.2 PURPOSE OF AND NEED FOR THE PROPOSED ACTION 1-1
1.3 SCOPE 1-2
1.3.1 Study Area and Regions of Influence 1-3
1.3.2 Resource Areas 1-5
1.3.3 Large-Scale Development 1-7
1.4 PUBLIC INVOLVEMENT AND SCOPING 1-7
1.4.1 Public Involvement 1-7
1.4.2 Public and Agency Scoping 1-7
1.4.3 Public Review of Draft EIS 1-8
1.4.4 Public Meeting 1-9
1.5 REGULATORY AUTHORITIES AND PROCESSES 1-9

SECTION 2.0:
PROPOSED ACTION 2-1

2.1 INTRODUCTION 2-1
2.2 STATEMENT OF THE PROPOSED ACTION 2-1
2.2.1 Trends Analysis 2-2
2.2.2 Special-Purpose Methodology 2-2
2.2.3 Implementation Methods for Individual Large-Scale Permit Applications 2-4
2.2.4 Guiding Principles 2-7

SECTION 3.0:
ALTERNATIVES 3-1

3.1 INTRODUCTION 3-1
3.2 PERMIT REVIEW METHODOLOGY
AND COMPREHENSIVE TRENDS ANALYSIS 3-1
3.3 DEFERRAL TO STATE/LOCAL AGENCIES 3-1
3.4 NO ACTION ALTERNATIVE 3-2

SECTION 4.0
AFFECTED ENVIRONMENT 4-1

4.1 SOCIOECONOMICS 4-1
4.1.1 Population 4-1
4.1.2 Employment 4-3
4.1.3 Income 4-7
4.1.4 Housing 4-8
4.1.5 Quality of Life 4-9
4.1.5.1 Schools 4-9

4.1.5.2 Public Safety 4-12
4.1.5.3 Recreation 4-16
4.1.6 Environmental Justice 4-17
4.1.7 Protection of Children 4-17
4.2 LAND USE AND LAND COVER 4-18
4.2.1 Coastal Counties 4-20
4.2.1.1 Hancock County 4-25
4.2.1.2 Harrison County 4-27
4.2.1.3 Jackson County 4-27
4.2.2 Coastal Study Area 4-30
4.2.3 Watershed Study Area 4-32
4.2.3.1 Bay St. Louis Watershed 4-34
4.2.3.2 Biloxi Bay Watershed 4-36
4.2.4 Land Use Controls 4-36
4.3 UTILITIES 4-38
4.3.1 Water Supply 4-38
4.3.1.1 Groundwater as a Source of Supply 4-38
4.3.1.2 City of Gulfport Water System 4-40
4.3.1.3 City of Biloxi Water System 4-41
4.3.1.4 D'Iberville, Ocean Springs, and Gautier Water Systems 4-42
4.3.1.5 Water Service in the Unincorporated Areas 4-43
4.3.2 Wastewater 4-43
4.3.2.1 Wastewater Treatment Facilities in the Three-County Region 4-47
4.3.2.1.1 Hancock County Wastewater Treatment Facilities 4-47
4.3.2.1.2 Harrison County Wastewater Treatment Facilities 4-48
4.3.2.1.3 Jackson County Wastewater Treatment Facilities 4-50
4.3.2.2 Wastewater Collection System Facilities in the Three-County Region 4-52
4.3.2.2.1 Hancock County Wastewater Collection System 4-52
4.3.2.2.2 Harrison County Wastewater Collection System 4-52
4.3.2.2.3 Jackson County Wastewater Collection System 4-55
4.3.3 Storm Water 4-56
4.3.3.1 City of Biloxi Storm Water System 4-56
4.3.3.2 City of Gulfport Storm Water System 4-56
4.3.3.3 Jackson County Storm Water System 4-57
4.3.4 Solid Waste and Hazardous Waste 4-57
4.3.4.1 Solid Waste Collection and Disposal System in the Three-County Region 4-57
4.3.4.2 Hazardous Waste Facilities in the Three-County Region 4-58
4.3.4.2.1 Hancock County Hazardous Waste Sites 4-59
4.3.4.2.2 Harrison County Hazardous Waste Sites 4-59
4.3.4.2.3 Jackson County Hazardous Waste Sites 4-60
4.3.5 Telecommunications and Energy Systems 4-61
4.3.5.1 Telecommunications Systems in the Three-County Region 4-61
4.3.5.2 Energy Systems in the Three-County Region 4-61
4.3.5.2.1 Electrical Power Utilities 4-61

4.3.5.2.2 Natural Gas Utilities 4-62
4.4 TRANSPORTATION AND TRAFFIC 4-63
4.4.1 Airports 4-63
4.4.1.1 Gulfport-Biloxi International Airport 4-63
4.4.1.1.1 Commercial and Charter Operations 4-63
4.4.1.1.2 Air Cargo Operations 4-67
4.4.1.1.3 Military Operations 4-68
4.4.1.1.4 General Aviation Operations 4-68
4.4.1.1.5 Summary 4-68
4.4.1.2 Stennis International Airport 4-68
4.4.2 Railroads 4-69
4.4.2.1 CSX Railroad 4-69
4.4.2.2 Kansas City Southern Railroad 4-69
4.4.2.3 Port Bienville Shortline Railroad 4-69
4.4.2.4 Railroad Grade Crossings 4-71
4.4.2.5 CSX Mainline Relocation 4-71
4.4.3 Transit 4-72
4.4.3.1 Coast Transit Authority 4-72
4.4.3.2 Operations 4-72
4.4.3.3 Ridership 4-74
4.4.3.4 Future Transit Plans 4-74
4.4.4 Ports 4-76
4.4.4.1 Port Bienville 4-76
4.4.4.2 Port Of Gulfport 4-77
4.4.4.3 Port Of Biloxi 4-78
4.4.5 Roadways 4-79
4.4.5.1 Background 4-79
4.4.5.2 Existing Transportation Plan and Implementation 4-80
4.4.5.3 Existing Congestion 4-81
4.4.5.4 Levels of Service 4-82
4.4.5.5 Jackson County 4-82
4.4.5.6 New Roadway Route 4-83
4.5 AIR QUALITY 4-84
4.5.1 Baseline Conditions 4-86
4.5.2 Air Quality 4-90
4.6 NOISE 4-92
4.6.1 Baseline Conditions 4-94
4.7 GEOLOGY AND SOILS 4-95
4.7.1 General Physiographic Location 4-95
4.7.2 Geology 4-96
4.7.2.1 Pleiocene, Miocene, Oligocence, and Eocene Sediments 4-96
4.7.2.2 Recent Pleistocene Sediments 4-98
4.7.2.3 Seismicity 4-99
4.7.3 Soils 4-99

4.7.3.1 Soil Erosion and Best Management Practices 4-99
4.7.3.2 Agricultural Use of Soil 4-108
4.7.3.3 Septic Tank Suitability 4-108
4.7.4 Hydrogeology 4-110
4.7.4.1 Description of Aquifer System 4-110
4.7.4.2 Water Use and Supply 4-111
4.7.4.3 Saltwater Intrusion 4-112
4.7.4.4 Aquifer Recharge 4-113
4.8 WATER RESOURCES 4-114
4.8.1 Government Agency Overview 4-114
4.8.2 Coastal Mississippi Watershed Study Area—Baseline Conditions 4-114
4.8.2.1 Location and Description 4-115
4.8.2.2 Tributaries 4-115
4.8.2.3 Topography 4-117
4.8.2.4 Flows and Exchanges 4-117
4.8.2.5 Watersheds 4-118
4.8.2.5.1 Bay St. Louis Watershed 4-118
4.8.2.5.1.1 Bayou La Croix 4-118
4.8.2.5.1.2 De Lisle 4-118
4.8.2.5.1.3 Lower Wolf River–Can Creek Subwatershed 4-120
4.8.2.5.1.4 Rotten Bayou 4-121
4.8.2.5.1.5 Upper Jordan River 4-121
4.8.2.5.1.6 Upper Wolf River 4-122
4.8.2.5.2 Biloxi Watershed 4-122
4.8.2.5.2.1 Biloxi River 4-123
4.8.2.5.2.2 Turkey Creek–Old Fort Bayou 4-123
4.8.2.5.2.3 Tuxachanie Creek 4-125
4.8.2.5.3 The Islands Watershed 4-126
4.8.2.6 Beaches 4-126
4.8.2.7 Sediment Quality 4-126
4.8.3 Pollutant Loads 4-126
4.8.3.1 Watershed Loads 4-126
4.8.3.2 Point Source Discharges 4-136
4.8.3.3 Water Quality 4-137
4.8.3.3.1 Physical Characteristics 4-140
4.8.3.3.2 Pathogens 4-141
4.8.3.3.3 Sediment 4-141
4.8.3.3.4 Eutrophication 4-141
4.8.3.3.5 Metals 4-142
4.8.3.3.6 Organics 4-142
4.8.3.4 Beaches 4-142
4.8.3.5 Sediment Quality 4-143
4.8.4 Mississippi Coastal Study Area Watersheds–Historical Analysis 4-144
4.8.4.1 Historical Conditions 4-144

4.8.4.1.1 Physical Characteristics 4-144
4.8.4.1.2 Pathogens 4-145
4.8.4.1.3 Sediment 4-145
4.8.4.1.4 Eutrophication 4-145
4.8.4.1.5 Metals 4-145
4.8.4.1.6 Organics 4-145
4.8.4.1.7 Beaches 4-146
4.8.4.1.8 Sediment Quality 4-146
4.8.4.2 Historical Trends 4-147
4.8.4.2.1 Physical Characteristics 4-147
4.8.4.2.2 Pathogens 4-148
4.8.4.2.3 Sediment 4-149
4.8.4.2.4 Eutrophication 4-150
4.8.4.2.5 Metals 4-154
4.8.4.2.6 Organics 4-157
4.8.4.2.7 Beaches 4-157
4.8.4.2.8 Sediment Quality 4-157
4.8.4.3 Summary 4-159
4.9 COASTAL PROCESSES 4-160
4.9.1 Coastal Processes—Baseline Conditions 4-160
4.9.1.1 Coastline Changes 4-160
4.9.1.2 Wind Effects 4-161
4.9.1.3 Circulation 4-161
4.9.1.4 Human Changes to the System 4-161
4.9.2 Coastal Processes—Historical Analysis 4-161
4.10 BIOLOGICAL RESOURCES 4-162
4.10.1 Terrestrial Vegetation 4-163
4.10.1.1 Upland Deciduous Forest 4-163
4.10.1.2 Upland Mixed Forest 4-164
4.10.1.3 Upland Pine Forest 4-164
4.10.1.4 Upland/Wet Scrub/Shrub 4-165
4.10.1.5 Upland/Wet Cutover Land/Burned Land 4-165
4.10.1.6 Upland/Wet Sand/Barren Land 4-165
4.10.1.7 Bottomland Hardwood Forest/Swamp 4-165
4.10.1.8 Wet Pine Forest/Pine Savannah 4-166
4.10.1.9 Emergent Wetlands 4-166
4.10.1.10 Historical Trends 4-167
4.10.2 Wetlands 4-168
4.10.2.1 Introduction 4-168
4.10.2.2 Baseline Conditions 4-170
4.10.2.3 Historical Look at Wetland Loss, Nationwide and in Mississippi 4-171
4.10.2.4 Specific Wetland Losses (from Corps Permitting Records, 1992-2000) 4-173
4.10.2.5 Summary 4-179
4.10.3 Aquatic Resources 4-180

4.10.3.1 Baseline Conditions 4-180
4.10.3.2 Aquatic Plants 4-181
4.10.3.3 Aquatic Invertebrates 4-183
4.10.3.4 Commercial Fisheries 4-184
4.10.3.5 Fish Species 4-187
4.10.3.5.1 Finfish 4-188
4.10.3.5.2 Shrimp 4-190
4.10.3.5.3 Oysters 4-192
4.10.3.5.4 Blue Crabs 4-195
4.10.3.6 Essential Fish Habitat (EFH)Assessment 4-196
4.10.3.6.1 EFH in Mississippi Sound 4-199
4.10.3.6.2 EFH Alterations of Particular Concern 4-200
4.10.3.6.3 EFH Loss Rates and Trends in Mississippi 4-201
4.10.3.6.4 Threats to Essential Fish Habitat 4-201
4.10.4 Threatened and Endangered Species 4-202
4.10.4.1 Introduction 4-202
4.10.4.2 Baseline Conditions 4-203
4.10.4.2.1 Alabama Red-bellied Turtle 4-206
4.10.4.2.2 Bald Eagle 4-207
4.10.4.2.3 Black Pine Snake 4-207
4.10.4.2.4 Brown Pelican 4-208
4.10.4.2.5 Eastern Indigo Snake 4-208
4.10.4.2.6 Gopher Tortoise 4-208
4.10.4.2.7 Green Sea Turtle 4-209
4.10.4.2.8 Gulf Sturgeon 4-210
4.10.4.2.9 Kemp's Ridley Sea Turtle 4-210
4.10.4.2.10 Loggerhead Turtle 4-211
4.10.4.2.11 Louisiana Black Bear 4-211
4.10.4.2.12 Louisiana Quillwort 4-212
4.10.4.2.13 Manatee 4-213
4.10.4.2.14 Mississippi Gopher Frog 4-213
4.10.4.2.15 Mississippi Sandhill Crane 4-214
4.10.4.2.16 Pearl Darter 4-214
4.10.4.2.17 Piping Plover 4-215
4.10.4.2.17.1 Critical Habitat for the Piping Plover 4-216
4.10.4.2.17.2 Critical Habitat Designation/Land Ownership 4-216
4.10.4.2.18 Red-Cockaded Woodpecker 4-220
4.10.4.2.19 Yellow-Blotched Map Turtle 4-221
4.10.4.3 Historical Trends 4-221
4.10.4.3.1 Introduction 4-221
4.10.4.3.2 The Period of 1972 through 1992 4-222
4.10.4.3.3 The Period of 1992 through 2000 4-223
4.11 CULTURAL RESOURCES 4-224
4.11.1 Introduction 4-224

4.11.2 Baseline Conditions 4-225
4.11.2.1 Prehistoric Period Resources 4-234
4.11.2.2 Historic Period Resources 4-236
4.11.2.3 Underwater Resources 4-243
4.11.2.4 Native American Resources 4-243
4.11.2.5 Previous Work in the Coastal Study Area 4-243
4.11.3 Historical Trends 4-245
4.12 VISUAL AND AESTHETIC RESOURCES 4-245
4.12.1 Introduction 4-245
4.12.2 National Forest 4-247
4.12.3 National Seashore 4-247
4.12.4 National Wildlife Refuges 4-247
4.12.5 National or State Register of Historic Places 4-247
4.12.6 State Parks 4-247
4.12.7 State Historic District 4-247
4.12.8 Historical Trends 4-248

SECTION 5.0
ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES 5-1

5.1 SOCIOECONOMICS 5-3
5.1.1 Socioeconomic Conditions 5-3
5.1.1.1 Trends Analysis for Socioeconomic Conditions 5-3
5.1.1.2 Growth Scenarios 5-4
5.1.1.2.1 Description of the Most-Likely (Baseline) Economic Growth Scenario 5-4
5.1.1.2.2 Description of the Low-, Medium-, and High-Growth Scenarios for the Trends Analysis 5-7
5.1.1.3 Consequences on Socioeconomic Conditions 5-13
5.1.1.3.1 No Action Alternative 5-13
5.1.1.3.2 Proposed Action 5-14
5.1.1.3.2.1 Regional Conservation Practices 5-14
5.1.1.3.2.2 Effects of Implementing the Proposed Action on Socioeconomic Conditions 5-15
5.1.2 Public Services and Safety 5-15
5.1.2.1 Trends Analysis for Public Services and Safety 5-15
5.1.2.2 Consequences for Public Services and Safety Under the No Action Alternative 5-16
5.1.2.3 Consequences for Public Services and Safety Under the Proposed Action 5-16
5.1.3 Environmental Justice 5-17
5.1.3.1 Trends Analysis for Environmental Justice 5-17
5.1.3.2 Consequences of the No Action Alternative on Environmental Justice 5-20
5.1.3.3 Consequences of the Proposed Action on Environmental Justice 5-20
5.1.4 Protection of Children 5-21
5.1.4.1 Trends Analysis for the Protection of Children 5-21
5.1.4.2 Consequences of the No Action Alternative on the Protection of Children 5-21
5.1.4.3 Consequences of the Proposed Action on the Protection of Children 5-21

5.2 LAND USE AND LAND COVER 5-22
5.2.1 Trends Analysis 5-22
5.2.1.1 Technical Approach 5-22
5.2.1.2 Growth Scenarios 5-25
5.2.1.2.1 Most-Likely Growth Scenario 5-25
5.2.1.2.2 Low-Growth Scenario 5-30
5.2.1.2.3 Medium-Growth Scenario 5-31
5.2.1.2.4 High-Growth Scenario 5-36
5.2.2 No Action Alternative 5-41
5.2.2.1 Comparison of Changes in Urban Growth Under the Various Growth Scenarios 5-42
5.2.2.2 Loss of Land Cover Types to Urban Areas Under the Various Growth Scenarios 5-46
5.2.2.3 Comparison of Changes in Impervious Surfaces Under the Various Growth Scenarios 5-47
5.2.2.4 Comparison of Changes in Employment Sector Space under the Various Growth Scenarios 5-47
5.2.3 Proposed Action 5-48
5.2.3.1 Regional Conservation Practices 5-48
5.2.3.2 Effects of Implementing the Proposed Action 5-48
5.3 WATER RESOURCES 5-49
5.3.1 Surface Water 5-49
5.3.1.1 Trends Analysis for Surface Water Resources 5-49
5.3.1.1.1 Technical Approach for Surface Water Resources 5-49
5.3.1.1.2 Growth Scenarios 5-50
5.3.1.2 No Action Alternative 5-58
5.3.1.3 Proposed Action 5-62
5.3.1.3.1 Regional Conservation Practices 5-62
5.3.1.3.2 Effects of Implementing the Proposed Action 5-65
5.3.2 Coastal Processes 5-65
5.4 GEOLOGY, SOILS, and GROUNDWATER 5-65
5.4.1 Trends Analysis for Geology, Soils, and Groundwater 5-65
5.4.2 No Action Alternative 5-67
5.4.3 Proposed Action 5-67
5.4.3.1 Regional Conservation Practices 5-67
5.4.3.2 Effects of Implementing the Proposed Action 5-69
5.5 BIOLOGICAL RESOURCES 5-69
5.5.1 Terrestrial Life 5-69
5.5.1.1 Trends Analysis for Terrestrial Life 5-69
5.5.1.1.1 Technical Approach for Terrestrial Life 5-69
5.5.1.1.2 Growth Scenarios 5-70
5.5.1.2 No Action Alternative 5-74
5.5.1.3 Proposed Action 5-74
5.5.1.3.1 Regional Conservation Practices 5-74
5.5.1.3.2 Effects of Implementing the Proposed Action 5-76
5.5.2 Wetlands 5-76

5.5.2.1 Trends Analysis for Wetlands 5-77
5.5.2.1.1 Technical Approach for Wetlands 5-77
5.5.2.1.2 Growth Scenarios 5-77
5.5.2.2 No Action Alternative 5-80
5.5.2.3 Proposed Action 5-80
5.5.2.3.1 Regional Conservation Practices 5-81
5.5.2.3.2 Effects of Implementing the Proposed Action 5-82
5.5.3 Marine Aquatic Life 5-83
5.5.3.1 Trends Analysis for Marine Aquatic Life 5-83
5.5.3.1.1 Technical Approach for Marine Aquatic Life 5-83
5.5.3.1.2 Growth Scenarios 5-83
5.5.3.2 No Action Alternative 5-86
5.5.3.3 Proposed Action 5-88
5.5.3.3.1 Regional Conservation Practices 5-88
5.5.3.3.2 Effects of Implementing the Proposed Action 5-91
5.5.4 Rare, Threatened, and Endangered Species 5-91
5.5.4.1 Trends Analysis for Rare, Threatened, and Endangered Species 5-91
5.5.4.1.1 Technical Approach for Rare, Threatened, and Endangered Species 5-91
5.5.4.1.2 Growth Scenarios 5-92
5.5.4.2 No Action Alternative 5-96
5.5.4.3 Proposed Action 5-96
5.5.4.3.1 Regional Conservation Practices 5-96
5.5.4.3.2 Effects of Implementing the Proposed Action 5-99
5.6 CULTURAL RESOURCES 5-99
5.6.1 Trends Analysis, Mississippi Coastal EIS Cultural Resources 5-99
5.6.1.1 Technical Approach 5-99
5.6.1.2 Growth Scenarios 5-100
5.6.2 No Action Alternative 5-101
5.6.3 Proposed Action Alternative 5-102
5.6.3.1 Regional Conservation Practices 5-102
5.6.3.2 Effects of Implementing the Proposed Action 5-102
5.7 AIR QUALITY 5-103
5.7.1 Trends Analysis 5-104
5.7.1.1 Technical Approach 5-104
5.7.1.2 Growth Scenarios 5-104
5.7.2 No Action Alternative 5-105
5.7.3 Proposed Action 5-106
5.7.3.1 Regional Conservation Practices 5-106
5.7.3.2 Effects of Implementing Proposed Action 5-106
5.8 NOISE 5-107
5.8.1 Trends Analysis for Noise 5-107
5.8.1.1 Technical Approach for Noise 5-107
5.8.1.2 Growth Scenarios 5-107
5.8.2 No Action Alternative 5-108

5.8.3 Proposed Action 5-109
5.8.3.1 Regional Conservation Practices 5-109
5.8.3.2 Effects of Implementing the Proposed Action 5-110
5.9 UTILITIES 5-110
5.9.1 Trends Analysis for Utilities 5-110
5.9.1.1 Technical Approach 5-110
5.9.1.2 Growth Scenarios 5-111
5.9.2 No Action Alternative 5-115
5.9.3 Proposed Action 5-115
5.9.3.1 Regional Conservation Practices 5-115
5.9.3.2 Consequences of the Proposed Action 5-117
5.10 TRANSPORTATION 5-117
5.10.1 Trends Analysis 5-117
5.10.1.1 Technical Approach for Transportation 5-117
5.10.1.2 Growth Scenarios 5-118
5.10.2 No Action Alternative 5-121
5.10.3 Proposed Action 5-122
5.10.3.1 Regional Conservation Practices 5-122
5.10.3.2 Effects of Implementing the Proposed Action 5-123
5.11 VISUAL AND AESTHETIC RESOURCES 5-123
5.11.1 Trends Analysis for Visual and Aesthetic Resources 5-123
5.11.1.1 Technical Approach 5-123
5.11.1.2 Growth Scenarios 5-123
5.11.2 No Action Alternative 5-126
5.11.3 Preferred Alternative 5-126
5.11.3.1 Regional Conservation Practices 5-126
5.11.3.2 Effects of Implementing the Preferred Alternative 5-127
5.12 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS 5-127
5.13 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES 5-128
5.14 SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY 5-129
5.15 SUMMARY OF ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES 5-129

SECTION 6.0
LIST OF PREPARERS 6-1

SECTION 7.0
BIBLIOGRAPHY 7-1

SECTION 8.0
PERSONS CONSULTED 8-1

SECTION 9.0
GLOSSARY 9-1

SECTION 10.0
DISTRIBUTION LIST 10-1

INDEX

ACRONYMS AND ABBREVIATIONS

APPENDICES

Appendix A: Public Comments A-1
Appendix B: Implementation Methods for Individual Permitting Actions in the Coastal Study Area B-1
Appendix C: Point Source Discharge Locations C-1
Appendix D: Detailed Coastal Mississippi Land Uses D-1
Appendix E: Water Quality Data Tables E-1
Appendix F: Mississippi Beach Monitoring Provisional Data 2000-2002 ..... F-1
Appendix G: Sediment Quality Data Tables G-1
Appendix H: Water Quality Historical Trends Analysis Graphs H-1
Appendix I: Sediment Quality Historical Trend Analysis Graphs I-1
Appendix J: Distribution and Relative Abundance of the Managed Species within Essential Fish Habitat of the Mississippi Sound and Back Bay Region J-1
Appendix K: Agency Correspondences K-1
Appendix L: The REMI Policy Insight Model L-1
Appendix M: Population Projection Comparison Between the REMI Model and Other Forecasts M-1
Appendix N: Square Footage Demand Calculations and Assumptions N-1
Appendix O: Projected Land Use O-1
Appendix P: Future Trend Predictions for Each Subwatershed P-1

TABLES

Table 2.2-1 Economic Conditions for Growth Scenarios in the ROI for the Period 2000 to 2020 2-5
Table 4.1-1 Historical Population Levels 4-2
Table 4.1-2 Percent Population Change 4-2
Table 4.1-3 Total Full-Time and Part-Time Employment by Industry 4-4
Table 4.1-4 Labor Force and Unemployment Rates 4-6
Table 4.1-5 ROI Largest Employers 4-6
Table 4.1-6 Casino Employers 4-7
Table 4.1-7 Income Levels for the ROI and Mississippi 4-7
Table 4.1-8 2000 ROI Housing Stock 4-8
Table 4.1-9 Residential Building Permits for the ROI 4-9
Table 4.1-10 1999–2000 School Year Public Education Inventory by School District 4-10
Table 4.1-11 Construction Projects Completed and Future Expansion Plans by School District 4-11
Table 4.1-12 Revenue by Source by District, 1999–2000 School Year 4-11
Table 4.1-13 Police Resources for the ROI 4-12
Table 4.1-14 Fire Protection Resources for the ROI 4-13
Table 4.1-15 ROI Health Care Facilities and Professionals 4-14
Table 4.1-16 2000 Race, Ethnicity, and Poverty Status in the ROI, Mississippi, and the United States 4-18
Table 4.2-1 Coastal Mississippi Land Use – Coastal Counties 4-22
Table 4.2-2 Coastal Mississippi Land Use – Hancock County 4-26

Table 4.2-3 Coastal Mississippi Land Use – Harrison County 4-28
Table 4.2-4 Coastal Mississippi Land Use – Jackson County 4-29
Table 4.2-5 Coastal Mississippi Land Use - Coastal Study Area 4-31
Table 4.2-6 Coastal Mississippi Land Use - Watershed Study Area 4-33
Table 4.2-7 Coastal Mississippi Land Use – Bay St. Louis Watershed 4-35
Table 4.2-8 Coastal Mississippi Land Use – Biloxi Bay Watershed 4-37
Table 4.3-1 Water Well Capacity, City of Gulfport 4-41
Table 4.3-2 Types of Wastewater Systems in Three-County Region 4-44
Table 4.3-3 Service Area of Wastewater Treatment Systems Based on Population 4-45
Table 4.3-4 Unincorporated Population in Three-County Region 4-46
Table 4.3-5 Impaired Water Bodies in the Three-County Region 4-47
Table 4.3-6 Wastewater Treatment Plant Capacities in Hancock County 4-48
Table 4.3-7 Harrison County Wastewater Treatment Plant Capacities 4-49
Table 4.3-8 Wastewater Treatment Plant Capacities in West Jackson County 4-52
Table 4.3-9 Lift Stations Operated By the HCWSWMD 4-54
Table 4.3-10 UST and LUST Locations in Southern Hancock County 4-59
Table 4.3-11 UST and LUST Locations in Southern Harrison County 4-60
Table 4.3-12 UST and LUST Locations in Southwestern Jackson County 4-61
Table 4.4-1 Mississippi Gulf Coast Railroad Grade Crossings 4-71
Table 4.4-2 Fixed Bus Routes in the Coastal Area 4-72
Table 4.4-3 Level of Service Analysis for Selected Signalized Intersections: 1998 4-82
Table 4.5-1 National Ambient Air Quality Standards (Primary) 4-85
Table 4.5-2 Annual Average Daily Traffic for Interstate 10 4-87
Table 4.5-3 Title V Emissions for 2001 by County 4-88
Table 4.5-4 2001 Title V Emissions by Facility 4-88
Table 4.6-1 Common Sound Levels 4-93
Table 4.6-2 Examples of Outdoor Day-Night Average Sound Levels 4-94
Table 4.7-1 Soils of Harrison County, Mississippi 4-100
Table 4.7-2 Soils of Hancock County, Mississippi 4-104
Table 4.7-3 Yield of Sediment by Land Use Relative to Agricultural Land 4-108
Table 4.7-4 Appropriateness of Soils for Septic Tank Use 4-109
Table 4.7-5 Calculation of Per Capita Water Consumption 4-111
Table 4.8-1 USGS Flow Stations in the Coastal Mississippi Watershed 4-117
Table 4.8-2 Statistics on USGS Flow Stations 4-117
Table 4.8-3. 303(d) Listed Impaired Waters in Bayou La Croix Subwatershed 4-119
Table 4.8-4. Mine Locations 4-119
Table 4.8-5. 303(d) Listed Impaired Waters in De Lisle Subwatershed 4-120
Table 4.8-6. 303(d) Listed Impaired Waters in Lower Wolf River–Cane Creek Subwatershed 4-121
Table 4.8-7. 303(d) Listed Impaired Waters in Upper Jourdan River Subwatershed 4-122
Table 4.8-8. 303(d) Listed Impaired Waters in Upper Wolf River Subwatershed 4-122
Table 4.8-9. 303(d) Listed Impaired Waters in Biloxi River Subwatershed 4-123
Table 4.8-10. 303(d) Listed Impaired Waters in Turkey Creek–Old Fort Bayou Subwatershed 4-124
Table 4.8-11. 303(d) Listed Impaired Waters in Tuxachanie Subwatershed 4-125
Table 4.8-12. Land Use Groupings 4-127
Table 4.8-13. 2000 Land Cover Distribution in Each Subwatershed 4-127
Table 4.8-14. Yield of Pathogens by Land Cover Type Relative to Urban Land 4-128
Table 4.8-15. 2000 Pathogen Contribution by Land Cover Type for Each Subwatershed 4-129
Table 4.8-16. Yield of Sediment by Land Cover Type Relative to Agricultural Land 4-129
Table 4.8-17. 2000 Sediment Contribution Per Land Cover Type for Each Subwatershed 4-130
Table 4.8-18. Yield of BOD_5 by Land Cover Relative to Urban Land 4-130
Table 4.8-19. 2000 BOD_5 Contribution Per Land Cover Type for Each Subwatershed 4-131

Table 4.8-20. Yield of Total Nitrogen by Land Cover Type Relative to Urban Land..... 4-131
Table 4.8-21. 2000 Nitrogen Contribution Per Land Cover Type for Each Subwatershed 4-132
Table 4.8-22. Yield of Total Phosphorus by Land Cover Type Relative to Urban Land 4-132
Table 4.8-23. 2000 Total Phosphorus Contribution Per Land Cover Type for Each Subwatershed.... 4-133
Table 4.8-24. Yield of Cadmium by Land Cover Type Relative to Urban Land..... 4-133
Table 4.8-25. 2000 Cadmium Contribution by Land Cover Type for Each Subwatershed 4-133
Table 4.8-26. Yield of Chromium by Land Cover Type Relative to Urban Land 4-134
Table 4.8-27. 2000 Chromium Contribution by Land Cover Type for Each Subwatershed..... 4-134
Table 4.8-28. Yield of Copper by Land Cover Type Relative to Urban Land 4-135
Table 4.8-29. 2000 Copper Contribution by Land Cover Type for Each Subwatershed..... 4-135
Table 4.8-30. Yield of Zinc by Land Cover Type Relative to Urban Land..... 4-136
Table 4.8-31. 2000 Zinc Contribution by Land Cover Type for Each Subwatershed..... 4-137
Table 4.8-32. Water Quality Sampling Station Locations 4-137
Table 4.8-33. Water Quality Standards for Coastal Mississippi 4-139
Table 4.8-34. Mississippi Beach Closures (1999-2001) 4-143
Table 4.8-35. Sediment Quality Mean Effects Guidelines for Coastal Mississippi..... 4-146
Table 4.10-1. Land Use, Coastal Counties 4-167
Table 4.10-2. Distribution of Emergent Wetlands by County, 1972 to 2000..... 4-171
Table 4.10-3. Distribution of Emergent Wetlands by Watershed and Coastal Study Area, 1972 to 2000 4-171
Table 4.10-4. Wetlands of the Southeastern United States, Mid-1980s..... 4-172
Table 4.10-5. Wetland Losses in the United States, Mid-1980s to 1997 4-172
Table 4.10-6. Individually Permitted Large Wetland Losses by Location, 1992-2000 4-173
Table 4.10-7. Corps Individual Permits by Year..... 4-174
Table 4.10-8. Mitigation Required Under Individual Permits 4-175
Table 4.10-9. Number of Nationwide Permits 26 Issued by County and Location, 1992-2000..... 4-177
Table 4.10-10. Area of Emergent Wetlands, 1972 to 2000 4-177
Table 4.10-11. Change in Extent of Emergent Wetlands, 1972-2000 4-179
Table 4.10-12. Comparison of Estimated Areas of SAV During 1969 and 1992, and Potential Seagrass Habitat Currently Available 4-183
Table 4.10-13. Annual Landings of Commercial Fish Species in Mississippi..... 4-186
Table 4.10-14. Frequently Encountered Recreational Fish Species – 1998..... 4-190
Table 4.10-15. Annual Landings of Shrimp 4-191
Table 4.10-16. Oyster Reefs in Mississippi – 1966..... 4-193
Table 4.10-17. Annual Landings of Oysters – 1972-2000 4-194
Table 4.10-18. Annual Landings of Blue Crabs..... 4-197
Table 4.10-19. Species Potentially Affected by Impacts to Essential Fish Habitat..... 4-199
Table 4.10-20. Threats to Essential Fish Habitat 4-202
Table 4.10-21. Federally Listed Rare, Threatened, and Endangered Species 4-205
Table 4.10-22. Approximate Land Area of Designated Critical Habitat Units for Wintering Piping Plover 4-218
Table 4.10-23. Piping Plover Critical Habitat in Mississippi..... 4-218
Table 4.11-1. Archaeological Sites Within the Project Area..... 4-225
Table 4.11-2. National Register Standing Structures and Historic Districts 4-237
Table 4.11-3. Federally Recognized Indian Tribes Associated with Southern Mississippi..... 4-243
Table 5.1-1. Population Projections for the Most-Likely Growth Scenario (Baseline) for the Period from 2000 to 2020.....5-4
Table 5.1-2. Employment Projections for the Most-Likely Growth Scenario (Baseline).....5-5
Table 5.1-3. Economic Projections for Low Growth Scenario 5-8
Table 5.1-4. Low Growth Rate Scenario Population and Employment Decreases From Baseline Conditions 5-9

Table 5.1-5. Economic Projections for Medium Growth Scenario 5-10
Table 5.1-6. Medium Growth Rate Scenario Population and Employment Increases Over Baseline Conditions 5-10
Table 5.1-7. Economic Projections for High Growth Scenario 5-11
Table 5.1-8. High Growth Rate Scenario Population and Employment Increases Over Baseline Conditions 5-12
Table 5.1-9. Comparison of Economic and Demographic Projections in the Year 2020 for ROI 5-13
Table 5.1-10. Percentage of Minority and Low-Income Populations Per County and for the ROI 5-18
Table 5.2-1. Coastal Counties Projected Land Use for the Year 2020—Most-Likely Growth Scenario 5-26
Table 5.2-2. Coastal Study Area Projected Land Use for the Year 2020—Most-Likely Growth Scenario 5-28
Table 5.2-3. Projected Percent Subwatershed Imperviousness for the Year 2020—Most Likely Growth Scenario 5-28
Table 5.2-4. Watershed Study Area Projected Land Use for the Year 2020—Most-Likely Growth Scenario 5-29
Table 5.2-5. Coastal Counties Projected Land Use for the Year 2020—Medium Growth Scenario 5-31
Table 5.2-6. Coastal Study Area Projected Land Use for the Year 2020—Medium Growth Scenario 5-34
Table 5.2-7. Projected Percent Subwatershed Imperviousness for the Year 2020—Medium Growth Scenario 5-34
Table 5.2-8. Watershed Study Area Projected Land Use for the Year 2020—Medium Growth Scenario 5-35
Table 5.2-9. Coastal Counties Projected Land Use for the Year 2020—High Growth Scenario 5-37
Table 5.2-10. Coastal Study Area Projected Land Use for the Year 2020—High Growth Scenario 5-39
Table 5.2-11. Projected Percent Subwatershed Imperviousness for the Year 2020—High Growth Scenario 5-40
Table 5.2-12. Watershed Study Area Projected Land Use for the Year 2020—High Growth Scenario 5-41
Table 5.2-13. Potential Alterations from Land Use/Land Cover Change 5-43
Table 5.2-14. Projected Loss of Selected Land Cover Types to Urban Areas 5-46
Table 5.5-1. Bay St. Louis Watershed, Trends in Vegetation and Wildlife Habitat Coverages 5-70
Table 5.5-2. Biloxi Bay Watershed, Trends in Vegetation and Wildlife Habitat Coverages 5-71
Table 5.5-3. Coastal Study Area, Trends in Vegetation and Wildlife Habitat Coverages 5-72
Table 5.5-4. Bay St. Louis Watershed, Trends in Acres of Emergent Wetlands 5-77
Table 5.5-5. Biloxi Bay Watershed, Trends in Acres of Emergent Wetlands 5-78
Table 5.5-6. Coastal Study Area, Trends in Acres of Emergent Wetlands 5-78
Table 5.5-7. Threats to Essential Fish Habitat 5-85
Table 5.8-1. Examples of Noise Levels at Various Locations 5-108
Table 5.9-1. Projected Water Demand, City of Gulfport 5-111
Table 5.10-1. Year 2025 Projected Conditions—A.M. Peak Hour Conditions 5-120
Table 5.10-2. Traffic Volumes 5-120
Table 5.15-1. Summary of Environmental and Socioeconomic Effects 5-130
Table 5.15-2. Summary of Regional Conservation Practices 5-136

FIGURES

Figure 1.3-1 Coastal Mississippi Study Areas 1-4
Figure 1.3-2 Mississippi Coast Casinos and Municipalities 1-6
Figure 4.1-1 Violent Crimes Reported in the ROI from 1985-2000 4-15
Figure 4.1-2 Non-Violent Crimes Reported in the ROI from 1985 to 2000 4-15
Figure 4.2-1 2000 Land Use in the County Study Area 4-21
Figure 4.2-2 1992 Land Use in the County Study Area 4-23
Figure 4.2-3 1972 Land Use in the County Study Area 4-24
Figure 4.3-1. Areas Without an Available Public Water System 4-39
Figure 4.3-2. Percentage of Households Not On Public Water System 4-39
Figure 4.3-3. Areas Without Access to a Public Wastewater System 4-44
Figure 4.3-4. Percentage of Households That Do Not Use a Public Wastewater System 4-45
Figure 4.4-1. Comparison of 1992-2000 Chartered, Scheduled, and Total Passengers 4-65
Figure 4.4-2. Hotel Room/Air Passenger Correlation 4-66
Figure 4.4-3. General Transportation Map 4-70
Figure 4.4-4. Bus Routes 4-73
Figure 4.4-5. Hourly Ridership for Beachcomber Bus Route 4-75
Figure 4.5-1. Ozone Trends in Hancock County 4-91
Figure 4.5-2. Ozone Trends in Harrison County 4-91
Figure 4.5-3. Ozone Trends in Jackson County 4-92
Figure 4.7-1. Physiographic Provinces of Coastal Mississippi 4-97
Figure 4.7-2. Geologic Units, Major Aquifers, and Hydrologic Layering of the Miocene Aquifer System in South Mississippi 4-98
Figure 4.7-3. Historical Precipitation at Saucier Experimental Forest 4-113
Figure 4.8-1. Coastal Mississippi Watersheds and Monitoring Stations 4-116
Figure 4.8-2. Increasing Potential for Pathogens Available for Transport to Surface Waters Due to Changes in Land Use 4-149
Figure 4.8-3. Trends for Sediment Available for Transport to Surface Waters Due to Changes in Land Use 4-150
Figure 4.8-4. Trends for Total Nitrogen Available for Transport to Surface Waters Due to Changes in Land Use 4-151
Figure 4.8-5. Trends for BOD_5 Available for Transport to Surface Waters Due to Changes in Land Use 4-152
Figure 4.8-6. Trends for Total Phosphorus Available for Transport to Surface Waters Due to Changes in Land Use 4-153
Figure 4.8-7. Trends for Cadmium Available for Transport to Surface Waters Due to Changes in Land Use 4-154
Figure 4.8-8. Trends for Chromium Available for Transport to Surface Waters Due to Changes in Land Use 4-155
Figure 4.8-9. Trends for Copper Available for Transport to Surface Waters Due to Changes in Land Use 4-156
Figure 4.8-10. Trends for Zinc Available for Transport to Surface Waters Due to Changes in Land Use 4-157
Figure 4.10-1. Emergent Wetland Community Type Changes, 1972-2000 4-178
Figure 4.10-2. Oyster Reefs 4-185
Figure 4.10-3. Annual Landings of Commercial Fish Species in Mississippi 4-187
Figure 4.10-4. Aquatic and Marine Resources 4-189
Figure 4.10-5. Annual Landings of Shrimp 4-192
Figure 4.10-6. Annual Landings of Oysters 4-193
Figure 4.10-7. Annual Landings of Blue Crabs—1972-1999 4-198

Figure 4.10-8. Sensitive Species 4-204
Figure 4.10-9. Piping Plover Critical Habitat Unit Designations 4-217
Figure 4.12-1. Noteworthy Visual and Aesthetic Resources..... 4-246
Figure 5.1-1. Census Minority Populations 5-19
Figure 5.3-1. Increased Pathogen Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use..... 5-50
Figure 5.3-2. Changing Sediment Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use 5-51
Figure 5.3-3. Changing BOD_5 Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use..... 5-51
Figure 5.3-4. Changing Total Nitrogen Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use..... 5-52
Figure 5.3-5. Changing Total Phosphorus Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use..... 5-52
Figure 5.3-6. Changing Copper Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use 5-53
Figure 5.3-7. Changing Zinc Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use 5-53

SECTION 1.0: INTRODUCTION, PURPOSE, AND NEED

1.1 INTRODUCTION

This Environmental Impact Statement (EIS) has been prepared by the United States Army Corps of Engineers (the Corps) to address the environmental and socioeconomic consequences of developing and implementing a methodology that would use a trends-based analysis to provide consistent and objective consideration of cumulative effects in environmental impact analyses associated with permit evaluations for future large-scale development projects in coastal Mississippi for which a Corps individual permit is required. It has been undertaken in accordance with the National Environmental Policy Act of 1969 (NEPA; 42 U.S.C. 4321 et seq.), *Council on Environmental Quality Regulations Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR Parts 1500-1508), and Corps regulations for implementing NEPA (33 CFR Parts 230 and 325).

For several decades prior to 1992, development in coastal Mississippi had occurred on a relatively small scale and had been localized to the areas immediately adjacent to the Mississippi Sound. In recent years, however, coastal Mississippi has experienced significant growth and development. Pursuant to Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act, in those instances in which proposed development projects would directly, indirectly, or cumulatively affect jurisdictional waters of the United States, developers are required to seek Corps permits. During the past 8 years, acting under its regulatory program authorities, the Corps has evaluated applications and issued permits for a number of large-scale development projects. In the permitting process, consideration of potential environmental effects has historically focused on the direct and indirect effects of individual projects. More recently, because of growing concerns over the effects of induced growth and the incremental loss of sensitive resources such as wetlands and other coastal habitats, there has been a growing call for an improved understanding and consideration of the cumulative effects (see Sections 1.2 and 2.2, below) of proposed actions for which permits are required, as well as those of other, unrelated, regional development activities.

The methodology evaluated in this EIS would apply to administrative actions of the Corps, acting within its statutory authority under Section 10 of the Rivers and Harbors Act of 1899 or Section 404 of the Clean Water Act of 1972. However, it is not within the statutory authority of the Corps to impose zoning restrictions, “smart growth” programs, or other regional conservation practices (RCPs). It is for this reason that no proposal to evaluate the effects of implementing any of a range of such measures (e.g., low growth, restrictive zoning) for the study area can be made by the Corps. Rather, this EIS considers a range of regional growth scenarios likely to occur in the future that could pertain to permit applications considered using the proposed special-purpose methodology.

1.2 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The purpose of the proposed action is to allow for improved evaluation of the cumulative effects of large-scale development enabled by Corps permits, especially in those areas of coastal Mississippi considered to be sensitive from an environmental standpoint.

Cumulative effects are environmental effects that result from the incremental impact of various past, present, and reasonably foreseeable future actions. Assessment of projects for which Corps permits are required must include consideration of cumulative effects. Accurate evaluation of cumulative effects is a task that relies on the gathering of substantial amounts of information. Although the permitting process over the past decade has attempted to take cumulative impacts into account, the Corps believes there is a need for a better, more comprehensive approach and understanding of cumulative effects. This need could be met if a comprehensive regional trends analysis could be made available to local and regional planners, developers, the Corps, other regulatory agencies, and the public.

A major limitation of traditional cumulative effects analysis is that individual permit applicants typically assess only those cumulative effects closely related to their projects. Activities or projects not interrelated with a proposed action and more geographically distant are often ignored or evaluated qualitatively. The reason for this is twofold. First, individual applicants are reluctant to extend their cumulative effects consideration to areas not directly affected by or adjacent to their projects because of the increased costs of conducting such an analysis. Second, because the actual impact of a project is usually quite limited in terms of spatial and temporal impact, imposition of a regional-scale analysis for such projects would appear unreasonable and overly burdensome. This major limitation, together with the rapid and significant economic and environmental changes to the Mississippi coastal region, prompts the Corps to develop a specific methodology for more fully capturing the cumulative effects of future proposals for large-scale development projects.

1.3 SCOPE

This EIS is a hybrid document with a scope that departs in several notable ways from a traditional NEPA analysis. The scope is twofold: (1) to produce a comprehensive analysis of recent and reasonably foreseeable development trends and associated environmental conditions, and (2) to consider the effects of putting into place a tailored method for evaluating cumulative effects in environmental impact evaluations associated with future permit applications for large-scale development projects in coastal Mississippi. This methodology is further described in Section 2.0, Proposed Action.

Based on relevant data and studies, the trends analysis underlying the proposed methodology projects coastal Mississippi development trends and their cumulative effects spanning the period from 1992 to 2020. The EIS itself assesses the environmental and socioeconomic effects of developing and implementing a consistent methodology for conducting cumulative effects analyses that will rely on the results of the trends analysis in future Corps decisions on permit applications for large-scale development projects in coastal Mississippi requiring individual Corps permits.

Although a trends analysis can be a useful planning tool for a variety of local, state, regional, and federal entities, the Corps believes that the adoption of this specifically tailored analysis for use by the Corps as an integral part of its proposed special-purpose methodology for evaluating permit applications for future large-scale developments in the study area is an action that should be reviewed through the NEPA process. An added benefit of this approach is that future project-specific NEPA analyses in the study area may, as appropriate, incorporate by reference applicable portions of this EIS.

Several federal and state agencies have joined the Corps in preparation of this EIS. The Corps is the lead agency, and the other agencies are participating in cooperating agency roles. These other

agencies bring to the NEPA process information and experience in resource-specific areas, as well as an interest in identifying and analyzing the relevant issues. Federal agencies participating in the preparation of this EIS are the U.S. Environmental Protection Agency (USEPA), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), Federal Highway Administration (FHWA), and National Aeronautics and Space Administration (NASA). Participating state and local agencies include the Mississippi Secretary of State; Mississippi Department of Marine Resources (MDMR); Mississippi Department of Environmental Quality (MDEQ); Mississippi Department of Wildlife, Fisheries and Parks (MDWFP); Mississippi Department of Archives and History (MDAH); Mississippi Department of Transportation (MDOT); Hancock County Port and Harbor Commission; Gulf Regional Planning Commission (GRPC); Jackson County Board of Supervisors; Hancock County Board of Supervisors; Harrison County Economic Development Commission; and Mississippi Gulf Coast Chamber of Commerce.

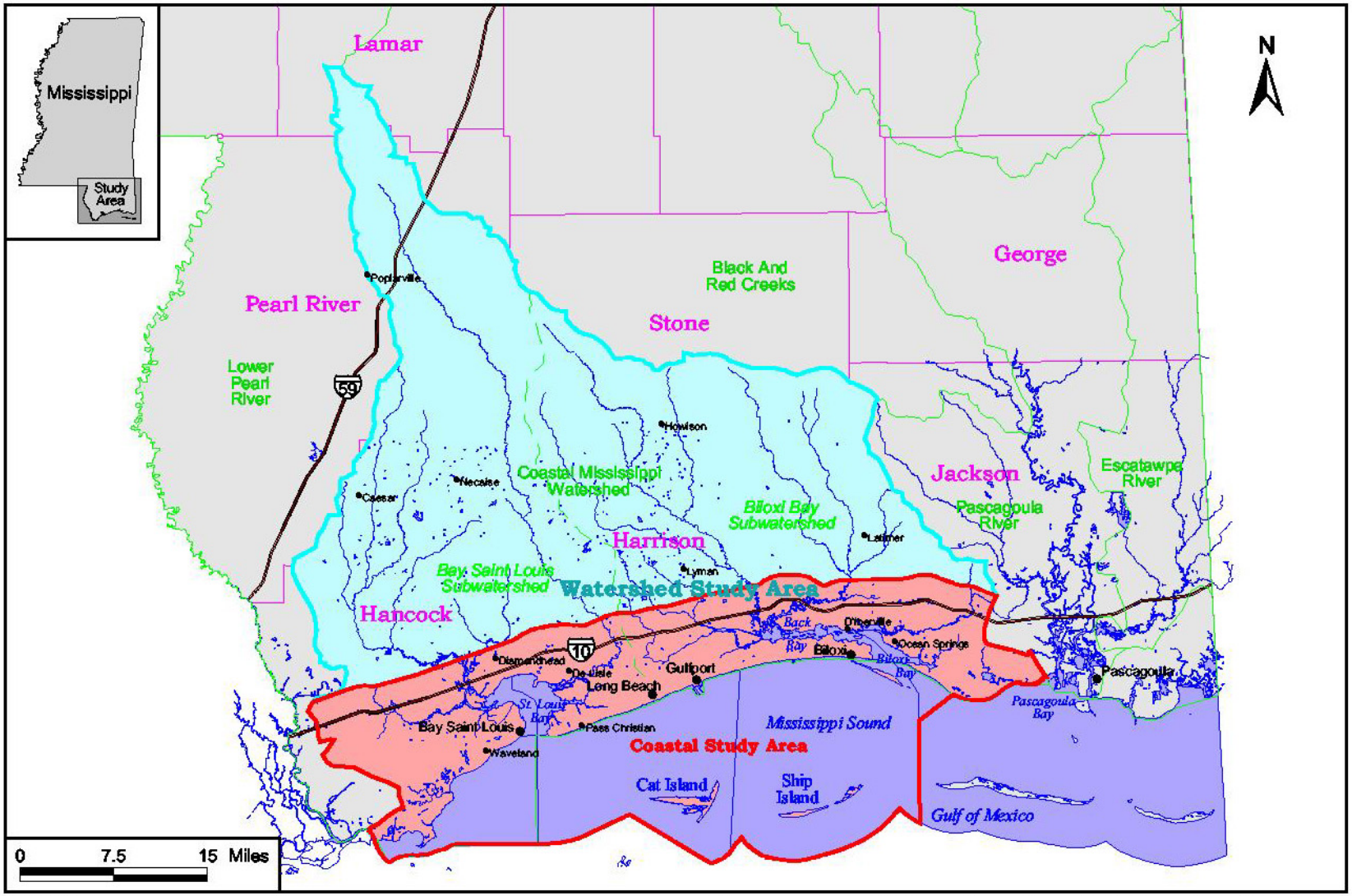
An interdisciplinary team of environmental scientists, biologists, geologists, planners, economists, engineers, and cultural resource specialists has evaluated the proposed action and alternatives in the context of current methods and procedures for evaluating permit applications. Conditions existing as of 2000 provide the baseline ("present") for evaluation of past, present, and reasonably foreseeable future actions contributing to development and to environmental trends and cumulative effects. The proposed action is described in detail in Section 2.0, Proposed Action. Alternatives to the proposed action are presented in Section 3.0, Alternatives. Existing conditions are described in Section 4.0, Affected Environment. Environmental consequences of the proposed action and the results of the trends analysis are presented in Section 5.0, Environmental Consequences.

1.3.1 Study Area and Regions of Influence

The primary region of influence (ROI) considered in this EIS encompasses all of the coastal counties of Mississippi: Hancock, Harrison, and Jackson Counties. Because most of the development that can be linked to Corps permitting actions has occurred along the coast, a more focused assessment of cumulative impacts was conducted for what is referred to in this document as the "Coastal Study Area." The Coastal Study Area consists of areas from the coastline to 2 miles north of Interstate 10 (I-10) within Hancock and Harrison Counties, as well as the western portion of Jackson County.[1] It should be noted, however, that for several of the environmental resource areas, the trends analysis included all portions of the three-county area, as well as portions of counties to the north. For example, for certain natural resources, such as surface water, it was more appropriate to define the ROI in terms of watershed boundaries, because water quality is influenced by the cumulative effects of all actions that occur within the entire watershed. Administrative boundaries, such as county lines, can be used to evaluate socioeconomic impacts but are not particularly useful in delineating the physical and biological impacts of development projects.

The three coastal counties lie adjacent to the Mississippi Sound in the northern area of the Gulf of Mexico between Louisiana and Florida. St. Louis Bay (Hancock County) and Back Bay (principally in Harrison County) are two major bays along the Mississippi Sound. The coastal Mississippi area has numerous estuaries and bayous. Figure 1.3–1 shows the three-county ROI, along with the Coastal Study Area and the watershed-based study areas for St. Louis Bay and Back Bay.

[1] It should be noted that portions of Hancock County west of the Pearl River are within the jurisdictional boundaries of the Vicksburg District of the Corps of Engineers, not the Mobile District. Permit applications for actions within the boundaries of the Vicksburg District would not be subject to the methodology proposed in this EIS, unless the Vicksburg District were to adopt the methodology as well.



LEGEND

- Coastal Study Area
- Watershed Study Area
- County Boundary
- USGS Hydrologic Unit

Source: MARIS, 2001.

Coastal Mississippi Study Areas

Figure 1.3-1

A large portion of the recent growth and development that has occurred in the study area, both direct and induced, is attributed, in part, to the state's authorization of dockside gaming through passage of the Mississippi Gaming Control Act of 1990. Legalization of dockside gaming led development of casinos in Mississippi Sound waters. Hancock and Harrison Counties authorized gaming within their jurisdictions, but Jackson County has not done so. To date, 11 of 12 operating gaming casinos in Coastal Mississippi are in Harrison County. Most of the gaming casinos are in the city of Biloxi in eastern Harrison County, and are close to Jackson County. Figure 1.3–2 shows the corporate limits of principal municipalities, as well as the locations of gaming casinos, in the coastal counties.

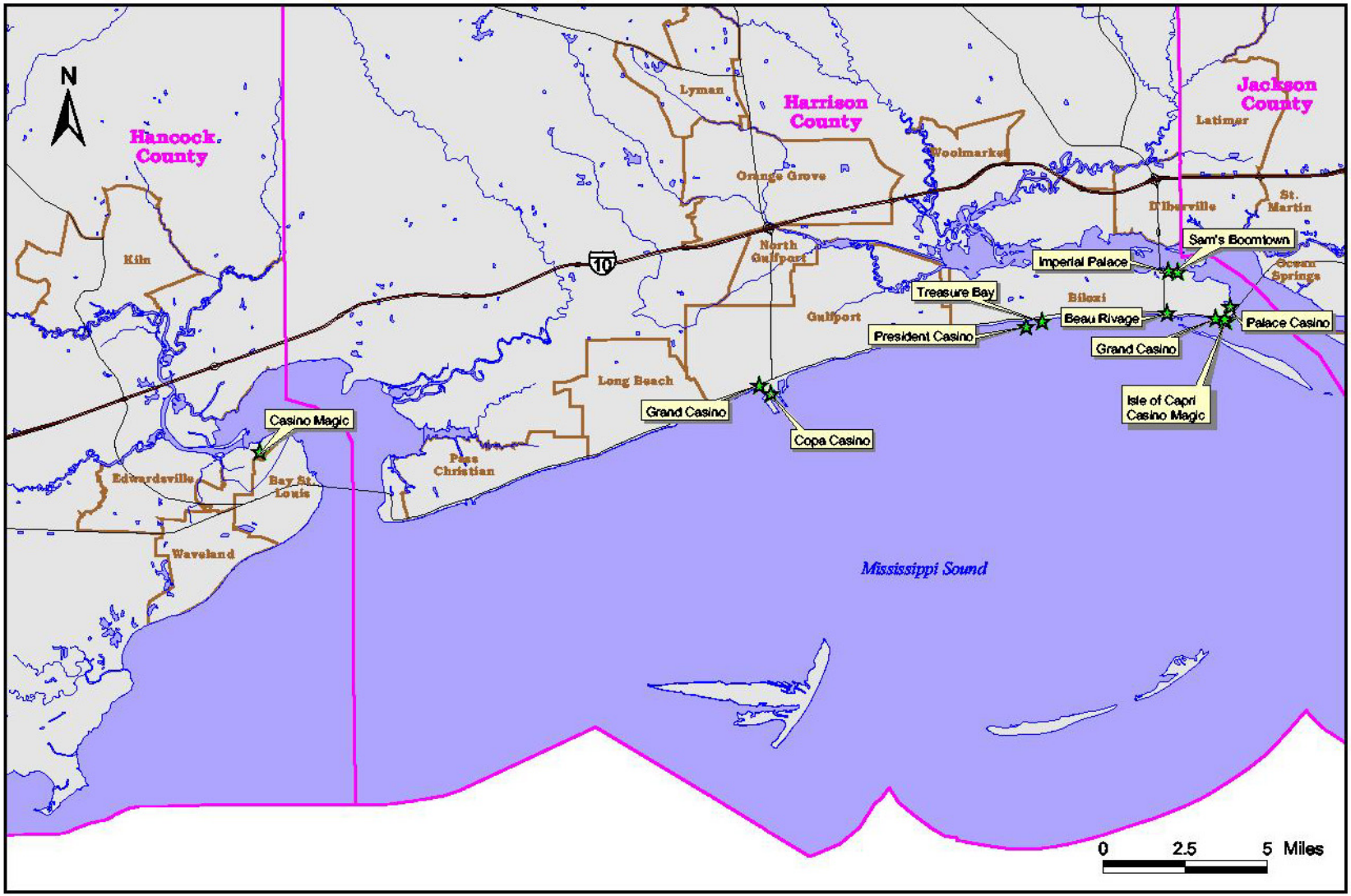
Pursuant to Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act of 1972, the Corps, through its Mobile District office, issues permits for all areas in the coastal counties. To date, most large-scale development permits have been for projects clustered along the coastline between the Gulf and I-10, where most of the growth has occurred. Although large-scale development to date has occurred primarily south of I-10, constraints such as availability of land and infrastructure make it likely that future development will increasingly be sited north of I-10.

Large-scale development in Harrison County has induced considerable growth and resulted in substantial effects in Jackson County west of the Pascagoula River delta (Krizman, Personal Communication, 2000). Many residents of Jackson County, especially those in the vicinity of Ocean Springs, work in Harrison County. State Highway 59, which connects I-10 and U.S. Highway 90 (along which much of the recent development in Biloxi has occurred), is a major roadway that passes through Ocean Springs in Jackson County. The western edge of Jackson County abuts Back Bay, one of the two major bays along the coast. These factors link Harrison and Jackson Counties.

1.3.2 Resource Areas

The human and natural environments consist of a variety of components. The evaluation of the cumulative effects of large-scale development focuses on those components that bear on the ecological system and permit quantification. The Corps has identified the following components of the human and natural environments for analysis:

- Air quality
- Biological resources
- Coastal processes
- Cultural resources
- Environmental justice
- Geology and soils
- Hydrology
- Infrastructure
- Land use
- Noise
- Quality of life
- Socioeconomics
- Transportation
- Water resources



LEGEND

Casino Location

Municipal Boundary

Source: MARIS, 2001.

Mississippi Coast Casinos and Municipalities

Figure 1.3-2

1.3.3 Large-Scale Development

Permits under Section 10 of the Rivers and Harbors Act of 1899 basically pertain to all work (e.g., obstructions or structures) placed over, in, or under navigable waters. Permits under Section 404 of the Clean Water Act of 1972 deal with the discharge of dredged or fill material into the "waters of the United States," including, specifically, wetlands. The Mobile District office of the Corps issues more than 4,000 permits each year to applicants whose projects require evaluation pursuant to the provisions of Section 10 of the Rivers and Harbors Act, Section 404 of the Clean Water Act, or both. Although only a fraction of the permits pertain to "large-scale" projects, those projects represent a notable potential for environmental degradation because of the size of the areas affected and the variety and magnitude of induced effects.

The Notice of Intent (NOI) for preparation of the Coastal Mississippi EIS provided examples of large-scale projects in coastal Mississippi since 1992 for which the Corps has issued permits under Section 10 of the Rivers and Harbors Act or Section 404 of the Clean Water Act. There is no statutory or regulatory definition of what constitutes a "large-scale" development project. At its discretion, the Corps identifies as "large scale" those projects that have the potential to significantly affect the quality of the human environment, for example, wetlands, water quality, fish and wildlife, and/or navigation.

1.4 PUBLIC INVOLVEMENT AND SCOPING

1.4.1 Public Involvement

Public participation in the NEPA process promotes open communication between the public and the Corps and, consequently, better decision making. Persons and organizations having a potential interest in the proposed action, including minority, low-income, disadvantaged, and Native American groups, have been urged to participate in the environmental impact analysis process.

Public information and participation have included the Corps's publication in the *Federal Register* of an NOI to prepare the EIS, as well as hosting of public scoping meetings.

1.4.2 Public and Agency Scoping

Public scoping meetings were held in Biloxi, Mississippi, on May 16, 2000, and in Bay St. Louis, Mississippi, on May 18, 2000. The Corps also hosted an agency scoping meeting on May 17, 2000, in Biloxi. The Draft EIS was available for public and agency review and comment for a period of 60 days beginning December 12, 2003. All comments received on the Draft EIS were considered in preparation of the Final EIS.

In conducting scoping for this EIS, the Corps solicited both oral and written comments from various federal, state, and local agencies and the public. Issues brought to the Corps's attention include the following:

- Appropriateness of the proposed action.
- Definition of the study area, including consideration of Jackson County.
- Adequacy of community infrastructure (e.g., roads, potable water, sewage treatment, landfills).

- Concern for secondary and cumulative impacts of large-scale development projects, both existing and pending.
- Preservation of community and environmental amenities in the coastal Mississippi area.
- Need for preservation of wetlands and effective mitigation when wetlands are affected by development projects.
- Water quality of the Mississippi Sound, including bayous and estuaries.
- Carrying capacity of coastal Mississippi for new development.
- Potential for large-scale development projects having environmental justice impacts.
- Consideration of effects on cultural resources such as coastal Mississippi's fisheries heritage.
- Essential fish habitat.
- Adequacy of emergency evacuation capabilities.
- Availability of labor in local areas.
- Chemical contamination in bayous and rivers.
- Preservation of floodplains.

The Corps has considered each of the foregoing representative issues for inclusion in the EIS. The wide array of resource areas suggested for consideration by the public and agencies, however, exceeds the resources available to allow for each of them to be specifically included in the EIS. To maintain focus on those matters most likely to shed light on the future evaluation of cumulative impacts, numerous related but tangential issues are addressed qualitatively, in combination with other issues, or excluded from the analysis. A scoping report was prepared as an adjunct to the preparation of the EIS. The scoping report summarizes the breadth of matters brought to the Corps's attention and identifies those areas believed most to warrant specific inclusion in the analysis.

1.4.3 Public Review of Draft EIS

The Draft EIS was made available for public review and comment. A Notice of Availability (NOA) of the Draft EIS was published in the Federal Register on December 8, 2003. The NOA was published the Mississippi Sun Herald, the Hattiesburg American, and the Mobile Press Register on Monday, December 8, 2003. Copies of the Draft EIS were sent to the offices and individuals on the mailing list and to those who requested copies in response to the NOA. All persons, agencies, and organizations thought to have a potential interest in the Army's action were included. In addition, copies of the Draft EIS were provided to each of the libraries in Hancock, Harrison, and Jackson Counties, and the document was also available on the Mobile District's Website at www.sam.usace.army.mil. Agencies, organizations, and individuals were invited to review and comment on the analysis results and on other aspects of the EIS process for a period of 60 days. Comments were requested to be sent to the Army Corps of Engineers in Mobile, Alabama, by February 14, 2004.

1.4.4 Public Meeting

The Army conducted public meetings in the evening on January 27, 2004, at the Mississippi Gulf Coast Coliseum in Biloxi and on January 29, 2004, at the Hancock County Civic Center in Bay St. Louis to solicit comments concerning the adequacy of the Draft EIS and the merits of the alternatives analyzed. Advertisements announcing the availability of the Draft EIS for review and the exact location and time of the public meetings were published in the Mississippi Sun Herald, the Hattiesburg American, and the Mobile Press Register on January 23, 2004. Both oral and written comments were provided by the public and agencies at both meetings. All comments received during the meetings as well as throughout the comment period were considered in preparation of the Final EIS. A matrix containing all comments received and the Corps' responses to them is provided in Appendix A of the Final EIS.

1.5 REGULATORY AUTHORITIES AND PROCESSES

State and local regulatory agencies have primary jurisdiction in land use and development matters within their political boundaries. The Corps becomes involved when a proposed project requires a permit under Section 10 of the Rivers and Harbors Act of 1899 or Section 404 of the Clean Water Act of 1972. Sizable proportions of the lands along coastal Mississippi where recent large-scale development has occurred and continues to occur are wetlands. These factors result in Corps involvement, through the permitting process, in development activities in coastal Mississippi.

The Rivers and Harbors Act protects navigable waters and maintains interstate commerce. Section 10 of the act prohibits the creation of obstructions to navigation in waters of the United States and authorizes the Corps to regulate the construction of structures in, over, or under navigable waters; the excavation of materials from navigable waters; and the deposition of material into navigable waters, including dredging and filling activities. Section 404 of the Clean Water Act authorizes the Corps to regulate the discharge of dredged or fill materials in waters of the United States, including wetlands. The Corps and the USEPA jointly administer Section 404 insofar as the Corps acts on permits in accordance with guidelines developed by USEPA for assessing the environmental effects of proposed projects.

The Corps issues five types of individual or general permits:

Individual permits

1. *Standard permits.* A standard permit is a permit processed through the public interest review procedures (see below), including public notice and receipt of comments. The standard individual permit is contained in Engineering Form 1721.

2. *Letters of permission.* A letter of permission identifies the permittee, the authorized work and its location, the statutory authority, limitations on the work, a construction time limit, and a requirement for a report of completed work. A copy of relevant general conditions from Engineering Form 1721 is attached to the letter of permission.

General permits

1. *Regional permits.* A regional permit is a type of general permit issued after compliance with specified Corps regulations published at 33 CFR Part 325. If the public interest so requires,

the permit may require a case-by-case reporting and acknowledgment system. No other separate applications or authorization documents are required.

2. *Nationwide permits.* Nationwide permits represent Department of the Army authorizations that have been issued at 33 CFR Part 330 for certain specified activities nationwide. If certain conditions are met, the specified activities can take place without the need for an individual or regional permit.

3. *Programmatic permits.* A programmatic permit is a type of general permit founded on an existing state, local, or other federal agency program and is designed to avoid duplication with that program.

The Corps is neither a proponent nor an opponent of a permit application. The decision to issue a permit is based on an evaluation of the probable impacts, including cumulative impacts, of the proposed activity and its intended use on the public interest. Evaluation of the probable impact that a proposed activity might have on the public interest requires a weighing of all relevant factors in each particular case. The benefits that reasonably may be expected to accrue from a proposal are balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal and, if so, the conditions under which it would be allowed to occur are therefore determined by the outcome of this general balancing process. That decision should reflect the national concern for both the protection and use of important resources. All factors that might be relevant to the proposal must be considered, including its cumulative effects. Among these factors are conservation, economics, aesthetics, general environmental concerns, wetlands, historic properties, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people. For activities involving Section 404 discharges, a permit will be denied if the discharge that would be authorized by that permit would not comply with guidelines issued by the USEPA under Section 404(b)(1) of the Clean Water Act.

The Corps considers three general criteria in evaluating a permit application: (1) the relative extent of the public and private need for the proposed structure or work; (2) where there are unresolved conflicts as to resource use, the practicality of using reasonable alternative locations and methods to accomplish the objectives of the proposed structure or work; and (3) the extent and permanence of the beneficial or detrimental effects that the proposed structure or work is likely to have on the public and private uses for which the area is suited. The weight of each of these factors may vary with each proposal.

The Corps adds special conditions to permits when such conditions are necessary to satisfy legal requirements or to otherwise satisfy the public interest requirement. Permit conditions are directly related to the impacts of the proposal, appropriate to the scope and degree of those impacts, and reasonably enforceable. If the Corps determines that special conditions are necessary to ensure the proposal will not be contrary to the public interest, but that those conditions would not be reasonably implementable or enforceable, the permit is denied.

SECTION 2.0: PROPOSED ACTION

2.1 INTRODUCTION

The National Environmental Policy Act of 1969 declares the national policy to encourage a productive and enjoyable harmony between man and his environment. To the fullest extent possible, the policies, regulations, and public laws of the United States are to be interpreted and administered in accordance with the policies set forth in NEPA. Among these is that all agencies of the federal government are to ensure that currently unquantified environmental amenities and values be given appropriate consideration in decision making along with economic and technical considerations.

NEPA requires analysis of every major federal action significantly affecting the quality of the human environment. Compliance with NEPA is part of Corps action on each permit application under Section 10 of the Rivers and Harbors Act of 1899 or Section 404 of the Clean Water Act of 1972. The Corps achieves compliance with NEPA by preparing an Environmental Impact Statement or an Environmental Assessment or by citing a Categorical Exclusion indicating that, based on experience with such proposals, significant impacts are not expected to result from the project.

Compliance with NEPA for all permitted projects in coastal Mississippi has to date focused on the merits of each individual project. The high degree of growth in coastal Mississippi, both direct and induced, was not accurately predicted in the early 1990s. NEPA documentation to date for individual projects has not appeared to fully capture the magnitude or importance of regional long-term cumulative effects. This is no doubt due, in part, to the manner in which individual permittee's projects have been evaluated. That is, the temporal and spatial boundaries for individual projects have been set in close proximity to each project, and thus there has been inadequate consideration of regional, long-term effects. An enhanced analysis and understanding of regional long-term cumulative impacts outside the confines of a permit application for any single project are needed. The proposed action is intended to enhance the Corps's understanding of cumulative effects in the study area resulting from past, present, and reasonably foreseeable future regional development and other trends affecting environmental quality and sustainability, as well as the Corps's ability to continue to make sound regulatory decisions in the public interest.

2.2 STATEMENT OF THE PROPOSED ACTION

The Corps proposes to implement a specially tailored method for reviewing permits (special-purpose methodology), based in part on use of a comprehensive regional trends analysis, that would provide consistent and objective consideration of cumulative effects in environmental impact analyses associated with permit evaluations for future large-scale development projects in coastal Mississippi for which an individual Corps permit is required.

This EIS does not analyze the effects of any particular proposal for which an applicant has sought or might seek a permit. Rather, in order to provide a more informed understanding of the cumulative effects of large-scale regional development in coastal Mississippi, the EIS considers actions in the study area since 1992, known pending actions, and postulated future actions, and analyzes the environmental and socioeconomic effects of adopting a methodology that makes use of a trends-based growth analysis as a tool for better understanding the potential cumulative effects on regional

resources of proposed projects for which an individual Corps permit is required. The effects of adopting the proposed special-purpose methodology will be compared with the effects of the Corps taking no action and with those of other reasonable alternatives, as described in Section 3.0, for satisfying the purpose of and need for the proposed action.

2.2.1 Trends Analysis

The technical approach for conducting the trends analysis is presented in Section 5.0 of the EIS. Major features of this approach are described below.

Temporal scope. The Corps employs two principal time frames for the trends analysis. The first occurs from 1992 until 2000 and serves as a benchmark for measuring the rate of growth in the past. The second occurs from 2000 until 2020. The year 2000 serves as the baseline year for the study because much of the most recent analytical data used in the trends analysis represent conditions in the year 2000. The year 2020 is the endpoint for which trends and cumulative effects are projected.

Simulation of change. The key indicators of growth simulated are land cover changes, socioeconomic parameters (e.g., economic output, population), and resource conservation strategies employed within defined areas for the year 2020. These simulations are used as inputs for various resource-specific predictive models to characterize resource conditions in 2020.

Four growth scenarios. The trends analysis relies on four growth scenarios: *low growth* (relative to historical trends), *most-likely growth* (based on average growth [baseline] over the past 30 years), *medium growth* (between baseline and high-growth scenarios), and *high growth* (continuation of recent growth rates since 1992).

Evaluation of conditions. The trends analysis examines two variants for each growth scenario. The first variant assumes growth proceeds in the presence of existing conservation, resource management, and infrastructure practices. The second variant assumes growth proceeds with enhanced conservation, resource management, and infrastructure conditions and practices. In this case, it is assumed that localities develop and enforce an optimal regime of controls and other measures benefiting the natural and human environments. It should be noted that the majority of these RCPs are beyond the regulatory authority of the Corps, and are provided only as *recommendations* to assist other groups in managing coastal resources.

Spatial scope. The spatial scope of the trends analysis depends on the resource area being evaluated. Generally speaking the three-county area was used as the spatial boundary with an emphasis given to areas within the Coastal Study Area. As previously mentioned, certain resources, such as surface water quality, were assessed at a larger scale and encompass the watershed boundaries, which extend well to the north of the coastal counties.

2.2.2 Special-Purpose Methodology

The Corps's proposed special-purpose methodology builds on existing local permit applications and review procedures and the Corps's regulations for NEPA compliance in performing regulatory program functions (33 CFR Parts 230 and 325). The Corps's adoption of this methodology is not intended to change or lengthen the permit application process. Rather, these procedures should significantly enhance the cumulative effects analyses provided in environmental documentation for large-scale development projects, thereby effectively reducing the potential for delays in permit

decisions (as well as project implementation, if approved). Furthermore, the results of this EIS will provide a conduit for advice on resource management measures that other groups may adopt for reducing the adverse environmental effects of regional development. The new methodology, as proposed, is outlined below.

- Conduct a comprehensive regional cumulative effects analysis using trends analysis and available studies (from MDMR under the Coastal Resource Management Planning effort and other groups) in order to achieve an enhanced understanding of the long-term, regional cumulative effects from past, present, and potential future growth, particularly as it relates to Corps permitting actions.

- Provide data/results/methods so that future permit applicants and Corps permit writers/evaluators can use the results of the trends analysis as part of the cumulative effects section in future NEPA analysis and documentation, for either site-specific Environmental Assessments (EAs) or EISs. It is not the intention of this "new methodology" to require permit applicants to conduct a detailed analysis of regional cumulative effects that replicates the level of analysis and detail presented in this EIS. On the contrary, one of the objectives of the special-purpose methodology is to provide a means for future permit applicants to quickly link their site-specific actions to the trends analysis provided in this EIS (discussed further in Section 2.2.3) to facilitate addressing difficult regional cumulative effects issues in their NEPA documentation (be it an EA or EIS). Thus, the special-purpose methodology should streamline the process for analyzing and documenting regional cumulative effects issues as it pertains to Corps permitting decisions for future permitting actions

- Based on the results of the trends analysis, develop/identify Regional Conservation Practices (RCPs) that can be used for the management of coastal resources and avoidance/reduction of adverse cumulative effects on the environmental due to development. As part of the special-purpose methodology, these RCPs may be used and implemented in the following two ways:

  1) *Formulate site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects*. After reviewing proposed large-scale development projects, the Corps may formulate site-specific permit conditions based in part on applicable RCPs for the avoidance/reduction of adverse environmental effects.

  2) *Foster adoption of RCPs that non–Corps entities (e.g., federal, state, and local agencies, and private entities) may elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects.* Based on the results of the trends analysis presented in Section 5.0, the vast majority of the RCPs that are needed to reduce cumulative effects are beyond the regulatory authority of the Corps and thus fall into this category. These RCPs may be implemented in the following ways:

     - State and local regulatory authorities may elect to formulate new regulations based in part on these RCPs to manage coastal resources and reduce environmental and/or socioeconomic effects from development.

- Federal, state, and local regulatory authorities, as well as nongovernmental organizations may elect to conduct studies based in part on these RCPs to provide a better understanding of the effects of development on coastal resources.

- Federal, state, and local regulatory authorities, as well as nongovernmental organizations may elect to incorporate, in whole or in part, RCPs as part of ongoing and/or new coastal planning initiatives for the conservation of coastal resources.

- Private entities may elect to formulate mitigation measures and best management practices (BMPs) based in part on these RCPs in order to reduce adverse environmental and/or socioeconomic effects associated with specific development projects.

In addition, in the case of wetlands, a third type of RCP has been identified: Regional studies and management approaches could be implemented through an interagency cooperative effort for the conservation of coastal resources (pending the availability of funds).

2.2.3 Implementation Methods for Individual Large-Scale Permit Applications

The Corps has developed implementation methods so that applicants can use the results of the trends analysis presented in this EIS to streamline the process of conducting regional, long-term cumulative effects analysis for NEPA analysis and documentation. Using these methods, an applicant may more quickly provide the necessary level of analysis for documenting the regional cumulative impacts for the NEPA analysis. The same steps can be used for either EAs or EISs. It should be noted, however, that applicants may elect to develop their own regional cumulative effects analysis and/or update the analysis presented in this EIS, for the purposes of evaluating the induced regional cumulative effects associated with their proposed large-scale development project.

The analytical steps for implementing these methods are presented below. For each step, examples are given to illustrate the application of these methods based on two hypothetical projects proposed for construction in the year 2007, as presented below. For a more detailed discussion please refer to Appendix B.

Example #1 involves the construction of a large complex in the tourism service sector that would employ 2,500 service workers and attract customers in the southeastern United States, serving areas well beyond the ROI; and

Example #2 involves the construction of a large shopping complex in the retail service sector that would employ 250 retail workers and serve customers principally within the local ROI.

1. *Evaluate project-specific economic impacts.* For large-scale development projects, the applicant would evaluate the direct and induced economic effect associated with the proposed project on the regional economy (i.e., Jackson, Harrison, and Hancock Counties). Consideration should be given to the number of jobs created, the potential need to import workers from outside the ROI, and the location of customers being served (e.g., support services to customers currently within the ROI or tourism that serves customers within the southeastern United States and beyond). For large-scale development projects that have the potential to serve customers well beyond the ROI (e.g., casino/hotel complexes, or a very large manufacturing facility serving customers worldwide) and to create numerous jobs (e.g., >2,000) such as Example #1, the use of an

economics model (e.g., IMPLAN, REMI) for measuring the economic impact of the project may be warranted. Key indicators of economic activity to be quantified would include direct and induced job creation and economic output. For large-scale projects that serve the local ROI, such as Example #2 and residential housing projects, a qualitative approach may be sufficient.

2. *Identify current economic growth conditions.* The applicant should identify the current condition of the economy within the ROI in terms of the growth scenario described in the EIS (i.e., either low-, most-likely-, medium-, or high-growth conditions, as defined in Section 5.1.1.2 and summarized in Table 2.2–1). So in the year 2007, the applicant (for either Example #1 or #2) may readily obtain 2005 Census Bureau population statistics for the ROI or other economic data (e.g., GRP, employment statistics) to determine whether the economy has been growing at a rate commensurate with baseline growth (i.e., the most-likely growth scenario) projections, medium-growth projections, high-growth projections, or low-growth projections. (Note: if 2007 estimates are obtained it would be reasonable to calculate 2007 values for each of the growth scenarios based on the 2005 estimates and annual growth projections presented in Table 2.2–1 or to obtain 2005 available statistics and compare them with the values presented in Table 2.2–1.) Currently, the economy is exhibiting most-likely growth conditions. These statistics can be compared with those presented in Table 2.2–1 below in order to identify the appropriate growth scenario.

Table 2.2–1

Economic Conditions for Growth Scenarios in the ROI for the Period 2000–2020

	2000	2005	2010	2015	2020	Total Percent Growth	Annual Growth Rate
Population in the ROI							
Low Growth	367,000	388,000	404,000	418,000	430,000	17%	0.8%
Most-Likely (Baseline)	367,000	389,000	406,000	420,000	431,000	17%	0.8%
Medium Growth	367,000	399,000	433,000	468,000	502,000	37%	1.6%
High Growth	367,000	408,000	457,000	510,000	565,000	54%	2.2%
Employment in the ROI							
Low Growth	222,000	235,000	240,000	247,000	252,000	14%	0.6%
Most-Likely (Baseline)	222,000	236,000	241,000	247,000	252,000	14%	0.6%
Medium Growth	225,000	248,000	264,000	281,000	297,000	32%	1.5%
High Growth	225,000	259,000	283,000	310,000	337,000	50%	2.1%
GRP in the ROI ($Billions)							
Low Growth	$9.9	$11.0	$12.0	$13.3	$14.5	46%	1.9%
Most-Likely (Baseline)	$9.9	$11.0	$12.0	$13.3	$14.5	46%	1.9%
Medium Growth	$9.9	$11.5	$13.0	$14.8	$16.8	70%	2.7%
High Growth	$9.9	$11.9	$13.8	$16.2	$18.7	89%	3.2%

3. *Evaluate incremental contribution of project to regional growth.* The applicant would quantify the percent contribution of the projected economic activity generated by the project to the overall growth and economic activity of the region under current conditions. The applicant would also compare the projected growth rates with the levels defined for each of the growth scenarios presented in Section 5.1.1.2 (and summarized in Table 2.2–1) and document the results.

   For Example #1, the estimates calculated in Step 1 (i.e., increase in jobs [both direct and induced], population, and GRP) and Step 2 (i.e., most-likely conditions in 2007) would be used to calculate the percent change in population, jobs, and economic activity within the ROI relative to baseline conditions in 2007. This predicted incremental growth rate in the economy attributable to the project would be evaluated in light of the estimated growth rates for each of the growth scenarios presented in Table 2.2–1. Using these results, a semi-quantitative assessment of the effect that this project would have on the overall growth rate of the region can be assessed. A key question to address is whether the proposed project would generate such an increase in economic activity that it may significantly alter the growth rate of the region. For example, if the proposed project generates a 0.1 percent increase in the GRP relative to baseline conditions in 2005 and the economy is currently experiencing most-likely growth conditions (as defined in Step 2), then the project would not result in a measurable change in the current economic growth rate, and thus the overall economy would continue to grow at a rate commensurate with the most-likely growth scenario. However, if the proposed project generates a 3 percent increase in the GRP relative to baseline conditions in 2005, such a change may result in a dramatic increase in the growth rate, which may be more commensurate with the medium-growth scenario. Through an evaluation of the economic effect of the project and the assumed annual growth rates for the region, it may be appropriate to evaluate a range of growth scenarios (e.g., most-likely to medium) when assessing long-term cumulative effects.

   For Example #2, the incremental contribution of the project would be quite small. In fact, many projects that serve the local ROI may principally result in the shifting of economic activity away from established businesses, rather than stimulating additional economic activity. Therefore, for large-scale projects that would serve the local economy, a qualitative assessment of the incremental effect of the project on the regional economy would be appropriate.

4. *Document cumulative effects using the trends analysis presented in this EIS.* In consideration of the analysis in Steps 2 and 3 above (i.e., identification of the appropriate growth scenario or bounding future growth with two scenarios, and assessment of the incremental impact of the project on the regional economy), the applicant would cite relevant sections of this EIS and include appropriate summary information from Section 5.0 and/or Table 5.15–1 to document regional cumulative efforts. For Example #1 and other very large projects that would support customers well beyond the ROI, consideration should be given to whether the proposed project would have the potential to significantly increase economic activity and growth, thereby changing the growth scenario from most-likely growth levels to medium- or high-growth levels. For Example #2 and similar projects that would provide local support to the ROI, it would be sufficient to characterize short-term and long-term regional cumulative effects based on the growth scenario identified in Step 2.

5. *Consider/adopt applicable Regional Conservation Practices to reduce effects.* In addition to standard mitigation measures, the applicant should consider appropriate site-specific measures listed in this EIS for the reduction of direct and induced cumulative effects (i.e., RCPs). On a case-by-case basis, the Corps would consider RCPs that are within its regulatory authority for the

purpose of formulating site-specific permit conditions for large-scale development projects. It should be emphasized, however, that the vast majority of resource management measures (i.e., RCPs) identified through this EIS to reduce cumulative effects within the ROI are beyond the regulatory authority of the Corps and would need to be adopted voluntarily by other non–Corps entities (e.g., other federal, state, and local agencies, or the private sector). Only a certain number of RCPs (identified in Section 5.0 and Table 5.15–2) may be considered for formulating site-specific permit conditions to reduce regional effects from development.

2.2.4 Guiding Principles

The Corps's evaluation of cumulative effects using the results of the trends analysis would be undertaken in light of eight guiding principles. The Council on Environmental Quality (CEQ) promulgated these principles in 1997 in *Considering Cumulative Effects Under the National Environmental Policy Act*, a handbook intended to provide federal agencies with a framework for advancing environmental impact analysis by addressing cumulative effects. The handbook notes that although agencies routinely address the direct and indirect effects of their proposed actions on the environment, analyzing cumulative effects is more challenging, primarily because of the difficulty in defining geographic (spatial) and time (temporal) boundaries. The CEQ's eight principles are as follows:

1. Cumulative effects are caused by the aggregate of past, present, and reasonably foreseeable future actions.

2. Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem, and human community of all actions taken, no matter which agency (federal, nonfederal, or private) has taken the actions.

3. Cumulative effects need to be analyzed in terms of the specific resource, ecosystem, and human community being affected.

4. It is not practical to analyze the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.

5. Cumulative effects on a given resource, ecosystem, and human community are rarely aligned with political or administrative boundaries.

6. Cumulative effects can result from the accumulation of similar effects or the synergistic interaction of different effects.

7. Cumulative effects can last for many years beyond the life of the action that caused the effects.

8. Each affected resource, ecosystem, and human community must be analyzed in terms of its capacity to accommodate additional effects, based on its own time and space parameters.

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SECTION 3.0: ALTERNATIVES

3.1 INTRODUCTION

The Corps's proposed action is described in Section 2.0. Alternatives considered by the Corps include (1) the proposed action, including development and use of a comprehensive trends analysis, and
(2) deferral,[2] on development trends and cumulative effects matters, to appropriate state, regional, and/or local agencies, within the constraints of the law, including passage of any enabling legislation that might be required. This alternative could have the Corps prepare the trends analysis, or could consist of a deferral, which would not involve a Corps-prepared trends analysis. (3) Under the third alternative, the "no action" alternative, which is also evaluated as required by CEQ regulations, the Corps would continue to evaluate cumulative effects on an ad hoc basis. No trends analysis would be used under the no action alternative. These alternatives are discussed in further detail below.

3.2 PERMIT REVIEW METHODOLOGY AND COMPREHENSIVE TRENDS ANALYSIS

Implementation of a special-purpose permit evaluation methodology based on the results of a comprehensive trends analysis constitute the proposed action described in Section 2.0. This is the Corps's preferred alternative for considering cumulative effects associated with actions resulting from the permitting of large-scale development projects in coastal Mississippi.

3.3 DEFERRAL TO STATE/LOCAL AGENCIES

Coastal Mississippi applicants for permits for activities subject to Section 10 of the Rivers and Harbors Act or Section 404 of the Clean Water Act submit a *Joint Application and Notification* to MDMR, which then forwards the application to the Corps. In evaluating each permit application, the Corps weighs the many factors described in Section 1.5 prior to making its final decision.

The Corps invites public and agency comments on all individual permit applications. Agency views are accorded due weight because they reflect the expert opinion of officials who have both subject matter expertise and responsibility for the types of actions at issue.

It would be possible for the Corps to provide trends analysis information to state and local agency officials or to a state-empowered and jointly staffed regional agency and to solicit their views on whether permits should be issued based on their evaluation of cumulative effects matters. However, three principal factors render this alternative impracticable. First, various state and local agencies and their federal counterparts could reasonably draw opposing conclusions concerning cumulative effects based on the same data. In such case, the Corps would have to decide among the differing agencies' recommendations in a process little different from the approach currently used. Second, no state-empowered regional development authority or environmental protection authority currently exists that can override other state and local agencies on development decisions. Third, decision making on

[2] In common usage, *defer* means either "to put off to another time" or "to yield in judgment or opinion." The Corps intends that only the latter use of the word pertain in this document.

permit applications ultimately rests solely with the Corps. Absent congressional action granting such authority, acceptance of state and local recommendations as binding on Corps decisions could represent an impermissible compromise of the independent responsibility and judgment entrusted to the Corps. Because of these factors and the time that would be required to change them, adoption of an alternative predicated on deferral to state and local agency judgment is not feasible and, therefore, is not further examined in this EIS.

3.4 NO ACTION ALTERNATIVE

Under the no action alternative, the Corps would not implement the proposed methodology nor make use of the trends analysis. The Corps would continue to perform cumulative effects analysis for permits on an ad hoc basis. Inclusion of the CEQ-required no action alternative in the EIS will also serve as a benchmark against which the proposed action and alternatives can be evaluated.

SECTION 4.0: AFFECTED ENVIRONMENT

4.1 SOCIOECONOMICS

This section describes the social and economic environment that would be potentially affected by the Proposed Action and alternative actions. The social and economic environment of the Mississippi Coastal Region is characterized by its demographic composition, the structure and size of its economy, and the types and levels of public services available to its citizens. Accordingly, this study evaluates potential effects of Corps permitting actions on the region's population growth, employment and income levels, business activities, housing stock, public services, environmental justice, and the protection of children.

The socioeconomic environment evaluated for this EIS encompasses the three coastal counties of Mississippi—Hancock, Harrison, and Jackson Counties. These counties form the economic region of influence (ROI) and define the geographic area in which the predominant social and economic impacts from large-scale development projects are likely to take place.[1] The geographical area of the ROI was defined based on economic development trends, existing commuting patterns, and the degree of economic interaction that takes place among these three counties. Nonetheless, the study recognizes that socioeconomic effects from proposed and alternative actions may well extend beyond the ROI, and even beyond the state of Mississippi, although these impacts would be significantly diminished beyond the ROI evaluated in this EIS.

4.1.1 Population

Population growth in the Mississippi Coastal Region during the past three decades has been characterized by alternating periods of relatively robust growth and stagnation. In the decade spanning the 1970s, for example, the three-county ROI experienced significant growth, as the population increased by more than 25 percent. During this decade, the ROI population increased at almost double the growth rate for the State of Mississippi and more than twice that of the United States. In contrast, during the 1980s the ROI population expanded by only 4 percent. This rate of increase, while exceeding that for the Mississippi, was less than half the growth rate for the United States. The most recent decade, however, has seen a modest rebound in the region's population growth. During that period, the ROI population increased by about 16 percent, compared to about a 13 percent growth for the nation as a whole.

Population growth patterns also have varied within the three counties that comprise the ROI. Jackson County experienced a steep growth in population during the 1970s (34 percent), which was followed by a decade during which population actually decreased. Hancock County, the smallest of the three counties, expanded at a fairly consistent rate during the 30-year period from 1970 to 2000, although the fastest growth in terms of percentage was in the 1970s. Harrison County, which is the largest of the three counties and accounts for about half of the total ROI population, has experienced relatively

[1] As discussed in Section 1.3.1, all of Jackson County was included in the impact analysis because it was not feasible to measure changes in economic activities at the sub-county level. Economic models generally project changes at the county level or above.

slow growth through much of the 30-year period, with the exception of the 1990s. Table 4.1–1 summarizes population trends for each of the ROI counties for the last three decades. Table 4.1–2 provides percentage changes in population for each of the counties presented in Table 4.1–1. Data for Mississippi and the United States are also provided for comparison purposes. As shown in the tables, Mississippi has been characterized by sluggish growth throughout the period, especially during the 1980s, when total state population increased by only 2 percent.

Table 4.1–1
Historical Population Levels[1,2]

Location	1970	1980	1990	2000
Hancock County	17,387	24,537	31,760	42,967
Harrison County	134,582	157,665	165,365	189,601
Jackson County	87,975	118,015	115,243	131,420
ROI	239,944	300,217	312,368	363,988
Mississippi	2,216,912	2,520,638	2,573,216	2,844,658
United States	203,211,926	226,545,805	248,709,873	281,421,906

[1] Source of 1970, 1980, and 1990 data: US DOC, Census, 1995.
[2] Source of 2000 data: US DOC, Census, 2001a.

Table 4.1–2
Percent Population Change

Location	% Change 1970–1980	% Change 1980–1990	% Change 1990–2000	% Change 1970–2000
Hancock County	41.1	29.4	35.3	147.1
Harrison County	17.2	4.9	14.7	40.9
Jackson County	34.1	-2.3	14.0	49.4
ROI	25.1	4.0	16.5	51.7
Mississippi	13.7	2.1	10.5	28.3
United States	11.5	9.8	13.2	38.5

Population dynamics in the ROI have been strongly influenced by several economic factors, including the effects from the expansion of several large government installations, the stagnation and decline of certain industrial sectors (including the seafood industry), and the more recent onset of large-scale development associated with the gaming industry. In particular, the development of Stennis Space Center has served as a strong economic and population stimulus to Hancock County, while Keesler Air Force Base has provided a degree of stability to Harrison County in the face of job losses in the manufacturing and seafood sectors. Development of the casino industry during the past decade has had a profound effect on reversing trends of net out-migration and has spurred both population and economic growth in Harrison County and, to a lesser extent, Hancock and Jackson Counties.

4.1.2 Employment

The ROI economy has undergone significant structural changes during the past 30 years that have mirrored changes occurring throughout the United States. In general, the ROI's economy has become more service sector-oriented and less dependent on traditional manufacturing sectors to generate employment[2]. Another major trend in the ROI has been a diminishing reliance on the public sector as a source of employment. These economic trends are shown in Table 4.1–3, which presents ROI employment by industry for 1970, 1980, 1990, and 2000. As shown in the table, the public sector was the single largest source of regional employment during the 1970s and 1980s, accounting for more than 34 percent of the areas jobs in 1970 (Table 4.1–3). The other major sources of employment during this period were manufacturing (19 percent), services (16 percent), and retail trade (13 percent). However, by 1990, public sector employment accounted for only 27 percent of the region's employment, while the proportion of employment in the private sector services and retail trade sectors increased to 20.1 percent and 16.7 percent, respectively. These employment trends continued throughout the 1990s. By the year 2000, the private services sector was providing 29.8 percent of employment, followed by government at 21.9 percent, retail trade at 17.0 percent, and manufacturing at only 11.8 percent of ROI employment. Even in Jackson County, where the manufacturing sector remains the largest single source of employment, the shift to service jobs has been significant. For example, in the period 1990 to 2000, service sector employment increased by about 50 percent, while the number of manufacturing jobs decreased by 10 percent.

The accelerated growth of the services sector and to a lesser extent the expansion of the retail trade sector, especially during the 1990s, can be largely attributed to the establishment of casino gaming and resort developments on the Mississippi coast. In fact, the economic impact of gaming was the most significant determinant of economic expansion on the coast (GSERC, 2001). Economic expansion, primarily associated with this development during the 1990s, attracted approximately 39,000 additional persons into the workforce (Table 4.1–4). That increase is explained by a combination of population growth, an influx of workers from outside the area, and decisions by locals to reenter the workforce, possibly attracted by rising wages (GSERC, 2001). The unemployment rates in Hancock, Harrison, and Jackson Counties significantly decreased during the 1990s (Table 4.1–4). In 1990 the unemployment rate was well above the national rate, although below Mississippi's rate. In 2000 the unemployment rate for the ROI was only slightly above the national unemployment rate, and still below the rate for Mississippi.

[2] The services industry includes establishments primarily engaged in providing a variety of services, such as hotels and other lodging places; establishments providing personal, business, repair, and amusement services; health, legal, engineering, and other professional services; educational institutions; membership organizations; and other miscellaneous services (OSHA, 2001).

Table 4.1–3
Total Full-Time and Part-Time Employment by Industry

	1970					1980				
	Hancock	**Harrison**	**Jackson**	**ROI**	**Percent**	**Hancock**	**Harrison**	**Jackson**	**ROI**	**Percent**
Agricultural Services, Forestry, Fishing, and Other	11	68	439	518	0.5	63	450	450	963	0.7
Mining	13	175	140	328	0.3	102	89	86	277	0.2
Construction	630	3,852	3,101	7,583	6.9	329	3,484	6,089	9,902	6.9
Manufacturing	939	4,381	16,065	21,385	19.5	1,027	6,673	19,172	26,872	18.8
Transportation, Public Utilities	231	2,714	868	3,813	3.5	333	4,116	1,564	6,013	4.2
Wholesale Trade	105	1,641	490	2,236	2.0	129	2,616	1,182	3,927	2.8
Retail Trade	586	8,639	3,999	13,224	12.1	1,180	12,902	6,841	20,923	14.7
Finance, Insurance, Real Estate	350	3,087	1,230	4,667	4.3	558	4,299	2,116	6,973	4.9
Services	2,465	10,350	4,558	17,373	15.8	2,360	14,148	6,354	22,862	16.0
Government	1,101	31,469	5,378	37,948	34.6	2,897	31,371	8,483	42,751	30.0
Total Nonfarm Employment	6,431	66,376	36,268	109,075	99.4	8,978	80,148	52,337	141,463	99.2
Farm Employment	202	259	181	642	0.6	350	430	335	1,115	0.8
Total Employment	6,633	66,635	36,449	109,717	100.0	9,328	80,578	52,672	142,578	100.0

Table 4.1–3
Total Full-Time and Part-Time Employment by Industry (continued)

	1990					2000				
	Hancock	**Harrison**	**Jackson**	**ROI**	**Percent**	**Hancock**	**Harrison**	**Jackson**	**ROI**	**Percent**
Agricultural Services, Forestry, Fishing, and Other	106	1,031	734	1,871	1.2	--[1]	1,548	--	1,548	0.7
Mining	42	162	81	285	0.2	--	95	--	95	0.0
Construction	455	3,724	3,199	7,378	4.8	1,458	7,530	6,444	15,432	7.2
Manufacturing	2,071	7,234	19,226	28,531	18.4	1,572	5,820	17,709	25,101	11.8
Transportation, Public Utilities	355	3,990	1,685	6,030	3.9	585	6,345	1,374	8,304	3.9
Wholesale Trade	129	2,384	871	3,3384	2.2	197	3,064	841	4,102	1.9
Retail Trade	1,712	16,319	7,936	25,967	16.7	3,011	22,268	10,944	36,223	17.0
	1990					**2000**				
	Hancock	**Harrison**	**Jackson**	**ROI**	**Percent**	**Hancock**	**Harrison**	**Jackson**	**ROI**	**Percent**
Finance, Insurance, Real Estate	476	4,530	1,737	6,743	4.3	1,014	6,302	2,661	9,977	4.7
Services	4,096	18,605	8,561	31,262	20.1	7,647	43,487	12,456	63,590	29.8
Government	3,537	29,919	9,480	42,936	27.7	4,204	30,216	12,328	46,478	21.9
Total Nonfarm Employment	12,979	87,898	53,510	154,387	99.4	20,057	126,675	65,571	212,303	99.5
Farm Employment	240	336	307	883	0.6	306	363	466	1,135	0.5
Total Employment	13,219	88,234	53,817	155,270	100.0	20,363	127,038	66,037	213,438	100.0

[1] These data are not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
Source: US DOC, BEA, 2001.

Table 4.1–4
Labor Force and Unemployment Rates

	1990			2000		
Location	**Civilian Labor Force**	**Persons Unemployed**	**Rate**	**Civilian Labor Force**	**Persons Unemployed**	**Rate**
Hancock County[1]	12,880	930	7.2	18,790	740	3.9
Harrison County	72,230	4,840	6.7	88,200	3,710	4.2
Jackson County	55,310	3,980	7.2	72,840	4,000	5.5
ROI	140,420	9,750	7.0	179,830	8,450	4.5
Mississippi	1,183,600	90,100	7.6	1,326,400	75,300	5.7
United States[2]	125,840,000	7,047,000	5.6	209,699,000	5,655,000	4.0

[1] Source for Hancock, Harrison, and Jackson Counties and the state of Mississippi: MESC, 2001.
[2] Source for the United States: BLS, 2001.

The 10 largest employers in the three-county region are shown in Table 4.1–5. Although the largest sources of employment still include federal government facilities (military and related facilities), shipbuilding facilities, and two hospitals, three of the region's casinos together provide almost 12,000 jobs. As shown in Table 4.1–6, other casinos in the ROI employ from about 500 to 1,500 people each, bringing total direct employment in this sector to more than 19,000.

Table 4.1–5
ROI Largest Employers

Employer	Location	Number of Employees
Keesler Air Force Base	Biloxi	15,674
Northrop Grumman/Litton Industries	Pascagoula	10,839
Grand Casino/Park Place Entertainment	Biloxi/Gulfport	5,460
Beau Rivage	Biloxi	4,150
Stennis Space Center	Stennis	4,514
Naval Construction Battalion Center	Gulfport	4,392
Naval Station Pascagoula	Pascagoula	3,065
Memorial Hospital at Gulfport	Gulfport	2,200
Singing River Hospital	Pascagoula	2,100
President Casino	Biloxi	1,991

Source: HCDC, 2001a.

Table 4.1–6
Casino Employers

Employer	Location	Number of Employees
Grand Casino	Biloxi/Gulfport	5,460
Beau Rivage	Biloxi	4,150
President	Biloxi	1,991
Imperial Palace	Biloxi	1,500
Casino Magic	Biloxi/Bay Saint Louis	1,360
Treasure Bay	Biloxi	1,200
Isle of Capri	Biloxi	1,077
Boomtown	Biloxi	1,000
The New Palace	Biloxi	800
Copa Casino	Gulfport	530
Total	ROI	19,068

Source: HCDC, 2001a.

4.1.3 Income

Table 4.1–7 shows income data for the each county in the ROI and for the state as reported in 1979, 1989, and 1999. Per capita income and median household income have risen for each county since 1980. In general, Hancock County, Harrison County, and Jackson County have maintained per capita incomes and median household incomes higher than that of Mississippi, although by 1997 per capita income in Hancock County had fallen below that of Mississippi. Of the three counties, Harrison County saw the largest increase in per capita income between 1979 and 1999, although Jackson County had the highest median household income of the three counties at the end of 1999.

Table 4.1–7
Income Levels for the ROI and Mississippi [1]

	Hancock County			Harrison County		
	1979	**1989**	**1999**	**1979**	**1989**	**1999**
Per Capita Income	$5,705	$9,534	$17,748	$5,807	$9,504	$18,024
Median Household Income	$13,139	$20,720	$35,202	$13,402	$22,157	$35,624
	Jackson County			**Mississippi**		
	1979	**1989**	**1999**	**1979**	**1989**	**1999**
Per Capita Income	$6,122	$9,952	$17,768	$5,183	$8,621	$15,853
Median Household Income	$16,986	$26,444	$39,118	$12,096	$20,136	$31,330

[1] Source for 1979 and 1989, and 1999 data: US Census Bureau, 1980 and 1990, and 2000 Census

4.1.4 Housing

The housing stock along the Mississippi Gulf Coast, based on the 2000 Census, is summarized in Table 4.1–8. This table identifies both owner-occupied and renter-occupied homes, along with median home values, for each county in the ROI. The homes identified include all structure types (e.g., single-family homes, apartments, and mobile homes). Harrison County, the most populous of the three counties, also has most of the region's housing stock (52.3 percent). Hancock County has the lowest number of homes and the lowest population, with 13.8 percent of the housing stock.

Table 4.1–8
2000 ROI Housing Stock

	Hancock County	Harrison County	Jackson County	ROI
Total Housing Units	21,072	79,636	51,678	152,386
Occupied Housing Units	16,897	71,538	47,676	136,111
Vacant Housing Units	4,175	8,098	4,002	16,275
For Sale (percent)	6.9	10.7	13.7	10.4
For Rent (percent)	14.9	39.0	34.2	29.4
Seasonal Use (percent)	56.8	20.7	15.3	30.9
Vacancy Rate, Homeowner	2.1	1.9	1.5	1.8
Vacancy Rate, Rental	15.3	10.6	10.1	12.0

Source: US DOC, Census, 2001c

The residential housing market varied among the three counties during the 1990s (Table 4.1–9). Overall, approximately 17,500 new permits for single-family dwellings were issued in the three-county region from 1990 to 2000 (GRPC, 2001a). Jackson County accounted for the largest number of these permits with 9,067, followed by Harrison County with 5,776 (GRPC, 2001a). The number of permits issued in Harrison and Jackson Counties during 1990 and 1991 actually declined (likely influenced by the effects of the national economic recession at that time) from previous years, then increased over the next 2 years, but dropped again mid-decade. Growth increased again in 1997 and 1998, but Harrison County issued fewer permits in 2000 than in 1999. The number of permits issued by Jackson County, however, increased by about 11 percent.

Hancock County, with less than a third of the population of either Harrison or Jackson County, also has the smallest housing market. This is reflected by the much smaller number of residential building permits issued in the county, although the figures provided in the table likely underestimate the annual number of permits issued before 1997. This is because prior to 1997, building permits in Hancock County were required only for residential construction in the flood zone. Since 1997 a permit has been required for residential construction anywhere in Hancock County, explaining the dramatic increase in residential building permits issued beginning in 1998 (Hancock County Building Inspection and Permits, personal communication, 2001).

Table 4.1–9
Residential Building Permits for the ROI

Year	Hancock County	Harrison County	Jackson County	ROI
1990	56	251	545	852
1991	74	231	530	835
1992	73	325	699	1,097
1993	80	702	816	1,598
1994	134	531	778	1,443
1995	117	363	615	1,095
1996	89	440	808	1,337
1997	89	607	806	1,502
1998	248	784	1,091	2,123
1999	767	848	1,126	2,741
2000	998	694	1,253	2,945
Total	2,725	5,776	9,067	17,568

Source: GRPC, 2001a.

4.1.5 Quality of Life

Quality of Life encompasses those attributes or resources (man-made or naturally occurring) of a region that contribute to the well being of its residents. The relative importance of these attributes to a person's well-being is subjective (e.g., some individuals consider educational opportunities essential to their well-being, others may place a high value on the availability of health care services, and still others may hold public safety as their primary quality-of-life concern). NEPA quality-of-life analyses typically address issues relating to potential impacts of the proposed action on the availability of public services and leisure activities that contribute to quality of life of the affected ROI's inhabitants. For purposes of this study, the affected environment for quality of life includes public schools, law enforcement, medical facilities, and fire protection services. Recreational opportunities, including sporting, shopping, and cultural resources are also described.

4.1.5.1 Schools

Within the ROI, 11 public schools provide education for approximately 62,700 school-age children. Each county's public school district provides education facilities for those students residing within the county's unincorporated areas for kindergarten through 12th grade. Each incorporated area in the ROI provides kindergarten through 12th grade education facilities for its student population. Table 4.1–10 provides a general inventory of public education facilities within the ROI. The "other schools" identified in the table consist primarily of vocational centers, as well as alternative schools and development centers.

The public school districts in the ROI currently have adequate capacity to accommodate additional students. The available capacity is not substantial, however, and keeping up with population growth

Table 4.1–10
1999–2000 School Year Public Education Inventory by School District[1]

School District	Elementary Schools	Middle Schools	High Schools	Other Schools	Student Enrollment	Student Capacity[2]
Hancock County	4	0	1	1	4,044	5,000
Bay St. Louis/Waveland	2	1	1	0	2,416	3,000
Harrison County	12	3	2	3	12,761	13,000
Biloxi	7	3	1	1	6,096	6,500
Gulfport	7	2	1	2	6,339	7,000
Long Beach	3	1	1	0	3,641	4,000
Pass Christian	2	1	1	0	1,803	2,250
Jackson County	7	4	3	2	8,507	9,000
Moss Point	6	2	1	2	4,724	6,000
Ocean Springs	4	1	1	1	4,904	5,320
Pascagoula	10	3	2	3	7,484	8,000

[1] Source: USDOE, NCES, 2001.
[2] MDOE, 1999a,b,c, as cited in USACE, Mobile District, 2000.

continues to be one of the major challenges facing all school districts in the ROI (Arledge, personal communication, no date, and Batstone, personal communication, 1999, as cited in USACE, Mobile District, 2000). Seven school districts in the three-county ROI have either recently constructed new facilities or expanded capacity (Table 4.1–11).

The public school districts in the ROI receive funding from local, state, and federal sources. Funding levels are a reflection of the student body size of each district. Consequently, Harrison County School District receives the highest level of funding and Pass Christian School District receives the lowest level. Table 4.1–12 lists revenue by source for each district, from highest to lowest, for the 1999–2000 school year. Federal funds constituted the smallest contribution to each school district, with funding ranging from 7.2 percent to 17.7 percent of total revenue. State funding typically made up the largest funding source for each school district, ranging from 41.7 percent to 60.6 percent. Two exceptions were Gulfport and Pass Christian, which received greater funding from local sources than from state or federal sources. Although local revenue sources contribute the smallest amount of funding to the school districts, with the exception of the two districts previously mentioned, the local contributions are not significantly lower than the amounts contributed by the state. Local sources contributed from 32.1 percent to 47.7 percent.

Under the 1992 gaming tax legislation, the cities of Biloxi and Gulfport in Harrison County are required to impose a 3.2 percent tax on the gross revenue of gaming vessels docked within the geographic confines of each municipality (USACE, Mobile District, 2000). Each city is required to distribute 10 percent for educational purposes within Harrison County (USACE, Mobile District, 2000). The contribution from each municipality is distributed to all school districts with the county based on enrollment (USACE, Mobile District, 2000). In addition to the 10 percent, the cities of Biloxi and Gulfport allocate an additional 20 percent each for educational purposes within their school districts (*The Sun Herald*, 1997, as cited in USACE, Mobile District, 2000).

Table 4.1–11
Construction Projects Completed and Future Expansion Plans by School District

School District	Expansion Plans/Comments
Hancock County	Constructed a new elementary school and a new middle school, and renovated two elementary schools.
Bay St. Louis/Waveland	Constructed new middle school.
Harrison County	Added four classrooms each to six elementary schools.
Biloxi	Constructed new elementary school .
Gulfport	Expanded all elementary schools by adding classrooms for the purpose of reducing class size in grades 1 through 3.
Long Beach	No expansion plans.
Pass Christian	Expanded the high school.
Jackson County	No expansion plans.
Moss Point	No expansion plans.
Ocean Springs	No expansion plans.
Pascagoula	Constructed a new elementary school. .

Source: Hancock County School District, personal communication, 2001; Bay St. Louis/Waveland School District, personal communication, 2001; Harrison County School District, personal communication, 2001; Biloxi School District, personal communication, 2001; Gulfport School District, personal communication, 2001; Long Beach School District, personal communication, 2001; Pass Christian School District, personal communication, 2001; Jackson County School District, personal communication, 2001; Moss Point School District, personal communication, 2001; Ocean Springs School District, personal communication, 2001; and Pascagoula District School District, personal communication, 2001.

Table 4.1–12
Revenue by Source by District, 1999–2000 School Year

School District	Local	Local Percent	State	State Percent	Federal	Federal Percent	Total
Harrison County	$22,010,943	34.6	$33,794,944	53.2	$7,735,828	12.2	$63,541,714
Pascagoula	$21,313,946	44.0	$21,963,117	45.4	$5,108,429	10.6	$48,385,493
Gulfport	$21,147,910	46.5	$19,467,720	42.8	$4,868,345	10.7	$45,483,975
Biloxi	$17,538,393	40.6	$18,034,395	41.7	$7,650,523	17.7	$43,223,310
Jackson County	$15,218,460	36.1	$23,479,698	55.8	$3,416,186	8.1	$42,114,344
Moss Point	$8,745,783	32.8	$13,933,995	52.2	$3,988,004	15.0	$26,667,782
Ocean Springs	$9,792,018	37.3	$14,593,495	55.5	$1,893,519	7.2	$26,279,031
Hancock County	$9,740,403	40.3	$11,812,152	48.9	$2,607,801	10.8	$24,160,356
Long Beach	$6,105,104	32.1	$11,525,493	60.6	$1,400,220	7.4	$19,030,816
Bay St. Louis/ Waveland	$6,200,498	41.4	$6,810,510	45.4	$1,978,857	13.2	$14,989,865
Pass Christian	$5,780,766	47.7	$5,182,527	42.7	$1,165,721	9.6	$12,129,015

Source: MDOE, 2001.

Hancock County is the only other county in the ROI that permits casinos. The one casino currently located in Hancock County is in the city of Bay St. Louis and consequently provides revenue only for the Bay St. Louis/Waveland School District. The Hancock County School District does not receive any portion of gaming tax revenue (Ehrlich, personal communication, no date, and Batstone, personal communication, 1999, as cited in USACE, Mobile District, 2000).

Gaming tax revenues collected from the gaming industry are included in the local funding sources and are considered supplemental funds to those school districts that benefit directly from the tax (USACE, Mobile District, 2000). Consequently, per-pupil expenditures tend to be higher in school districts that receive gaming tax contributions (Arledge, personal communication, no date, and Batstone, personal communication, 1999, as cited in USACE, Mobile District, 2000). Gaming tax contributions to the school districts in Mississippi have been a substantial source of revenue that has provided for teacher pay raises, health benefits for school employees, air conditioners in classrooms, new textbooks, and bus and building improvements (Harp, 1999, as cited in USACE, Mobile District, 2000).

4.1.5.2 Public Safety

Police Services. Thirteen police departments in the ROI are responsible for the protection of the population. The Sheriff Departments of Hancock, Harrison, and Jackson Counties provide safety services for the general population in unincorporated areas. Ten municipal police departments are responsible for the protection of residents in incorporated areas. Table 4.1–13 lists police resources for the most current year available.

Table 4.1–13
Police Resources for the ROI

Agency	Full-Time Employees	Part-Time Employees	FY 1998 Budget	Patrol Cars	Other Vehicles
Hancock County	73	28	$2,865,829	35	7
Bay St. Louis	27	0	N/A	22	10
Waveland	19	5	$1,200,000	19	3
Harrison County	200	50	$1,551,830	57	40
Biloxi	117	39	$10,453,139	101	44
Gulfport	173	3	$1,293,540	206	69
Long Beach	28	0	$1,551,830	11	15
Pass Christian	18	20	$825,273	14	0
Jackson County	94	19	$3,830,789	91	17
Gautier	28	25	$1,687,000	14	4
Moss Point	40	0	$1,333,472	24	8
Ocean Springs	56	0	$3,600,000	56	3
Pascagoula	32	18	$1,879,967	26	1

Source: GRPC, 1998c, as cited in USACE, Mobile, 2000.

Fire Services/EMS. Fire protection services in the ROI are provided through municipal fire departments, county fire departments, and volunteer fire departments. Emergency Medical Services (EMS) in Hancock and Harrison Counties are handled primarily by a private company, American Medical Response (AMR), which is the nation's largest provider of medical transportation. Acadian Ambulance Service is the main provider of EMS in Jackson County. Municipal fire departments in the ROI act in only an administrative capacity, coordinating of these services with AMR; they do not actually provide the services.

Municipal fire departments are responsible for fire protection services within their municipal boundaries, whereas county fire departments and volunteer fire departments are responsible for protection services within the unincorporated areas. Typically, municipal fire departments respond to nearby unincorporated areas if needed; however, most unincorporated communities in the ROI maintain volunteer fire departments. To provide optimum aid to neighboring jurisdictions, fire departments in the region participate in various cross-training efforts to familiarize themselves with the terrain and geography (Mixon, personal communication, no date, and Batstone, personal communication, no date, as cited in USACE, Mobile District, 2000). Table 4.1–14 lists fire protection resources for the most current year available.

Table 4.1–14
Fire Protection Resources for the ROI

Agency	Full-Time Firefighters	Part-Time Firefighters	FY 1998 Budget	Vehicles
Hancock County	N/A	N/A	N/A	N/A
Bay St. Louis	15	9	$836,755	3
Waveland	12	15	$631,499	10
Harrison County	8	100	$1,373,546	32
Biloxi	108	0	$5,292,940	21
Gulfport	173	0	$8,500,000	29
Long Beach	34	0	$1,450,464	12
Pass Christian	18	30	$586,201	9
Jackson County	10	250	$1,540,000	64
Gautier	23	0	$907,673	5
Moss Point	39	0	$1,841,250	10
Ocean Springs	37	0	$1,071,325	7
Pascagoula	57	0	$3,051,730	10

Source: GRPC, 1997, as cited in USACE, Mobile District, 2000.

The public safety agencies of Harrison County, the city of Biloxi, and the city of Gulfport receive a portion of the revenues generated from the operation of casinos within their jurisdictions. The gaming tax legislation, which passed in 1992, requires the cities of Biloxi, Gulfport, and D'Iberville to impose a 3.2 percent tax on the gross revenue of gaming vessels docked within the geographic confines of each municipality (USACE, Mobile District, 2000). The legislation requires that 20

percent of the tax revenue generated within the cities of Biloxi and Gulfport be allocated for public safety purposes within each city (Wilemon, 1999, as cited in USACE, Mobile District, 2000).

The revenue generated from gaming taxes in the cities of Biloxi, Gulfport, and Bay St. Louis and the counties of Hancock and Harrison has enhanced the budgets of public safety agencies in these areas. As a result of the gaming tax, both police and fire departments have had the opportunities to expand their programs and increase their personnel and vehicle inventory (USACE, Mobile District, 2000).

Health Care Facilities and Professionals. The ROI has 11 hospitals (Table 4.1–15), with a total of 1,815 beds. The Keesler Medical Center is world-renowned and is the second largest medical treatment facility in the Air Force (City of Biloxi, 2001). It serves more then 52,000 patients from the local community and also brokers health care to nearly 60,000 beneficiaries in Department of Defense Health Services Region IV, covering all of Mississippi, Alabama, Tennessee, and parts of Louisiana and Florida (City of Biloxi, 2001). Home health care services are offered in the ROI by licensed agencies, including Quality Home Health Care of the Gulf Coast, Inc. (City of Biloxi, 2001). Quality Home Health Care also operates a hospice in the ROI. The hospice provides in-home care to support the needs of terminally ill patients and their families (City of Biloxi, 2001).

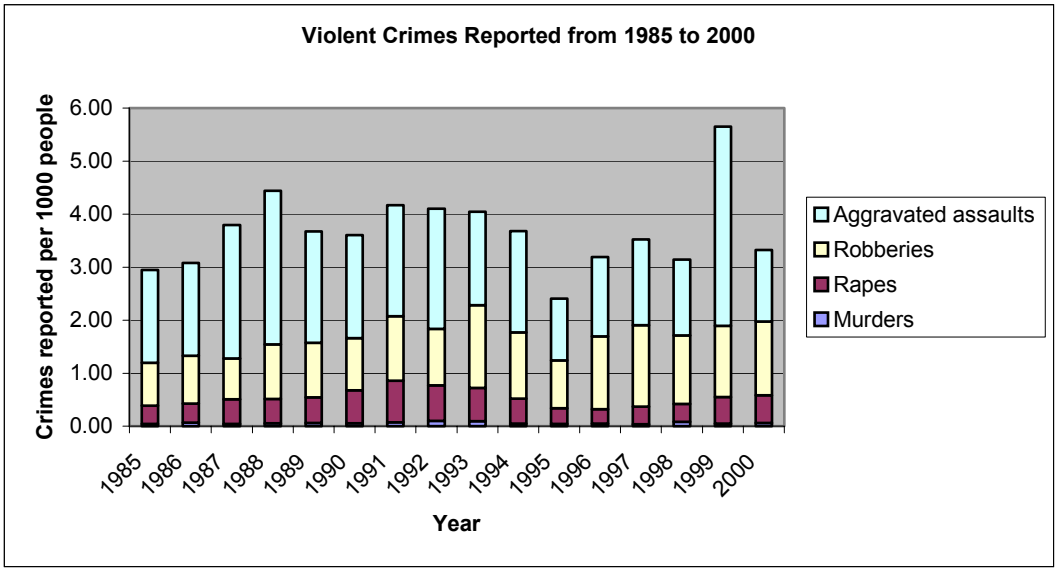
Table 4.1–15
ROI Health Care Facilities and Professionals

County or Entity	Hospitals	Total Beds	Physicians	RNs	LPNs	Dentists
Hancock	1	66	53	0	69	8
Harrison	5	835	449	9	552	87
Jackson	2	539	221	0	303	46
Veteran's Admin.	2	275	73	2	79	6
Keesler Medical Center	1	100	154	9	--	7
ROI	11	1,815	950	6	1,003	154

Source: GRPC, 1999.
[1] Number includes RNs and LPNs.

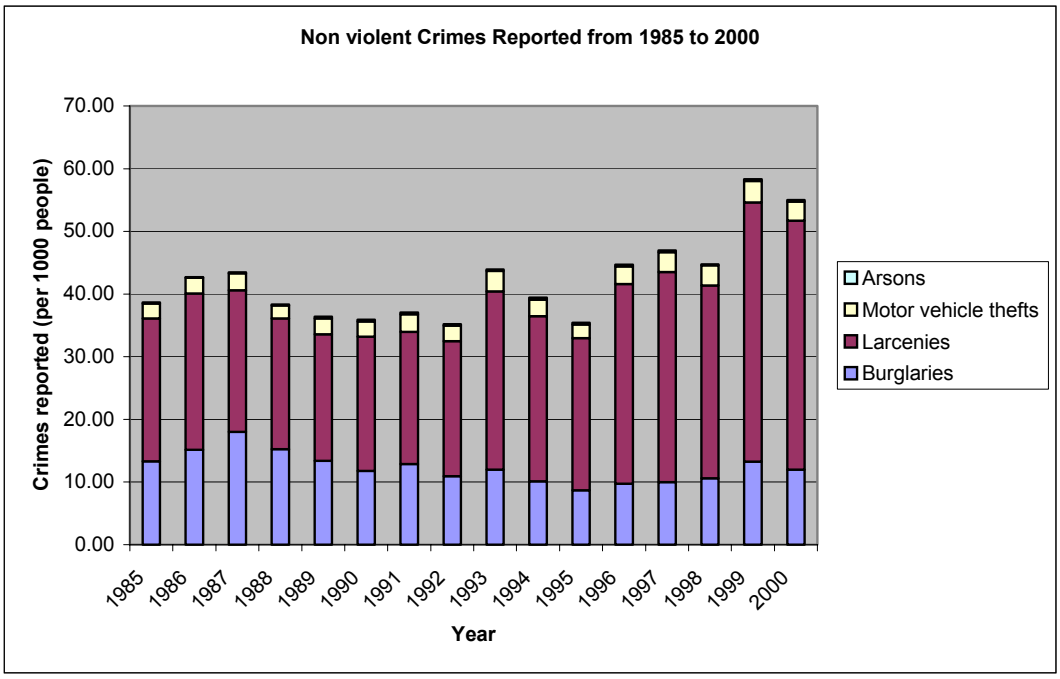
Crime. Data for the number of crimes reported in the ROI between the years 1985 and 2000 show an increasing trend. Non-violent crimes include arson, motor vehicle thefts, larcenies, and burglaries while violent crimes consist of aggravated assaults, robberies, rapes and murders. Most of the rates for crime categories fluctuated between years. The crime rates for total crimes, total nonviolent crimes, total violent crimes, murders, rapes, larcenies, motor vehicle thefts, and arsons were all higher in 2000 than in 1985 (Figures 4.1–1 and 4.1–2). The 2000 crime rates for robberies, aggravated assaults, and burglaries were lower than 1985 rates. It should be noted that a change in the reporting methodology was implemented in 1994. Therefore, trends from 1985 to 1993 should be evaluated independently from trends from 1994 to 2000.

Harrison County showed the highest levels of increase compared to the other ROI counties, Hancock County and Jackson County. Crime rates for this county increased in all areas except for murder, aggravated assault, and burglaries. The categories of crime with the highest percent increase over the 15-year period were larceny, robbery, and arson.



Source: U.S. Department of Justice, Federal Bureau of Investigation, 2002.

Figure 4.1–1. Violent Crimes Reported in the ROI from 1985 to 2000[1]



Source: U.S. Department of Justice, Federal Bureau of Investigation, 2002.

Figure 4.1–2. Non-violent Crimes Reported in the ROI from 1985 to 2000[1]

4.1.5.3 Recreation

With 26 miles of Gulf of Mexico coastline, the Gulf Coast of Mississippi has many recreational opportunities for residents and also is a popular tourist destination. In the year 2000 there were an estimated 22 million visitors to the region (HCDC, 2001b). Water sports, casinos gaming, golfing, fresh and saltwater fishing, camping, historic tours, and cultural sites are available in the ROI. Each county has parks, playgrounds, community playfields (softball, baseball, soccer), tennis courts, swimming pools, jogging and walking trails, and community centers that are open to county residents.

Beaches/Resorts/Casinos. The waterfront areas along the Gulf Coast and the back bays and the barrier islands in the Gulf are popular spots for swimming, windsurfing, parasailing, motor boating, water skiing, and sailing. A boat can be taken to Ship Island in the Gulf, which is noted for its beautiful beaches and historic Fort Massachusetts (MDECD, no date). The barrier islands off Mississippi are part of the Gulf Islands National Seashore, which stretches from West Ship Island in Mississippi to Santa Rosa Island in Florida (NPS, 2001). For fiscal year 2000 the Gulf Islands National Seashore had 875,000 visitors, and 26,000 of these visitors stayed overnight.

The introduction of casino gaming in 1992 brought a new attraction to the Mississippi coast. There are now 12 casinos along the coast, 1 in Bay St. Louis, 2 in Gulfport, and 9 in Biloxi. The casinos are all open 24 hours a day, 365 days a year, and they offer slots, craps, blackjack, mini-baccarat, poker, and roulette (Mississippi Gulf Coast, 2001). Nine of the casinos are part of resort hotel complexes, which offer such amenities as spas, salons, retail shops, fitness facilities, swimming pools, live entertainment (Las Vegas-type shows), restaurants, and sunset cruises (Mississippi Gulf Coast, 2001). In 2000, 25 percent of the visitors to the casinos were from Mississippi (MGC, 2001); the remaining 75 percent were from outside the state.

Golf. There are more than 20 golf courses in the ROI for every skill level (Mississippi Gulf Coast Golf Association, 2001). An estimated 798,000 rounds of golf were played in the ROI in 2000 (HCDC, 2001b). Public courses, resort courses, and semi-private courses are available. Several courses have been recently refurbished, and new courses are under construction or in the planning stages (Mississippi Gulf Coast Golf Association, 2001). Green fees are lower than those of comparable golf resort areas (Mississippi Gulf Coast Golf Association, 2001).

Fishing. Fishing is a popular sport in the ROI because of the 200 varieties of saltwater fish in the Gulf and a climate suitable for year-round fishing (Mississippi Gulf Coast, 2001). More than 30 public boat ramps, marina slips, and a number of private camps and launches provide rental boats, charter boats, and bait (Mississippi Gulf Coast, 2001). A wide variety of charter boats are available for small groups of one to six passengers or for large parties (Mississippi Gulf Coast, 2001). Fishing trips can be scheduled for from 4 hours up to an overnight stay (Mississippi Gulf Coast, 2001). Numerous fishing tournaments are held every year, including the Mississippi Deep Sea Fishing Rodeo, which is the largest event of its kind in the world (Mississippi Gulf Coast, 2001).

Museums and Culture. Beauvoir, the final home of Jefferson Davis (the president of the Confederate States of America during the Civil War) is in Biloxi in Harrison County. In addition to tours of the home and grounds, the site offers a new Presidential Library, Confederate Museum and Cemetery, and re-creation of an 1861 Confederate boot camp (Mississippi Gulf Coast, no date). There are numerous art museums and galleries all along the coast, including the George E. Ohr Arts and Cultural Center, which features the works of the noted potter, and the Walter Anderson Museum of Art, featuring the art of this Mississippi artist, writer, and naturalist (Mississippi Gulf Coast, no

date). Biloxi has a Mardi Gras Museum. There are a number of maritime museums and aquariums along the coast, including the J.L. Scott Marine Education Center and Aquarium, the Maritime and Seafood Industry Museum, and the Marine Life Oceanarium.

Military Installations and Tours. The Mississippi coast has a strong history in the nation's military and national defense. CEC/SEABEE Memorial Museum in Gulfport honors the presence of the Navy's Civil Engineering Corps and the Navy Seabees in the gulf coast (Mississippi Gulf Coast, no date). The Keesler Air Force Base and Naval Station Pascagoula offer driving tours to visitors. NASA's John C. Stennis Space Center, in Hancock County, has a museum with spacecraft, space artifacts, and a history of the race to the moon (Mississippi Gulf Coast, no date).

4.1.6 Environmental Justice

On February 11, 1994, President Clinton issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. The Executive Order is designed to focus the attention of federal agencies on the human health and environmental conditions in minority communities and low-income communities. Environmental justice analyses are performed to identify potential disproportionately high and adverse impacts from proposed actions and to identify alternatives that might mitigate these impacts. Data from the U.S Department of Commerce 2000 Census of Population and Housing were used for this environmental justice analysis. Minority populations included in the census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other. Poverty status, used in this EIS to define low-income status, is reported as the number of persons with income below poverty level. The 2000 Census defines the poverty level as $8,794 of annual income, or less, for an individual, and $17,603 of annual income, or less, for a family of four.

The ROI has a lower percentage of minority residents than the state of Mississippi and the United States, as shown in Table 4.1–16. In 2000, 79.6 percent of the ROI population was white and 16.3 percent was black. All other racial groups combined totaled approximately 4.1 percent of the population, while 2.2 percent were of Hispanic origin. In Mississippi, 61.4 percent of the population was white, 36.3 percent was black, 2.3 percent was of another minority racial group, and 1.4 percent was of Hispanic origin. For the United States, 75.1 percent of the population was white, 12.3 percent was black, and 12.6 percent was of other minority racial groups. Approximately 12.5 percent of the U.S. population was Hispanic.

The Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. In 1997 approximately 14.6 percent of the ROI residents were classified as living in poverty, lower than the state of Mississippi but slightly higher than the poverty rate for the United States as a whole.

4.1.7 Protection of Children

On April 21, 1997, the President issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. This Executive Order directs each federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks. EO 13045 recognizes that a growing body of scientific knowledge demonstrates that children may suffer disproportionately from environmental health risks and safety risks. These risks arise because children's neurological, immunological,

digestive, and other bodily systems are still developing; children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults; children's size and weight may diminish their protection from standard safety features; and children's behavior patterns make them more susceptible to accidents because they are less able to protect themselves. Therefore, to the extent permitted by law and appropriate, and consistent with the agency's mission, the President has directed each federal agency to (1) make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children, and (2) ensure that the agency's policies, programs, and standards address disproportionate health risks to children that result from environmental health risks or safety risks. Examples of risks to children include increased traffic volumes and industrial or production-oriented activities that would generate substances or pollutants that children may come into contact with or ingest. Actions or alternatives indicating potential disproportionate risks to children will be identified and addressed in Section 5 of this EIS.

Table 4.1–16
2000 Race, Ethnicity, and Poverty Status in the ROI, Mississippi, and the United States

	Hancock County	Harrison County	Jackson County	ROI	Mississippi	United States
White	90.2%	73.1%	75.4%	79.6%	61.4%	75.1%
Black/African American	6.8%	21.1%	20.9%	16.3%	36.3%	12.3%
American Indian, Alaska Native	0.6%	0.5%	0.3%	0.5%	0.4%	0.9%
Asian	0.9%	2.6%	1.6%	1.7%	0.7%	3.6%
Native Hawaiian, Other Pacific Islander	—[1]	0.1%	—[1]	—[1]	—[1]	0.1%
Other	0.3%	0.9%	0.7%	0.6%	0.5%	5.5%
Two or More Races	1.1%	1.7%	1.1%	1.3%	0.7%	2.4%
Hispanic or Latino[2]	1.8%	2.6%	2.1%	2.2%	1.4%	12.5%
Persons Living in Poverty[3]	15.3%	14.9%	13.6%	14.6%	18.1%	13.3%

Source: US DOC, Census, 2001a.
[1] Value is greater than zero but less than half unit of measure shown.
[2] Persons of Hispanic origin may be of any race.
[3] Persons living in poverty is for 1997.

4.2 LAND USE AND LAND COVER

Land use describes what is practiced, permitted, or planned. Land cover, an increasingly important attribute of land use, describes what is physically on the ground. It is defined as the type of material that covers the earth's surface at a specific location at a specific time. Land use is the manner in which human beings use a specific tract of the earth's surface. For example, the land use in an area might be cropland, but the land cover at a specific location within the area might be wheat, corn,

soybeans, bare soil, grass, or even trees (as in a windbreak). Similarly, in an area used for single-family residences, the land cover at a specific location might be asphalt, concrete, grass, or trees. Furthermore, land cover can change dramatically in a short period while land use remains the same. A field that had a land cover of wheat in May, for example, might be bare soil in August, though the land use remains agricultural.

The terms *land use* and *land cover* are often used simultaneously with respect to maps that provide information about the types of features found on the earth's surface (land cover) and the human activity associated with them (land use). In some cases, a hybrid approach results in mapping land cover and land use together. Such maps are produced from remotely sensed data (satellite images and aerial photography) at scales that are amenable to planning, environmental assessment, and development studies.

This section describes the current land use and land cover and changes in them over time in the Coastal Study Area. In particular, it focuses on changes in the amount of developed land, and on the relationship between population growth and the amount of developed land and impervious cover. Impervious cover is a key environmental indicator that is measurable and can be used to estimate or predict cumulative water resource impacts. For a programmatic analysis, detailed site information is inappropriate (and frequently unavailable) in many instances. Estimating impervious surface coverage, however, is generally a feasible and cost-effective way to address water pollution issues (Arnold and Gibbons, 1996).

To calculate current and historical land use patterns, land use data sets representative of historical land use, pre-casino development land use, and current land use were reviewed. GIS coverages of land use from 1972, 1992, and 2000 were selected. These data sets were available from USGS (1972 data); MARIS, USGS, and EPA (1992 data); and MARIS (2000 data). Because the land use data sets had originally been developed with different classification schemes, a consolidated classification scheme was developed and applied to each data set to allow comparison between them. The consolidated categories are medium-density urban, high-density urban, transportation, cropland/pasture/grassland, deciduous/mixed/bottomland forest/swamp, upland coniferous forest, wet coniferous forest/savanna, scrub-shrub/cutover/barren, emergent wetland, and surface water/other. Comparing data sets collected in different ways, however, can limit data interpretation. For example, the 1972 data set shows an unexpectedly low acreage of agricultural land. This discrepancy could be due to areas captured as pasture/grassland in the 1992 and 2000 data sets (an agricultural use) having been categorized as wet coniferous forest/savanna in the 1972 data set. Furthermore, because of data limitations, land cover identified as agriculture may actually include additional cover types including fallow fields, golf courses, cemeteries, parks, picnic groves, and right-of –ways. Because of these data limitations and the relative minor importance of agriculture in the Coastal Study Area, the time-series analyses focus on changes in developed land acreage, which for the purposes of this study is the primary indicator of changes in land use and environmental conditions in the region. Section 5.2.1.1 and Appendix O provide more detail on the land use data sets and their limitations.

The terms *developed land* and *impervious surfaces* are used throughout this section. Developed land includes medium- and high-density urban areas and transportation corridors with at least 25 percent impervious cover (such as pavement or rooftops). Impervious surfaces are impenetrable surfaces such as pavement and rooftops through which water cannot flow. Impervious surfaces result in storm water channeling and increased flows of storm water at downgradient collection points. These hydrologic effects can be detrimental to water quality. To estimate the amount of impervious surface, the acreages of the urban area and transportation categories were combined using 12 percent of the

medium-density urban acreage, 85 percent of the high-density urban acreage, and 100 percent of the transportation class acreage (USDA, NRCS, 1986).

The following sections describe land use and land cover in 2000 and trends in them since 1972 for (1) the coastal counties, (2) the Coastal Study Area, and (3) the watersheds. County-level information is provided because counties, along with the incorporated and unincorporated areas they contain, are responsible for land use regulations and controls. Land use and land cover information is also provided for the coastal study area because it is the area where the impacts of large-scale development have predominantly occurred. Finally, changes are assessed at the watershed level because analyses for other environmental resources addressed in the EIS are based on watersheds, not on man-made administrative boundaries.

4.2.1 Coastal Counties

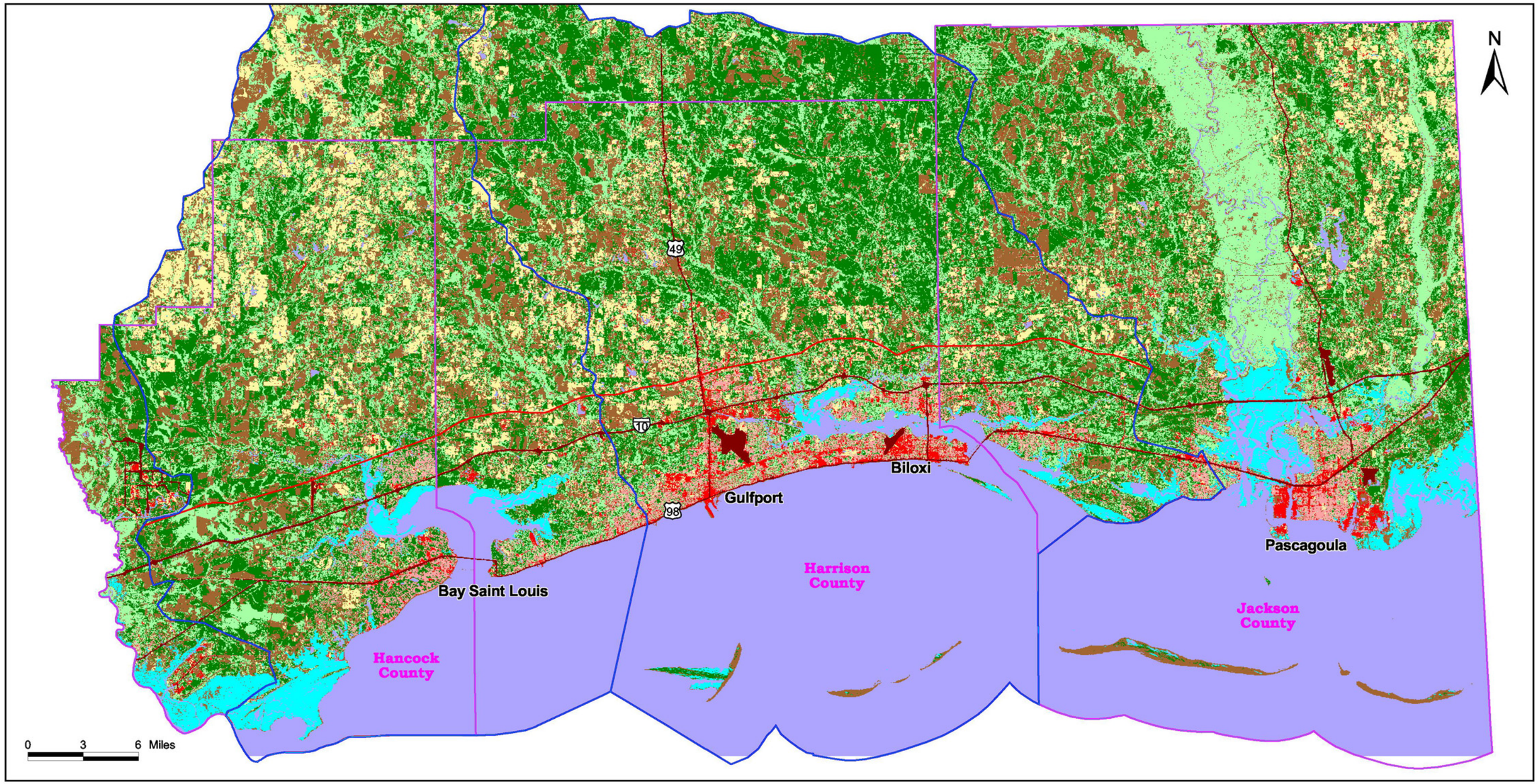
In 2000, natural vegetation covered 82 percent of the three coastal counties. Forest, scrub-shrub/cutover/barren, and emergent wetlands were the predominant natural cover types (Figure 4.2–1). Developed land covered about 8 percent of the counties. More than half of the developed land was medium-density urban land, 27 percent was high-density urban land, and the rest was transportation infrastructure (roads, streets, bridges). Impervious surfaces covered approximately 4 percent of the three-county region (Table 4.2–1). The largest concentrations of developed land were near the coast along US Highway 90 and south of I-10 (Figure 4.2–1).

From 1972 to 1992, land use patterns in the three counties underwent a number of changes. Developed land acreage increased by 37 percent, and natural land cover decreased by 8 percent. Losses in coniferous forest/savanna and emergent wetlands accounted for most of the natural land cover loss. During the same period, impervious surfaces increased by 36 percent. From 1992 to 2000 developed land increased by 11 percent; concurrently, impervious surfaces increased by 16 percent (Table 4.2–1).

Table 4.2–1 shows land cover changes from 1972 to 2000. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

The relationship between land use change and population growth varied among the coastal counties during the nearly 30 years from 1972 to 2000. Between 1972 and 1992, the population in the three-county region increased from 240,000 to 312,000, or by 30 percent. During the same period developed land area increased from 59,700 acres to 81,400 acres, or by 36 percent. Impervious surface area also increased by 36 percent, from 26,900 acres to 36,500 acres.

Between 1992 and 2000, developed land acreage continued to increase, but it increased only two-thirds as much as the population (by 11 percent compared to 17 percent). This pattern ran counter to the national trends in population and land development. Nationally, the amount of developed land increased by 13 percent from 1992 to 1997 while the population increased by only 5 percent (NRCS, 2001). High-density urban land in the three coastal Mississippi counties, however, increased twice as much as population did between 1992 and 2000. Impervious surfaces increased about 50 percent more than developed land but less than population (Table 4.2–1).



LEGEND

- Coastal Study Area
- County Study Area
- Watershed Study Area

Source: MARIS, 2000.

Land Use Types

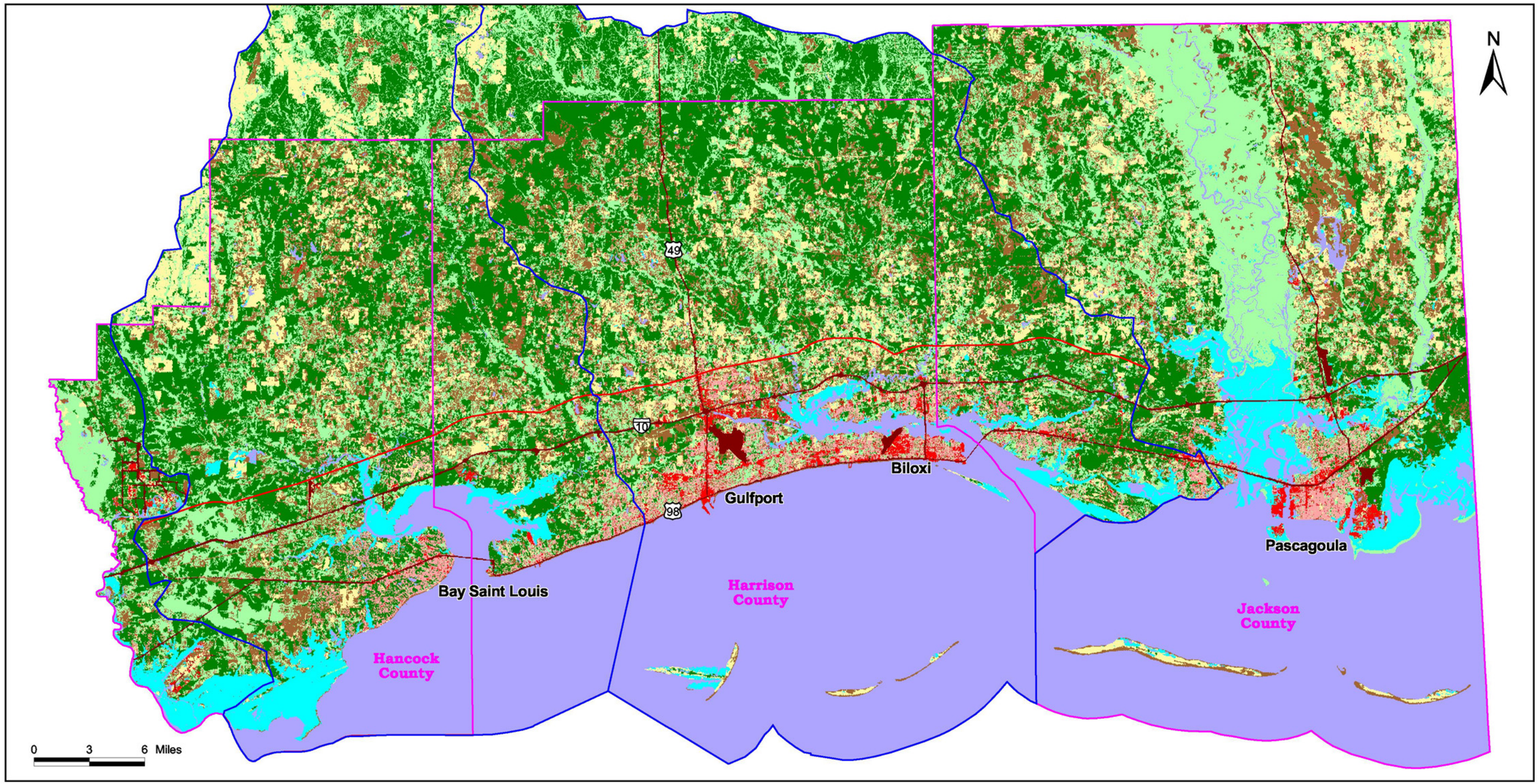
- Medium Density Urban
- High Density Urban
- Transportation
- Cropland/Pasture/Grassland
- Deciduous/Mixed/Bottomland Forest/Swamp
- Pine Forest/Savanna
- Scrub-Shrub/Cutover/Barren
- Emergent Wetlands
- Surface Water/Other

2000 Land Use in the County Study Area

Figure 4.2-1

Table 4.2–1
Coastal Mississippi Land Use–Coastal Counties

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	59,682	5.2%	81,400	7.1%	36.4%	90,203	7.9%	10.8%	51.1%
- Impervious	26,896		36,516		35.8%	42,367		16.0%	57.5%
Natural	1,017,639	87.9%	937,865	81.8%	-7.8%	940,687	82.1%	0.3%	-7.6%
Agricultural	68,062	5.9%	115,376	10.1%	69.5%	101,725	8.9%	-11.8%	49.5%
Inland Fresh Water	12,577	1.1%	12,577	1.1%		12,577	1.1%	0.0%	0.0%
Subtotals	1,157,960	100.0%	1,147,218	100.0%		1,145,192	100.0%		
Surface Water/Other	497,064		507,806			509,833			
TOTAL Acres	1,655,024		1,655,024			1,655,024			
Land Use – Detailed									
Medium-Density Urban Land	34,923	3.0%	47,898	4.2%	37.2%	50,170	4.4%	4.7%	43.7%
High-Density Urban Land	13,695	1.2%	18,223	1.6%	33.1%	24,572	2.1%	34.8%	79.4%
Transportation	11,064	1.0%	15,278	1.3%	38.1%	15,461	1.4%	1.2%	39.7%
Cropland/Pasture/Grassland	68,062	5.9%	115,376	10.1%	69.5%	101,725	8.9%	-11.8%	49.5%
Deciduous/Mixed Bottomland Forest/Swamp	262,916	22.7%	299,391	26.1%	13.9%	295,602	25.8%	-1.3%	12.4%
Coniferous Forest/Savanna	595,885	51.5%	385,631	33.6%	-35.3%	352,510	30.8%	-8.6%	-40.8%
Scrub-Shrub/Cutover/Barren	75,872	6.6%	180,221	15.7%	137.5%	236,848	20.7%	31.4%	212.2%
Emergent Wetland	82,966	7.2%	72,622	6.3%	-12.5%	55,726	4.9%	-23.3%	-32.8%
Inland Fresh Water	12,577	1.1%	12,577	1.1%	0.0%	12,577	1.1%	0.0%	0.0%
Subtotals	1,157,960	100.0%	1,147,218	100.0%		1,145,192	100.0%		
Surface Water/Other	497,064		507,806			509,833			
TOTAL Acres	1,655,024		1,655,024			1,655,024			



LEGEND

- Coastal Study Area
- County Study Area
- Watershed Study Area

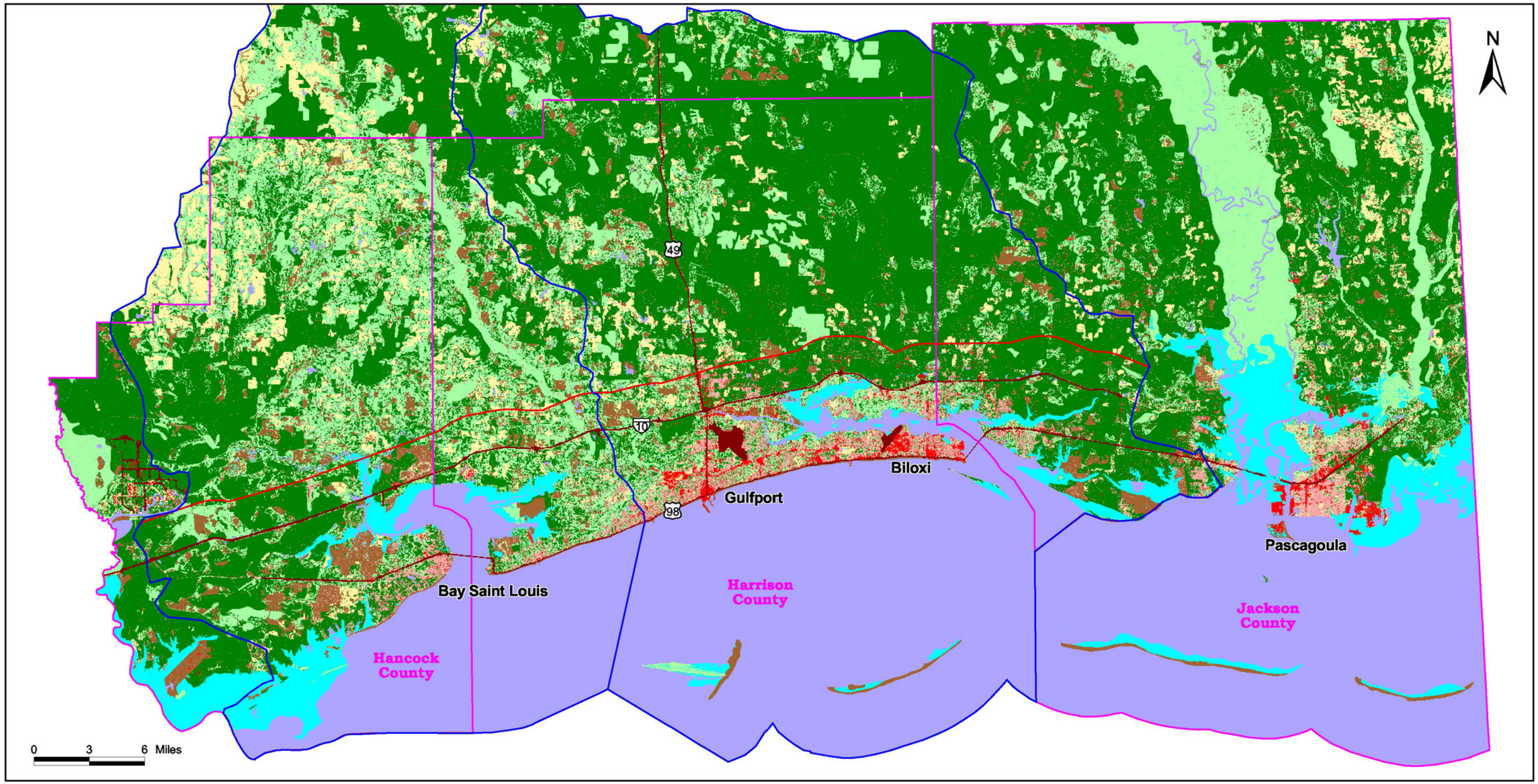
Source: MARIS, 1992.

Land Use Types

- Medium Density Urban
- High Density Urban
- Transportation
- Cropland/Pasture/Grassland
- Deciduous/Mixed/Bottomland Forest/Swamp
- Pine Forest/Savanna
- Scrub-Shrub/Cutover/Barren
- Emergent Wetlands
- Surface Water/Other

1992 Land Use in the County Study Area

Figure 4.2-2



LEGEND
- Coastal Study Area
- County Study Area
- Watershed Study Area

Source: USGS, 1972.

Land Use Types
- Medium Density Urban
- High Density Urban
- Transportation
- Cropland/Pasture/Grassland
- Deciduous/Mixed/Bottomland Forest/Swamp
- Pine Forest/Savanna
- Scrub-Shrub/Cutover/Barren
- Emergent Wetlands
- Surface Water/Other

1972 Land Use in the County Study Area

Figure 4.2.3

4.2.1.1 Hancock County

2000 Land Use/Land Cover

In 2000, natural cover accounted for 84 percent of Hancock County's total acreage. Forest, scrub-shrub/cutover/barren, and emergent wetland were the predominant natural cover types (Figure 4.2–1). Developed land, most of which was classified as medium-density urban land, accounted for 5 percent of the county, and the rest was primarily transportation infrastructure and high-density urban land. Impervious surfaces covered slightly more than 2 percent of the county (Table 4.2–2).

Most of Hancock County's developed land is medium-density urban land and is in the coastal areas of Waveland, Clermont Harbor, Lakeshore, and Bay St. Louis south of US Highway 90; the NASA Test Site complex in the western portion of the county; and the area between I-10 and Bay St. Louis (Figure 4.2–1).

Land Use/Land Cover

From 1972 to 1992, developed land acreage in Hancock County increased by 58 percent and natural land cover decreased by 3 percent. Impervious surface area increased by 41 percent. From 1992 to 2000 developed land acreage expanded by 14 percent, and impervious surface area increased by 16 percent (Table 4.2–2).

Table 4.2–2 shows land cover changes in Hancock County from 1972 to 2000. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

Land Use and Population Growth

Between 1972 and 1992, the population of Hancock County grew from 17,000 to 32,000, an increase of 88 percent. During the same period developed land area increased from 9,200 acres to 14,500 acres, or by 58 percent. Impervious surface acreage increased from 4,600 acres to 6,500 acres, or by 40 percent. Overall, developed land grew about two-thirds as much as population (58 percent compared to 83 percent), and impervious surfaces increased about half as much as the population (40 percent compared to 83 percent).

Developed land area increased during the period 1992 to 2000 (from 14,500 acres to 16,500 acres, or by 14 percent) about two-fifths as much as population (from 32,000 to 43,000, or by 34 percent). High-density urban land increased by 59 percent, while impervious surfaces expanded by 16 percent during the same period (Table 4.2–2).

Between 1972 and 1992 the population per acre of developed land increased from 1.9 persons per acre to about 2.2 persons per acre. This trend continued between 1992 and 2000, during which the population per acre of developed land increased to 2.6 persons per acre. Overall, the county remained heavily rural with a low population density compared to the other two counties in the CSA.

Table 4.2-2

Coastal Mississippi Land Use – Hancock County

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	9,163	3.0%	14,471	4.7%	57.9%	16,457	5.4%	13.7%	79.6%
- Impervious	4,627		6,498		40.4%	7,550		16.2%	63.2%
Natural	273,176	88.3%	266,305	86.4%	-2.5%	257,517	83.9%	-3.3%	-5.7%
Agricultural	23,362	7.6%	23,938	7.8%	2.5%	29,320	9.6%	22.5%	25.5%
Inland Fresh Water	3,530	1.1%	3,530	1.1%	0.0%	3,530	1.2%	0.0%	0.0%
Subtotals	309,231	100.0%	308,245	100.0%		306,824	100.0%		
Surface Water/Other	44,392		45,379			46,800			
TOTAL Acres	353,623		353,623			353,623			
Land Use – Detailed									
Medium-Density Urban Land	4,970	1.6%	8,753	2.8%	76.1%	9,633	3.1%	10.0%	93.8%
High-Density Urban Land	1,083	0.4%	1,803	0.6%	66.4%	2,864	0.9%	58.9%	164.3%
Transportation	3,110	1.0%	3,915	1.3%	25.9%	3,960	1.3%	1.2%	27.4%
Cropland/Pasture/Grassland	23,362	7.6%	23,938	7.8%	2.5%	29,320	9.6%	22.5%	25.5%
Deciduous/Mixed Bottomland Forest/Swamp	80,994	26.2%	78,342	25.4%	-3.3%	73,879	24.1%	-5.7%	-8.8%
Coniferous Forest/Savanna	135,820	43.9%	114,617	37.2%	-15.6%	90,079	29.4%	-21.4%	-33.7%
Scrub-Shrub/Cutover/Barren	28,480	9.2%	48,477	15.7%	70.2%	72,932	23.8%	50.4%	156.1%
Emergent Wetland	27,881	9.0%	24,869	8.1%	-10.8%	20,626	6.7%	-17.1%	-26.0%
Inland Fresh Water	3,530	1.1%	3,530	1.1%	0.0%	3,530	1.2%	0.0%	0.0%
Subtotals	309,231	100.0%	308,245	100.0%		306,824	100.0%		
Surface Water/Other	44,392		45,379			46,800			
TOTAL Acres	353,623		353,623			353,623			

4.2.1.2 Harrison County

2000 Land Use/Land Cover

In 2000, natural vegetation covered 78 percent of Harrison County. Most of the natural areas were in forest, scrub-shrub/cutover/barren, and emergent wetlands (Figure 4.2–1). Developed land acreage accounted for 11 percent of the total land area. About half of the developed areas were medium-density urban land, and the remainder were either high-density urban land or transportation infrastructure. Impervious surface area covered 5 percent of the county in 2000 (Table 4.2–3).

Developed land in Harrison County is primarily concentrated along the coastal strip between Pass Christian and Biloxi, the area straddling US Highway 49 between Gulfport and I-10, just north and west of the intersection of I-10 and US Highway 49, and north of Big Lake and the Back Bay of Biloxi and D'Iberville. Approximately two-thirds of this area is medium-density urban land and one-third is high-density urban land or transportation infrastructure, particularly in the cities of Gulfport and Biloxi (Figure 4.2–1).

From 1972 to 1992, developed land acreage increased by 25 percent, natural land cover decreased by 8 percent, and impervious surface area increased by 21 percent. From 1992 to 2000 developed land increased by 13 percent and impervious surfaces increased by 16 percent (Table 4.2–3).

Table 4.2–3 shows changes in land cover in Harrison County from 1972 to 1992. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

During the period 1972 to 1992, the population of Harrison County increased from 135,000 to 165,000, or by 22 percent. During the same period, developed land area increased from 28,300 acres to 35,400 acres, or by 25 percent. Impervious surface area increased from 13,600 acres to 16,500 acres, or by 21 percent.

From 1992 to 2000, developed land area increased from 35,400 to 39,800 acres (by 12 percent). However, this growth was less than that of population (by 15 percent). High-density urban land increased by 29 percent, while the population grew by 15 percent. During the same period impervious surface area increased from 16,400 acres to 19,000 acres or by 16 percent (Table 4.2–3).

During the period 1972 to 1992, the population per acre of developed land decreased slightly from 4.76 persons per acre to 4.68 persons per acre. This trend was reversed between 1992 and 2000, when the population per acre of developed land increased to 4.76 persons per acre.

4.2.1.3 Jackson County

In 2000, natural cover accounted for 84 percent of the land in Jackson County. Forest, scrub-shrub/cutover/barren, and emergent wetland (Figure 4.2–1) were the most abundant natural cover types. Developed land acreage constituted 7 percent of the county's land area. About half of the developed land acreage was medium-density urban land and the rest was high-density urban land and transportation infrastructure. Impervious surfaces covered 3 percent of the county (Table 4.2–4).

Table 4.2–3

Coastal Mississippi Land Use – Harrison County

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	28,269	7.5%	35,351	9.5%	25.1%	39,816	10.7%	12.6%	40.8%
- Impervious	13,623		16,430		20.6%	18,971		15.5%	39.3%
Natural	321,652	85.8%	294,792	79.5%	-8.4%	290,883	78.3%	-1.3%	-9.6%
Agricultural	22,550	6.0%	38,551	10.4%	71.0%	38,744	10.4%	0.5%	71.8%
Inland Fresh Water	2,223	0.6%	2,223	0.6%	0.0%	2,223	0.6%	0.0%	0.0%
Subtotals	374,694	100.0%	370,918	100.0%		371,667	100.0%		
Surface Water/Other	252,213		255,990			255,241			
TOTAL Acres	626,907		626,907			626,907			
Land Use – Detailed									
Medium-Density Urban Land	15,488	4.1%	19,895	5.4%	28.5%	21,624	5.8%	8.7%	39.6%
High-Density Urban Land	6,774	1.8%	9,424	2.5%	39.1%	12,109	3.3%	28.5%	78.7%
Transportation	6,007	1.6%	6,032	1.6%	0.4%	6,084	1.6%	0.9%	1.3%
Cropland/Pasture/Grassland	22,550	6.0%	38,551	10.4%	71.0%	38,744	10.4%	0.5%	71.8%
Deciduous/Mixed Bottomland Forest/Swamp	82,245	21.9%	75,595	20.4%	-8.1%	77,002	20.7%	1.9%	-6.4%
Coniferous Forest/Savanna	202,268	54.0%	145,839	39.3%	-27.9%	129,680	34.9%	-11.1%	-35.9%
Scrub-Shrub/Cutover/Barren	26,683	7.1%	64,732	17.5%	142.6%	77,381	20.8%	19.5%	190.0%
Emergent Wetland	10,455	2.8%	8,626	2.3%	-17.5%	6,820	1.8%	-20.9%	-34.8%
Inland Fresh Water	2,223	0.6%	2,223	0.6%	0.0%	2,223	0.6%	0.0%	0.0%
Subtotals	374,694	100.0%	370,918	100.0%		371,667	100.0%		
Surface Water/Other	252,213		255,990			255,241			
TOTAL Acres	626,907		626,907			626,907			

Table 4.2-4

Coastal Mississippi Land Use – Jackson County

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	22,250	4.7%	31,579	6.7%	41.9%	33,930	7.3%	7.4%	52.5%
- Impervious	8,646		13,589		57.2%	15,846		16.6%	83.3%
Natural	422,812	89.2%	376,768	80.5%	-10.9%	392,287	84.1%	4.1%	-7.2%
Agricultural	22,150	4.7%	52,886	11.3%	138.8%	33,661	7.2%	-36.4%	52.0%
Inland Fresh Water	6,823	1.4%	6,823	1.5%	0.0%	6,823	1.5%	0.0%	0.0%
Subtotals	474,035	100.0%	468,055	100.0%		466,701	100.0%		
Surface Water/Other	200,459		206,438			207,792			
TOTAL Acres	674,493		674,493			674,493			
Land Use – Detailed									
Medium-Density Urban Land	14,464	3.1%	19,250	4.1%	33.1%	18,914	4.1%	-1.7%	30.8%
High-Density Urban Land	5,838	1.2%	6,997	1.5%	19.9%	9,599	2.1%	37.2%	64.4%
Transportation	1,948	0.4%	5,332	1.1%	173.7%	5,417	1.2%	1.6%	178.1%
Cropland/Pasture/Grassland	22,150	4.7%	52,886	11.3%	138.8%	33,661	7.2%	-36.4%	52.0%
Deciduous/Mixed Bottomland Forest/Swamp	99,677	21.0%	145,454	31.1%	45.9%	144,721	31.0%	-0.5%	45.2%
Coniferous Forest/Savanna	257,797	54.4%	125,175	26.7%	-51.4%	132,751	28.4%	6.1%	-48.5%
Scrub-Shrub/Cutover/Barren	20,708	4.4%	67,012	14.3%	223.6%	86,535	18.5%	29.1%	317.9%
Emergent Wetland	44,630	9.4%	39,126	8.4%	-12.3%	28,280	6.1%	-27.7%	-36.6%
Inland Fresh Water	6,823	1.4%	6,823	1.5%	0.0%	6,823	1.5%	0.0%	0.0%
Subtotals	474,035	100.0%	468,055	100.0%		466,701	100.0%		
Surface Water/Other	200,459		206,438			207,792			
TOTAL Acres	674,493		674,493			674,493			

Developed land in the county is primarily concentrated along the coastal strip between Ocean Springs and Pascagoula south of US Highway 90. Most of the high-density urban land is concentrated in Pascagoula (Figure 4.2–1).

Developed land acreage increased by 42 percent, impervious surface area increased by 58 percent, and natural land decreased by 11 percent during the period 1972 to 1992. From 1992 to 2000 developed land acreage increased by 7 percent, while impervious surface area increased by only 16 percent (Table 4.2–4).

Table 4.2–4 shows land cover changes from 1972 to 2000. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

The population of Jackson County grew from 88,000 to 115,000, or by 31 percent during the period 1972 to 1992. During the same period, developed land area increased from 22,300 acres to 31,600 acres, or by 42 percent. Impervious surface area increased from 8,600 acres to 13,600 acres, or by 58 percent. Overall during the 20-year period, impervious surface area expanded more than either developed land or population.

From 1992 through 2000, developed land area in Jackson County increased by 7 percent (from 31,600 to 33,900 acres), while population grew by 14 percent (from 115,000 to 131,000). The area of high-density urban land increased by 37 percent, or more than twice as much as population. Impervious surface area increased from 13,600 acres to 15,800 acres or by 16 percent (Table 4.2–4).

For the 20-year period 1972 to 1992, the population per acre of developed land declined from 3.95 persons per acre to 3.65 persons per acre. This population density trend was reversed during the remainder of the 1990s, when the population per acre of developed land increased to 3.87 persons per acre.

4.2.2 Coastal Study Area

In 2000, natural cover was found on 73 percent of the Coastal Study Area (CSA). Forest, scrub-shrub/
cutover/barren, and emergent wetland are the primary natural cover types in the CSA (Figure 4.2–1). About 20 percent of the CSA is developed land, and more than half of that is medium-density urban land. The remaining developed land acreage was primarily high-density urban land and transportation infrastructure. Agriculture covered about 6 percent of the CSA, and impervious surface area constituted 9 percent of the area (Table 4.2–5).

Developed land in the CSA is concentrated near the coast, particularly in Waveland, Clermont Harbor, Lakeshore, and Bay St. Louis; and, continuing from west to east, from Pass Christian to Gulfport and in Biloxi, Ocean Springs, and Gautier. Most of the developed land acreage is medium-density urban, though the areas immediately in and around Gulfport, Biloxi, and D'Iberville and the intersection of I-10 and US Highway 49 are high-density urban. Gulfport-Biloxi Airport north-northeast of Gulfport and Keesler Air Force Base west of Biloxi are the two prominent transportation infrastructure areas noticeable on satellite imagery (Figure 4.2–1).

From 1972 to 1992, developed land acreage increased by 33 percent, and natural cover decreased by 13 percent. Losses in coniferous forest/savanna and emergent wetlands accounted for most of the natural land cover change. Impervious surface area increased by 25 percent during the same period.

Table 4.2–5
Coastal Mississippi Land Use – Coastal Study Area

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	36,298	13.7%	48,250	18.6%	32.9%	51,053	19.8%	5.8%	40.6%
- Impervious	17,023		21,277		25.0%	23,840		12.0%	40.0%
Natural	215,527	81.5%	189,301	72.9%	-12.2%	188,815	73.1%	-0.3%	-12.4%
Agricultural	10,479	4.0%	20,080	7.7%	91.6%	16,387	6.3%	-18.4%	56.4%
Inland Fresh Water	2,103	0.8%	2,103	0.8%	0.0%	2,103	0.8%	0.0%	0.0%
Subtotals	264,406	100.0%	259,734	100.0%		258,357	100.0%		
Surface Water/Other	302,596		307,268			308,645			
TOTAL Acres	567,002		567,002			567,002			
Land Use – Detailed									
Medium-Density Urban Land	20,657	7.8%	28,840	11.1%	39.6%	28,615	11.1%	-0.8%	38.5%
High-Density Urban Land	7,317	2.8%	10,623	4.1%	45.2%	13,551	5.2%	27.6%	85.2%
Transportation	8,324	3.1%	8,787	3.4%	5.6%	8,888	3.4%	1.1%	6.8%
Cropland/Pasture/Grassland	10,479	4.0%	20,080	7.7%	91.6%	16,387	6.3%	-18.4%	56.4%
Deciduous/Mixed Bottomland Forest/Swamp	47,697	18.0%	52,563	20.2%	10.2%	50,827	19.7%	-3.3%	6.6%
Coniferous Forest/Savanna	103,634	39.2%	69,089	26.6%	-33.3%	68,191	26.4%	-1.3%	-34.2%
Scrub-Shrub/Cutover/Barren	31,539	11.9%	38,702	14.9%	22.7%	46,933	18.2%	21.3%	48.8%
Emergent Wetland	32,656	12.4%	28,947	11.1%	-11.4%	22,863	8.8%	-21.0%	-30.0%
Inland Fresh Water	2,103	0.8%	2,103	0.8%	0.0%	2,103	0.8%	0.0%	0.0%
Subtotals	264,406	100.0%	259,734	100.0%		258,357	100.0%		
Surface Water/Other	302,596		307,268			308,645			
TOTAL Acres	567,002		567,002			567,002			

From 1992 to 2000 developed land further increased by 6 percent, and impervious surface area increased by 12 percent (Table 4.2–5).

Table 4.2–5 shows land cover changes in the CSA from 1972 to 2000. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

From 1972 to 1992, the population of the CSA grew from 158,000 to 207,000, a 31 percent increase. During the same period, developed land acreage increased by about the same percentage (33 percent, from 36,300 acres to 48,300 acres), while the impervious surface area increased by 25 percent (from 17,000 acres to 21,300 acres).

During the period 1992 to 2000, developed land acreage continued to increase, but only about half as much as population (6 percent compared to 13 percent). High-density urban land, however, increased by 28 percent, and impervious surface area expanded by 12 percent (Table 4.2–5).

For the period 1972 to 1992, the population per acre of developed land decreased from 4.37 persons per acre to 4.28 persons per acre. This trend was reversed between 1992 and 2000, when the population per acre of developed land increased to 4.56 persons per acre. These population density trends indicate that during the latter part of the 1990s population growth in the CSA took place mainly in urbanized areas.

4.2.3 Watershed Study Area

The watershed study area (WSA) consists of two watersheds—the Bay St. Louis watershed and the Biloxi Bay watershed. In 2000 natural cover accounted for 82 percent of the two watersheds. Forest, scrub-shrub/cutover/barren, and emergent wetlands were the primary natural land cover types (Figure 4.2–1). Developed land covered 7 percent of the WSA. More than half of the developed land was medium-density urban land, 25 percent was high-density urban land, and the rest was transportation infrastructure. Impervious surfaces covered 3 percent of the WSA (Table 4.2–6).

Developed land in the WSA is concentrated near the coast along US Highway 90 and south of I-10 (Figure 4.2–1).

From 1972 to 1992, developed land acreage increased by 33 percent. Natural land cover, however, decreased by 7 percent, mostly through losses in coniferous forest/savanna and emergent wetlands. Impervious surface area increased by 25 percent. From 1992 to 2000, developed land acreage increased by 13 percent and impervious surface area increased by 16 percent (Table 4.2–6).

Table 4.2–6 shows land cover changes in the WSA from 1972 to 2000. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

During the period 1972 to 1992, the population of the WSA grew from 184,000 to 245,000, or by 33 percent. Developed land area increased from 42,700 acres to 56,700 acres, also 33 percent, during the same period. Impervious surface area increased from 19,900 acres to 24,700 acres (by 24 percent). Overall, impervious surface area increased less than both developed land and population.

Table 4.2-6
Coastal Mississippi Land Use - Watershed Study Area

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	42,651	4.3%	56,656	5.8%	32.8%	64,002	6.5%	13.0%	50.1%
- Impervious	19,868		24,728		24.5%	28,752		16.3%	44.7%
Natural	862,005	87.1%	804,358	81.7%	-6.7%	810,108	82.4%	0.7%	-6.0%
Agricultural	80,605	8.1%	119,245	12.1%	47.9%	105,117	10.7%	-11.8%	30.4%
Inland Fresh Water	4,290	0.4%	4,290	0.4%	0.0%	4,290	0.4%	0.0%	0.0%
Subtotals	989,550	100.0%	984,548	100.0%		983,517	100.0%		
Surface Water/Other	304,613		309,615			310,646			
TOTAL Acres	1,294,163		1,294,163			1,294,163			
Land Use – Detailed									
Medium-Density Urban Land	24,429	2.5%	34,168	3.5%	39.9%	37,235	3.8%	9.0%	52.4%
High-Density Urban Land	8,568	0.9%	12,397	1.3%	44.7%	16,552	1.7%	33.5%	93.2%
Transportation	9,653	1.0%	10,090	1.0%	4.5%	10,215	1.0%	1.2%	5.8%
Cropland/Pasture/Grassland	80,605	8.1%	119,245	12.1%	47.9%	105,117	10.7%	-11.8%	30.4%
Deciduous/Mixed Bottomland Forest/Swamp	233,169	23.6%	240,608	24.4%	3.2%	235,461	23.9%	-2.1%	1.0%
Coniferous Forest/Savanna	523,070	52.9%	395,644	40.2%	-24.4%	323,772	32.9%	-18.2%	-38.1%
Scrub-Shrub/Cutover/Barren	71,281	7.2%	136,896	13.9%	92.0%	226,951	23.1%	65.8%	218.4%
Emergent Wetland	34,484	3.5%	31,210	3.2%	-9.5%	23,924	2.4%	-23.3%	-30.6%
Inland Fresh Water	4,290	0.4%	4,290	0.4%	0.0%	4,290	0.4%	0.0%	0.0%
Subtotals	989,550	100.0%	984,548	100.0%		983,517	100.0%		
Surface Water/Other	304,613		309,615			310,646			
TOTAL Acres	1,294,163		1,294,163			1,294,163			

From 1992 to 2000, developed land acreage increased in the WSA by about 13 percent compared to a 20 percent increase in the WSA population, High-density urban land increased more than one and one-half times as much as the population. Impervious surface area expanded a bit more than developed land (Table 4.2–6).

During 1972 to 1992, the population per acre of developed land increased slightly from 4.31 persons per acre to 4.32 persons per acre. During the subsequent 8 years, population density in developed area increased to 4.59 persons per acre.

4.2.3.1 Bay St. Louis Watershed

In 2000, natural vegetation covered 83 percent of the Bay St. Louis watershed. Forest, scrub-shrub/ cutover/barren, and emergent wetlands were the primary natural cover types in the watershed (Figure 4.2–1). Developed land constituted 4 percent of the watershed. About three-quarters of the developed land was medium-density urban land, and 25 percent was t divided between high-density urban land and transportation infrastructure. Impervious surface area covers less than 2 percent of the watershed (Table 4.2–7).

Developed land is concentrated around Bay St. Louis, particularly in Lakeshore, Clermont Harbor, Waveland, and Bay St. Louis, and in the unincorporated area between Bay St. Louis and just north of I-10 (Figure 4.2–1).

From 1972 to 1992, developed land acreage increased by 44 percent and natural land cover decreased by 4 percent, with losses in emergent wetlands, deciduous/mixed/bottomland forest/swamp, and coniferous forest/savanna. Impervious surface area increased by 29 percent. From 1992 to 2000 developed land acreage increased by another 18 percent and impervious surface expanded by 21 percent (Table 4.2–7).

Table 4.2–7 shows land cover changes from 1972 to 1992. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

For the period 1972 to 1992, the population of the Bay St. Louis watershed grew from 41,100 to 61,000, or by 49 percent. During the same period, developed land increased from 13,000 acres to 18,700 acres, or by 44 percent, and impervious surfaces increased from 5,600 acres to 7,200 acres, or by 29 percent. Between 1992 and 2000 in the Bay St. Louis watershed, developed land grew only half as much as the population (18 percent compared to 33 percent) while high-density urban land increased twice as much as the population. Impervious surfaces increased by 21 percent, slightly more than developed land (Table 4.2–7).

During the period 1972 and 1992, the population per acre of developed land increased from 3.17 persons per acre to 3.25 persons per acre. During the subsequent 8 years, the population per acre of developed land further increased to 3.65 persons per acre.

Table 4.2–7
Coastal Mississippi Land Use – Bay St. Louis Watershed

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	12,992	2.5%	18,703	3.5%	44.0%	22,085	4.2%	18.1%	70.0%
- Impervious	5,606		7,222		28.8%	8,762		21.3%	56.3%
Natural	454,803	85.9%	436,940	82.7%	-3.9%	434,969	82.6%	-0.5%	-4.4%
Agricultural	59,094	11.2%	70,539	13.3%	19.4%	67,197	12.8%	-4.7%	13.7%
Inland Fresh Water	2,358	0.4%	2,358	0.4%	0.0%	2,358	0.4%	0.0%	0.0%
Subtotals	529,247	100.0%	528,540	100.0%		526,609	100.0%		
Surface Water/Other	97,565		98,273			100,204			
TOTAL Acres	626,812		626,812			626,812			
Land Use – Detailed									
Medium-Density Urban Land	8,139	1.5%	12,658	2.4%	55.5%	14,497	2.8%	14.5%	78.1%
High-Density Urban Land	1,491	0.3%	2,280	0.4%	52.9%	3,768	0.7%	65.3%	152.7%
Transportation	3,362	0.6%	3,765	0.7%	12.0%	3,820	0.7%	1.5%	13.6%
Cropland/Pasture/Grassland	59,094	11.2%	70,539	13.3%	19.4%	67,197	12.8%	-4.7%	13.7%
Deciduous/Mixed Bottomland Forest/Swamp	165,729	31.3%	138,052	26.1%	-16.7%	137,917	26.2%	-0.1%	-16.8%
Coniferous Forest/Savanna	222,452	42.0%	204,860	38.8%	-7.9%	141,355	26.8%	-31.0%	-36.5%
Scrub-Shrub/Cutover/Barren	45,020	8.5%	73,779	14.0%	63.9%	139,638	26.5%	89.3%	210.2%
Emergent Wetland	21,603	4.1%	20,249	3.8%	-6.3%	16,059	3.0%	-20.7%	-25.7%
Inland Fresh Water	2,358	0.4%	2,358	0.4%	0.0%	2,358	0.4%	0.0%	0.0%
Subtotals	529,247	100.0%	528,540	100.0%		526,609	100.0%		
Surface Water/Other	97,565		98,273			100,204			
TOTAL Acres	626,812		626,812			626,812			

4.2.3.2 Biloxi Bay Watershed

In 2000, natural cover—primarily forest, scrub-shrub/cutover/barren, and emergent wetlands—accounted for 82 percent of the Biloxi Bay watershed (Figure 4.2–1). Developed land, of which more than 50 percent was medium-density urban land, covered 9 percent of the watershed. The remainder of the developed land was high-density urban land and transportation infrastructure. Agricultural land covered 8 percent of the watershed, and impervious surface area constituted only about 4 percent of the watershed area (Table 4.2–8).

Developed land in the watershed is primarily concentrated around Biloxi Bay, particularly in Gulfport, Biloxi, and D'Iberville, and in Ocean Springs east of the bay along US Highway 90 (Figure 4.2–1).

From 1972 to 1992, developed land increased by 28 percent, and natural land cover decreased by 10 percent, mostly as losses in emergent wetlands and coniferous forest/savanna. Impervious surface area expanded by 23 percent. From 1992 to 2000, developed land acreage increased by 10 percent and impervious surface area increased by 14 percent (Table 4.2–8).

Table 4.2–8 shows land cover changes from 1972 to 2000. Figures 4.2–2 and 4.2–3 provide snapshots of land cover in 1992 and 1972 and can be compared with the land cover in 2000 shown in Figure 4.2–1.

During the period 1972 to 1992, the population of the Biloxi Bay watershed grew by 30 percent, from 142,000 to 184,000. During the same period, developed land area increased by 28 percent from about 29,700 acres to 38,000 acres, and impervious surface area expanded by 22 percent, from 14,300 acres to 17,500 acres. Overall, developed land acreage increased about as much as did population, while impervious surface area increased less.

During the period 1992 to 2000, developed land acreage continued to increase, but it increased less than the population grew (10 percent compared to 16 percent). High-density urban land, meanwhile, increased by 26 percent. Impervious surface area increased from 17,500 to 20,000 acres, or by 14 percent (Table 4.2–8).

During the period 1972 to 1992, the population per acre of developed land increased slightly from 4.80 persons per acre to 4.85 persons per acre. During the subsequent 8 years, the population per acre of developed land increased to 5.09 persons per acre.

4.2.4 Land Use Controls

Land use in each county, except for those lands within the unincorporated areas, is governed by Comprehensive Plans and zoning ordinances. In the unincorporated areas, land use is governed by county zoning ordinances. Land use controls vary from quite lax to very restrictive covenants, codes, and restrictions on private subdivisions.

Table 4.2–8

Coastal Mississippi Land Use – Biloxi Bay Watershed

	1972	%Total 1972	1992	%Total 1992	% Change 1972-1992	2000	%Total 2000	% Change 1992-2000	% Change 1972-2000
Land Use – General									
Developed	29,659	6.4%	37,953	8.3%	28.0%	41,917	9.2%	10.4%	41.3%
- Impervious	14,261		17,506		22.8%	19,990		14.2%	40.2%
Natural	407,202	88.5%	367,417	80.6%	-9.8%	375,139	82.1%	2.1%	-7.9%
Agricultural	21,510	4.7%	48,706	10.7%	126.4%	37,920	8.3%	-22.1%	76.3%
Inland Fresh Water	1,932	0.4%	1,932	0.4%	0.0%	1,932	0.4%	0.0%	0.0%
Subtotals	460,303	100.0%	456,008	100.0%		456,908	100.0%		
Surface Water/Other	207,048		211,343			210,443			
TOTAL Acres	667,351		667,351			667,351			
Land Use – Detailed									
Medium-Density Urban Land	16,291	3.5%	21,510	4.7%	32.0%	22,738	5.0%	5.7%	39.6%
High-Density Urban Land	7,077	1.5%	10,117	2.2%	43.0%	12,784	2.8%	26.4%	80.6%
Transportation	6,291	1.4%	6,326	1.4%	0.5%	6,395	1.4%	1.1%	1.6%
Cropland/Pasture/Grassland	21,510	4.7%	48,706	10.7%	126.4%	37,920	8.3%	-22.1%	76.3%
Deciduous/Mixed Bottomland Forest/Swamp	67,441	14.7%	102,557	22.5%	52.1%	97,544	21.3%	-4.9%	44.6%
Coniferous Forest/Savanna	300,618	65.3%	190,784	41.8%	-36.5%	182,417	39.9%	-4.4%	-39.3%
Scrub-Shrub/Cutover/Barren	26,262	5.7%	63,117	13.8%	140.3%	87,313	19.1%	38.3%	232.5%
Emergent Wetland	12,881	2.8%	10,961	2.4%	-14.9%	7,866	1.7%	-28.2%	-38.9%
Inland Fresh Water	1,932	0.4%	1,932	0.4%	0.0%	1,932	0.4%	0.0%	0.0%
Subtotals	460,303	100.0%	456,008	100.0%		456,908	100.0%		
Surface Water/Other	207,048		211,343			210,443			
TOTAL Acres	667,351		667,351			667,351			

4.3 UTILITIES

This section describes the utilities that would potentially be affected by the Proposed Action and alternative actions. Utilities include water supply, wastewater, storm water, solid waste, hazardous waste, and telecommunications and energy systems. Accordingly, this study evaluates the potential effects of Corps permitting actions on the region's utilities. The geographical region evaluated for utilities encompasses the Mississippi Coastal Study Area (CSA), which includes Hancock and Harrison counties and western Jackson County.

4.3.1 Water Supply

Eighty-eight community water systems provide potable water to the tri-county area of the Mississippi Gulf Coast, excluding the western part of Hancock County's shoreline and the bayous of eastern Jackson County (GWSTF, 2001). The water they provide is available for residential, commercial, industrial, and agricultural use, including landscape irrigation, and it is delivered by a system of wells, water distribution piping, and water storage tanks that together make up the water supply infrastructure of the Mississippi Coast. All of these systems rely on groundwater as their sole source of supply for drinking water, although in Jackson County surface water is used for industrial end use. As shown in Figures 4.3–1 and 4.3–2, the inland portions of the three-county region are largely without public water systems.

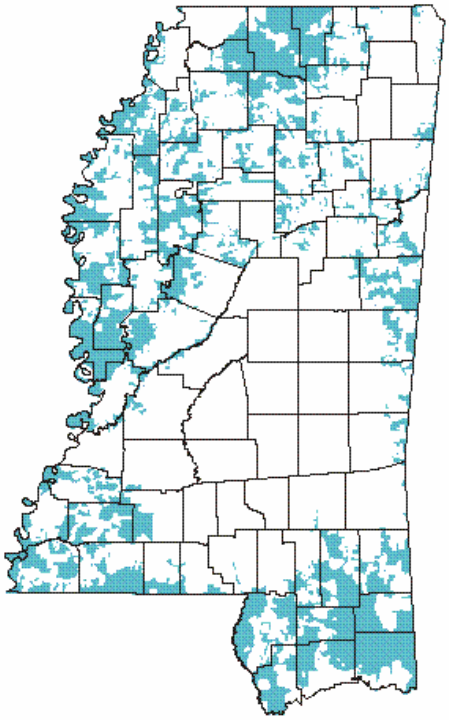
The availability of water for future connections will vary, depending on the resources available to each system. The two largest systems are owned by the Cities of Biloxi and Gulfport, with each serving almost 50,000 people. The smaller incorporated municipalities are next in importance and include Gautier, Ocean Springs, and D'Iberville. The remainder of the area is served by small wastewater entities, water associations, privately owned utilities, and individual wells.

4.3.1.1 Groundwater as a Source of Supply

The predominant source of fresh water used in Mississippi is groundwater. In the coastal counties, all water needed for public supply is drawn from groundwater. In addition, much of the water for agriculture, industrial, mining, thermopower, and commercial use is also drawn from groundwater. About 68 percent of the fresh water used for all purposes in Mississippi is from groundwater.

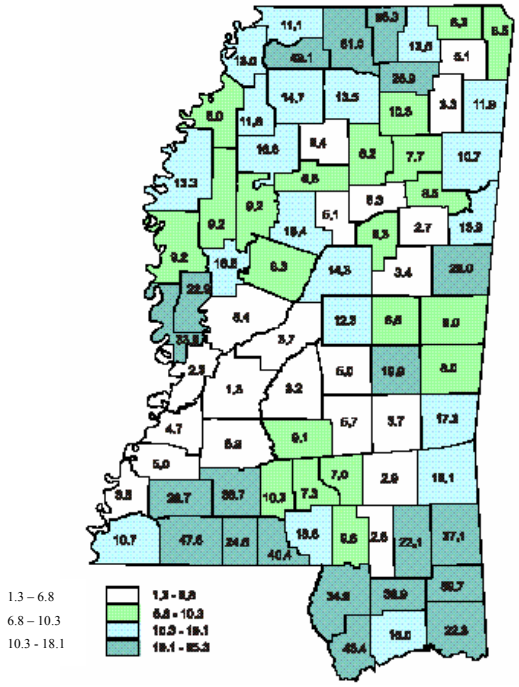
Although some parts of Mississippi (Tupelo, Madison County, and Union County) have experienced problems with falling aquifer levels, the coastal counties have not experienced groundwater quantity problems. During the drought of 2000, most coastal counties were able to meet demands, even with the increased demands of landscape irrigation.

In the *Ground Water Atlas of the United States*, the USGS describes the most widely used aquifer in the coastal counties as the coastal lowland aquifer system. The coastal lowland aquifer system extends west to the Rio Grande basin of Texas, east to the western part of the Florida panhandle, and north to merge with the Mississippi River Valley Alluvial Aquifer. To the south, the coastal lowland aquifer system extends into the Gulf of Mexico to the edge of the continental shelf. The aquifer contains saline water in most of its offshore locations.



Source: GWSTF, 2001.
Note: Shaded areas do not have access to a public water system.

Figure 4.3–1. Areas Without an Available Public Water System.



Source: GWSTF, 2001.

Figure 4.3–2. Percentage of Households Not on Public Water System.

More than 90 years of increasing pumping rates has altered the natural groundwater flow direction. The natural groundwater flow direction is from the groundwater to the streams and rivers. As the water tables have fallen, the flow direction has reversed, with water from the rivers and streams recharging the groundwater.

In 1992 the Mississippi Office of Land and Water Resources (OLWR) began compiling fresh water withdrawal data from Mississippi aquifers. OLWR is using these data to generate information on the response of aquifers to changes in pumping; and, in some cases, the data allow OLWR to provide certifications to developers assuring the long-term (20-year) viability of the aquifer for their use.

If in the future groundwater withdrawal in the coastal counties was to become restricted, other options would be available, although at higher costs. Use of surface water and treatment of lower quality groundwater would possibly be viable options.

4.3.1.2 City of Gulfport Water System

In January 1994 Gulfport annexed 33 square miles north of I-10, an area containing several communities including Orange Grove and North Gulfport. This annexation increased the city's population by 22,000 people, for a total of 64,000 residents. The annexation contained a provision that Gulfport would provide municipal utility services to the annexed area by acquiring, then upgrading, the four privately owned utilities, a challenge yet to be fulfilled. In 1999, Gulfport reached an agreement with Orange Grove Utilities to purchase their water and sewer systems at a cost of $34 million. Negotiations are still underway to acquire the three smaller, privately owned water systems: Dedeaux Utilities, Oakleigh Manor, and Superior Utilities, as required under the 1994 annexation.

The difficulty in operating and maintaining the water distribution system in the annexed area is that the system was designed as a rural system, not a municipal system; therefore, it has limited capability to provide fire flows. Gulfport has plans in place to address this deficiency. Gulfport completed its water and sewer master plans in the year 2000 and has budgeted more than $5 million for implementation of Water Master Plan recommendations to improve the water distribution system, mainly north of I-10, enhancing its ability to deliver improved fire protection with greater reliability.

The Water Master Plan also recommends more than $48 million in short-term and long-term improvements, including new water supply wells and distribution system piping, to be implemented over a 20-year period.

The three smaller utilities suffer capacity and reliability problems, which, according to the Water Master Plan, would be mostly solved by physically linking them together. These interconnections are recommended in the Water Master Plan, to be implemented at such time as Gulfport acquires the small systems.

Although taken as a whole there is sufficient well capacity to meet the peak day demands, the small private systems have little to no redundancy, a problem that will be solved after Gulfport acquires and interconnects them. Table 4.3–1 illustrates this point.

Table 4.3–1
Water Well Capacity, City of Gulfport (in gallons per minute)

Service Area	Number of Wells	Total Well Capacity	Capacity Without Largest Well	Peak Day Demand	Excess Capacity
North of I-10, Orange Grove	9	6,800	4,800	3,204	1,596
North of I-10, Dedeaux Util.	3	1,200	550	600	(50)
North of I-10, Oakleigh Manor	2	360	60	128	(68)
North of I-10, Superior Util.	1	200	---	78	0
South of I-10	13	13,050	11,250	8,878	2,372
Total	28	8,439	10,070	12,888	3,850

Source: GWSTF, 2001.

4.3.1.3 City of Biloxi Water System

In 1999, the City of Biloxi annexed 34 square miles, bringing the total area to 62 square miles. The population of the annexed area is served by three private water utilities, which have been acquired by the City of Biloxi (about 1,400 people), but the greater percentage of people in the annexed area (nearly 4,000 people) are served by individual wells. The private water systems, developed as rural rather than municipal systems, were targeted at the time of annexation to be upgraded to the City of Biloxi standards. The acquired water systems were French Utilities (purchased for $1,000,000), Cedar Lake Utilities (purchased for $180,000) and the Thomas H. Smith Water Company. To address needed improvements in the annexation areas, Biloxi pledged at least $12 million to be spent over a 5-year period for improvements to the water and sewer utilities. In 1996, Biloxi began making improvements to the water and sewer system in the Point Cadet area, increasing both storage capacity and water pressure to improve the system's ability to meet the fire demands. In July 2001, Biloxi had several water projects in design, with estimated costs of more than $1 million.

Biloxi has 22 wells with a maximum 24-hour pumping capacity of 26.1 MGD. The average daily demand is 8.35 MGD whereas the peak demand is 11.35 MGD. Total storage capacity is 5.1 million gallons. Biloxi projects that long-term average daily demand will be 12 to 15 MGD. Planned expansions include two 1-million-gallon storage tanks, two 1,400-gpm wells, and various water line extensions and expansions. Biloxi maintains a well-operated system with no water quality violations (Furr, personal communication, 2002). The city's expansion strategy is to respond to problem areas and focus on areas of high growth and demand. New residential growth is expected to occur in the North Biloxi area (north of the Back Bay of Biloxi) in the newly annexed area.

4.3.1.4 D'Iberville, Ocean Springs, and Gautier Water Systems

The three smaller incorporated coastal Mississippi cities are seeking to expand through annexation. Their annexation of 23 square miles was effective on February 23, 2002. As a result, the population of Gautier grew from 12,000 to 18,000 people. Water service in these annexation areas has been provided by public or private utility systems or by individual wells. The utility systems typically do not provide the same level of fire protection as municipal systems, and the areas served by individual wells have no water distribution system available for fire protection. Bringing the water service to municipal standards within these annexed areas will take years to plan and implement, and would require a commitment of financial resources. The City of Gautier recently annexed the Gautier Utility District, which was responsible for providing water and sewer service to the City of Gautier and much of the annexed area. It was also responsible for providing fire protection and the fire rating for the City of Gautier.

Water service in the annexed areas is provided by public or private utility systems or by individual wells. The areas served by individual wells have no water distribution system available for fire protection.

West Jackson County Utility District, which lies north of Ocean Springs, is a public entity that provides water to much of the unincorporated area in West Jackson County.

Ocean Springs is engaged in a water system capital improvement program. Moran, Seymour, & Associates, Inc. and Southern Consultants, Inc. jointly authorized the "Ocean Springs Water Systems Analysis" in April 1999. The report cited deficiencies in the Ocean Springs Water Systems and recommended the following short-term improvements to meet "Immediate Needs (2003)" at an estimated cost of $4.5 million:

a. New 1,000 GPM well;
b. New 0.5 MG elevated tank;
c. Raise the Homestead Road and Civic Center Tanks, 40 feet;
d. Take the City Hall and Hospital Tank out of service;
e. Install approximately 36,000 LF of 12-inch and 8-inch water mains; and
f. Other minor improvements to increase fire flows throughout the city.

Longer-term recommendations to accommodate growth were also included in the report, at an estimated cost of $6.2 million:

a. Acquire the Sunplex 0.4 MGD tank and related facilities;
b. New 1,000 GPM well;
c. New 1.0 MG elevated tank;
d. 20,000 to 30,000 LF of 12-inch through 16-inch water lines; and
e. Acquisition of other utility systems.

According to a two-page status report prepared by Moran, Seymour, & Associates, dated May 5, 2003, the following water distribution improvements have been implemented:

a. Installed 3,900 feet of 12-inch water main in Government Street from Pine to Handy – FY 2003;
b. Constructed 500,000 gallon elevated tank – FY 2003;
c. Installed 3,900 feet of 12-inch water main in Government Street from Pine to Bechtel – FY 2000;
d. Raised the Homestead Tank and Civic Center Tank – FY 2003;

e. Installed 15,000 feet of water main CCC Camp Road and Riley Road to Lakeview Subdivision – FY 2000;
f. Installed 2,800 feet of water main in Highway 90 from M.L.K. to Washington – FY 2000;
g. Installed 7,200 feet of water main in Highway 90 from Lakeview Subdivision to Highway 57;
h. Purchased Sunplex Utility System from Jackson County Port Authority – FY 2003;
i. Installed 3,300 feet water main to Eagle Point area;
j. Obtained SRF loan approval for new well – FY 2002;
k. Complete a comprehensive water study – 1999; and
l. Installed 3,6000 feet of 12-inch water main in Highway 90 from Bechtel to Handy.

In 2001, the Mississippi State Department of Health began a program to assess the technical, managerial, and financial capacity of public water systems. In 2002, Ocean Springs' overall capacity rating was 3.0 out of a possible 5.0. The average for the state was 3.15. In 2003, Ocean Springs was rated at 3.7 in this evaluation.

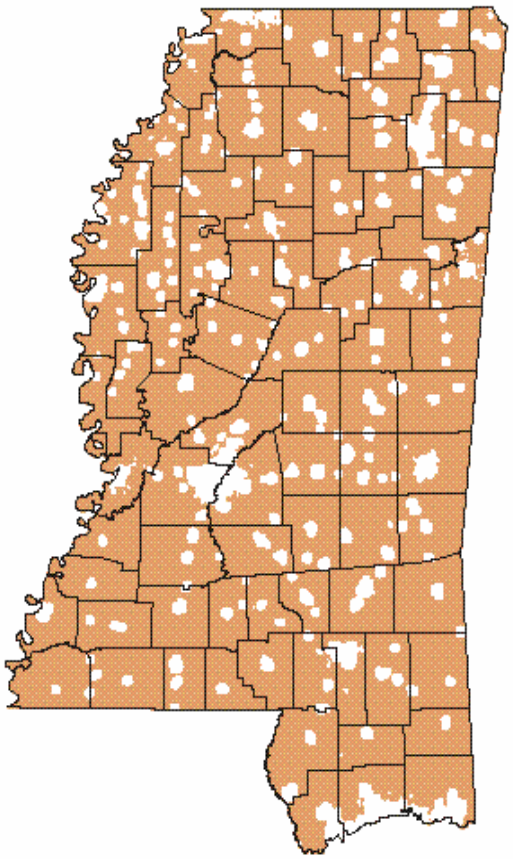
4.3.1.5 Water Service in the Unincorporated Areas

The unincorporated areas of the three coastal counties are served either by publicly or privately owned water utilities or by individual wells. Although the level of service has been sufficient for the existing population, the capability of these systems to accommodate future growth may be limited in comparison to the municipal systems. In the last 10 years, growth in the incorporated municipalities has been similar to historic growth, even considering the introduction of casinos in the early 1990s. Growth in the unincorporated areas, however, has occurred at greater than historic rates. With population increasing in the areas least able to accommodate new growth, new development may be forced to rely on individual wells for water service and septic tanks for sewer service, increasing the number of septic tanks beyond the current estimate of 25,000 (Peterson, 1999).

4.3.2 Wastewater

This section focuses on the capacity of the wastewater treatment and collection facilities in the Three-County Region of Hancock, Harrison, and Jackson Counties along the Mississippi Gulf Coast. The public wastewater system consists of a network of pipes and lift stations that convey the wastewater to central treatment facilities. Once at the treatment facilities, the wastewater is treated to remove pollutants as per the National Pollutant Discharge Elimination System (NPDES) requirements set forth by Mississippi Department of Environmental Quality (MDEQ) and the USEPA.

Whereas 87 percent of the state of Mississippi has access to public water systems, only 58 percent has access to central wastewater collection and treatment systems. In the three Mississippi Gulf Coast counties, 49.5 percent of Hancock County, 18.9 percent of Harrison County, and 27.0 percent of Jackson County do not have access to a public wastewater system (see Figures 4.3–3 and 4.3–4) (GWSTF, 2001). A majority of the areas that do not have access to a public wastewater system, however, lie north of I-10.



Source: GWSTF, 2001.

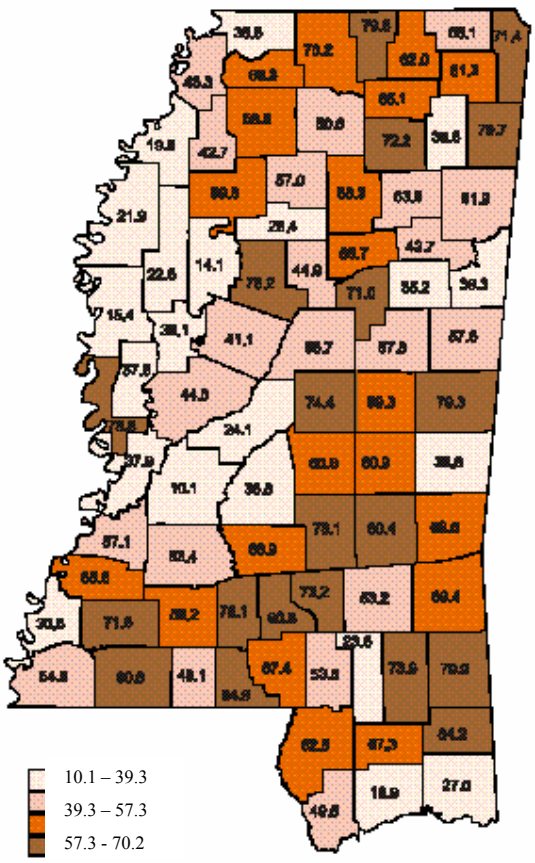
Figure 4.3–3. Areas Without Access to a Public Wastewater System (Shaded Areas).

Table 4.3–2 shows a breakdown of the types of wastewater treatment facilities in each county. Table 4.3–3 breaks down the coverage areas of different types of wastewater treatment systems based on population. The cost of connecting areas to a public wastewater system can be very high and the logistics can be difficult because of the sparse population and housing in the areas. Table 4.3–4 displays the population in the unincorporated areas of the three coastal counties in 1998.

Table 4.3–2
Types of Wastewater Systems in Three-County Region

County	Public WW System	Septic Tank System	Other WW System	Total Households
Hancock	8,371 / 50.5%	7,921 / 47.8%	269 / 1.6%	16,561
Harrison	55,015 / 81.1%	12,379 / 18.3%	419 / 0.6%	67,813
Jackson	33,236 / 73.0%	12,041 / 26.4%	265 / 0.6%	45,542
Total	**96,622 / 74.4%**	**32,341 / 24.9%**	**953 / 0.7%**	**129,916**

Source: GRPC, 2001b.



Source: GWSTF, 2001.

Figure 4.3–4. Percentage of Households That Do Not Use a Public Wastewater System.

Table 4.3–3
Service Area of Wastewater Treatment Systems Based on Population

County	Total Population	Centralized WW System	Septic Tank System	Percent of Soil Unsuitable for Septic Tanks
Hancock	40,327	30,627 / 75.9%	9,700 / 24.1%	50.3
Harrison	178,000	158,500 / 89.1%	19,500 / 10.1%	32.2
Jackson	130,910	90,910 / 69.4%	40,000 / 30.6%	57.6
Total	**349,237**	**280,037 / 80.2%**	**69,200 / 19.8%**	**---**

Source: Peterson, 1999.

Table 4.3–4
Unincorporated Population in Three-County Region

County	Hancock	Harrison	Jackson	Total
Total County Population[1]	42,967	189,601	131,420	363,988
Unincorporated Population[2]	28,084	36,323	60,463	124,870
Percent of Population	**65.4%**	**19.2%**	**46.0%**	**34.3%**

Source: GRPC 2001a and 2001b.

The percentage of the population living in the unincorporated areas of the three coastal counties coincides somewhat with the percentage of households that do not have access to a public wastewater system. The growth of the rural population along the Gulf Coast was much higher than the urban population. Since 1990, the rural population has grown by nearly 40 percent, compared with 7.8 percent growth in the municipal population. This trend is expected to continue because several of the cities along the Gulf Coast are completely built out (GRPC, 2001b).

Wastewater customers who cannot connect to a public wastewater system generally employ one of two types of on-site treatment systems—package plants or septic tanks/drain fields. Package plants are small, self-contained wastewater treatment facilities built to serve a developed area, such as a subdivision or a school. Septic tanks and drain fields, typically installed at individual households, collect wastewater in an underground tank and slowly release the treated water to a drain field where it is absorbed and filtered by the surrounding soil (USACE, Mobile District, 2000).

If septic tanks are properly designed, installed, operated, and maintained in appropriate soil and groundwater conditions, they can be very economical and efficient in treating wastewater. However, failing septic tanks in coastal Mississippi have contributed significantly to the impaired water quality along the Gulf Coast area (EcoSystems, 2000).

Water quality assessments conducted by the MDEQ have determined that failing and substandard individual on-site treatment systems are the primary cause of degraded or polluted water sources in the coastal area of Mississippi. Degraded and polluted coastal waters pose an immediate and cumulative health and environmental hazard to people and aquatic life (GRPC, 2001b). Bacteria leaking into the Mississippi Sound from septic tanks and other sources force the Department of Marine Resources (DMR) to close oyster reefs after each heavy rainfall (Peterson, 1999).

The MDEQ currently monitors, analyzes, and reports on the water quality throughout the state every 4 years. The 1998 report identified 159 segments of water bodies in the state as being impaired. Of the 159 segments, 39 were located in the Mississippi Gulf Coast counties, with 27 of 39 impaired because of the presence of fecal coliform bacteria (pathogens). MDEQ prioritizes the list of impaired water bodies in the order of seriousness of impairment. The Three-County Region contains 8 of the top 11 impaired water bodies in the state. Table 4.3–5 lists the 8 impaired water bodies along the Gulf Coast.

Between April and September 2001, there were 15 closures of various beaches along the Mississippi Gulf Coast because of high bacteria levels. Of the closures, 14 occurred in Harrison County and one occurred in Jackson County (GRPC, 2001b).

Table 4.3–5
Impaired Water Bodies in the Three-County Region

Rank	Water Body Name	County	Impaired Uses	Cause
1	St. Louis Bay Coastline	Hancock/ Harrison	Contact Recreation, Shell fishing	Pathogens
2	St. Louis Bay Coastline Near Delisle	Hancock/ Harrison	Contact Recreation, Shell fishing	Pathogens
3	St. Louis Bay Coastline Near Pass Christian	Hancock/ Harrison	Contact Recreation, Shell fishing	Pathogens
4	Mississippi Sound Coastline from Ocean Springs to Gautier	Jackson	Shell fishing	Pathogens
5	Mississippi Sound Coastline from Pass Christian to Biloxi	Harrison	Shell fishing	Pathogens
6	Bayou Cumbest	Jackson	Contact Recreation, Shell fishing	Pathogens
7	St. Louis Bay	Hancock/ Harrison	Contact Recreation, Shell fishing	Pathogens
11	Biloxi Bay	Harrison/ Jackson	Shell fishing	Pathogens

Source: GRPC 2001b.

4.3.2.1 Wastewater Treatment Facilities in the Three-County Region

Several wastewater management entities operate the wastewater treatment facilities in the Three-County Region. In Hancock County, there are two wastewater management entities, the Diamondhead Water and Sewer District and the South Regional Wastewater Management District (SRWMD). In Harrison County, the Harrison County Wastewater and Solid Waste Management District (HCWSWMD) operates all the major wastewater treatment facilities. The Mississippi Gulf Coast Regional Wastewater Authority (MGCRWA) operates the major wastewater treatment facilities in Jackson County.

The wastewater treatment facilities in the Three-County Region treat more than 45 million gallons of wastewater each day. Hancock County treatment facilities treat approximately 3.00 million gallons per day (MGD), Harrison County facilities treat 29.3 MGD, and Jackson County facilities, including Pascagoula and Escatawpa, treat 12.0 MGD (Peterson, 1999).

4.3.2.1.1 Hancock County Wastewater Treatment Facilities

There are two major wastewater treatment facilities in Hancock County—the Diamondhead Wastewater Treatment Plant (WWTP) and the South Regional WWTP at Waveland. The Diamondhead Water and Sewer District operates the Diamondhead facility, whereas the SRWMD operates the Waveland facility.

Table 4.3–6 lists the permitted design capacities, peak capacities, and average and peak daily flows from 2001 for the wastewater treatment plants in southern Hancock County. The table also identifies the remaining treatment capacity available based on the average daily flow.

Table 4.3–6
Wastewater Treatment Plant Capacities in Hancock County

Wastewater Treatment Facility	Type of Treatment	Average Daily Flow (MGD)	Peak Flow (MGD)	Design Capacity (MGD)	Peak Capacity (MGD)	Remaining Treatment Capacity Available (percent)
Diamondhead	Activated Sludge	0.55	1.75	1.25	2.50	56
SRWMD Waveland	Activated Sludge	2.95	9.00	4.90	---	40

Source: McGraw, personal communication, 2002, and Glover, personal communication, 2002.

The Diamondhead WWTP treats an average daily flow (ADF) of between 0.50 to 0.60 MGD, with a peak inflow of 1.50 to 2.00 MGD. The plant is an activated sludge facility with an oxidation ditch and interchannel clarifiers. Flow projections indicate that the plant will reach its design capacity of 1.25 MGD in approximately 10 years.

The South Regional WWTP at Waveland treats an ADF of 2.90 to 3.00 MGD and a peak flow of up to 9.00 MGD, depending on the rainfall event. According to Dr. Bill Glover with the SRWMD, the WWTP receives a significant amount of inflow and infiltration because of the age and condition of the existing clay pipe collection system. The plant is an activated sludge facility that uses two oxidation ditches. Future plans for the facility include increasing the design capacity from the existing 4.90 MGD to 6.00 MGD.

4.3.2.1.2 Harrison County Wastewater Treatment Facilities

The wastewater systems, including interceptor sewers, primary lift stations, and major treatment facilities, in the municipalities and the unincorporated areas of Harrison County are operated by the HCWSWMD. HCWSWMD contracts with Op-Tech International, Inc., to oversee the operations of the wastewater treatment facilities.

A six-member Board of Directors governs the HCWSWMD. Members consist of mayors from five county municipalities and a representative from the Harrison County Board of Supervisors (USACE, Mobile District, 2000).

The HCWSWMD operates six wastewater treatment facilities in Harrison County. Of the six facilities, two are located in Gulfport, two in Biloxi, and one each in Long Beach/Pass Christian and D'Iberville. Each plant has an NPDES permit from the MDEQ authorizing the effluent discharge into state waters.

Table 4.3–7 lists the permitted average daily discharge capacities, peak capacities, and monthly average and peak inflows from 1998 and 1999 for the six wastewater treatment plants managed by

Table 4.3–7
Harrison County Wastewater Treatment Plant Capacities

Wastewater Treatment Facility	Level of Treatment	Annual Average Monthly Inflow (MGD)	Annual Peak Monthly Inflow (MGD)	Sustainable Daily Inflow (MGD)	Peak Capacity (MGD)	Remaining Treatment Capacity Available (percent)
Gulfport South	Secondary	7.60	10.90	10.50 May-Oct. 16.00 Nov.-April	40.00	28%[1]
Gulfport North	Tertiary	2.90	4.20	5.50	---	47%
Keegan Bayou (East Biloxi)	Secondary	5.80	6.60	10.00	14.40	42%
West Biloxi	Secondary	8.50	10.80	9.00 June-Nov. 11.70 Dec.-May	27.10	6%[2]
Long Beach/ Pass Christian	Secondary	3.10	4.40	7.00	12.10	56%
D'Iberville	Secondary	0.83	0.99	1.156	3.20	28%

Source: USACE, Mobile District, 2000; USEPA and MDEQ, 2002.
[1] Based on May through October discharge limitation.
[2] Based on June through November discharge limitation.

HCWSWMD. The table also identifies the remaining treatment capacity available based on the average monthly inflow.

Two WWTPs serve the Gulfport area—the Gulfport South facility and the Gulfport North facility. The original NPDES permit was issued for the Gulfport South facility in December 1974. Gulfport South WWTP is a trickling filter/secondary clarification facility that includes a secondary trickling filter for nitrogen removal, a two-stage anaerobic digestion process, 2.0-meter belt filter presses, primary and secondary clarifiers, and dechlorination. This facility was designed for an average capacity of 10.50 MGD between May and October and 16.00 MGD between November and April. The peak capacity of the facility is 40.00 MGD. In 1998 and 1999, the facility received an average inflow of 7.60 MGD and a peak inflow of 10.90 MGD. The effluent from the WWTP is discharged into Bernard Bayou (Gulfport Lake).

The Gulfport North WWTP was added in 1998 to reduce the load on the Gulfport South facility. The Gulfport North facility was designed for an average capacity of 5.50 MGD. During 1998 and 1999, the Gulfport North WWTP received an average inflow of 2.90 MGD and a peak inflow of 4.20 MGD. Effluent from this WWTP is discharged into Bernard Bayou (Gulfport Lake).

The Biloxi peninsula is also served by two wastewater treatment plants—the Keegan Bayou (East Biloxi) plant and the West Biloxi plant. The Keegan Bayou WWTP was originally permitted by MDEQ in September 1974 for an average capacity of 3.40 MGD. However, by 1996, seven casinos were discharging into the Keegan Bayou WWTP, causing the facility to exceed the design flow with

inflows of nearly 5.00 MGD. The plant was upgraded in 1998, expanding the permitted average capacity to 10.00 MGD (USACE, Mobile District, 2000). The peak capacity of the WWTP is 14.40 MGD. The upgrade allowed the facility to accept the average and peak inflows of 5.80 MGD and 6.60 MGD, respectively, in 1998 and 1999. The effluent from the Keegan Bayou WWTP is discharged into the Back Bay of Biloxi.

The West Biloxi WWTP, which receives wastewater from Keesler Air Force Base, East Gulfport, and West Biloxi, is an activated sludge wastewater treatment facility that includes aerobic digesters, a 2.0-meter belt filter press, and secondary clarification. In 1998 and 1999, the WWTP was operating near its permitted average discharge limitation of 9.00 MGD between June and November and 11.70 MGD between December and May, with an average inflow of 8.50 MGD and a peak inflow of 10.80 MGD. The peak capacity of the WWTP is 27.10 MGD. Average monthly flows at West Biloxi exceeded the permitted maximum flow during 4 months in 1998, and once during the first 7 months of 1999 (USACE, Mobile District, 2000).

In November 1999, the West Biloxi WWTP was awarded an EPA Operations and Maintenance (O & M) Excellence Award for a 3.00 to 10.00 MGD, Secondary Wastewater Treatment Plant. This award recognized plant personnel and local officials for outstanding O & M of publicly owned wastewater treatment plants over 1998 and 1999.

The Long Beach/Pass Christian WWTP is an activated sludge facility, utilizing an oxidation ditch for treatment. The permitted average discharge limit for this facility is 7.00 MGD with a peak capacity of 12.10 MGD. In 1998 and 1999, the facility was receiving an average daily flow of 3.10 MGD and a peak flow of 4.40 MGD.

The D'Iberville WWTP also uses an oxidation ditch for treatment. This facility is permitted for an average flow of 1.156 MGD and has a peak capacity of 3.20 MGD. In 1998 and 1999, the plant was receiving an average daily flow of 0.83 MGD and a peak flow of 0.99 MGD.

Overall, wastewater flows treated by HCWSWMD plants generally have been steady over the past 5 years. Only the West Biloxi WWTP experienced significant increases in average annual flows, with 16 percent growth between 1993 and 1998. Improved inflow and infiltration control in municipal sewer systems through rehabilitation and new construction have likely limited growth in total wastewater volumes despite the increasing development in Harrison County (USACE, Mobile District, 2000).

The HCWSWMD has begun a $40 million upgrade to its wastewater facilities to handle current growth. However, as the rural population continues to increase as and as more areas begin to tie into the system, an additional upgrade may be necessary (GRPC, 2001b).

4.3.2.1.3 Jackson County Wastewater Treatment Facilities

In Jackson County, there are 12 separate wastewater entities in the CSA: Coast Waterworks, Inc; Gautier Utility District (acquired by the City of Gautier); Gulf Park Water Company, Inc.; Hallmark Utility, Inc.; Houston Estates Utility Company; Jordan Road Utility Company, Inc.; Magnolia Utilities, Inc.; Millette Enterprises, Inc.; St. Andrews Water and Sewer, Inc.; Wejac Utilities, Inc.; Westwick Utilities, Inc.; West Jackson County Utility District; and Woodland Park Utilities (GRPC, 2001b and 2002b). Some of the private utility companies that provide service to the rural areas also provide service to some residents inside city limits (GRPC, 2001b).

Over the past several years Jackson County has been working to improve and expand its wastewater treatment systems and extend treatment capabilities to more of the residents within the county. In 1999, the West Jackson County Utility District, which serves St. Martin, began a $6 million project to convert 3,000 homes south of I-10 from septic tanks to a centralized wastewater treatment system. Septic tank failures in Old St. Martin and Gulf Hills area were causing bacteria leakage into the Back Bay of Biloxi and Old Fort Bayou. The district was also planning a project to bring sewer lines to 1,000 to 2,000 homes north of I-10 that were served by septic tanks (Peterson, 1999). The West Jackson County Utility District also applied for $5.2 million from the 2001 State Revolving Loan Fund (SRF Program) for extensions of existing wastewater collection facilities. The extensions will bring service to areas of the county that do not have access to a public wastewater system (GRPC, 2001b).

In February 2002, the City of Gautier assumed wastewater treatment service of the Gautier Utility District, increasing the service area of the city from 12,000 to 18,000 residents through the annexation of 23 square miles to the north and west of Gautier. It is estimated that $8 million will be required to upgrade the Gautier Utility District's water and sewer system. The City of Gautier and the City of Ocean Springs have also acquired portions of the water and sewer systems for the Sunplex Industrial Park. These acquisitions will provide service along U.S. Highway 90 and up U.S. Highway 57 to I-10. The acquired area also includes an area east of U.S. Highway 57. This project was funded through SRF programs and CDBG grants.

The City of Ocean Springs has implemented the following wastewater system improvements:

a. In 1999, a new lift station at Helmers Lane was constructed, including 500 linear feet of force main.

b. Between 1999 and 2003, a full-time maintenance contractor has made repairs to the collection system.

c. Since 2000, 24 lift stations have been upgraded.

d. In 2001, Gollot Road sewer extension was completed, providing sewer to the University of Southern Mississippi Cedar Point Facility, and consisting of 2,800 linear feet of gravity sewer and a lift station.

e. In 2001, programs to comply with EPA's MOM Program were developed.

f. In 2001, Lift Station 10 bypass, which consisted of 2,500 linear feet of force main and upgrades to two lift stations, was completed.

g. In 2003, Eagle Point and Quave Road sewer extension, which consisted of 2,300 linear feet of gravity sewer and two lift stations, was completed.

h. In 2003, an SSES Study of the entire collection systems was performed.

i. In 2003, sewer extension along U.S. Highway 90 from Lakeview to U.S. Highway 57, which consisted of 7,300 linear feet of gravity sewer and two lift stations, was completed.

In the next 5 years, the MGCRWA will begin an expansion to connect a force main flowing from lift station #7 on B Street to a proposed lift station to be installed within the St. Andrews Water and Sewer service area. Another problem area in Jackson County has been identified between Gautier and Ocean Springs near the I-10/Highway 57 interchange. This area does not have wastewater treatment facilities, and since it drains into the Back Bay of Biloxi, it is in need of treatment services (GRPC 2001b).

4.3.2.2 Wastewater Collection System Facilities in the Three-County Region

More than 20 different wastewater utilities exist in the Three-County Region of southern Mississippi. An overview of the wastewater collection systems and entities in each county is given below. The focus of this section, however, will be on the two largest utilities in the area, which are also the two largest cities, Biloxi and Gulfport.

4.3.2.2.1 Hancock County Wastewater Collection System

In Hancock County, there are five separate wastewater entities in the coastal region: Hancock Water and Sewer District, Diamondhead Water and Sewer District, City of Waveland, Jourdan River Shores Utilities, Inc., and Seashore Utilities, Inc.

Hancock County has the largest percentage of area in the Three-County Region that is served by septic tanks, as only 18 percent of Hancock County residents who lived in unincorporated areas were within wastewater entities (GRPC, 2001b). In 1999, the Hancock County Water and Sewer District focused on eliminating septic tanks in subdivisions south of I-10. The district completed a $2 million project that brought public wastewater service to 900 homes in Clermont Harbor and Shoreline Park. The district was also planning to provide service to homes in Lakeshore and Bayside Park on U.S. Highway 90 outside of Waveland (Peterson, 1999).

The Hancock County Water and Sewer District prepared a Facilities Plan in 1999 for collection systems in four areas of the county: Harbor Drive, Bayside Park, Lakeshore, and West Highway 90. The projected construction cost to serve these four areas was $8,175,825 and consisted of installing a combination of gravity sewers and grinder pump/pressure systems for 1,600 units. The annual operations and maintenance costs were estimated at $97,835 per year. To treat the wastewater at the SRWMD facilities, the annual cost would be $120,000 per year, resulting in a $35 per month users fee for the 1,600 units in the program (Mississippi Gulf Coast Rural Wastewater Planning Initiative conducted by the GRPC in September 2001).

The Hancock County Wastewater District #1 projected a phased approach to upgrade the wastewater system. The cost estimate, divided into three phases, is $2.1 million for Phase I, $1.8 million for Phase II, and $2.3 million for Phase III (Mississippi Gulf Coast Rural Wastewater Planning Initiative conducted by the GRPC in September 2001).

The Pearlington Water and Sewer District has proposed a new vacuum collection system and lagoon system for wastewater treatment that would cost an estimated $6.4 million. The proposed system would tie into the Port Bienville Industrial Park (Mississippi Gulf Coast Rural Wastewater Planning Initiative conducted by the GRPC in September 2001).

4.3.2.2.2 Harrison County Wastewater Collection System

In Harrison County, there are 26 separate wastewater entities in the coastal region. Some of the larger entities include: City of D'Iberville; City of Gulfport; Coast Waterworks, Inc.; Dedeaux Utility Company; Diamondhead Water and Sewer District; Discovery Bay Utility Company, Inc.; French Utilities, Inc; Lakewood Environmental Corporation; Magnolia Utilities, Inc.; Pass Christian Isles Utility, Inc.; Robinwood Forest Utilities, Inc.; Seashore Utilities, Inc.; Superior Utilities, Inc.; and Sutter Water Service, Inc.

While private utility companies provide water service to most of the rural areas in Harrison County, wastewater service is unavailable. The septic tank users in the County can dispose of their wastewater at the South Gulfport, North Gulfport, West Biloxi, Keegan Bayou, or Long Beach/Pass Christian WWTP, all operated by the HCWSWMD (GRPC, 2001b). Nonetheless, reliance on septic tank/drain field wastewater systems has been declining in Harrison County. The Harrison County Health Department converts approximately 1,000 to 2,000 unincorporated households to centralized wastewater systems each year (USACE, Mobile District, 2000).

The HCWSWMD also operates 30 lift stations and interceptor lines throughout Harrison County. The various lift stations operated by the HCWSWMD are shown in Table 4.3–9.

The West Harrison County Water and Sewer District, which serves the Delisle area, completed a Facilities Plan in 1998 that projected annual wastewater service expenses at $304,300 for the year 2000 and $421,150 for the year 2005. The capital cost for construction was projected at $1.5 million for the year 2000 (Mississippi Gulf Coast Rural Wastewater Planning Initiative conducted by the GRPC in September 2001).

Two major developments are planned for southern Harrison County. The first is a residential development planned for the north Woolmarket area, with a portion of the new development lying in the newly annexed area of the City of Biloxi, where centralized wastewater service is not available. The second development is located in western Harrison County and is part of a gaming venture to be situated on the northern shore of the Bay of St. Louis. The state has approved the site with the condition that a collection and treatment system will be installed to serve both the gaming facilities and the surrounding communities (Mississippi Gulf Coast Rural Wastewater Planning Initiative conducted by the GRPC in September 2001).

City of Biloxi Wastewater Collection System. The City of Biloxi wastewater system serves approximately 49,000 customers in three areas: the City of Biloxi (41,906 customers), North Biloxi (5,533 customers), and the City of Biloxi—French (1,125 customers).

The wastewater system is divided into two major service areas—the Biloxi peninsula collection system and the North Biloxi collection system. The City of Biloxi Public Works Department operates the gravity collection system that transports the wastewater to the treatment facilities and is responsible for line construction and rehabilitation. The city has hired a private contractor, ECO Resources, Inc., to provide customer billing and upkeep of the lift station system (USACE, Mobile District, 2000).

In the Biloxi area south of I-10, only a few isolated pockets of septic tanks remain. Areas of needed sewer expansion are in the newly annexed portion of the city, from just south of I-10 northward to the intersection of Old and New Highway 67. Wastewater collection and treatment in this 34-square-mile area consists primarily of individual septic tank systems and a small lagoon treatment facility.

During the 2001–2002 time frame, the City of Biloxi Public Works Department invested more than a half million dollars improving its wastewater treatment system.

City of Gulfport Wastewater Collection System. The City of Gulfport serves approximately 49,000 customers. After Gulfport annexed the City of Orange Grove in 1994, the purchase of Orange Grove Utilities added 14,100 customers to Gulfport's service area. In addition to the purchase of Orange Grove Utilities, the 1994 annexation agreement requires Gulfport to purchase the three remaining utilities in the Orange Grove area: Dedeaux Utilities (3,995 customers), Superior Utilities (620 customers), and Lyman Utilities (120 customers). In October 2001, the Gulfport City Council voted

Table 4.3–9
Lift Stations Operated By the HCWSWMD

Service Area	*Lift Station Name*	*Lift Station Capacity*	
		(MGD)	**(gpm)**
West Biloxi Area (South of I-10)	Debuys Road LS	7.20	5,000
	Sunkist LS	3.89	2,700
	Park LS	1.01	700
	Seaway Island LS	1.01	700
	Sharon Hills LS	0.55	384
	Brentwood LS	0.33	230
	Cedar Lake LS	0.14	100
	Golfview LS	0.14	100
Long Beach/Pass Christian Area	LB – Johnson Rd LS	9.36	6,500
	LB-PS #5 – Nicholson LS	5.04	3,500
	LB – West Railroad LS	2.66	1,850
	LB-PS #4 – Alverado/DP LS	1.57	1,090
	LB-PS #2 – S. Forrest/PP LS	1.20	833
	LB-PS #1 – Henderson LS	0.86	600
	LB-PS #3 – Wisteria LS	0.52	360
Gulfport Area (South of I-10)	34th Street LS	14.40	10,000
	GPT PS #7 – Turkey Creek LS	3.46	2,400
	West Gulfport LS	0.58	400
North Gulfport Area (North of I-10)	GPT PS #3 – Airport LS	11.52	8,000
	GPT PS #8 – Coleman Rd LS	3.74	2,600
	GPT PS #1 – Loren D (Tandy) LS	3.60	2,500
	GPT PS #2 – Oakleigh LS	1.01	700
	GPT PS #9 – Highway 49 LS	0.66	455
	GPT PS #5 – Ollie Road LS	0.40	280
	GPT PS #4 – Orange Grove (Montana's) LS	0.29	200
	GPT PS #6 – River Road LS	0.29	200
D'Iberville Area	DI-PS "B" – Brodie LS	1.18	820
	DI-PS "C" – Mose LS	1.11	770
	DI-PS "A" – Locust Drive LS	1.04	725

Source: GRPC, 2001b.

to borrow $15 million to purchase the three utilities and upgrade the water and sewer system in Orange Grove (Scallan, 2001a). After purchasing the remaining utilities in Orange Grove, the City of Gulfport will serve approximately 68,000 customers.

The wastewater system is divided into two major service areas—the Orange Grove area north of I-10 and the City of Gulfport area south of I-10. The City of Gulfport Public Works Department operates the collection system and is responsible for new construction or rehabilitation of the wastewater system. With the newly annexed section of Orange Grove, the city has inherited some problem areas because the wastewater system has antiquated sewer pipes. As part of the EPA Capacity, Management, Operations, and Maintenance Program, a self-audit of the wastewater collection system discovered 16 problem areas, the majority occurring in the Orange Grove area.

A current budget of $27.7 million has been allocated to upgrade and rehabilitate the water distribution and wastewater collection systems. Of this amount, the city estimates that $25.2 million will come from the State Revolving Loan Fund (SRF Program). The other $2.5 million will cover costs of acquiring rights-of-way and easements, which are not covered by the SRF Program. The money will be used to construct six projects recommended in the city's water and sewer master plan that will repair and replace pump stations and gravity sewer systems throughout the city (Scallan, 2001b).

4.3.2.2.3 Jackson County Wastewater Collection System

In Jackson County, there are 12 separate wastewater entities in the study area: Coast Waterworks, Inc; Gautier Utility District (GUD) (acquired by the City of Gautier); Gulf Park Water Company, Inc.; Hallmark Utility, Inc.; Houston Estates Utility Company; Jordan Road Utility Company, Inc.; Magnolia Utilities, Inc.; Millette Enterprises, Inc.; St. Andrews Water and Sewer, Inc.; Wejac Utilities, Inc.; West Jackson County Utility District; Westwick Utilities, Inc.; and Woodland Park Utilities (GRPC, 2001b and 2002b). Some of the private utility companies that provide service to the rural areas also provide service to some residents inside city limits (GRPC, 2001b).

Over the past several years Jackson County has been working to improve and expand its wastewater treatment systems and extend treatment capabilities to more of the residents within the county. In 1999, the West Jackson County Utility District, which serves St. Martin, began a $6 million project to convert 3,000 homes south of I-10 from septic tanks to a centralized wastewater treatment system. Septic tank failures in Old St. Martin and Gulf Hills area were causing bacteria leakage into the Back Bay of Biloxi and Old Fort Bayou. The district was also planning a project to bring sewer lines to 1,000 to 2,000 homes north of I-10 that were served by septic tanks (Peterson, 1999). The West Jackson County Utility District also applied for $5.2 million from the 2001 State Revolving Loan Fund (SRF Program) for extensions of existing wastewater collection facilities. The extensions will bring service to areas of the county that do not have access to a public wastewater system (GRPC, 2001b).

In October 2000, county supervisors initiated a plan to partially fund a project to extend wastewater service from the Sunplex Industrial Park to south of I-10, at a cost of $1.6 million, to allow for faster development in the eastern part of Ocean Springs and the land between Ocean Springs and Gautier. The project has been taken over by the City of Gautier and expanded to encompass the area along Highway 90 and along Highway 57 to I-10. In February of 2002, the City of Gautier assumed wastewater treatment service of the GUD, increasing the service area of the city from 12,000 to 18,000 residents through the annexation of 23 square miles to the north and west of Gautier. It is estimated that $8 million will be required to upgrade the GUD's water and sewer system.

In the next 5 years, the MGCRWA will begin an expansion to connect a force main flowing from lift station #7 on B Street to a proposed lift station to be installed within the St. Andrews Water and Sewer service area. Another problem area in Jackson County has been identified between Gautier and Ocean Springs near the I-10/Highway 57 interchange. This area does not have wastewater

treatment facilities, and since it drains into the Back Bay of Biloxi, it is in need of treatment services (GRPC 2001b).

4.3.3 Storm Water

This section focuses on the capacity of the storm water collection and drainage facilities in the Three-County Region of Hancock, Harrison, and Jackson Counties along the Mississippi Gulf Coast. The storm water system consists of a network of curbs, gutters, pipes, and natural features that convey the storm water from developed areas to surface waters.

Mississippi has the authority to administer the National Pollutant Discharge Elimination System (NPDES) permit program for stormwater discharges in the state. A stormwater NPDES permit is required for certain activities (e.g., construction) and for cities with a population over 100,000. The state also may require a NPDES stormwater permit if there is high potential for polluted runoff.

A storm water pollution prevention plan (SWPPP) is required by the Mississippi Department of Environmental Quality (MDEQ) for a Construction Storm Water General NPDES Permit. In addition, state prescribed erosion and sediment controls should be followed to protect the state's waters from storm water runoff. These controls are detailed in MDEQ, MSSWCC, and NRCS's 1994 *Planning & Design Manual for the Control of Erosion, Sediment and Stormwater*.

4.3.3.1 City of Biloxi Storm Water System

The City of Biloxi uses a variety of management techniques and systems to control storm water. The city requires developers to install storm water drainage facilities designed to control runoff quantity, but does not require specific storm water quality control measures (USACE, Mobile District, 2000). Storm water from Biloxi is discharged into two surface water sources—the Back Bay of Biloxi and the Mississippi Sound. There are four major runoff areas in the city: in East Biloxi, the storm water runoff flows south from Howard Avenue to the Mississippi Sound; in West Biloxi, south of Pass Road, the runoff flows south to the Mississippi Sound; in West Biloxi, north of Pass Road, the runoff flows south to the Back Bay of Biloxi; and in North Biloxi, the storm water drains south to the Back Bay of Biloxi (USACE, Mobile District, 2000).

In 1999–2000, the city upgraded the drainage infrastructure north of U.S. Highway 90. The main outfall lines in the area were upgraded to average 48 inches in diameter (USACE, Mobile District, 2000). In July 2001, a total budget of $15,141,838 had been allocated for numerous drainage-improvement projects in the Biloxi storm water system. Of the total budget, $5,518,500 was allocated for design projects, $1,725,000 was allocated for projects under construction, and $7,898,338 had been spent on completed projects. In 2002, a total of $1,725,000 had been allocated for additional storm water improvement projects (City of Biloxi, 2002).

4.3.3.2 City of Gulfport Storm Water System

The City of Gulfport's storm water drainage system has endured numerous problems during the past few years, as parts of the city, particularly in the Orange Grove area, have experienced both street and house flooding. Numerous improvement projects in the last few years have eliminated the house flooding problem, but the street flooding remains. The city has developed a storm drainage master plan that addresses the needs to eliminate any storm water-related flooding in the Gulfport and Orange Grove areas.

In November 2001, the Harrison County Board of Supervisors approved $150,000 for the City of Gulfport to install a box culvert under Dedeaux Road to help resolve a drainage problem in the Orange Grove area (Sun-Herald, 2001b). The city is also proposing changes in its storm water drainage requirements that will require developers to increase the drainage capacity in subdivisions. In early November, the City Council delayed approval of the Crystal Wells subdivision on O'Neal Road because of flooding concerns. Since construction began in 1999, residents from surrounding areas, which have been dry for years, have experienced flooding in their homes, yards, and streets (Scallan, 2001c).

4.3.3.3 Jackson County Storm Water System

Jackson County and each municipality within the County have adopted a storm water plan that addresses the capabilities and requirements of the various storm water systems. In February 2003, Jackson County submitted a Phase II Storm Water Program to the EPA that addressed the following issues:

a. General non-point source pollution;
b. Raw sewage;
c. Solid waste dumping;
d. Illegal disposal of wastes;
e. Lack of erosion and sediment controls; and
f. Impaired water bodies and TMDL programs.

The Storm Water Program includes procedures to provide public education, public involvement, illicit discharges detection and elimination, construction site runoff controls, post-construction runoff controls, and pollution prevention/good housekeeping.

4.3.4 Solid Waste and Hazardous Waste

This section focuses on the capacity of the solid waste collection and disposal facilities and hazardous waste facilities in the Three-County Region of Hancock, Harrison, and Jackson Counties along the Mississippi Gulf Coast. The solid waste system consists of means to collect nonhazardous municipal solid waste and construction and demolition debris to dispose of it in a permitted landfill. The hazardous waste system consists of a means to identify, clean up, and dispose of hazardous waste materials to prevent contamination of the surrounding environment.

Nonhazardous solid wastes consist of municipal solid waste, which includes domestic waste and non-hazardous commercial and industrial wastes, and construction and demolition debris, which includes concrete, asphalt, wood, metals, and land-clearing materials.

Hazardous wastes pose potential health and safety risks and could cause contamination if released into the surrounding environment. Hazardous waste sources include asbestos, underground storage tanks (USTs), and toxic chemicals.

4.3.4.1 Solid Waste Collection and Disposal System in the Three-County Region

The State of Mississippi regulates three categories of nonhazardous solid waste landfills: Municipal Solid Waste Landfills that receive household waste and other types of Subtitle D material, such as commercial and industrial solid waste and nonhazardous sludge; Class I Rubbish Sites that accept

construction and demolition (C&D) debris, brick, concrete, asphalt, natural vegetation, furniture, sawdust and wood shavings, plastic, and metal; and Class II Rubbish Sites that accept natural vegetation, brick, concrete, and asphalt (USACE, Mobile District, 2000). Permitting for a solid waste facility is handled by the MDEQ Permitting Board. The Board reviews applications for new facilities and expansions of existing landfills to ensure compliance with federal and state safety criteria. In order to receive a permit for a new solid waste facility or expansion of an existing facility, a Solid Waste Plan must be in place and amended to incorporate the requirements of the new or expanded facility. The HCWSWMD provides solid waste management services to all Harrison County residential users with 10 or fewer units and small commercial users with four or fewer waste containers per pickup. Two different contractors are used to collect and dispose of the solid waste—Browning-Ferris, Inc., collects the waste and Waste Management, Inc., disposes of the waste at a permitted landfill.

There is one permitted municipal solid waste landfill in the Three-County Region and seven Class I rubbish sites for construction-related waste. The Pecan Grove Landfill and Recycling Center, operated by Waste Management, Inc., receives approximately 90 percent of the total solid waste stream produced in the three coastal counties. The landfill is located in Pass Christian.

The Pecan Grove Landfill is located at 6985 Firetower Road and is operated by Waste Management and regulated by MDEQ. It opened in 1988 as a 76-acre landfill. By 1998 and 1999, however, the landfill was approaching capacity. The daily disposal during this time period was approximately 1,500 tons, which would have closed the landfill in the fall of 2000 if an expansion were not approved. In June 2000 the HCWSWMD approved a 100-acre expansion that will allow the landfill to remain open for another fifteen years. Completed in 2002, the landfill can accept 1,200 to 1,600 tons of garbage a day, with 800 tons coming from Harrison County. The landfill also accepts garbage from within 100 miles. In addition to the Pecan Grove Landfill, there are other options for solid waste disposal in the area. Central Landfill in Pearl River County (80 miles from Biloxi) has an estimated life of 15 to 20 years; and landfills in Mobile, Alabama, and New Orleans, Louisiana, are also options (USACE, Mobile District, 2002)

4.3.4.2 Hazardous Waste Facilities in the Three-County Region

Statewide, the MDEQ's Office of Pollution Control Hazardous Waste Division (HWD) regulates hazardous wastes. The Hazardous Waste Division oversees the assessment and remediation of both abandoned and responsible party sites where hazardous or toxic substances have been released to the environment. The HWD also provides support to the Environmental Permits Division (EPD) and Environmental Compliance and Enforcement Division (ECED) in regulating the management of hazardous waste under the Resource Conservation and Recovery Act (RCRA).

The information contained in the following sections pertaining to hazardous waste was taken from the GRPC's GIS Data for South Mississippi (Hancock, Harrison, Jackson, Pearl River, Stone, and George Counties). The GIS data included locations of contaminated sites, RCRA sites, and toxic material sites in the six-county region. Other sources included the MDEQ Office of Pollution Control Hazardous Waste Division, MDEQ Underground Storage Tank (UST) Program, and the UST and Leaking UST (LUST) databases.

4.3.4.2.1 Hancock County Hazardous Waste Sites

Hancock County, as a whole, contains more than 230 USTs. Of this number, 24 have been classified as LUSTs. The USTs and LUSTs for the six incorporated areas in Hancock County are presented in Table 4.3–10.

Table 4.3–10
UST and LUST Locations in Southern Hancock County

Incorporated Area	*UST Locations*	*LUST Locations*	*Percentage of Tanks Leaking*
Bay St. Louis	144	15	10.4
Diamondhead	7	3	42.9
Edwardsville	0	0	0.00
Kiln	21	1	4.76
Pearlington	8	0	0.00
Waveland	41	5	12.2
Total	**221**	**24**	**10.9**

Source: MDEQ, 2002a.

Of the 232 USTs and 24 LUSTs in the county, 221 USTs, or 95 percent, and 24 LUSTs, or 100 percent, are located in the Gulf Coast region. There are 182 gasoline USTs (200- to 14,000-gallon tanks), 38 diesel USTs (500- to 12,000-gallon tanks), 7 used oil USTs (150- to 1,000-gallon tanks), 2 kerosene USTs (2,000- and 4,000-gallon tanks), 2 other USTs (8,000- and 10,000-gallon tanks), and 1 gasohol UST (10,000-gallon tanks). Only 91 of the 232 USTs are currently in use, while 2 are temporarily out of use and 139 are permanently out of use.

A total of 21 contaminated sites, owned by various companies, exist in the southern portion of the county, along with two RCRA sites and two toxic material sites. A list of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Uncontrolled Sites contained 13 contaminated sites for southern Hancock County (MDEQ, 2002b).

4.3.4.2.2 Harrison County Hazardous Waste Sites

Harrison County contains more than 1,600 USTs. Approximately 150 of these USTs are classified as LUSTs. Table 4.3–11 lists the cities in Southern Harrison County along with the number of USTs and LUSTs.

Of the 1,640 USTs and 160 LUSTs in the county, 1,475 USTs, or 90 percent, and 149 LUSTs, or 93 percent, are located in the Gulf Coast region. There are 1,188 gasoline USTs (120- to 25,000-gallon tanks), 302 diesel USTs (150- to 25,000-gallon tanks), 106 used oil USTs (250- to 12,000-gallon tanks), 17 kerosene USTs (250- and 12,000-gallon tanks), 13 not listed or other USTs, four hazardous substance USTs (500 to 750 gallon tanks), 3 gasohol USTs (1,000 to 2,000 gallon tanks), 3 jet aviation fuel USTs (10,000-gallon tanks), 2 heating oil USTs (20,000-gallon tanks), 1 avgas UST (10,000-gallon tank), and 1 diesel/gasoline UST (15,000-gallon tank). Only 540 of the 1,640 USTs

Table 4.3–11
UST and LUST Locations in Southern Harrison County

Incorporated Area	*UST Locations*	*LUST Locations*	*Percentage of Tanks Leaking*
Biloxi	361	37	10.2
D'Iberville	123	12	9.76
Gulfport	793	77	9.71
Long Beach	103	14	13.6
Lyman	0	0	0.00
North Gulfport	0	0	0.00
Orange Grove	0	0	0.00
Pass Christian	95	9	9.47
Woolmarket	0	0	0.00
Total	**1,475**	**149**	**10.1**

Source: MDEQ, 2002a.

are currently in use, while 23 are temporarily out of use, 2 have registration pending, 4 have permanent closure pending, and 1,071 are permanently out of use.

Southern Harrison County also contains a total of 117 contaminated sites, 19 RCRA sites, and 15 toxic material sites. A list of CERCLA Uncontrolled Sites contained 67 contaminated sites for Harrison County (MDEQ, 2002b).

In July 1999, EPA announced that a Superfund hazardous material removal project has begun at the Chemfax site in Gulfport. The project included restriction of site access; removal and disposal of asbestos insulation on boilers and pipes; inventory, analysis, and preparation of drums, tanks, and miscellaneous containers; transportation and disposal of hazardous substances and contaminated debris; and excavation and disposal of contaminated soils. Chemfax is an inactive, abandoned facility that manufactured synthetic hydrocarbon resins and waxes from 1955 to 1995. The project was scheduled for completion in December 1999 at an estimated cost of $1.8 million. In August 2000, EPA released the Administrative Record for the Chemfax, Inc., Removal Action for public review.

4.3.4.2.3 Jackson County Hazardous Waste Sites

Jackson County contains more than 830 USTs. More than 75 of which are classified as LUSTs. Table 4.3–12 lists the cities in Southwestern Jackson County, along with the number of USTs and LUSTs.

Of the 836 USTs and 79 LUSTs in the county, 328 USTs, or 39 percent, and 36 LUSTs, or 46 percent, are located in the Gulf Coast region. There are 659 gasoline USTs (1,000- to 10,000-gallon tanks), 126 diesel USTs (280- to 20,000-gallon tanks), 30 used oil USTs (250- to 5,000-gallon tanks), 9 not listed USTs, 8 kerosene USTs (1,000 and 6,000 gallon tanks), and 4 gasohol USTs (1,000- to 10,000-gallon tanks). Only 312 of the 1,640 USTs are currently in use, while 11 are temporarily out of use, 3 have registration pending, 1 has permanent closure pending, and 509 are permanently out of use.

Table 4.3–12
UST and LUST Locations in Southwestern Jackson County

Incorporated Area	*UST Locations*	*LUST Locations*	*Percentage of Tanks Leaking*
Gautier	86	13	15.1
Latimer	0	0	0.00
Ocean Springs	233	23	9.87
South Vancleave	0	0	0.00
St. Martin	0	0	0.00
Vancleave	9	0	0.00
Total	**328**	**36**	**11.0**

Source: MDEQ, 2002a.

Jackson County also contains 112 contaminated sites in the southern region of the county, along with 15 RCRA sites and 17 toxic material sites. A list of CERCLA Uncontrolled Sites contained 41 contaminated sites for Jackson County (MDEQ, 2002b).

4.3.5 Telecommunications and Energy Systems

This section focuses on the capacity of the telecommunications and energy facilities in the Three-County Region of Hancock, Harrison, and Jackson Counties along the Mississippi Gulf Coast. The telecommunications system consists of telephone and other communications services. The energy systems include electrical power and natural gas.

4.3.5.1 Telecommunications Systems in the Three-County Region

Two carriers in the Gulf Coast area, Bellsouth Telecommunications, Inc., and Franklin Telephone Company, Inc., provide telecommunications services. Bellsouth provides the largest service area in the three counties and throughout the State of Mississippi. Franklin Telephone provides service to a small section of Jackson (28,120 acres) and Harrison (2,380 acres) Counties. The Mississippi Public Service Commission regulates intrastate operations for telecommunications services.

4.3.5.2 Energy Systems in the Three-County Region

4.3.5.2.1 Electrical Power Utilities

Three utility providers supply electrical power in the Three-County Region: Mississippi Power Company, Coast Electric Power Association, and Singing River Electric Power Association. Mississippi Power Company is by far the largest electric power provider in the area. Mississippi Power provides electricity to more than 191,000 customers in 23 counties in southeast Mississippi. Of the 191,348 total customers in Mississippi Power's coverage area, approximately 50 percent, or 95,026 customers, reside in the Gulf Coast area.

Mississippi Power's headquarters is located in Gulfport, and there are two power plants in the area. Plant Watson is a 1,012-megawatt, five-unit, coal-, gas-, and oil-fired steam-generating plant located in Gulfport. Plant Daniel is a new 2,080-megawatt generating plant in Jackson County near Escatawpa, with two coal-fired and two natural gas-fired units. The two coal-fired units are jointly

owned with Gulf Power Company. Mississippi Power maintains 157 substations and more than 9,300 miles of power lines.

Coast Electric Power Association has 57,411 customers in Hancock, Harrison, and Pearl River Counties; it does not provide service to Jackson County. The electric distribution system has 4,729 miles of electric power lines. The headquarters is located in Bay St. Louis, with offices in Gulfport, Biloxi, Picayune, and Poplarville.

Singing River Electric Power Association has more than 59,000 customers in southeast Mississippi and maintains more than 5,800 miles of power lines in Jackson, George, Greene, Harrison, Perry, and Wayne Counties. Singing River's headquarters is located in Lucedale, with branch offices in Gautier and Sand Hill.

Hancock County Electrical Service Area. Two electric power companies, Coast Electric Power Association and Mississippi Power Company, serve Hancock County. Coast serves the largest area of the county, serving a total of approximately 300,000 acres, including Pearlington, Kiln, Diamondhead, Edwardsville, and small sections of Waveland and Bay St. Louis. Mississippi Power serves approximately 14,250 acres in the Gulf Coast region of the county, including a majority of Waveland and Bay St. Louis.

Harrison County Electrical Service Area. In Harrison County, three utility companies provide electrical power: Coast Electric Power Association, Mississippi Power Company, and Singing River Electric Power Association. Mississippi Power provides service to the largest area along the coast, south of I-10. Mississippi Power provides service to approximately 90,000 acres throughout the county, with a majority of the service area in the coastal region, including all of Gulfport, North Gulfport, and Pass Christian, a majority of Biloxi and Long Beach, and parts of D'Iberville, Orange Grove, and Lyman. Coast Electric Power Association has a service area of approximately 287,250 acres throughout the county. However, most of this service area lies north of I-10. Coast serves all of Woolmarket, a majority of D'Iberville, Orange Grove, and Lyman; and parts of Biloxi and Long Beach. Singing River services 12,270 acres throughout the county, with approximately 555 acres lying in the coastal region in D'Iberville.

Jackson County Electrical Service Area. Mississippi Power Company and Singing River Electric Power Association service Jackson County with electrical power. Mississippi Power services approximately 65,800 acres in the southern part of the county, including a majority of Pascagoula, Moss Point, and Ocean Springs, and parts of D'Iberville and St. Martin.

Singing River Electric Power Association services approximately 414,400 acres throughout the county, with a majority lying north of I-10. Cities served by Singing River include all of Gautier, Vancleave, South Vancleave, Gulf Islands National Seashore, Latimer, and Escatawpa; a majority of D'Iberville and St. Martin; and parts of Pascagoula, Moss Point, and Ocean Springs.

4.3.5.2.2 Natural Gas Utilities

Reliant Energy Resources Corporation (or Entex), the City of Pascagoula, and Seashore Utilities, Inc. provide the Three-County Region with natural gas.

Hancock County Natural Gas Service Area. Hancock County receives natural gas via Entex and Seashore Utilities. Entex services approximately 59,100 acres of the county, with a majority of its customers south of I-10, including parts of Pearlington, Edwardsville, and Waveland. Seashore Utilities services a small area, approximately 520 acres in the northern section of Bay St. Louis.

Natural gas is not available in a majority of Bay St. Louis, Waveland, Edwardsville, Kiln, and Diamondhead. Most of the natural gas service area in southern Hancock County is in the south central region south of I-10.

Harrison County Natural Gas Service Area. Entex provides all of the natural gas to Harrison County, with a service area of approximately 140,300 acres along the north and south of I-10. Natural gas is available to all the cities in the southern part of the county, with small pockets of unserviced areas throughout the region.

Jackson County Natural Gas Service Area. The City of Pascagoula provides a majority of the natural gas to Jackson County. Its service area is approximately 203,625 acres on the eastern side of the county and includes Pascagoula, Moss Point, and Escatawpa. Entex provides natural gas to the western part of the county, on both sides of I-10, and has a service area of approximately 75,240 acres, which includes the cities of Ocean Springs, Gulf Islands National Seashore, St. Martin, D'Iberville, Latimer, and Vancleave. Natural gas service is not yet available in the City of Gautier and the South Vancleave portions of Vancleave.

4.4 TRANSPORTATION AND TRAFFIC

Transportation in and around the Coastal Study Area is achieved mainly via air systems, rail routes, water systems, and road networks. The following section describes these transportation resources and their importance to the surrounding communities. The discussion will focus on trends in the relationship between population growth and the relative use of these resources.

4.4.1 Airports

4.4.1.1 Gulfport-Biloxi International Airport

The Gulfport-Biloxi International Airport is the only passenger airport in the Coastal Study Area. The airport was originally constructed in 1942 to train B-25 and B-29 flight crews for World War II. The airport was conveyed from the military to the City of Gulfport in 1949 for use as a municipal airport. Southern Airways and National Airlines began to provide passenger and cargo service in the early 1950s. Through the late 1970s, Southern Airways continued as the primary airline followed by successors, Republic and Northwest, into the 1990s.

In 1977, the Gulfport-Biloxi Regional Airport Authority was established. During the next two decades more than $46 million in capital improvements were completed at the airport with 80 percent federal funding. The airport currently has a 9,000-foot, all-weather jet runway and a 5,000-foot general aviation runway. Air traffic control service is provided by a Federal Aviation Authority (FAA) control tower with approach control radar. Precision Instrument Landing Systems (ILS) and weather service are available (Frallic, personal communication, 2002).

4.4.1.1.1 Commercial and Charter Operations

In 1990 the Airport had service from three airlines, Northwest, Eastern Metro, and Continental. The number of scheduled seats averaged 660 per day for the three airlines combined. Charter service (six flights) was minuscule, and there were only 335 landings for the year (Frallic and Crawford, personal communication, 2002). After the advent of the casinos and gaming industry, passenger boardings grew 434 percent during the 1990s and the economic impact of the airport now exceeds $600 million

annually. This growth is shown in Figure 4.4–1. The airport was serviced by six commercial airlines during 2000 and 2001 and offered frequent nonstop jet service to 10 major airports connecting to some 2,000 flights throughout the United States and the world.

For the year 2001, the six commercial airlines and the charters provided 3,038 seats daily (a 460 percent increase over 1990) and had 8,067 total landings (a 241 percent increase over 1990) (Frallic and Crawford, personal communication, 2002). Charter services increased steadily from 1992 until 1994–1995 to compensate for insufficient commercial service to meet public demand. These charter flights were also partially supported by the gaming industry. However, with the increase in available commercial scheduled service and the entry of additional airlines, charter service has declined to less than 30 percent of the number of charter passengers in 1994.

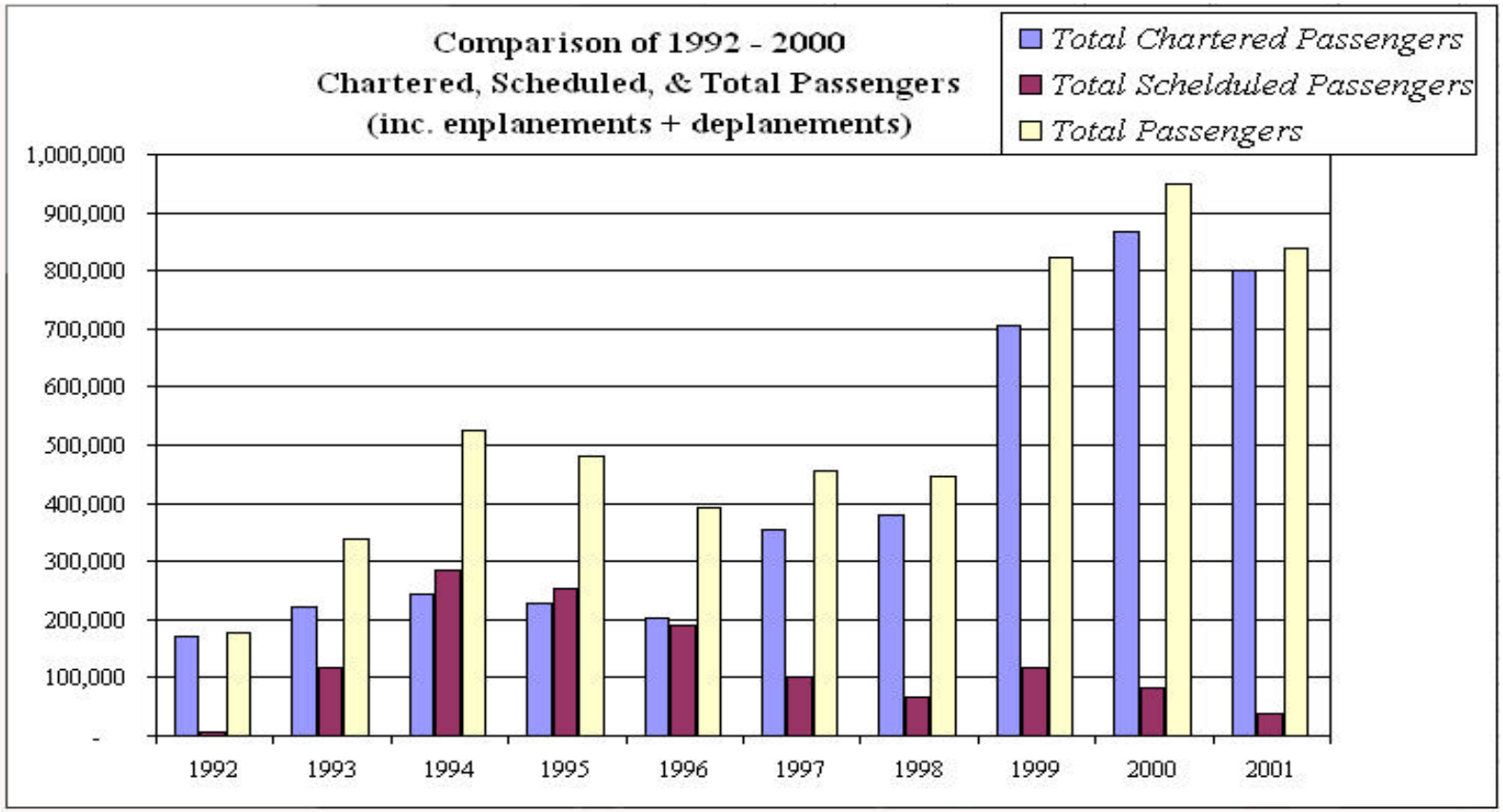
Major runway and lighting system improvements totaling $9.3 million were completed in the late 1990s, setting the stage for expanded commercial and military users. Having handled as many as 950,000 passengers per year at the end of the decade, the airport forecast over 1,000,000 total passenger movements in 2001, and terminal facilities are in place to accommodate that new passenger demand.

No space is currently available for new airlines. A major $28 million terminal expansion is planned for 2004-2005. This expansion will increase the terminal from 92,000 sq. ft. to 165,000 sq. ft. and provide space for two new airlines, expanded baggage claim, new gates and expanded security functions post 9/11.

Regarding passenger demand, the availability of high-quality hotel rooms, which has developed in conjunction with the gaming industry, is now the market driver for business and leisure travel. With nearly 16,000 rooms available, higher yield conventions and business traffic, as well as tour operator packages, require more airline passenger seats. Based on a historical response of passengers to new hotel rooms, each new first class room results in 100 new total passengers per year. Figure 4.4–2 shows this post-historical relationship for the Gulfport-Biloxi area.

It should be noted that, based on surveys, 45 percent of the new passengers at the Gulfport-Biloxi International Airport are classified as casino gamblers. Other passengers include vendors, convention attendees, suppliers, investors, managers and workers for the gaming industries, and their friends and families. A large part of the passenger base consists of staff members of the casinos who have relocated to the Mississippi Gulf Coast for job opportunities (Frallic and Crawford, personal communication, 2002).

The airport master plan forecast projects 2.1 million total passengers by 2020, which is a 121 percent increase over 2000. This 6 percent average annual growth rate is 40 percent higher than the FAA's forecast. Such an optimistic passenger growth rate anticipates steady growth in the resort and allied businesses, continued stability in the federal and defense sectors, and above-average growth in population. Accordingly, the airport will expand the existing terminal, baggage claim, and security screening areas by 30 percent in the short term, but the airport plans to build a new passenger terminal adjacent to the existing terminal when total passenger movements approach 1.3 million, expected by 2010. The existing terminal will simultaneously be converted to international and charter operations, which will permit growth up to 12 million passengers per year.

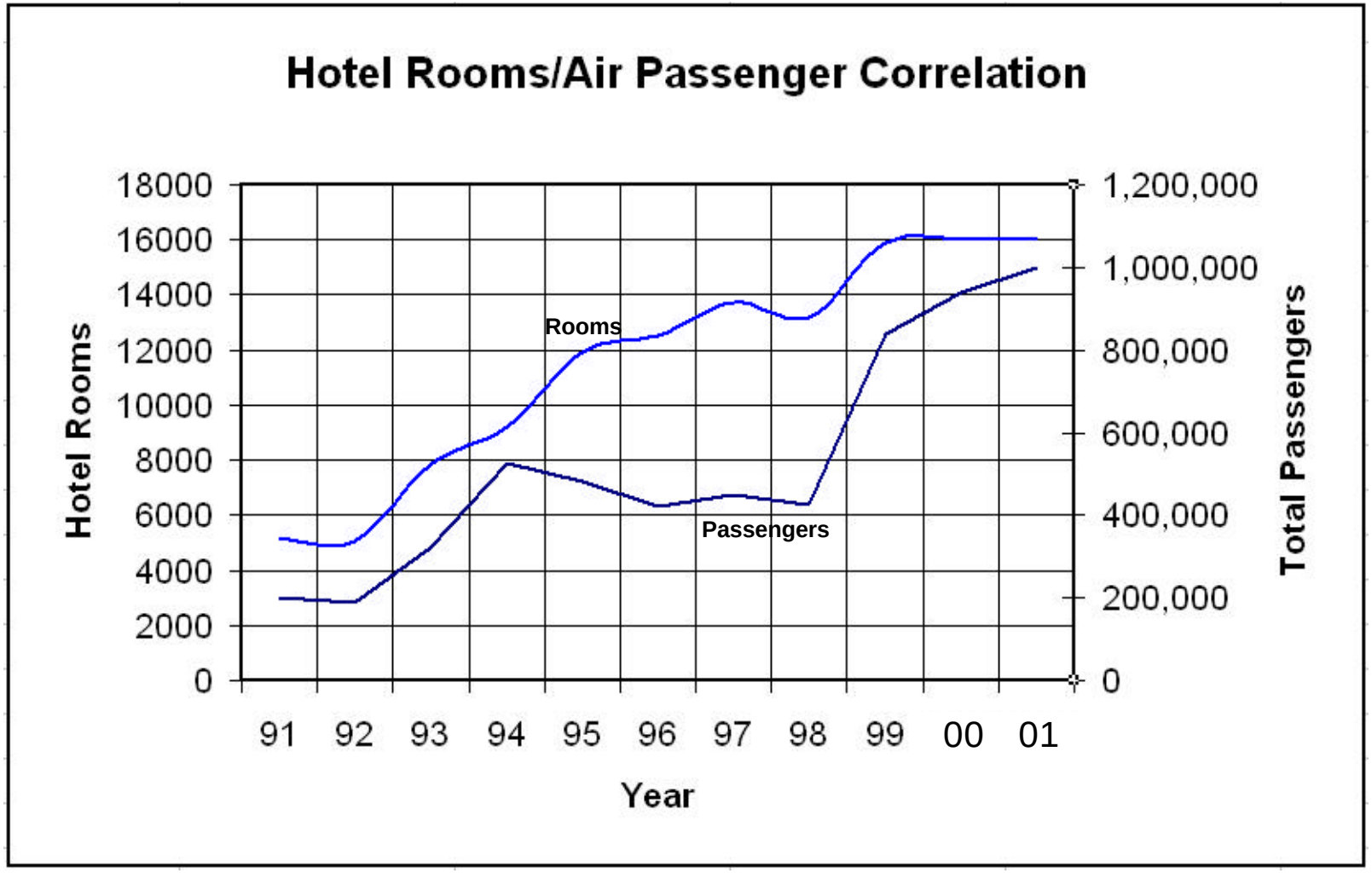


	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total Charter Passengers	4910	117084	283547	253529	188718	101731	66844	118395	82599
Total Scheduled Passengers	171630	220574	242129	228069	204052	354833	379746	705365	866630
Total Passengers	176540	337658	525676	481598	392770	456564	446590	823760	949229
% of increase over previous year		0.912643	0.5568297	-0.08385	-0.18444	0.16242076	-0.021846	0.8445554	0.152313

Comparison of 1992-2000 Chartered, Scheduled, and Total Passengers

Source: Gulfport Biloxi InternationalAirport, 2002.

Figure 4.4-1



Hotel Room/Air Passenger Correlation

Source: Gulfport BiloxiInternational Airport, 2002

Figure 4.4-2

In recognition that every airport has a capacity limit, the Gulfport-Biloxi International Airport Master Plan notes that the terminal can grow from 7 jet aircraft gates to 80 jet aircraft gates, accommodating 28 million passengers. On a three-runway operation, it can serve 720,000 annual operations. To reach this capacity, Gulfport-Biloxi would have to grow at twice the FAA forecast for 50 consecutive years, be supported by a population base of 3 to 4 million residents, have 120,000 first-class hotel rooms and capture 100 percent of Mississippi Coast Area passengers. Therefore, it is not practical to assume that capacity will be reached within any reasonable planning horizon.

As a small hub airport, Gulfport-Biloxi represents a unique situation with respect to multi-modal transportation development in the long run. Forty percent of the airport's passengers arrive at and depart from the airport on mass transit. Most of these passengers travel on shuttles or buses provided by the casinos. Therefore, the vehicle-to-passenger ratio is lower than that at most airports, as passengers transfer between air and hotel transportation. On the other hand, if this trend continues, the potential for some form of multi-modal facility and rail to supplement passenger movement to resort areas will become more feasible (Frallic and Crawford, personal communication, 2002). The airport master plan has set aside multi-modal access areas within the terminal complex.

While road access is adequate today, the master plan also identifies several improvements needed over the next 20 years. In order of priority, they are:

- Completion of Hewes Avenue relocation by the Air National Guard.
- Widening 8th Avenue North from 34th Street as general aviation is relocated.
- Connecting Washington Avenue to Creosote Road.
- Extension of Three Rivers Road south along the airport's west property line.
- A connector from the airport to I-10.

The Airport Master Plan also provides for continued construction of surface parking and concept plans for several parking structures to support growth of personal vehicle and rental car parking over the next 20 years. Surface parking has grown from 350 spaces in 1992 to nearly 1,000 spaces today. However, parking revenues are not yet sufficient to amortize the cost of constructing and operating a parking garage. As an interim measure, the airport has instituted an all-weather shuttle vehicle between the terminal and parking area. Covered walkways and shelters were scheduled to be constructed in the airport parking facilities in 2002.

4.4.1.1.2 Air Cargo Operations

With respect to growth projects, a cargo-based facility began operations in the late 1990s. The facility can accommodate domestic and international air cargo in Foreign Trade Zone No. 92 and is a joint venture of the Airport, Harrison County, and the state of Mississippi. More than 120 acres of airport property is set aside for cargo development. The airport has its first major freight forwarder in place and cargo activity is expected to grow significantly over the next 5 years.

4.4.1.1.3 Military Operations

Beginning in 1953 the Mississippi National Guard developed a training activity that has grown into a high-tech Combat Readiness Training Center, one of four in the Nation. Military traffic has expanded each year, and now more than 20,000 Air Guard and Reserve flight personnel are training at the base annually. Within 10 minutes, supersonic fighters and in-flight refuelers can simulate a combat environment over the Gulf of Mexico or at Camp Shelby in Hattiesburg, Mississippi. Additionally, the Army National Guard established the Aviation Classification Repair Depot operation, which repairs several types of combat and transport helicopters for military activities throughout the Southeast and Puerto Rico. For that reason, the federal government, through the FAA and the Department of Defense, has historically funded "fair share" construction of new or expanded airside and landside improvements. The airport has worked closely with the National Guard and FAA to jointly fund the relocation of the general aviation operation facilities and the extension of runway 18-36 in the near term.

4.4.1.1.4 General Aviation Operations

General aviation activity is operated by AvPort's FBO AvCenter and is a major contributor to the airport's aviation service resources. General aviation is growing steadily. The company provides fuel, maintenance, and aircraft service, and it services the expanding commercial charter airline business. A new 50-acre general aviation area is being developed, which will allow general aviation to be relocated from the east ramp (Hewes Avenue area) to the new southwest general aviation area during the period 2004 to 2006.

4.4.1.1.5 Summary

Airport operations from airline, general aviation, military, and cargo operations average 340 per day, or about 19 per hour based on an 18-hour day. Runway capacity is available to allow nearly three times that number, up to 1,080 operations per day. Aircraft size is increasing as carriers convert to jet aircraft. Therefore, the Airport can accommodate a substantially greater number of passengers with only a marginal increase in number of operations. In any event, the Airport is operating at 30 percent of capacity; and with the extension of runway 18-36 to 7,000 feet, capacity will increase by a factor of 1.75.

4.4.1.2 Stennis International Airport

Stennis International Airport is located 8 miles north of Bay St. Louis. Mississippi State Highway 43 provides road access to the facility. The airport has one runway that has a north/south orientation that is 8,500 feet in length. There are plans to add a parallel 10,000-foot runway. Stennis Airport has no domestic or air cargo operations but hopes to attract air cargo activity in the future. The airport is used for general aviation. Stennis International Airport has 7,500 operations per year—5,500 for general aviation and 2,000 for military (TranSystems, 2001).

An ILS will be installed at Stennis International Airport within a year. Also included in the airport's master plan are plans for two launch facilities for the X33 Venture Star Space Shuttle. Because both the existing and future airport runways are within the NASA Buffer Zone, noise and land availability are not issues. Desired road improvements include paving Texas Flat Road, a two-lane dirt road west of the airport, to provide direct access from Stennis Space Center to Stennis International Airport.

Also, the airfield is being developed as the heart of a business and commerce technology park for the future. Industrial tenants include Smith and Smith, a maker of aircraft machine parts; Hot Sticks Manufacturing, a maker of drumsticks; Baker Industries, a maker of wooden reels; and Koenig-Stimens, Inc. The Hancock County Port and Harbor Commission believes there is an opportunity to attract more high-tech tenants in the future.

4.4.2 Railroads

Railroads in the United States are stratified into three broad categories—Class I, II and III operators. Class I carriers have annual gross revenues of more than $250 million. Class II carriers have annual gross revenues of at least $20 million, but no more than $250 million. Class III carriers have less than $20 million in gross annual revenues (TranSystems, 2001).

As shown in Figure 4.4–3, the Study Area of the Mississippi Gulf Coast is served by three railroads including two Class I railroads. These railroads are CSX Transportation Railroad (CSX), Kansas City Southern Railroad, and Port Bienville Railroad.

4.4.2.1 CSX Railroad

The CSX is a Class I railroad serving the developed portion of the Mississippi Coastal Area. Its main lines traverse most of the region's municipalities. The 94-mile CSX trackage has an east-west orientation and serves as a major connection between the deep-water ports in New Orleans and Mobile. Between 20 and 24 trains pass through the region each day on the CSX line. Many coastal industries and Keesler Air Force Base use this railroad to transport goods and services. Industrial areas served by the CSX include Port Bienville Industrial Park, Pass Christian Industrial Park, Long Beach Industrial Park, Biloxi-Clay Industrial Park, International Paper, Ingalls Shipbuilding, and Jackson County's Bayou Cassotte Industrial Park. There are also numerous sidings and yards serving minor industrial areas along the CSX trackage. The Port of Pascagoula uses the CSX railroad 5 days a week, and the Port of Gulfport uses it 3 days a week.

4.4.2.2 Kansas City Southern Railroad

Kansas City Southern (KCS) Railroad is the second Class I railroad serving the study region. Its main line has a north-south orientation extending approximately 69 miles northward from the Port of Gulfport through Harrison, Stone, and Forrest Counties. It interchanges with the CSX line in downtown Gulfport and serves the Naval Construction Battalion Center, Dupont Company (via their own railroad) and Industrial Seaway in Bernard Bayou Industrial Park (via rail spurs). Current business activity on the KCS line is about 45 to 50 cars per day 6 days per week. The KCS line eventually connects with the Class I Illinois Central Railroad (IC) near Hattiesburg, Mississippi. The Port of Gulfport and the Mississippi Development Authority are evaluating the purchase of the rights to the KCS line to improve the line's service to the Port (DiGeorge, personal communication, 2002). Currently, the Port of Gulfport is required to switch lines between CSX and KCS in downtown Gulfport and this causes delays. The rail transit time from Gulfport, to Hattiesburg is 12 to 24 hours.

4.4.2.3 Port Bienville Shortline Railroad

The Port Bienville Shortline Railroad is a Class III railroad with 9 miles of track owned and operated by the Hancock County Port and Harbor Commission. It serves the Port Bienville Industrial Park and connects with the CSX southwest of Waveland.

General Transportation Map

Source: Neel-Schaffer,Inc.,1991.

Figure 4.4-3

4.4.2.4 Railroad Grade Crossings

Railroad grade crossings are considered a major problem on the Mississippi Gulf Coast. Table 4.4–1 shows the number of such crossings in each county, listed by railroad. The data were extracted from the Personal Computer Accident Prediction System provided by the Federal Railroad Administration's Office of Safety Analysis. The data are current as of September 30, 1998. Other information provided in Table 4.4–1 includes the number of crossings that are protected by automatic gates or flashing lights, highest vehicle ADT of the crossings, highest railroad speed through the segment, and number of collisions occurring between 1993 and 1997 for each segment of railroad.

Table 4.4–1
Mississippi Gulf Coast Railroad Grade Crossings

Railroad	County	Total Crossings	Protection		Highest ADT	Highest Speed (mph)	Collisions (1993-1997)
			Gate	FL			
CSX	Hancock	18	1	4	3,900	79	7
	Harrison	95	13	33	19,000	60	50
	Jackson[1]	47	10	15	17,000	79	10
KCS	Harrison	75	1	15	40,000	40	17
Port Bienville	Hancock	12	0	0	375	5	1
Total		247	25	67			85

[1] Some crossings in Jackson County are outside the study area.
Source: FRA, OSA, no date.

From Table 4.4–1, there are more than 240 railroad grade crossings in the three-county Mississippi Gulf Coast Region including the Coastal Study Area. Only 29 percent of these crossings are protected with gates or flashing lights. Furthermore, 85 rail-vehicle collisions occurred at these crossings between 1993 and 1997. That is an average of 17 collisions per year. The majority of these collisions occurred on the CSX line where the trains travel at speeds between 45 and 79 miles per hour as they traverse the most densely populated parts of the study region. Many of these collisions have resulted in fatalities. Not only are railroad crossings a major safety issue, but they also cause delays to motorists and trucks, especially in the downtown areas of Gulfport and Pascagoula. These delays hinder efficient goods movement in the Mississippi Gulf Coast Region.

4.4.2.5 CSX Mainline Relocation

There is a need to relocate the CSX mainline tracks to the north of I-10, not only in Mississippi but in Louisiana and Alabama also. CSX, Department of Transportation, and community leaders agree that the tracks should be moved north to eliminate the numerous at-grade rail/roadway crossings. This would eliminate the accidents, injuries, and deaths from frequent train-vehicle collisions and reduce traffic congestion associated with roadway closing to allow numerous trains running directly through the area's most populated corridor. With the exception of I-110 and SR 609, all major north/south routes and numerous surface streets have at-grade crossings of the CSX mainline tracks. A study was initiated to define a new corridor for location of the CSX mainline track to the north of I-10. The study will also evaluate the feasibility of using future vacated railroad right-of-way for an east/west

roadway corridor. Preliminary estimates show the rail relocation could cost more than $1 billion and the new east/west roadway could exceed $200 million. Funding sources for the construction of either project have not been identified.

4.4.3 Transit

4.4.3.1 Coast Transit Authority

The Coast Transit Authority (CTA) was created by an act of the Mississippi Legislature in 1970, with the mission to provide public transit on the Mississippi Gulf Coast (Burk-Kleinpeter, 2000). Given these broad directions, the CTA implemented bus service across all three coastal counties. As late as 1990, bus service was provided in Bay St. Louis, Waveland and Pascagoula. However, due to lack of a local match for funding and lack of ridership interest, service in these three communities was eliminated (Hopper, personal communication, 2002).

4.4.3.2 Operations

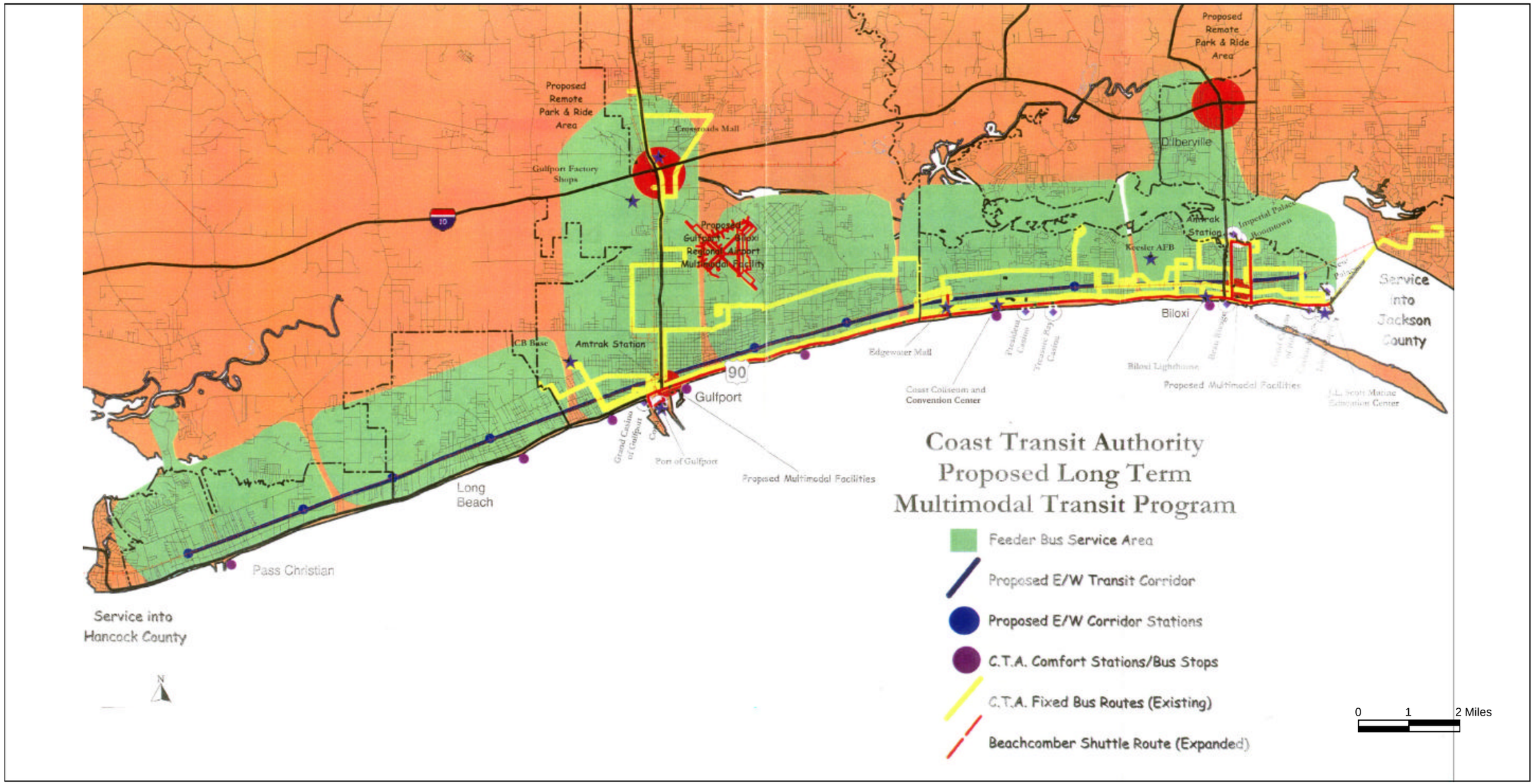
The CTA operates a fleet of 45 vehicles in two types of basic transit service, fixed route and demand response. Fixed route bus services are scheduled on fixed routes that operate on a "hub-and-spoke" routing system that extends from two existing transfer facilities. The transfer facilities are located in downtown Gulfport at the L&N Terminal and at the US Hwy 90 Beachfront at the Lighthouse Transfer Station. These two transfer facilities are connected by the Beachcomber Line (Route 1), which follows US Highway 90 from Point Cadet west into Gulfport.

Eight fixed routes are concentrated in the Gulfport/Biloxi area (Harrison County), with an extension (Route 7) to Ocean Springs in Jackson County. These routes are shown in Figure 4.4–4 and are listed in Table 4.4–2.

Demand-response services are offered across the area included by the fixed-route system. This system is operated to meet the needs of the members of the population who are mobility-impaired and are unable to use the existing fixed route system. Rides are provided on an appointment basis with CTA.

Table 4.4–2
Fixed Bus Routes in the Coastal Area

Route	*Route Name*
1	Beachcomer
7	Ocean Springs
24	Keesler Air Force Base
26	NCBC Base-Gulfport
31	Back Bay/West Biloxi
35	Pass Road
37	North Gulfport
38	Orange Grove



Bus Routes

Source: Burk-Kleinpeter, Inc., 2000.

Figure 4.4-4

4.4.3.3 Ridership

From 1992 to 2001 ridership increased by 52 percent (Hopper, personal communication, 2002). The number of riders per hour for the Beachcomber (Route 1) for the period of 1998 to 2002 is shown on Figure 4.4–5. It should be noted that there was a significant peak in ridership for the Beachcomber route in the year 2000. This is directly related to a 3-month shutdown of transit shuttles and buses provided by the gaming industry for transportation to provide access to the casinos. Shuttles and bus rides are offered free by the casinos and include rides from the airport to casino hotels and from other hotels, motels, RV parks, and lodging to the casinos. These services are provided not only for free but also on-call at any time as requested by phone by the rider. Therefore, these buses and shuttles do not follow any schedules or fixed routes. This is a unique situation; at no casino area other than the Mississippi Gulf Coast are these services offered by the gaming industry (Hopper, personal communication, 2002).

The casino transit shutdown in 2000 generated an increase of almost 100,000 riders over the number of riders in 1999. When the casino transit system restarted service, CTA ridership declined to 1999 levels. A conclusion can be drawn that the "casino transit" services provide a decrease in excess of 100,000 riders per year to the CTA's ridership numbers. If the "casino transit" services were permanently eliminated, or somehow combined with CTA's operation, it would result in a significant increase in CTA ridership. Discussions have been held with the gaming industries to explore the possibilities of integrating these "casino transit" services into CTA's operations. However, the gaming industry has shown no willingness to give up control of these services because they see them as a benefit to attracting people to their particular casino operations (Hopper, personal communication, 2002).

It also should be noted that there has been a significant decline in ridership since the September 11, 2001, terrorist attacks in New York City and Washington, DC. This decline can be attributed to the following (Hopper, personal communication, 2002):

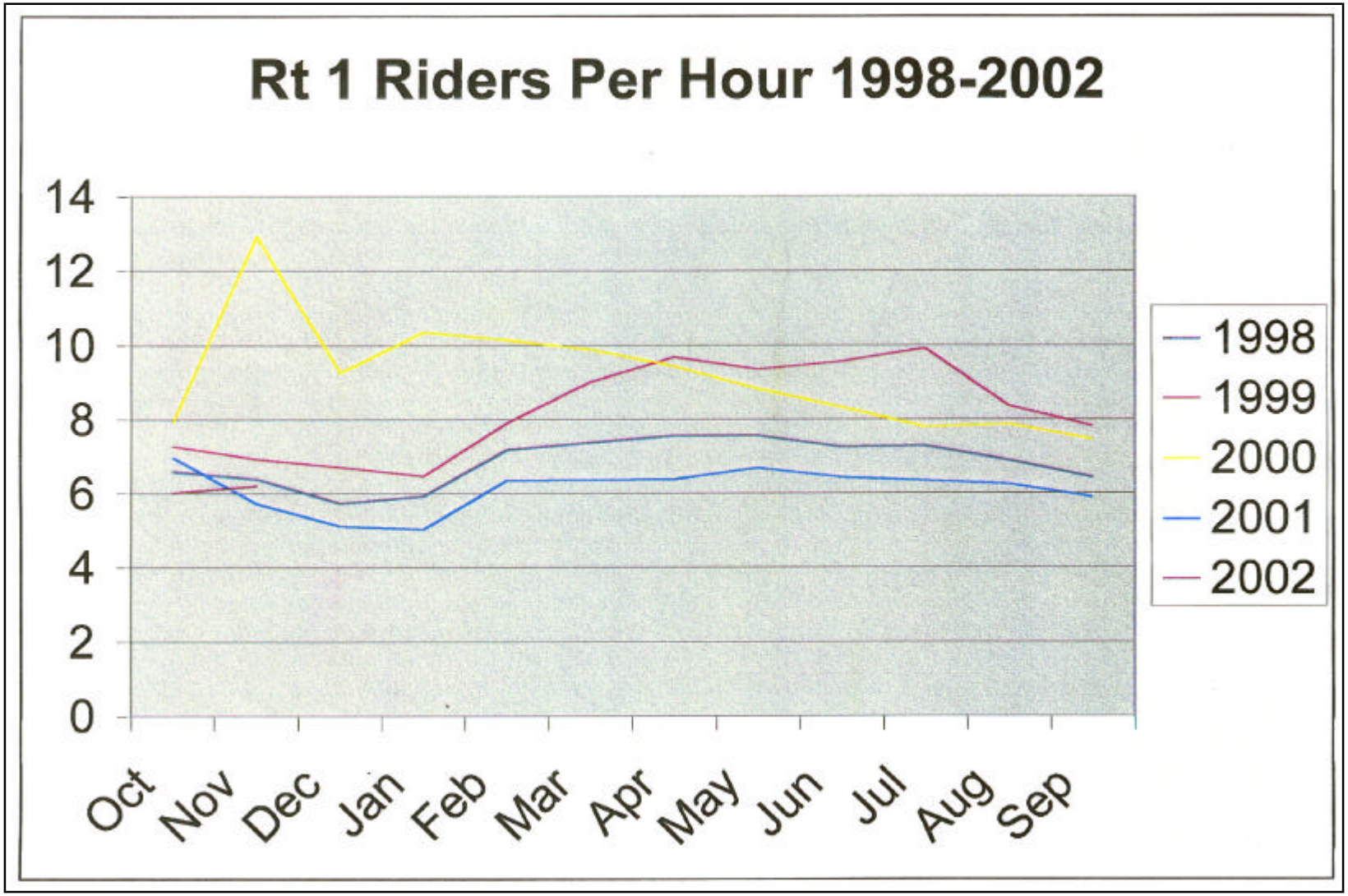
- Stronger security at Keesler Air Force Base has required that no CTA bus may enter the base on its fixed route as previously permitted. Getting on the bus at the main gate rather than at the barracks is less convenient for military personnel, who have eliminated or decreased their bus ridership. Military ridership on CTA buses was very strong prior to September 11, 2001.

- The casinos have had large layoffs of workers due to decreased business. These service industry workers are those most likely to use CTA buses to reach their place of employment.

A general, overall economic slowdown has also caused less ridership.

4.4.3.4 Future Transit Plans

In 1998 CTA received funding for developing a plan to implement a *Multimodal Transportation Plan* for Harrison County (GRPC, 1998). The plan has multiple phases and is designed to improve mass transit, decrease traffic congestion, stimulate economic development and improve air quality in Harrison County. The implementation plan was developed and published as a report in *Moving in the Right Direction* (Burk-Kleinpeter, 2000). The proposed long-term master plan is shown in Figure 4.4–4 and includes the following elements:



Hourly Ridership for Beachcomber Bus Route

Source: Burk-Kleinpeter,Inc.,2000.

Figure 4.4-5

- Acquisition of hybrid-electric buses for replacement of aging diesel-powered buses to reduce vehicle emissions and diminish noise pollution.

- Construction of Multimodal Transportation Center Terminals in downtown Gulfport and Biloxi. These will replace or enhance the current two Transfer Facilities. These Multimodal Terminals will include provisions for multiple conveyances such as long-distance bus, intercity bus, transit, taxis, rail, bicycle, and pedestrian modes. The terminals would include waiting rooms (with comfort stations), off-street parking facilities, and covered areas for passenger transfer.

- Expansion of service to provide service to additional areas of Harrison County and other counties as demand, community support, and financial resources allow.

- Construction of remote park-and-ride lots in the I-10/US 49 and I-10/I-110 areas. Linkage of these park-and-ride lots to the Multimodal Transportation Center Terminals will be provided by Express Bus Service.

- Enhancement of existing and expanded route bus stops by providing passenger amenities such as benches, shelters, and comfort stations as appropriate at high-demand areas.

Long-range plans may include development of an East/West Transit Corridor along the existing CSX Railroad line that would extend from Pass Christian to Biloxi (Figure 4.4–4). This facility might employ light-rail, fixed-route vehicles with rubber tires or other means. Interface with the Multimodal Terminal Facilities in Biloxi and Gulfport would be provided.

4.4.4 Ports

4.4.4.1 Port Bienville

Port Bienville is a shallow-draft port near Pearlington, Mississippi, on the Pearl River. It is administered by the Hancock County Port and Harbor Commission. A 12-foot-deep channel connects Port Bienville to the Mississippi Sound on the Gulf of Mexico and to the Intracoastal Waterway (Parsons et al., 2000).

Port Bienville has waterside, rail, and vehicular access with intermodal capabilities. There are three ship berths (600 feet in length with 16 to 20 feet of draft) and five barge berths (1,050 feet in length with a draft of 10 to 12 feet). Facilities include 6 acres of hard surface loading area, three mobile cranes, container-to-rail and truck loading capabilities, reefer plugs, direct dump ramps for barge loading, palletized load handling, a 30,000-square-foot dry storage warehouse, a 20,000-square-foot transit shed, and a 10-inch-diameter pipeline to move ethyl glycol from barges.

The port is serviced by the Port Bienville Shortline Railroad, owned by the Port, which connects to the CSX Mainline Railroad (Class I). Ample room is available for industrial and commercial development with 850 acres available on terminal and 850 acres available off terminal. Port Bienville's roadway access connects directly to US 90 and is 10 miles from I-10.

Various cargo is handled at Port Bienville, including twine, lumber, pulpwood, coal, ferric sulfate, USDA food products, general cargo, steel, and explosives. Major tenants at the Port included Calgon

Carbon Corporation, Con Tech Power Systems, Dupont, G.E. Plastics, Gulf Coast Fabrication, Atlas Powder International, Gulf Concrete, Kimberly Clark, and Polychemie.

From 1990 to 2000 the number of vessel calls at Port Bienville increased from one per week to one per day. From 1998 to 2001 yearly tonnage increased from 400,000 tons to more than 700,000 tons. None of this increase is related to the gaming industry in South Mississippi. Increases are related to increased industrial activity and additional industry using Port Bienville. Tonnage for the Port does not reflect shipments to NASA's Stennis Space Center, about 15 miles to the north on the Pearl River, which has its own docking facilities (Walters and Hemphill, personal communication, 2002).

4.4.4.2 Port Of Gulfport

The Port of Gulfport is a 184-acre deepwater port in Gulfport on the Mississippi Sound, with a 17-mile shipping channel leading to the Gulf of Mexico. The Port is at the intersection of US 90 and US 49. The Port of Gulfport is managed by the Mississippi State Port Authority Board of Port Commissioners, which was established in 1972. The Port is designated as the State Docks.

The Port of Gulfport has waterside, rail, and vehicular access with intermodal capabilities. There are nine deepwater ship berths from 525 feet to 750 feet in length and ranging from 32- to 36-foot draft. The dock also has extensive hard surface, two container berths, two break bulk cargo berths, one refrigerated cargo berth, one bulk cargo berth, three general cargo berths, and bulk liquid facilities. The Port also has a foreign trade zone, two gaming operations, and a small craft harbor for commercial fishing and commercial recreational areas.

The Port is serviced by the Kansas City Southern Railroad (KCS), which is a Class I railroad connecting to the east/west CSX Mainline. Vehicular access is provided by US 90 (east/west) and US 49 north 7 miles to I-10. No property is available for general industrial development.

The Port of Gulfport handles a variety of commodities. Primary import commodities consist of bananas, pineapples, other tropical fruit, ore, mahogany lumber, fence board, linerboard, and aluminum. The Port is one of the two largest U.S. ports for import of bananas and the largest Gulf port for mahogany lumber import. Primary exports consist of frozen poultry and containerized products. Gulfport is the largest U. S. port for export of frozen poultry to Russia. Major tenants at the Port include Dole, Chiquita Banana, Turbana (all fruit importers), Dupont, I.T.O. Corporation, and Duratex.

The gaming industry has benefited the Port of Gulfport. The last cruise ship calling at Gulfport was *Pride of Mississippi*, which was acquired by gaming interests and converted to the Copa Cabana Casino, which is now permanently moored at the Port. Additional access, property, and mooring were leased from the Port for the Grand Casino at Gulfport development. These two gaming facilities provide steady income for use by the Port for operations and capital improvements. This has allowed the Port to make these improvements earlier than the pre-gaming schedules had anticipated (DiGeorge, personal communication, 2002).

The port is pursuing two main improvements:

- ***Roadway Access from I-10 to the Port***. Due to congestion on the existing connector, US 49, a new route is supported by the Port for development. Working in conjunction with MDOT, a new location with a controlled access freeway from I-10 at Canal Road

(Exit 33), or another location on I-10, is being evaluated to provide better access for the Port and lessen truck traffic on US 49.

- ***Rail Access on the KCS Railroad***. Improvements to the existing rail line are required to provide for heavier rail cars, such as the double-decker container freight. The dock is pursuing the possible acquisition of the KCS Railroad all the way to Hattiesburg, Mississippi. This would allow the state docks to make improvements to the existing rail line to provide for heavier cars at a greater speed (DiGeorge, personal communication, 2002).

4.4.4.3 Port Of Biloxi

The Port of Biloxi is a shallow-draft port with facilities in Biloxi on the Mississippi Sound along US 90. The Port is mainly a marina facility with no cargo handling or throughput. The Biloxi Port Commission, established in 1960, manages the port facilities. The commission has emphasized tourism, recreation, and support of the shrimping fleet.

The Port of Biloxi does not engage in industrial cargo operations and, therefore, has no facilities for such operations. Primary facilities include a marina with 287 pleasure craft slips and support services (utilities, restrooms, laundry, tackle shops, charter fishing, hotels, and restaurants). A second marina includes 141 pleasure craft slips with support services. The Port also administers two commercial docking facilities with 96 berths for the local shrimping fleet, nine public piers, and five public boat-launching ramps. Limited land is available for additional development. Riparian land is needed for expansion of the marina facilities (Manuel, personal communication, 2002).

The Port of Biloxi supports privately owned seafood-processing plants to complement the commercial fishing and shrimping fleet activities. Major tenants at the Port include the Isle of Capri Casino, McElroys Seafood Restaurant, Starship Cruise Lines (day cruises to the Gulf), Gorenflo's Tackle Shop, and warehousing for the Grand Casino.

The Isle of Capri Casino and Grand Casino provide substantial revenue for the Port of Biloxi, which allows the Port to increase support of improvements to benefit tourism and recreation. By supporting fishing tournaments, the gaming industry has generated additional revenue for the Port. A tournament in 2001 had 65 entrants of large fishing boats that docked at the Port. Full-time dockage boats were temporarily moved to allow for the transient tournament dockage. These tournaments generate tourism/recreational revenue for the entire Biloxi area, as well as the Port (Manuel, personal communication, 2002).

Over the past decade demand for larger, longer boat slips has increased substantially. Demand for transient slips for the increasingly larger fishing tournaments has also increased. Because it is difficult, or impossible, for private interests to build new marinas and accomplish debt service due to provisions of the Tidelands Lease by the state of Mississippi, the Port of Biloxi has supported expansion of available larger slips through acquisition and development of riparian lands (Manuel, personal communication, 2002).

4.4.5 Roadways

4.4.5.1 Background

In response to the Federal Highway Act of 1962, the Transportation Planning Process for the Mississippi Gulf Coast Urbanized Area was officially established on May 21, 1968, through an agreement between the local governments and the Mississippi State Highway Department (now known as Mississippi Department of Transportation, MDOT). In 1970, a base-year transportation study called the Mississippi Gulf Coast Urban Area Transportation Study, was conducted to develop a transportation plan for the area along the Mississippi Gulf Coast that was projected to be urbanized by the year 1990. The primary component of the transportation plan, which was completed in 1974, is the *1990 Major Street and Highway Plan*. Traffic volume forecasts for the 1970 plan were developed using a mainframe computer model called *PLANPAC*. This model was created by the FHWA and was subsequently replaced by the Urban Transportation Planning Software (UTPS) model.

On December 20, 1973, the Gulf Regional Planning Commission (GRPC) was designated as the Metropolitan Planning Organization (MPO) responsible for updating the overall transportation plan for the Mississippi Gulf Coast Urbanized Area. To ensure continued progress in serving the current and future transportation needs of the urbanized area, it is necessary for the transportation plan to remain relevant. Federal regulations (23 CFR 450.322(a)) governing the Transportation Planning Process in urbanized areas required that the transportation plan be reviewed and updated at least "every five years in attainment areas to confirm its validity and its consistency with current and forecasted transportation and land use conditions and trends and to extend the forecast period." However, every 10 years a major reevaluation plan that incorporates new growth trends, new travel patterns, and traffic projections for the new design year (20 to 25 years beyond the current year) is required. This plan is used to determine the major transportation needs beyond the base study (1970) or last major update.

In 1990, GRPC's geographic area of responsibility encompassed two adjoining metropolitan statistical areas (MSA), the Biloxi-Gulfport urbanized area (Harrison and Hancock Counties) and the Pascagoula-Moss Point urbanized area (Jackson County). However, following the 1990 census the two were combined as the Biloxi-Gulfport-Pascagoula MSA, comprising all three counties on the Mississippi Gulf Coast. The Biloxi-Gulfport and Pascagoula-Moss Point urbanized areas remain distinct, although the former includes portions of all three counties.

In 1993 GRPC began a study to update the Transportation Plan adopted in 1981. The purpose of this study was twofold. First the long-range transportation plan for the Mississippi Gulf Coast Urbanized Area was to be updated as required by the 1962 Act. The new target years for this plan were 2010 for the Intermediate Stage and 2020 for the Long Range Stage. The second purpose was to develop a personal computer-based travel demand model using the TRANSPLAN software to replace the existing mainframe model housed at the Control Data Processing Authority (CDPA). The TRANPLAN model was used to eliminate extensive manpower and time required to update future adjustments to the transportation plan. The study was completed in 1996, and it provided an update of area travel characteristics, an inventory of the current roadway facilities, and an evaluation of the existing transportation system as a whole. Alternative improvements to the system were developed and analyzed. A transportation plan and staged improvement program were recommended. Furthermore, a travel demand model was developed, and local planners and MDOT staff members were trained in its use.

Under the MPO transportation planning function, two committees were established to oversee the planning process. The Transportation Planning Policy Committee (TPC) was established to make decisions regarding the approval and adoption of transportation plans and programs. The TPC was composed of the principal elected officials in the urbanized area, as well as state and federal representatives. The Technical Coordinating Committee (TCC) was established to provide review and evaluation of the technical aspects of the planning activities. The TCC includes planners, engineers, and other technically qualified persons on the local, state, and federal levels who have an interest in the transportation system. The membership of the TCC consists of two representatives from each of the three counties, 11 municipalities, the Executive Director of the Coast Transit Authority, the MDOT State Planning Engineer, the FHWA District Planner, the Director of the Gulfport-Biloxi Regional Airport Authority, the Executive Director of the Mississippi State Port Authority at Gulfport, the Director of the Jackson County Port Authority, the Director of the Hancock County Port and Harbor Commission, a representative of CSX Transportation, the Kansas City Southern Railroad, and the National Railroad Passenger Corporation (AMTRAK), and a representative of the Mississippi Trucking Association, the Naval Construction Battalion Center, and the Naval Station Pascagoula. The TCC meets approximately four times a year and elects a chairman and vice-chairman annually. Among other duties and obligations, the TCC is responsible for reviewing a unified planning work program and making recommendations to the TPC regarding adoption. The TPC includes the following officials or their designated representatives: Presidents of the respective Boards of Supervisors for Hancock, Harrison and Jackson Counties; Mayors of Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, D'Iberville, Ocean Springs, Gautier, Pascagoula and Moss Point; the Chairman of the Gulf Regional Planning Commission; the Chairman of the Coast Transit Authority; the Executive Director of MDOT; and the FHWA Division Administrator. The TPC meets three times a year for the purpose of making policy decisions. Among other duties and obligations, the TPC is responsible for reviewing and approving recommendations from the TCC regarding the adoption of a unified planning work program.

In 2000, MDOT began developing a statewide transportation plan titled the *Mississippi United Long-Range Transportation Infrastructure Plan* (MULTIPLAN). The MULTIPLAN updates the *1996 Mississippi Long-Range Transportation Plan* also developed by MDOT. A unique feature of the MULTIPLAN is the inclusion of the long-range transportation plans for the four urbanized areas of Mississippi, which include Jackson County and the Gulf Coast.

The MULTIPLAN project will include an effort to develop new computerized transportation planning models using TRANSCAD software for the forecast year 2030 for the four urbanized areas in Mississippi. For the Gulf Coast Urbanized Area, the effort will be a conversion of the existing TRANPLAN software models to the newer TRANSCAD software models. This work is scheduled to be completed by the end of 2004.

4.4.5.2 Existing Transportation Plan and Implementation

The most recent 2020 Transportation Plan, based on the *1996 Mississippi Long Transportation Plan*, was developed between 1993 and 1996 and adopted in October 1996 by the MPO. The 2020 Plan envisioned 443 miles of new roadway and 148.6 miles of widening and other improvements.

Numerous projects in the study area have been completed (see Figure 4.4-3) in recent years. MDOT has indicated that completion of numerous transportation projects has been accelerated due to additional funding generated by the gaming industries. Projects that have been completed within the past ten years include (Lee and Twedt, personal communication, 2002):

- *US 49*. Four widening projects to convert the existing four-lane highway to a six- or seven-lane highway; lane expansion for the road segment extending from Pass Road to O'Neal Road (3 miles north of I-10); intersection improvements at the US 90/US 49 and Pass Road/US 49 intersections; signalization improvements at intersections from US 90 north to Pass Road.

- *US 90*. Intersection improvements at the US 90/SR 609 intersection; construction of auxiliary lanes through the Waveland area; widening of US 90 from four to six lanes through "Casino Row" in Biloxi; bridge replacements at Henderson Point in Pass Christian; improvements to US 90 from I-110 to Renoir Street with funding generated by Beau Rivage Casino.

- *I-10*. Widening from the existing four lanes to six lanes from Long Beach (exit 2B) to the Harrison/Jackson County Line; a bridge replacement with higher vertical clearance over the Jourdan River between SR 43 (exit 13) and Diamondhead (exit 16).

- *Ties Between I-10 and US 90*. SR 603 Waveland/Bay St. Louis and SR 609 in Ocean Springs widened from two to four lanes between I-10 and US 90.

Cowan/Lorraine Road in Gulfport has been widened from two to four lanes between I-10 and US 90. This project included a new mid-level bascule bridge crossing of Bernard Bayou.

The three routes form the principal north/south ties between I-10 and US 90 in the study area: SR 603, SR 609, Cowan/Lorraine Road, and SR 57 in Gautier; I-110 in D'Iberville and Biloxi; and US 49 in Gulfport. These roads are extremely important for hurricane evacuation as well as daily traffic.

Additional projects which were in the planning stages at the time this Environmental Impact Statement was being prepared, included the following:

- Widening of I-10 from four lanes to six lanes from the Harrison/Jackson County line east to SR 57 in Gautier. The remainder of I-10 in Mississippi would require widening from four to six lanes by 2005, but funding may not be available.

- Widening SR 605 north to SR 67.

- Linking SR 67 to the I-110/I-10 interchange and extend the four-lane highway north to the intersection with US 49. "Traditions," a 5,000-acre planned community, would be located at that northern intersection. The community would be developed to an ultimate population of 40,000 to 50,000 and will be connected to I-10 and the Gulf Coast by SR 67 and US 49 (Stackpoole, personal communication, 2002).

- Extend the four-lanes of US 49 north to the intersection with SR 67.

4.4.5.3 Existing Congestion

The study area has serious highway congestion and access problems for vehicular travel, which is concentrated mainly in the Gulfport-Biloxi area. A lack of capacity and shortage of alternate routes for both north/south and east/west traffic are apparent.

4.4.5.4 Levels of Service

To describe the level of congestion on a roadway segment or at an intersection, transportation planners and engineers use the term *Level of Service* (LOS). LOSs range from LOS A, a free-flow condition, to LOS F, which is a complete breakdown of traffic. At a signalized intersection, LOS A exists when the average delay per vehicle is less than 5 seconds; LOS F has average delays of greater than 60 seconds.

US 90 has severe congestion areas in Biloxi along "Casino Row." Using procedures from the *Highway Capacity Manual* (Transportation Research Board Report 309), the signalized intersections from Beauvoir Road to Porter Avenue were analyzed for LOS in 1998. The analysis shows capacity adequate at six of the eight intersections. However, US 90 intersections at Veterans Avenue and Porter Avenue were heavily congested in the afternoon peak. The results are summarized in Table 4.4–3.

Table 4.4–3
Level of Service Analysis for Selected Signalized Intersections: 1998

Location	Intersection Type	LOS AM Peak	LOS PM Peak
US 90 at Beauvoir	Signalized	C	C
US 90 at Treasure Bay	Signalized	B	D
US 90 at Camelia Street	Signalized	B	B
US 90 at Veterans	Signalized	C	F
US 90 at Rodenberg	Signalized	B	C
US 90 at White	Signalized	B	C
US 90 at Porter	Signalized	B	F

Source: USACE, Mobile District, 2000.

4.4.5.5 Jackson County

Although no gaming facilities have been permitted in Jackson County, the cities of Ocean Springs and Gautier have experienced "spill over" growth associated with the casinos in Biloxi. Some improvements have been made to SR 609 and its intersection with US 90 in Ocean Springs. This intersection is the busiest intersection in the state because a large volume of western bound commuters exit I-10 and travel to Biloxi via SR 609 and US 90, using this route as a "shortcut" (Scruggs, personal communication, 2002).

Both Gautier and Ocean Springs have capacity problems on US 90 and support development of frontage roads along US 90 to address this problem (Scruggs, personal communication, 2002; Allan and Hode, personal communication, 2002). In addition, there is an interest in Ocean Springs in the development of another north/south tie to I-10 from US 90 to alleviate or avoid the congestion on SR 609 (Scruggs, personal communication, 2002).

4.4.5.6 New Roadway Route

Additional north/south routes are limited by the high cost and environmental impacts associated with crossing of the Back Bay as well as avoidance of facilities such as Keesler Air Force Base and the Biloxi-Gulfport International Airport. The I-110 connector has not provided sufficient additional capacity to alleviate congestion in either West Biloxi or on US 49 and Cowan/Lorraine Road in Gulfport. Many of the existing north/south surface routes are not continuous, requiring motorists to weave in and out of the east/west system, particularly at Pass Road (Taylor and Yarrow, personal communication, 2002).

Insufficient capacity on US 90 is the major factor limiting the flow of east/west traffic in the CSA. After using the north/south routes, motorists must relay on US 90 for local access. US 90 is the only east/west principal arterial spanning the length of the coastal urbanized area within the study area. Pass Road is only continuous from US 49 to Keesler Air Force Base. I-10 is too distant from the dense coastal development to serve the needs of many motorists (Taylor and Yarrow, personal communication, 2002).

To alleviate the problems of east/west travel, the Year 2010 and 2020 Cost Feasible Plan for Biloxi proposed widening US 90 from the existing four lanes to six and eight lanes from I-110 east to the Biloxi Bay Bridge. However, widening in this area and other areas to the west is made difficult due to a variety of concerns including preserving large live oak trees within and along the right-of-way, avoiding potential adverse effects on historic homes and other structures, and potential disruptions to businesses located adjacent to the roadway (Taylor and Yarrow, personal communication, 2002).

Road improvements in the study area are funded by federal, state, and local sources. State highway funds are provided pursuant to Section 65-1-141 of the *Mississippi Code 1972 Annotated* and are programmed, along with federal highway funds, in the State Transportation Improvements Program and 3-year Maintenance and Construction Program. In addition, the Mississippi Legislature created the gaming counties' state-assisted improvement fund during the 1994 Regular Session. The Casino Gaming Act generates approximately $36 million annually in highway funds that are divided among several counties, including Hancock and Harrison Counties. In its 1996 Regular Session, the legislature enacted House Bill 1269, which directed MDOT to conduct a statewide analysis to set priorities for highway improvements in counties such as Harrison and Hancock that host gaming facilities. This analysis is contained in the *Mississippi Gaming Road Capacity Analysis*, dated November 1996.

Three plans are being pursued to alleviate congestion on the major collectors in the study area:

- *East Harrison County Connector*. A new controlled-access freeway (four-lane) connecting I-10 to US 90. The location of the new facility is the subject of an environmental study.. A Draft EIS was signed on July 26, 2001, and several alternates have been identified. Construction of this connector would lessen congestion on I-110, I-10, and US 90 (Barnwell, personal communication, 2002).

- *Gulfport Connector*. This new controlled access freeway would connect I-10 (probably at Canal Road [exit 31]) to US 90 in the vicinity of the Port of Gulfport (30th Street). This project is strongly supported by the State Docks because it will provide much better access for truck traffic from I-10 to the Port of Gulfport. In doing so, it would alleviate congestion on US 49 by the diversion of truck traffic. (Barnwell, personal communication, 2002).

- *New East/West Connector*. A new east/west arterial roadway has been proposed to reduce congestion on US 90 and Pass Road. The new expressway would parallel the existing CSX Railroad from Veterans Avenue in Biloxi to Texas Avenue in Gulfport with a possible extension to Pass Christian. There is apparent support for implementing this route on a less-than-expressway basis (two-way pairs of four-lane on one side of the tracks) (Collins, personal communication, 2002). Additionally, this route has been proposed to use the existing CSX right-of-way if it is relocated to the north. A study has also been initiated to evaluate the relocation of the CSX tracks to the north.. Alternative locations for the CSX railroad north of I-10 would be addressed in an environmental assessment.

4.5 AIR QUALITY

Air pollution originates from many different sources: stationary sources such as factories, power plants, and smelters; relativity minor sources such as dry cleaners and degreasing operations; mobile sources such as cars, buses, aircraft, trucks, and trains; and naturally occurring sources such as biogenic sources, windblown dust, and volcanic eruptions. Air quality can be affected in many ways by the wide variety of pollutants emitted from these sources. The USEPA has classified these pollutants (sulfur dioxide, carbon monoxide, ozone, nitrogen oxides, lead, and particulate matter) as the six principal pollutants, or criteria pollutants. The USEPA, as well as national, state, and local agencies monitors these pollutants.

The Clean Air Act (CAA) establishes the principal framework for national, state, and local efforts to protect air quality. Under the Clean Air Act, the Office of Air Quality Planning and Standards (OAQPS) of the USEPA is responsible for setting standards, also known as National Ambient Air Quality Standards (NAAQS), for pollutants considered harmful to humans and the environment. Mississippi Ambient Air Quality Standards (MAAQS) are the same as the National Standards. OAQPS also is responsible for ensuring that these air quality standards are met or attained (in cooperation with state, tribal, and local governments) through national standards and strategies to control pollutant emissions from automobiles, factories, and other sources (USEPA, OAR, 2001a).

Section 110 of the CAA requires each state to submit a State Implementation Plan (SIP), which provides for the "implementation, maintenance, and enforcement" of the primary and secondary ambient air quality standards. The intent of the CAA is that each state submit a SIP that upon approval by the USEPA allows the state to regulate air pollution within its borders. SIPs must include enforceable emissions limitations, provide for monitoring, and prohibit emissions that will contribute to the nonattainment of a pollutant, among other things.

Table 4.5–1 shows NAAQS values for the six criteria pollutants. The CAA requires states to monitor ambient levels of these pollutants and to develop air quality management plans to ensure that the federal air quality standards are achieved and maintained. Mississippi has an approved SIP to address the requirements of the CAA. Areas that fail to meet the NAAQS are designated as nonattainment areas and are potentially subject to regulatory enforcement. MDEQ does address the emission of air toxics, also referred to as hazardous air pollutants (HAPs). HAPs include 188 compounds that the USEPA is required to regulate under the CAA. All HAPs are pollutants that are known, or suspected to, cause cancer and other health problems. The MDEQ implements the federally mandated HAP requirements, which include Maximum Achievable Control Technology (MACT) standards and regulations for prevention of accidental releases (MDEQ, OPC, 2002).

Table 4.5–1
National Ambient Air Quality Standards (Primary)

Pollutant	Standard Value	Standard Type
Carbon Monoxide (CO)		
8-hour Average	9 ppm	Primary
1-hour Average	35 ppm	Primary
Nitrogen Dioxide (NO_2)		
Annual Arithmetic Mean	0.053 ppm	Primary & Secondary
Ozone (O_3)		
1-hour Average	0.12 ppm	Primary & Secondary
Lead (Pb)		
Quarterly Average	1.5 $\mu g/m^3$	Primary & Secondary
Particulate (PM 10)		
Annual Arithmetic Mean	50 $\mu g/m^3$	Primary & Secondary
24-hour Average	150 $\mu g/m^3$	Primary & Secondary
Sulfur Dioxide (SO_2)		
Annual Arithmetic Mean	0.03 ppm	Primary
24-hour Average	0.14 ppm	Primary
3-hour Average	0.50 ppm	Secondary

Source: USEPA, OAR, 2001a.

EPA issued final air quality standards for particulate matter and ozone on July 16, 1997. In those final standards, the standard values for ozone and particulate matter where changed as follows:

Ozone

From: 1-hour Average 0.12 ppm (235 $\mu g/m^3$) Primary & Secondary

To: 8-hour Average ** 0.08 ppm (157 $\mu g/m^3$) Primary & Secondary

Particulate Matter

From: PM-10, *particles with diameters of 10 micrometers or less*

Annual Arithmetic Mean 50 $\mu g/m^3$ Primary & Secondary

24-hour Average 150 $\mu g/m^3$ Primary & Secondary

To: PM-2.5, *particles with diameters of 2.5 micrometers or less*

Annual Arithmetic Mean ** 15 $\mu g/m^3$ Primary & Secondary

24-hour Average ** 65 $\mu g/m^3$ Primary & Secondary

On May 14, 1999, the U.S. Court of Appeals for the District of Columbia Circuit issued an opinion regarding the final national ambient air quality standards for ozone and particulate matter that the USEPA had issued in July 1997. That 1999 federal court ruling blocked implementation of these standards. The USEPA asked the U.S. Supreme Court to reconsider that decision. On February 27, 2001, the U.S. Supreme Court unanimously affirmed EPA's ability to set national air quality standards that protect millions of people from the harmful effects of air pollution. The Supreme Court sent the case back to the D.C. Circuit Court of Appeals based on certain issues raised by industry petitioners that the D.C. Circuit had not decided in its earlier (May 1999) opinion.

While the case was pending before the Supreme Court, the ozone and fine particle standards remained in effect as a legal matter because the D.C. Circuit had not vacated the standards. The Supreme Court decision does not change this. For these two criteria pollutants, the implementation status at this time is described below.

Ozone. The USEPA is reviewing the results of the litigation to determine the approach and schedule for moving forward with implementing the ozone standard. The Agency will confer with states and other interested parties.

Particulate Matter. The litigation over the fine particle standards has not affected USEPA or state activities related to these standards. The USEPA cannot start implementing the 1997 fine particle standards until the Agency and the states collect 3 years of monitoring data to determine which areas are not attaining the standards. The fine particle-monitoring network was completed in 2000. In most cases, areas would not be designated "attainment" or "nonattainment" for fine particles until 2004–2005.

The CAA also established the Prevention of Significant Deterioration (PSD) Program. The PSD Program is intended to prevent areas that are cleaner than the minimum standards set by the NAAQS from having their air quality degraded, while at the same time allowing some growth. Every new or expanded "major emitting facility" in attainment or unclassifiable area is required to use the "best available control technology" for preventing significant degradation of air pollution. The PSD Program also establishes maximum allowable increases that limit the overall increase in pollution levels over the baseline concentrations in clean air areas.

4.5.1 Baseline Conditions

The air quality region of influence (ROI) consists of the coastal region of Mississippi, which includes Hancock, Harrison, and Jackson Counties The ROI is part of the Mobile (Alabama)-Pensacola-Panama City (Florida)-Southern Mississippi Interstate Air Quality Control Region, as defined in Section 302(f) of the CAA, 42 U.S.C. 1857h(f). All sources of air pollution in the Coastal Mississippi region are regulated by MDEQ's Office of Pollution Control.

Air quality in the region is affected by emissions from a large array of mobile and stationary sources, including passenger/commercial vehicles, aircraft, shipping vessels, and commercial/manufacturing operations. Interstate 10 is the only major interstate highway that runs through the study area. Other sources that must be considered are biogenic and area sources, which are difficult to quantify because of the nature of these processes. Both biogenic and area sources are discussed later in this section.

Currently all areas within in the ROI are in attainment with the NAAQS (USEPA, OAR, 2002a). Hancock, Harrison, and Jackson Counties lie in the Biloxi-Gulfport-Pascagoula Metropolitan Statistical Area (MSA). Although in attainment, there is a concern with respect to ozone levels in these three counties.

Ozone is not emitted directly into the air, but at ground level. Ozone is created by a chemical reaction between oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Ozone concentrations can vary from year to year. Changing weather patterns (especially the number of hot, sunny days), periods of air stagnation, and other factors that contribute to ozone formation make long-term predictions difficult (USEPA, OAR, 2002b). Due to the nature of weather patterns in the region, the Coastal Mississippi area is subject to large-scale, low-level atmospheric recirculation. This makes analyzing ozone trends in the study area difficult because weather trends have to be strongly considered. For example, recorded ozone levels in the year 2001 were lower than those in 2000, which can possibly be attributed to changing weather patterns and cooler average summer temperatures.

As previously described, the USEPA promulgated new standards for ozone. There is a concern that if the new standards are implemented the Mississippi Coastal area could potentially be classified as being in nonattainment. Current ozone levels in the three coastal counties have occasionally reached levels higher than the proposed standard.

Mobile sources are considered a large part of the increasing air emissions in the ROI. I-10 runs east-west through all three counties and is a major source of passenger and commercial vehicle emissions. Table 4.5-2 shows the increase in Annual Average Daily Traffic (AADT) values for I-10 through Hancock, Harrison, and Jackson Counties from 1992 to 1999. Traffic on I-10 increased the most in Harrison County where the AADT increased by 38 percent. It is highly likely that a portion of this increase can be attributable to the introduction of gaming facilities in the County during the same period. A countervailing factor in terms of air quality, is that emissions on a per vehicle basis have decreased due to more stringent air pollution control requirements on the automobile industry.

Table 4.5–2
Annual Average Daily Traffic for Interstate 10

County	1992	1999
Hancock	25,350	28,650
Harrison	30,250	42,000
Jackson	25,650	28,650

Source: Fagan, personal communication, 2002.

There are two coastal ports in the ROI. The Port of Gulfport is a major commercial shipping port that handled 977 short tons of cargo in 2001, an increase of 12.5 percent since 1994. The majority of the cargo is transported to and from the port via trucking, which is a significant source of mobile emissions. Funding has been approved for rail service to accommodate future cargo traffic. Use of rail service might decrease mobile emissions related to the Port of Gulfport. There are also plans to expand the port to include cruise ship berths. The addition of cruise ship berths to the Port of Gulfport could increase tourism, thereby increasing mobile emission sources (Hudson, 2002).

Port Biloxi is a private marina with the capacity to house 450 private boats, ranging in size from 25 feet to 80 feet. Primarily used for recreation, these boats are a minor source of mobile emissions.

The only passenger airport in the ROI is the Gulfport-Biloxi International Airport. As described in the transportation section of this EIS, since the introduction of gaming in Harrison County in 1992, passenger traffic has increased from less than 200,000 to almost 950,000 (GBRA, 2002). Aircraft

are a significant source of mobile emissions, and future increases in flight operations could have an effect on air quality.

Each major stationary source, or point source, of air pollution is required to obtain a Title V operating permit, which establishes air requirements applicable to the source and specifies the methods by which the source must demonstrate compliance (MDEQ, OPC, 2002). Table 4.5–3 lists all Title V emissions for each of the three counties in 2001. Table 4.5–4 lists each of the permitted facilities in the study area and total annual emissions for the year 2001.

Table 4.5–3
Title V Emissions for 2001 by County (Tons)

Pollutant		Hancock	Harrison	Jackson
CO	Actual	1,941	822	7,866
	Potential	2,162	1,933	7,796
NO_X	Actual	4,345	16,648	14,301
	Potential	7,564	28,470	54,869
SO_2	Actual	68	49,374	35,053
	Potential	168	248,499	159,055
PM-10	Actual	164	2,668	2,966
	Potential	371	14,170	10,321
VOCs	Actual	302	2,125	8,966
	Potential	513	3,589	4,174

Notes: CO = carbon monoxide; NO_x = nitrous oxides; SO_2 = sulfur dioxide; PM-10 = particulate matter less than 10 microns in diameter; VOCs = volatile organic compounds. Data include 20% permitted sources outside study area. The actual emissions are the estimated actual emissions. The potential emissions are the Potential to Emit (PTE) as defined by Title V and PSD regulations.
Source: Holden, personal communication, 2002.

Table 4.5–4
2001 Title V Emissions by Facility (Tons)

Facility Name	CO	NO_X	SO_2	VOC	PM_{10}
Hancock County					
General Electric Company	14.11	93.19	0.3	20.87	18.61
Calgon Carbon Corp.	12.103	163.168	11.808	0.025	39.062
Tennessee Gas Pipeline Co.	399.9	3015.95	0.27	82.04	-
RMC Ewell Inc., Waveland	-	-	-	-	52.56
Polychemie, Inc.	6.76	26.79	0.1186	25.22	2.663

Table 4.5–4
2001 Title V Emissions by Facility (Tons) (continued)

Facility Name	CO	NO_X	SO_2	VOC	PM_{10}
Harrison County					
Kessler Air Force Base	9.72	18.21	0.86	5.16	9.91
Hartson-Kennedy Cabinet Top	-	-	-	1030.874	-
Gulfport Terminals	-	-	-	151.65	-
MS Air National Guard	80.36	90.2	5.32	13.9	5.67
Halter Marine - Gulfport	-	-	-	28.4	39.31
Williams Paving Co.	6.61	8.81	0.03	4.82	1.83
Pecan Grove Sanitary Landfill	-	-	8.7	21.8	-
MS Power Co – Watson Plant	647.95	13471.41	42310.71	80.8	1883.41
Gulf Concrete	-	-	-	-	99
Coast Materials Co.	-	-	-	-	2.5
MS Army Natl Guard – Avcrad	0.06185	0.1794	0.01966	4.597058	0.46334
RMC Ewell Inc.	-	-	-	-	94.8
Munro Petroleum & Terminal	-	-	-	428.84	-
RMC Ewell Inc.	-	-	-	-	96.4
Avondale Industries	0.47	1.1	0.01	84.17	48.41
Ershigs Biloxi Inc.	-	-	-	50.5	-
RMC Ewell Inc.	-	-	-	-	46.8
E I Dupont De Nemours and Co.	76.52	3058.75	7041.94	9.72	207.646
Aarig Terminal Systems Inc.	0.06	0.2	7.35	210.24	0.03
Metro Concrete LLC	-	-	-	-	131.4
Jackson County					
Concrete Products and Supply	-	-	-	-	73
Ferson Optics, Inc	-	-	-	67.7	-
Metro Concrete	-	-	-	-	99

Notes: CO = carbon monoxide; NO_x = nitrous oxides; SO_2 = sulfur dioxide; PM-10 = particulate matter less than 10 microns in diameter; VOCs = volatile organic compounds.

Source: Holden, personal communication, 2002.

The Mississippi program for regulation of air emissions affects both industrial sources (oil refineries, paper mills, chemical plants, and all manufacturing processes) and commercial facilities (batch concrete plants, asphalt plants, and small commercial incinerators used by hospitals, department stores, and supermarkets). Regulation occurs primarily through review of engineering documents and other technical information, the application of emission standards and regulations in the issuance of permits, performance of field inspections, and assisting industries in determining their compliance status with applicable requirements.

Air quality problems can also be identified through complaints registered by citizens. Complaints about emission sources have ranged from objections to odorous emissions from large industrial sources to problems with individuals burning trash. These complaints are investigated, usually by performing an on-site inspection to observe the alleged problem (MDEQ, OPC, 2002). A complaint tracking system was implemented in 1999, and most of the registered complaints relate to odor, open burning, paint overspray, and dust. The number of recorded complaints in 1999 was 377; in 2000 it was 432; and in 2001 it was 366 (Aultman, personal communication, 2002).

Area sources collectively represent individual sources that are small and numerous and have not been inventoried at a specific point. Individual sources are typically grouped with other like sources into area source categories. The main reason these individual sources are not treated as point sources is that the effort required to gather data and estimate emissions for each individual facility is great, although per facility emissions are typically small. For these sources, a cutoff point typically based on annual emissions usually defines the distinction between point and area sources. SIP ozone inventories, for example, define VOC point sources as individual facilities that emit more than 10 tons of VOCs per year. The main distinction between point and area sources is the methodology used to estimate emissions. Point sources are inventoried individually, and area sources are inventoried collectively.

There are several natural sources of ozone precursors. Biogenic sources of VOC and NO_X are common, as well as lightning (as a source of NO_X) and geogenic processes like natural oil and gas seeps (a source of VOCs). The dominant source of VOCs as nonmethane hydrocarbons is vegetation. For the United States, natural-source VOCs are estimated to occur in greater amounts than anthropogenic-source VOCs. Natural-source VOCs in the southeastern and south-central portions of the United States account for approximately 43 percent of the national natural nonmethane hydrocarbon estimate. Soils emit NO_X through biological and abiological pathways, and emission rates can be categorized by land use. Agricultural lands and grasslands are the most significant emitters in this category. The quantity of NO_X emissions from agriculture depends on the rate of fertilizer application and the subsequent microbial nitrogen processing in the soil. Emissions of NO_X from soils are estimated to be as much as 16 percent of the global budget of NO_X in the troposphere and as much as 8 percent of the NO_X in North America (ASC, 1996).

4.5.2 Air Quality

The data available to assess the air quality trends in the ROI are limited. Monitoring data are available for ozone dating back to 1996. There are also limited monitoring data for NO_2, SO_2, and PM-10. Other potential indicators for mobile sources include AADT, port shipping records, and airport passengers. All three of these mobile source indicators show an increase over the past decade.

There are currently two ozone monitors in each of the three counties (USEPA, OAR, 2002c). Two of the three counties have complete monitoring data dating back to 1996. The data provide the fourth

highest daily 1-hour values of ozone (ppm) measured in each county. Figures 4.5–1, 4.5–2, and 4.5–3 show the temporal trends in ambient ozone levels for the three counties.

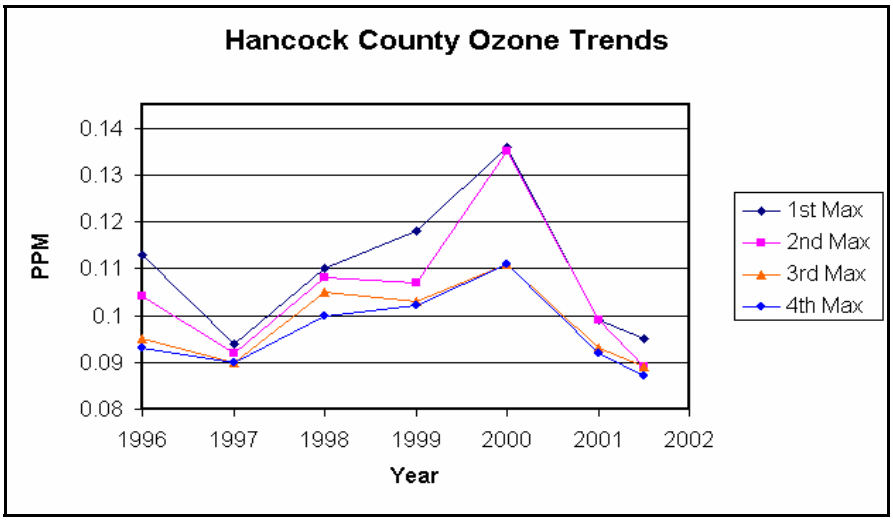


Figure 4.5–1. Ozone Trends in Hancock County

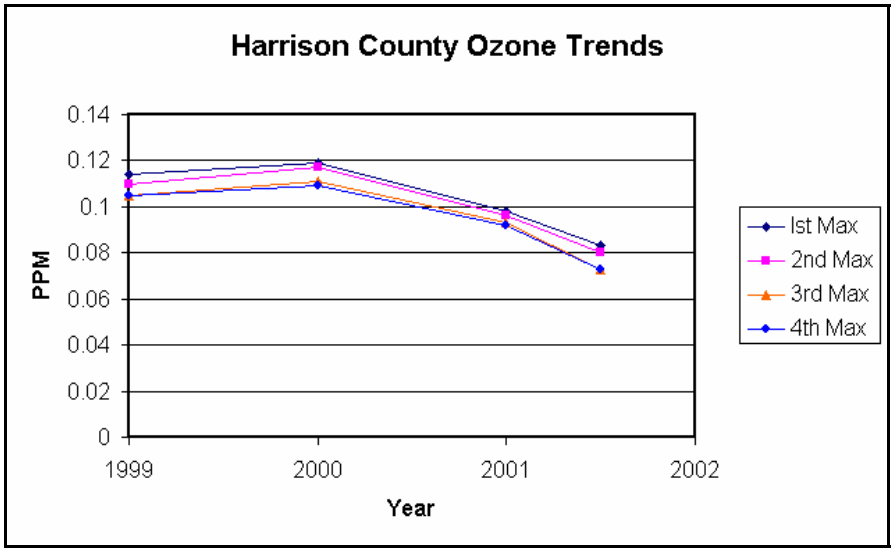
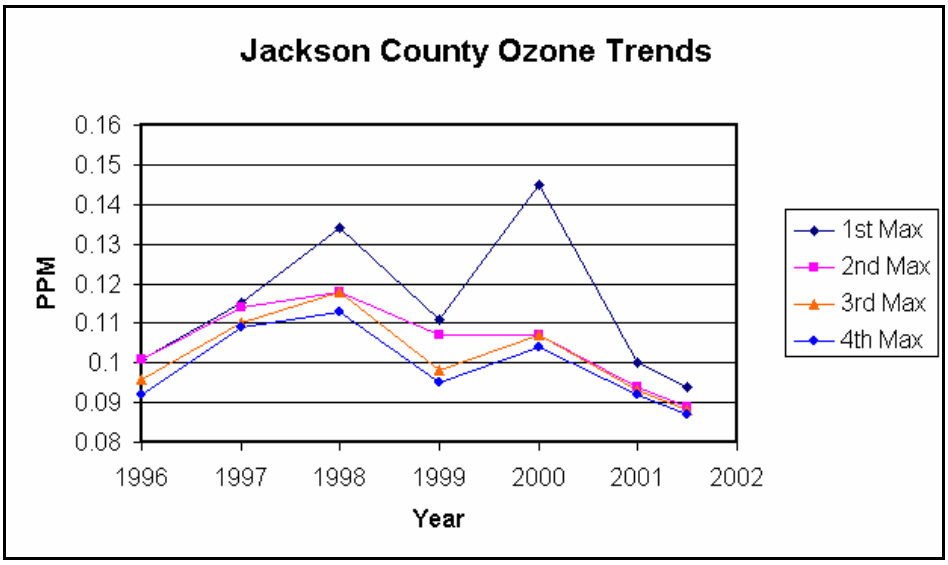


Figure 4.5–2. Ozone Trends in Harrison County



Source: USEPA, OAR, 2001b.

Figure 4.5–3. Ozone Trends in Jackson County

Overall, the ozone monitors show fluctuating levels of ozone with a predominately decreasing trend in ozone levels. All of the monitoring data from 2001 and 2002 indicate that ozone levels were below the current 1-hour average level of 0.12 ppm. These decreasing levels were found in spite of the significant increase in airport traffic, AADT counts, and port activity in this region. This result may be due to more efficient automobiles and aircraft or, to a much larger extent, changes in weather patterns.

4.6 NOISE

Noise is defined as "unwanted sound that interferes with normal human activities." There is a wide diversity of human responses to noise, which vary according to the type and characteristics of the noise source. There are several types of noise sources, including stationary sources such as ongoing commercial operations and mobile sources like heavy equipment, trucks, and automobiles.

Noise is among the most pervasive pollutants today. Unwanted sounds from road traffic, jet planes, jet skis, garbage trucks, construction equipment, manufacturing processes, lawnmowers, leaf blowers, and boom boxes, to name a few sources, are among the noise routinely broadcast into the air. Noise negatively affects the health and well-being of both humans and wildlife in many ways (NPC, 2001). Responses to noise vary, depending on the type and characteristics of the noise, expected level of noise, distance between the noise source and the receptor, the receptor's sensitivity, and the time of day. The most conspicuous problems related to noise are hearing loss, and hearing impairment due to masking. Other health impacts include stress and exacerbation of mental health problems; high blood pressure and ischemic heart disease; sleep loss, distraction, and loss of productivity; and a general reduction in the quality of life and opportunities for tranquility. Noise can provoke annoyance responses and changes in social behavior. The effects of noise can be immediate or latent due to long-term exposure (Plog, 1993; USEPA, 1974; WHO, 2001).

Sources of noise that have the potential to affect wildlife include aircraft overflights; recreational activities like motor boating and snowmobiling; domestic sources such as leaf blowers, lawnmowers, and chainsaws; automobile traffic; and heavy machinery and equipment. Responses vary among

species of wildlife, as well as among individuals of a particular species (Busnel and Fletcher, 1978), although the problems are similar to those found in humans. Increased noise levels mask sounds used by wildlife for communication; for example, they mask the squeaking of babies that parents use to locate their young or calls used to locate a mate (Dooling, no date; Schubert and Smith, 2000). Disturbed mammals sometimes trot short distances; birds might walk around flapping their wings. Panic and escape behavior results from more severe disturbances. Behavioral and physiological responses have a potential to cause injury, energy loss (from movement away from the noise source), decreased food intake, habitat avoidance and abandonment, and reproductive losses (NPS, 1994; NSS, 2001).

The basic unit to represent given sound levels is the decibel. Table 4.6–1 presents a range of decibel sound levels. A straight, unmodified sound level is not used, however. To quantify the intrusiveness of nighttime noise, the USEPA recommends a special type of 24-hour average known as the day-night level, or L_{dn}. The L_{dn} is calculated so that noises that occur after 10 p.m. and before 7 a.m. are treated as if they are 10 decibels (dB) more intense (Harris, 1979).

Table 4.6–1
Common Sound Levels

Location	Sound Level (decibels)
Near jet plane at takeoff	140
Near air-raid siren	130
Threshold of pain	120
Thunder	110
Garbage truck, trailer truck at roadside	110
Power lawnmower at 50 feet	90
Backhoe, paver	85
Cement mixer, power saw	80
Compressor	75
Freeway traffic at 50 feet	70
Conversational speech	60
Average residence	50
Bedroom	40
Soft whisper at 15 feet	30
Rustle of leaves	20
Breathing	10
Threshold of hearing	0

Source: Harris, 1979.

Many federal agencies, such as the USEPA, FHA, Department of Housing and Urban Development, Federal Aviation Administration, and Department of Defense, use the day-night sound level to protect the public from the impact of community noise (Cavanaugh and Tocci, no date) and apply an L_{dn} of 55 dB as a recommended outdoor limit (USEPA, 1974). See Table 4.6–2 for examples of outdoor day-night average sound levels. These agencies recognize 65 dB as the noise level at which residential land use becomes questionable, and areas where the level exceeds 75 dB are considered unacceptable for residential use. The World Health Organization has identified the range of noise between 50 and 55 dB for a period of 16 hours as the annoyance threshold (WHO, 2001). Although some federal agencies use these values, the values are only guidance values, not a regulatory criterion. There are no noise regulations or guidance at the state or county levels.

Table 4.6–2
Examples of Outdoor Day-Night Average Sound Levels

Outdoor Location	Sound Level (L_{dn}) in dB
Apartment next to freeway	88
0.75 mile from touchdown location at major airport	86
Urban high-density apartment	83
Urban row housing on major avenue	69
Urban residential area	59
Wood residential	51
Agricultural cropland	45
Rural residential	40
Wilderness background noise	35

Source: USEPA, 1974.

Noise naturally dissipates by atmospheric attenuation as it travels through the air. Aspects of weather, including temperature and humidity, have a large impact on the propagation of noise through the atmosphere. Some other factors that can affect the amount of attenuation are ground surface, foliage, and topography.

4.6.1 Baseline Conditions

Urbanization is the major cause of noise pollution in the Coastal Study Area. Increases in land development, population, tourism, vehicle, rail, and air traffic have all contributed to the increase in the ambient noise levels of moderate to highly populated urban areas. High-intensity transportation corridors like I-10 and areas around the Gulfport-Biloxi International Airport are highly susceptible to increasing ambient noise levels due to urban development.

The primary noise source in the coastal Mississippi region is vehicular traffic on the two high-volume roadways, US90 and I-10. According to the Mississippi Department of Transportation (MDOT), there have been very few complaints related to vehicular noise from US90 and I-10 because these roadways preceded much of the area's development and the fact that the development within close proximity of the roads are not noise sensitive (Holloway, personal communication, 2002). There are

also several continuous, secondary sources of noise, including local traffic volumes and pedestrian noise.

The prominent stationary sources of noise are the Gulfport-Biloxi International Airport, the Stennis Space Center, and Kessler Air Force Base.

Gulfport-Biloxi International Airport. The Gulfport-Biloxi International Airport is the only passenger airport in the study area. As described in the Transportation and Air Quality sections, the total number of passengers increased four-fold during the period 1992 to 2000. Total commercial operations also increased during the same period, although the noise footprint was unchanged. Gulfport-Biloxi airport officials assert that the introduction of quieter commercial aircraft has allowed for an increase in operations without a commensurate increase in noise. Moreover, the greater source of noise is from high-performance military aircraft, and these operations have not increased substantially over the last 10 years. Aircraft noise restrictions exist as Parts 36, 50, and 161 of the Airport Noise and Recovery Act of 1990. The number of public complaints to the airport concerning noise has not increased over the past 10 years (Frallic, personal communication, 2002).

Stennis Space Center. Because of the nature of static rocket testing, noise has always been an issue at Stennis Space Center. The land area required for the fee area and buffer zone was calculated based on acoustic environment calculations made for the NOVA first-stage rocket engine. NASA determined that it was necessary to purchase all land within the 125-dB acoustical boundary and to prohibit human habitation within the 110-dB acoustical boundary.

Current Space Shuttle main engine test procedures require pretest prediction of Overall Sound Pressure Level (OASPL) at the buffer zone boundary and at acoustic focusing points beyond the buffer zone. If the predicted OASPL is greater than 120 dB linear, no firing is approved until meteorological conditions change favorably. If the predicted OASPL is between 110 dB and 120 dB, firing is at the discretion of the project manager. Since this program has been adopted, there have been no complaints about noise that could be attributed to rocket test firing operations (NASA, 2001).

Kessler Air Force Base. The primary source of noise in the vicinity of Keesler AFB is a result of normal base operation and aircraft usage and maintenance. Noise generated independent of aircraft flight noise on Keesler AFB (maintenance and shop operations, ground traffic, construction, etc.) is comparable to the noise generated in the surrounding community; therefore, noise generated during aircraft flight operations represents the most substantial noise source on the base. The associated noise contours generally follow the shape of the runways, with the area of highest decibels (75 and higher) in the immediate vicinity of the runways and extended areas of higher-level noise following the aircraft approach and departure corridors. Approximately 381 acres and 485 off-base residences are located within an area receiving flight noise in the 65- to 70-dB range, and 326 acres are located within in area receiving noise in the 70-dB and higher range, although no residences are located on these 326 acres (ESC, 2000).

4.7 GEOLOGY AND SOILS

4.7.1 General Physiographic Location

The Mississippi Coastal Study Area is situated in the Outer Coastal Plain Mixed Forest Province Ecoregion according to the United States Department of Agriculture's (USDA) *Description of the Ecoregions of the United States* (USDA, 1995). Along the coast, flat coastal plains generally have

gentle slopes and local relief of less than 100 feet. Most of the numerous streams in the region are sluggish: marshes, lakes, and swamps.

There are two major physiographic regions in the Mississippi Coastal Region (Figure 4.7–1).

The Gulf Coast Flatwoods form an irregular belt through the southern half of the three-county region. This belt consists mainly of wet lowlands and poorly drained depressions, with some higher, adequately-drained areas. The second physiographic region, the Southern Lower Coastal Plain, is rolling and gently undulating interior uplands. Elevations in the CSA range from sea level along the coast in Hancock, Harrison, and Jackson Counties to about 420 feet above sea level. The slope of the land surface is generally oriented to the south. The area is underlain by a thick sequence of sedimentary deposits dipping to the south and west.

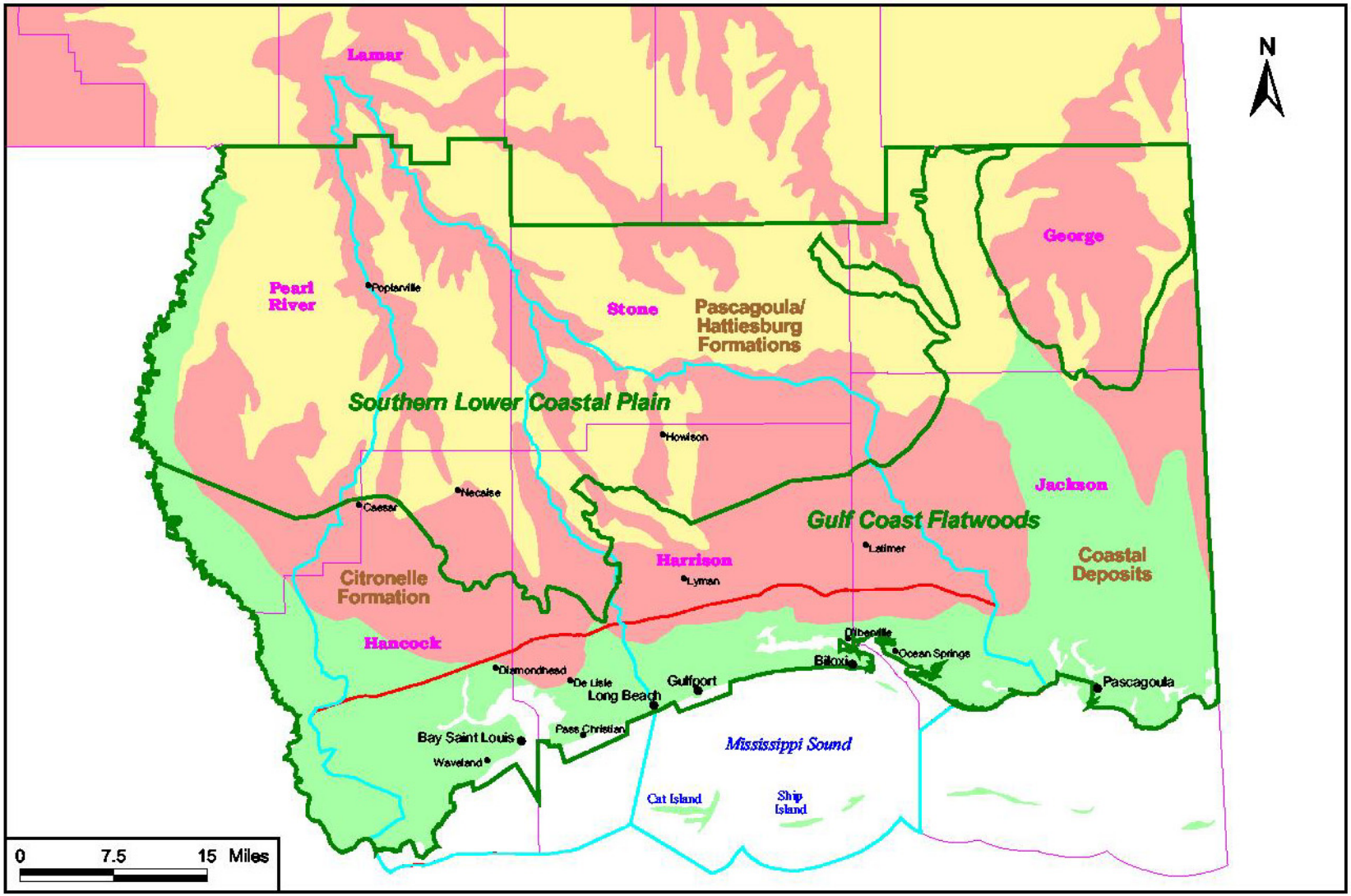
4.7.2 Geology

During the Cenozoic Era, the Gulf of Mexico began to acquire its present shape. A great river system, an ancestor of the current Mississippi River, drained the rising continental interior, depositing sediments from throughout the large continental drainage area into the Gulf of Mexico (Otvos, 1998). Both the large river system, which deposited delta sediments consisting of various eroding inland materials, and the regression and transgression of the ocean, which deposited various marine sediments, created the sediment layers of Pliocene, Miocene, Oligocene, and Eocene age that are currently found in the Coastal Mississippi Area (Figure 4.7–2).

4.7.2.1 Pliocene, Miocene, Oligocene, and Eocene Sediments

These sediments and sedimentary rocks consist of clay, silt, sand, gravel, and limestone. The Gulf Coast Geosyncline is the major structural feature affecting the younger Pliocene and Miocene sediments, and its axis is generally oriented to the southwest at slopes of less than 30 feet per mile. The slope increases in the down-dip direction, resulting in an increase in thickness to the south. Pliocene and Miocene age deposits consist of, in ascending order, the Catahoula Sandstone, Hattiesburg Formation, Pascagoula Formation, Graham Ferry Formation, and Citronelle Formation. These layers are primarily composed of clay, silt, and sand, with some gravel and deep limestone beds. The deeper formations to the south may be marine in origin, while sediments near the surficial outcrops may be terrestrial. The youngest and most extensive of these formations is the Citronelle Formation, which is easily recognized by its orange-red color. This formation was deposited as a relatively thin blanket of river sediments approximately 3 million years ago, and it is locally rich in pebbles and petrified tree trunks. Due to the slow rise of the Citronelle covered areas, the formation now caps coastal uplands. Deep valleys and gullies have incised into this formation. Thousands of dirt pits excavated in this formation have produced large quantities of reddish silty sand and gravel for building construction, road formation, and ground fill. Figure 4.7–1 shows a generalized distribution of these sediments in southern Mississippi.

Underlying these Miocene sediments are Oligocene and Eocene sediments consisting of several hundred feet of low-permeability clay and limestone in the Jackson and Vicksburg Groups. These formations also dip to the south-southwest.



LEGEND

Geology

- Citronelle Formation
- Coastal Deposits
- Pascagoula/Hattiesburg Formation
- Coastal Study Area
- Watershed Study Area
- County Boundary
- Physiographic Province Boundary

Source: MARIS, 2001.

Physiographic Provinces of Coastal Mississippi

Figure 4.7-1

System	Series	Group	Geologic Unit	Major Aquifer or Aquifer System		Hydrologic Layers	
						Layer number	Approximate depth to layer base in the vicinity of Pascagoula (feet)
Quaternary	Holocene and Pleistocene		Undifferentiated alluvium and terrace deposits		Surficial aquifer system—includes those parts of aquifers that are less than about 200 feet below land surface		
	Pleistocene		Loess Terrace deposits, undifferentiated	Miocene aquifer system		8	(not present)
Tertiary	Pliocene		Citronelle Formation			7	180
						6	450
			Graham Ferry Formation			5	650
						4	950
	Miocene		Pascagoula Formation Hattiesburg Formation Catahoula Sandstone			3 2 1	1,305 2,050 3,500
	Oligocene		Paynes Hammock Sand Chickasawhay Sandstone	Oligocene aquifer system			
		Vicksburg	Bucatunna Formation Byram Formation Glendon Formation Marianna Formation Mint Spring Formation				
			Forest Hill Formation				
	Eocene	Jackson	Yazoo Clay Moodys Branch Formation	Cockfield aquifer Sparta aquifer system			
		Claiborne	Cockfield Formation Cook Mountain Formation Sparta Sand Zilpha Clay				

Figure 4.7–2. Geologic Units, Major Aquifers, and Hydrologic Layering of the Miocene Aquifer System in South Mississippi

4.7.2.2 Recent Pleistocene Sediments

The geologic formations exposed on the surface of the Mississippian Gulf coast were deposited, beginning approximately 1.6 million years ago, atop the Pliocene and Miocene deposits. The deposits are up to 100 feet thick and consist of alluvium and terrace deposits (Otvos, 1998). The Biloxi Formation, the Prairie Formation, and the Gulfport Formation, all deposited during this time, are described below.

The Biloxi Formation was deposited during a period of rising sea level in marine and brackish water both nearshore and offshore. This formation is not exposed at the surface, except along the banks of the Industrial Seaway in Gulfport where it has been exposed from excavation. It ranges in thickness from 15 feet in Harrison County up to 120 feet in Jackson County, and consists of clay, fine sand, and sandy clay with abundant fossils. Both shells and microscopic foraminifera are found, and these fossils are used to identify the deposition environment (Oivanki, 1998).

The Prairie Formation, ranging from 15 to 40 feet thick, was deposited in river channels and inter-channel swamps. It is composed primarily of sands and muddy sands with petrified tree trunks and organic matter, and is visible along the Industrial Seaway road cut in Harrison County. The formation underlies the wide, generally flat coastal plain immediately north of the coastal marshes and beaches on the coast. The city of Bay St. Louis is built on the high sandy bluffs of the Prairie Formation (Oivanki, 1998).

The Gulfport Formation is a sand unit that was deposited during a time of sea level decline, following the highest sea level stage of the Pleistocene epoch. It forms the high ridge upon which the coastal cities of Pass Christian, Gulfport, and Biloxi are built. The Coastal Mississippi beaches are regularly replenished with sand dredged from the Mississippi Sound, and the source for much of this sand is the Gulfport Formation (Otvos, 1998).

4.7.2.3 Seismicity

Earthquakes are rare in Coastal Mississippi, and the region is listed in the Uniform Building Code as being in Zone 0, which does not require specific earthquake-proof building design considerations.

4.7.3 Soils

Soil data were obtained from soil surveys conducted for each county in the Coastal Mississippi watershed (Hancock and Harrison Counties). This information is useful for properly managing crops, pastures, woodlands, building sites, sanitary facilities, highways and other transportation systems, parks and other recreational facilities, and wildlife habitat. Soil data also can be used to help minimize soil erosion and septic tank failures in sensitive areas. Soil descriptions for Harrison and Hancock Counties are summarized in Tables 4.7–1 and 4.7–2.

4.7.3.1 Soil Erosion and Best Management Practices

Factors that affect erosion rates are steepness of slope, texture, permeability, and vegetative cover. Soil is frequently lost to erosion during storm events, depending on the conditions of the soil and the characteristics of the storm event. Poorly managed construction sites and agricultural fields are also likely to lose soil to erosion.

Land use trends are important indicators for predicting soil erosion. The relative contribution of any given land use can be used as an indicator of the major sources of sediment loadings in the watershed study area. Table 4.7–3 shows the sediment loadings from the different land use categories relative to agriculture, the single largest contributor to sediment loadings in the region. Urban land use is the second largest contributor generating a load approximately 49 percent of agriculture's contribution. Other categories of land use are generated smaller volumes of sediment runoff.

Although construction is thought to be a significant source of sediment runoff, its overall contribution to sediment loadings in the regions streams is difficult to estimate. The increase in land area under development, however, is an indicator of the level of construction activity that has occurred within the CSA during the past 30 years. As described in Section 4.3, in 1972, only 2.5 percent of the Bay Saint Louis watershed acreage was developed. By 1992, the percentage of developed acreage increased to 3.5 percent; and by 2000, 4.2 percent of the land areas was developed, and increase of 69 percent. The rate of development was also quite rapid in the Biloxi Bay watershed. While agricultural land use is still significant in both watersheds and likely remains the primary source of

Table 4.7–1
Soils of Harrison County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table[1]	Hydric	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reason
Atmore Series	poorly drained soils that formed in loamy material.	1[1]	Yes		Low, moderate at depth	Severe	Severe	Severe	Severe	High seasonal water table and flooding
Coastal Beach	clean white sand with a few shells		Yes		Low					
Escambia series	somewhat poorly drained soils on uplands, formed in loamy material	15-30	Inclusions		Low	Moderate	Severe	Moderate	Moderate	Slow permeability and wetness
Eustis series	somewhat excessively drained soils that formed in sandy material on uplands. Slopes are 0-17%.	60-120	Inclusions		Low	Slight to moderate	Slight to moderate	Slight to moderate	Moderate to severe	Loamy sand surface layer and slope
Handsboro series	very poorly drained soils that formed in highly decomposed herbaceous plant remains and thin mineral layers. These soils adjoin salt water or brackish water at elevations of less than 2 feet and are periodically flooded by high tides.	2[1]	Yes		Low	Severe	Severe	Severe	Severe	Low bearing capacity, flooding, wetness, and organic surface layer
Harleston series	moderately well drained soils that formed in loamy materials on uplands. Slopes are 0-5%.	18-24	Inclusions	Yes	Low	Moderate	Moderate	Moderate	Slight	Medium bearing capacity and wetness.
Hyde series	very poorly drained soils that have a thick, dark surface layer. These soils formed in loamy materials.	1[1]	Yes		Low, moderate at depth	Severe	Severe	Severe	Severe	Moderately slow permeability, wetness, and flooding.

Table 4.7–1
Soils of Harrison County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table[1]	Hydric	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reason
Jena series	well drained soils that formed in loamy material on flood plains of larger streams.	3[1]			Low	Slight	Slight	Slight	Slight	Severe in areas subject to flooding
Lakeland series	excessively drained soils on uplands, formed in sandy material.	60-120	No		Low	Slight	Slight	Moderate	Severe	Medium bearing capacity and fine sand surface layer
Latonia series	well drained soils on uplands, formed in loamy material high in sand content.	60-120	Inclusions	Yes	Low	Slight	Slight	Slight	Slight	
McLaurin series	well drained soils on uplands, formed in loamy material. Slopes are 2-8%.	>60	No		Low	Slight to moderate	Slight	Slight to moderate	Slight to moderate	Moderate risk in areas with high slope
Nahunta series	somewhat poorly drained soils on stream terraces, formed in loamy material.	0-15	Inclusions		Low, moderate at depth	Moderate	Severe	Moderate	Moderate to severe	Medium bearing capacity, slow permeability, and wetness
Nugent series	excessively drained stratified soils that formed in sandy materials on flood plains.	3[1]	Yes		Low	Severe	Severe	Severe	Severe	Flooding
Ocilla series	somewhat poorly drained soils on uplands, with a thick, sandy surface layer over loamy material.	0-15	Inclusions		Low	Moderate	Severe	Moderate	Moderate	wetness
Plummer series	poorly drained soils that have a thick sandy surface layer over loamy	0-15	Yes		Low	Severe	Severe	Severe	Severe	wetness and flooding

Table 4.7–1
Soils of Harrison County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table[1]	Hydric	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reason
	materials.									
Poarch series	well drained soils that formed in loamy materials on uplands. Slopes are 0-17%.	>50	Inclusions	Yes	Low	Slight to moderate	Moderate	Slight to moderate	Slight to severe	Medium bearing capacity, slope, moderately slow permeability
Ponzer series	very poorly drained soils that have a thick, dark mucky surface layer over loamy material, found on flood plains.	0-15	Yes		High	Severe	Severe	Severe	Severe	Low bearing capacity, wetness and flooding
Ruston series	well drained soils that formed in loamy materials on uplands. Slopes are 0-12%.	60-120	No	Yes		Moderate	Moderate	Moderate to severe	Moderate to severe	Slope
Saucier series	moderately well drained soils that formed in a thin mantle of loamy material overlying clayey material, found on uplands. Slopes are 2-12%.	15-30	Inclusions	Yes	Low, some moderate	Moderate	Severe	Moderate	Slight to severe	Medium to low bearing capacity, wetness, and slope
Smithdale series	well drained soils that formed in loamy materials on uplands.	60-120	No			Severe	Moderate	Moderate to severe	Moderate to severe	Slope
Smithton series	poorly drained soils that formed in loamy material.	0-15	Yes			Severe	Severe	Severe	Severe	Moderately slow permeability, wetness
St. Lucie series	excessively drained soils that formed in sandy material on Deer, Ship,	60-120	Inclusions			Slight	Slight	Slight	Severe	Sand surface

Table 4.7–1
Soils of Harrison County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table[1]	Hydric	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reason
	and Cat Islands.									
Sulfaquepts	soils that formed in areas of hydraulic fill, along marshes, beaches, and the Harrison County Industrial Waterway.	15-30	Inclusions			Moderate	Severe	Moderate to severe	Severe	High shrink-swell potential, sand surface, medium bearing capacity, wetness
Susquehanna series	somewhat poorly drained soils that formed in clayey materials. Slopes are 2-12%.	15-30	No		low, high at depth in clay zone	Severe	Severe	Severe	Moderate	High shrink-swell potential, very slow permeability, wetness, slope

[1-] 1-Water table at or near surface during winter and spring; 2-Water table at or above the surface most of the time; daily tidal flooding; 3-Water table within a depth of 60 inches for very brief periods.

Table 4.7–2
Soils of Hancock County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table (feet)	Hydrologic Group[1]	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reasons
Arkabutla	somewhat poorly drained soils of the Pearl River flood plain that formed in silty materials. Slopes range from 0-2%	1.5-2.5	C		Low	Severe	Severe	Severe	Moderate to severe	Floods, low strength, wetness
Rosebloom	poorly drained soils of the Pearl River flood plain. They formed in silty material, slopes range from 0-2%.	0-1.0	D		Moderate	Severe	Severe	Severe	Severe	floods, percs slowly, wetness
Atmore	poorly drained soils that formed in loamy materials on broad, wet upland flats. Slopes range from 0-2%.	0-1.0	B/D		Low	Severe	Severe	Severe	Severe	percs slowly, wetness
Beaches					not rated	not rated	not rated	not rated	not rated	
Bigbee	excessively drained soils that formed in sandy material on flood plains. Slopes range from 0-2%	3.5-6.0	A		Low	Severe	Severe	Moderate	Moderate	percs slowly, low strength, wetness
Bibb	poorly drained, stratified soils that formed in loamy material on flood plains. Slopes range from 0-2%.	0-1.5	C		Low	Severe	Severe	Severe	Severe	floods and wetness
Bohicket	very poorly drained soils of the tidal marshes, formed in clayey material and flooded by seawater daily. Slopes range from 0-1%.	+3-0	D		High	Severe	Severe	Severe	Severe	floods, shrink-swell potential, low strength, percs slowly, wetness, too clayey
Escambia	somewhat poorly drained soils that formed in loamy materials on uplands. Slopes range from 0-5%.	1.5-2.5	C	Yes	Low	Moderate	Severe	Moderate	Moderate	wetness, percs slowly, low strength

Table 4.7–2
Soils of Hancock County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table (feet)	Hydrologic Group[1]	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reasons
Eustis	somewhat excessively drained, formed in sandy material in uplands. Slopes range from 2-5%.	>6.0	A		Low	Slight	Slight	Slight	Moderate to severe	too sandy
Guyton	poorly drained soils that formed in loamy material. Slopes range from 0-1%.	0-1.5	D		Low	Severe	Severe	Severe	Severe	wetness, percs slowly
Handsboro	very poorly drained soils of the tidal marshes that are flooded by seawater daily. Formed in highly decomposed plant remains, with thin mineral layers. Slopes range from 0-1%	+3-0.5	D		Low	Severe	Severe	Severe	Severe	floods, wetness, low strength, excess humus
Harleston	moderately well drained upland soils that formed in loamy materials. Slopes range from 0-5%.	2.0-3.0	C	Yes	Low	Moderate	Severe	Slight	Slight to moderate	wetness, slope
Lucedale	well drained soils that formed in loamy material. Slopes range from 0-2%.	>6.0	B		Low	Slight	Slight	Slight	Slight	
Malbis	moderately well drained upland soils that formed in loamy materials. Slopes range from 0-8%.	2.5-4.0	B	Yes	Low	Slight	Severe	Moderate	Slight to severe	wetness, low strength, slope
McLaurin	well drained upland soils that formed in loamy material. Slopes range from 2-8%.	>6.0	B		Low	Slight	Slight	Slight	Slight to severe	slope

Table 4.7–2
Soils of Hancock County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table (feet)	Hydrologic Group[1]	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reasons
Ocilla	somewhat poorly drained upland soils that have a thick sandy surface layer over loamy materials. Slopes range from 0-2%.	1.0-2.5	C		Low	Moderate	Severe	Moderate	Moderate	wetness, too sandy
Pits					Low	not rated	not rated	not rated	no rating	
Plummer	poorly drained soils that have a thick sandy surface layer over loamy materials. Slopes range from 0-2%.	+2-1.5	B/D		Low	Severe	Severe	Severe	Severe	wetness, floods
Poarch	well drained upland soils that formed in loamy material. Slopes range from 0-12%.	2.5-5.0	B	Yes	Low	Moderate	Severe	Moderate	Slight to severe	percs slowly, low strength, slope
Ruston	well drained upland soils that formed in loamy materials. Slopes are 0-8%.	>6.0	B	Yes	Low	Slight	Slight	Moderate	Slight to severe	low strength, slope
Saucier	moderately well drained upland soils that formed in a thin mantle of loamy materials. Slopes range from 0-12%.	2.5-4.0	C	Yes	Low to Moderate	Moderate	Severe	Moderate	Slight to severe	low strength, wetness, slope
Susquehanna	somewhat poorly drained soils that formed in clayey materials on uplands. Slopes range from 2-12%.	>6.0	D		Low to High	Severe	Severe	Severe	Moderate	percs slowly, shrink swell potential, wetness
Smithdale	well drained soils that formed in loamy material on uplands. Slopes range from 8-17%.	>6.0	B		Low	Moderate	Moderate	Moderate	Slight to severe	slope

Table 4.7–2
Soils of Hancock County, Mississippi

Soil Series	Occurrence	Depth to Seasonal High Water Table (feet)	Hydrologic Group[1]	Prime or Unique Farmland	Shrink-swell potential	Limitations				
						Houses Without Basements	Septic Tank Uses	Local Roads or Streets, Commercial Buildings	Recreational Uses	Reasons
Smithton	poorly drained soils that formed in loamy materials on wet flats, in drainageways, and on stream terraces. Slopes range from 0-2%.	0-1.0	D		Low	Severe	Severe	Severe	Severe	percs slowly, wetness, floods
Sulfaquepts		0-1.0	D		not rated	not rated	not rated	not rated	not rated	
Trebloc	poorly drained soils that formed in silty material on broad wet flats and in drainageways. Slopes range from 0-2%.	0-1.0	D		Low to Moderate	Severe	Severe	Severe	Severe	floods, wetness, percs slowly, low strength

[1]Hydrologic Group - Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. Slope and plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to one of four hydrologic groups. Group A soils are mainly deep, well drained, and sandy or gravelly, and have a high infiltration rate when thoroughly wet and low runoff potential. Group D soils have a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Table 4.7–3
Yield of Sediment by Land Use Relative to Agricultural Land

Land Use	Sediment
Agriculture	100
Urban	49
Forest	35
Barren	35
Wetland	19

Source: CCBNEP, 1996.

sediment loading, construction and overall urbanization will likely become more significant nonpoint source problems in the future if land use trends continue.

4.7.3.2 Agricultural Use of Soil

Crops grown in the Coastal Mississippi Region include cotton, corn, soybeans, rice, hay, fruit, and pecans. About five percent of the soils used for agricultural purposes are classified as prime farmland soils. The Natural Resources Conservation Service (NRCS) defines prime farmland as nationally important land that has the best combination of physical and chemical characteristics for use as cropland, pastureland, rangeland, or forestland.

Agriculture production can generate soil loss and cause water quality degradation in surrounding water bodies. Exposing bare soil for long periods can result in soil erosion. In addition, excessive application of herbicides and pesticides could result in surface or groundwater contamination. Livestock feedlots, grazing, plowing, irrigation, fertilization, can also generate nonpoint source pollution.

During the past 10- years, there has been an increased use of agricultural best management practices (BMPs) and sustainable agricultural practices. BMPs include planting grass buffer strips along the edge of fields to soak up chemicals and filter out soil. Natural riparian buffer zones along the banks of streams and conservation tilling practices also help minimize erosion.

4.7.3.3 Septic Tank Suitability

Septic tank failure has been identified as a major source of nonpoint source pollution in the Coastal Mississippi area (Holloman, 1998). Water quality data collected in Mississippi's nearshore waters after periods of heavy precipitation indicate that sewage pollution exceeds allowable limits in many bays and estuaries (MSU, 1995). Waters contaminated by failing onsite wastewater disposal systems can cause public health problems and degradation of aquatic resources. Illnesses associated with septic tack effluent contaminated drinking and groundwater supplies include gastroenteritis, typhoid fever, dysentery, and infectious hepatitis. Other consequences of water quality degradation from septic tank seepage include beach closures, shellfish harvest restrictions, and loss of biological productivity in coastal habitats. Excessive nutrients from septic tanks (and agriculture) contribute to eutrophication, which limits oxygen supply and therefore adversely affects aquatic life.

According to the *Southern Hancock County Water Management Study* (1998), the high expense of installing an on-site sewage treatment and disposal system that meets the Mississippi Department of Health Standards has adversely affected residential and commercial growth. Although economic growth in the County has generated employment opportunities, the study found that many potential residents chose to live outside the county due the high cost of on-site sewage treatment. This problem is evident in the other coastal counties as well.

The typical on-site septic system is composed of a septic tank treatment unit and an absorption field for effluent disposal. Septic tank system failure results when the septic tank is blocked or the absorption field is not adequate to provide proper effluent disposal. Maintenance of septic tanks is not extensive, but it includes periodic pumping to remove solids. Toxic compounds such as some cleaning products and paints can damage the system. Table 4.7–4 shows the percentage of soils within each county that are designated as unsuitable, marginal, or suitable for underground absorption. An unsuitable rating indicates soils that inherently have characteristics that preclude them from properly treating septic tank effluent. These characteristics include soil saturation, high clay content, and presence of an impeding layer. Characteristics of soils suitable for septic tanks include proper texture and deep water tables. In each county, at least one-third of the soils are unsuitable for use with septic systems. Although these hydric (wet) soils are generally unsuitable, an on-site soil test would determine if a soil is suitable for septic tank use. The soil test measures how quickly or slowly water percolates through and whether there is evidence that the water table is regularly high.

Table 4.7–4
Appropriateness of Soils for Septic Tank Use

	Unsuitable		Marginal		Suitable	
	Acres	Percent	Acres	Percent	Acres	Percent
Hancock	156,027	50.3	128,804	41.5	25,569	8.2
Harrison	120,720	32.2	104,344	27.9	149,464	39.9
Jackson	274,423	57.6	39,517	8.3	162,220	34.1
Stone	Data not available[1]					
Pearl River	180,777	34.1	208,420	39.3	140,723	26.6

[1] At the time of this study, the soil survey for Stone County had not been completed.
Source: Holloman, 1998.

One recognized alternative to the septic tank is an Aerobic Treatment Unit (ATU). An ATU mixes sewage with air to enhance aerobic (presence of oxygen) digestion by microorganisms, which is more efficient than anaerobic (lack of oxygen) digestion used by microorganisms in a typical septic tank. The operation of an aerobic unit requires electricity because an electric motor drives the aeration device. More maintenance is required for an ATU than a septic tank, but the quality of effluent from an ATU is often better. However, microorganisms in the ATU must be continually supplied with sewage in order to survive, which may be problematic for seasonal residences.

In Mississippi, homeowners are required to hire a specialist to perform a soil site evaluation and recommend a proper on-site wastewater disposal system. However, the state does not require a county environmental scientist to follow-up or enforce determinations made in the recommendations.

Sometimes the recommendations are not followed and septic tanks are installed illegally where they will not function properly, resulting in poor treatment. Some counties, including Harrison and Pearl River Counties, have implemented mandatory final approval beyond the state requirements. Hancock, Jackson, and Stone Counties do not require final inspection (Holloman and LaSalle, 1995). Proposed legislations has been introduced recently into the Mississippi State Legislature that would require final inspection of wastewater disposal systems by the state, but these bills have been altered or died in committee.

In October 2001, the Governor's Water and Sewer Task Force published an issue paper which made recommendations regarding water and sewer utilities (GWSTF, 2001). Several issues involving the difficult economics of water and sewer development were discussed. One issue was that failing septic tank systems have created environmental problems in many rural areas of the state, resulting in associated obstacles to further economic development.

In Southern Mississippi, many centralized sewage treatment projects are in various stages of completion, and other proposed projects are awaiting funding. Some funding sources include Community Development Block Grants (CDBG) (from HUD), State Revolving Fund (SRC), Rural Utilities Service (RUS), Coastal Impact Assistance Plan (CIAP) (administered by NOAA), Section 592 Army Corps of Engineers, EPA Gulf of Mexico Program, and community matches.

4.7.4 Hydrogeology

Potable water is supplied almost entirely by groundwater sources in the Mississippi Coastal Region. Historically there has been an abundant supply of high-quality water. Some groundwater in Jackson County is filtered for taste and aesthetic purposes However, the adequacy of this source to meet the demands of current and continued development in Southern Mississippi is uncertain.

4.7.4.1 Description of Aquifer System

The Mississippi Coastal Region is underlain by thousands of feet of freshwater-bearing, south- or southwest-tipping Pliocene and Miocene sands. Within these sediments one unconfined layer is near the surface and many confined aquifers are found below. Individual aquifers range in thickness from 100 to 450 feet. In Hancock County, the freshwater-bearing zone is 2,000 to 3,000 feet thick in places (NASA, 2001). The sequence of alternating sands and discontinuous (lenticular) clay layers, creating the confining nature of the deeper aquifers, is part of the Coastal Lowlands Aquifer System. Because of the discontinuous nature of these sediments, correlation between wells is difficult and labeling of units is difficult (USGS, 1998a).

At shallow depths away from bays and estuaries, groundwater is generally hard, contains calcium bicarbonates with a slightly acidic pH, and has high concentrations of dissolved iron. As water moves along its flow path to the south, geochemical reactions with the aquifer sediments alter the quality of the water. These reactions result in increases in dissolved-solids concentrations and pH, and decreases in hardness and dissolved-iron concentrations. Further down gradient, the freshwater begins to mix with saltwater in the aquifer. The precise location of the freshwater- saltwater interface has not been determined, but is believed to be migrating inland as increasing development causes pumping levels to draw down freshwater supply.

4.7.4.2 Water Use and Supply

According to the *Ground Water Atlas of the United States* prepared by the U.S. Geological Survey (USGS, 1998a), in the Coastal Lowlands Aquifer System, 51 percent of water withdrawal is for agricultural uses, 25 percent for public supply, 16 percent for domestic and commercial uses, and the remainder for industrial uses, mining, and thermoelectric power. The Mississippi Department of Environmental Quality, Office of Land and Water Resources (MEDQ/OLWR), Water-Use Program was initiated in 1992 to compile site-specific freshwater withdrawal data from Mississippi's aquifers. These data represent a measurement of the stress applied to aquifer systems by pumping wells, and is presented in the USGS report.

The number of gallons per person per day was calculated for each the three counties in Coastal Mississippi using the data in the USGS report and U.S. Census data. Water use includes all groundwater use, and does not include water used during generation of electricity, which largely uses surface water. Using the estimated average gallons of water used per person per day, historical water use was calculated and future water use can be projected using estimated future population figures, assuming that per capita water consumption does not change.

Daily per capita groundwater use in the Coastal Mississippi counties is estimated to be 190 gallons, based on historical averages calculated from population and water use data shown in Table 4.7–5. Water use in the three counties combined was 54.5 million gallons per day (mgd) in 1985, 58.0 mgd in 1990, and 63.0 mgd in 1995. Based on these data, water use during 2000 was projected to be 69.2 mgd for the three counties combined, based on a population of 363,988.

Table 4.7–5
Calculation of Per Capita Water Consumption

Year	Per Capita Consumption (gallons per day)
1985	158.9
1990	202.9
1995	178.0
Average Per Capita Usage	190.0

Note: The accuracy of the 1985 population data used in this analysis could not be verified, so the average usage is based on the 1990 and 1995 estimates.

Sumner (1989) analyzed the effects of future withdrawals from the regional Miocene aquifer system based on historical changes and current conditions. A numerical groundwater flow model was designed and implemented. This study was based on conditions in 1985, prior to increased development in the region in the 1990s. In the late 1800s and early 1900s, water was supplied to the population along the coast by artesian wells with heads as high as 60 to 80 feet above sea level. The study also reported that water levels have declined as much as 100 feet in large areas of several of the aquifers along the coast. The resulting depressed potentiometric surfaces in some layers have caused moderately saline waters to move in the direction of pumping centers (Sumner, 1989).

MDEQ/OLWR is has been studying the problem of groundwater resource depletion and saltwater intrusion. A 2000 OLWR report on water resources of the Pascagoula area stated that water levels in Jackson County have generally been stable or slightly declining since the mid-1970s. However, it noted that ample water resources would be available for the foreseeable future if pumping rates were

maintained. Only wells located in the area along the coast from Gautier to Ocean Springs were showing steady declines in water levels (MDEQ, 2000).

4.7.4.3 Saltwater Intrusion

Dissolved-solids concentrations in groundwater increase with depth until the water is no longer fresh. Freshwater is defined in the USGS report (1998a) as having a total dissolved solids (TDS) concentration of less than 1,000 mg/L, and that definition is used in this EIS. In the northernmost coastal counties of Mississippi, freshwater is thought to occur down to the base of the Miocene sediments. The depth of the base of freshwater in the Miocene aquifer system is variable and is affected by pumping and recharge of freshwater to the aquifer system. To the south, the depth slopes down with the sediments. Along the coast, the base of the freshwater rises and meets the saltwater interface. According to Sumner (1989), the freshwater-saltwater interface at that time was several miles offshore in subsurface hydrologic layers 3 through 6 (Figure 4.7-2 of this document) in most of Hancock and Harrison Counties, whereas the interface appeared to be relatively close to water supply wells in some of the layers in the Pascagoula and Biloxi areas.

In simulating the effects of anticipated groundwater withdrawals, the model used by Sumner (1989) calculated a 1.5 percent annual increase in groundwater withdrawals along the Gulf Coast. At this rate, pumping in the year 2005 would approach 81 mgd, a 17 percent increase from 2000 rates discussed previously, nearly twice the increase in withdrawal rates from the previous decade. The study concluded that the most critical groundwater withdrawal and saltwater intrusion problems along the coast would occur in the Pascagoula area (Sumner, 1989).

MDEQ/OLWR published a study in 2000 addressing the results of the Sumner model predictions and the saltwater intrusion issue in the Pascagoula area. The report concluded that there is no indication of saltwater intrusion in the Pascagoula area as was postulated in previous reports, a 1978 Pascagoula Water Supply report and a USGS Miocene Model report. Only 3 of the 22 public supply wells sampled had chloride concentrations greater than 250 mg/L. Incomplete flushing of the salty water in some of the aquifers in the Pascagoula area has resulted in localized chloride concentrations higher than would normally be expected. At one time all of the water in these aquifers was salty. As the sea level fell and sediments subsided, the saltwater began to be flushed and replaced by fresh water. Therefore, the updip part of each aquifer contains fresh water, while denser saline water remains downdip. Based on current information, the location of saltwater fronts cannot be where postulated in the USGS report (MDEQ, 2000).

In April 2002, MDEQ/OLWR released another study of the groundwater resources of the entire coastal region to further address some of these issues. This report concluded that Sumner's (1989) suggestions of saltwater intrusion were based on limited data. An inland migration of the saltwater interface into the southern portion of Pascagoula and at Bayou Casotte did not occur. The collection and review of additional data indicated that the true positions of the saltwater interfaces in both the Graham Ferry and Pascagoula Aquifers were not at the location that the USGS report assumed. This report did state that the actual positions of the interfaces were unknown (USGS, 1989).

In other areas underlain by the Coastal Lowlands Aquifer System, particularly in the New Orleans and Baton Rouge areas, where heavy groundwater withdrawal has occurred (120 to 150 mgd in the Baton Rouge area between 1970 and 1990, and 200,000 to 400,000 gallons per day per square mile in the New Orleans area in 1980), there have been steady water level declines and saltwater intrusion. Some wells have been closed to allow aquifer recovery (USGS, 1998a). While many factors can contribute to the potential for saltwater intrusion, because Coastal Mississippi is on the edge of the

same aquifer system, if pumping rates in Coastal Mississippi were allowed to reach the levels in southern Louisiana, similar problems could occur.

4.7.4.4 Aquifer Recharge

Recharge to the Miocene aquifer system primarily occurs from the surficial aquifer system, which is fed by precipitation. Recharge from precipitation generally moves to the south and southeast along bedding planes towards the coast, where the water is either withdrawn by wells, discharges to the Gulf, or gradually percolates upward through the overlying layers into the shallower layers (USGS, 1989). Mississippi averages more than 60 inches of precipitation annually. Several inches may percolate into surficial aquifer systems in some areas; however, most of the precipitation flows relatively short distances to surface water drains as runoff. The amount of recharge to the deeper Miocene aquifer system was estimated in the report at potentially less than 1 inch per year (Sumner, 1989).

The amount of annual aquifer recharge can be estimated as total annual precipitation minus the sum of evapotranspiration, runoff, and consumptive use. Though sufficient data are not currently available to calculate aquifer recharge, trends in each component of the equation can present approximate recharge rates. Total annual precipitation in southern Mississippi averages around 64 inches per year between 1961 and 1990 (NRCS, 1997), and precipitation has increased slightly over the past century (USEPA, 1998a). Precipitation rates have been measured at Saucier Experimental Forest in southern Mississippi, and precipitation at this station indicate that there might have been an increasing trend between 1955 and 1995 by an amount of 3.6 inches, or 0.9 inch every 10 years (Figure 4.7-3). Evapotranspiration includes evaporation directly from surface water bodies and transpiration of water by plants. Evapotranspiration is often estimated to be about half of total precipitation, therefore in southern Mississippi evapotranspiration would be about 32 inches per year.

Runoff data are collected at stream gaging stations on the Biloxi and Wolf Rivers in southern Mississippi. Annual runoff is calculated by dividing discharge by watershed area above the monitoring station. The USGS gaging station 02481000, on the Biloxi River at Wortham, indicates a trend of increasing runoff during the period between 1953 and 2000.

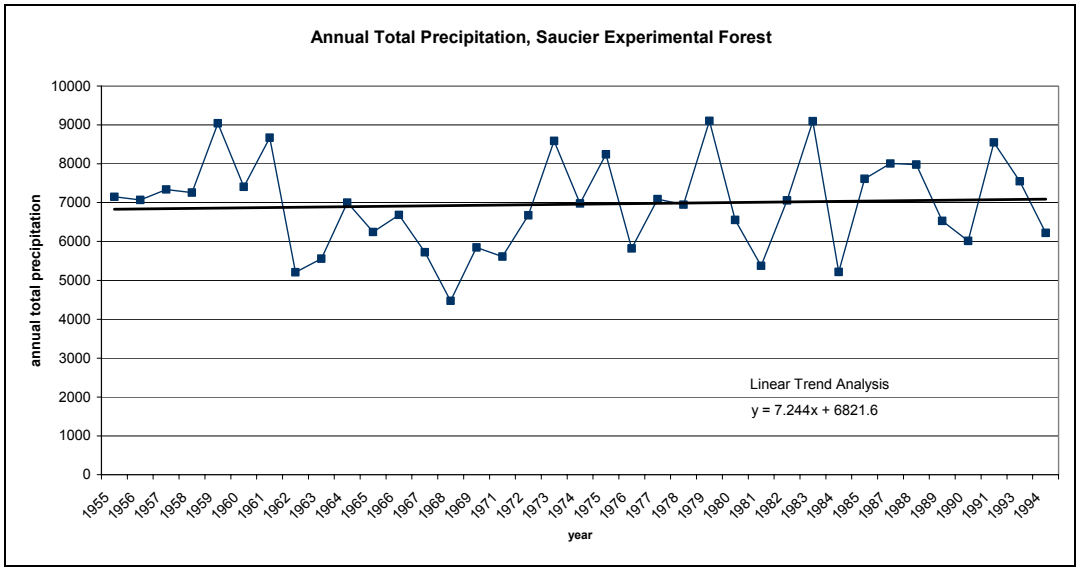


Figure 4.7–3. Historical precipitation (mm) at Saucier Experimental Forest.

In contrast, data collected on the Wolf River in the Bay St. Louis watershed indicate a historical trend of decreasing runoff during the period between 1972 and 2000.

As discussed in Section 4.2 (Land Use), developed areas and impervious surfaces have steadily increased since 1972. In 1972, 26,900 acres in the three-county region were covered by impervious surfaces. By 1992 this had increased to 36,600 acres, and by 2000, 42,400 acres were covered by impervious surfaces, an increase of 58 percent from 1972. An increase in impervious surfaces such as paved surfaces and rooftops can increase the amount of runoff and decrease infiltration to the aquifer system, and aquifer recharge could decrease with continued development.

4.8 WATER RESOURCES

4.8.1 Government Agency Overview

In 1978, the Mississippi Legislature consolidated five state agencies into the Department of Natural Resources. The agencies which were consolidated at that time included the Mississippi Geological Survey, the Board of Water Commissioners, the Air and Water Pollution Control Commission, the Park Commission, and the Mineral Lease Commission. During the 1989 Mississippi Legislative session, the Mississippi Department of Environmental Quality (MDEQ) was established to replace the Department of Natural Resources, and the Office of Recreation and Parks was moved to the Mississippi Department of Wildlife, Fisheries, and Parks. MDEQ is currently organized into four offices—Geology, Land and Water Resources, Pollution Control, and Administrative Services. The Mississippi Department of Wildlife, Fisheries, and Parks conserves and enhances Mississippi's natural resources, providing outdoor recreational opportunities, maintaining the ecological integrity and aesthetic quality of the resources, and ensuring socioeconomic and educational opportunities for present and future generations.

The Mississippi Department of Marine Resources (MDMR) is responsible for marine fisheries management and wetlands permitting as well as seafood plant inspection and certification, coastal preserves management, installation of marine pump out stations, removal of derelict vessels, administration of boat and water safety programs, marine law enforcement, shellfish growing-waters management, saltwater fish/shrimp/oyster licensing, Tidelands program administration, and management of the Grand Bay National Estuarine Research Reserve. The MDMR Coastal Ecology Permitting Department is responsible for permit for dredging of channels, canals, boat slips, marinas; construction of bulkheads, piers, boat ramps, boat houses, structures on designed sites for water dependent industry (coastal area only); any type of filling; burning; clearing; and seismic exploration.

The Pat Harrison Waterway District (PHWD) is a Mississippi state agency that is responsible for managing the rivers and their tributaries along the Pascagoula River Basin in southeastern and east central Mississippi (including Jackson County) and provides camping, cabins, and recreational facilities. PHWD focuses on three specific areas—flood control, water management, and recreation.

The Gulf Coast Research Lab collects and analyzes water samples for Mississippi's beach areas.

4.8.2 Coastal Mississippi Watershed Study Area— Baseline Conditions

Surface water resources consist of oceans, lakes, ponds, rivers, and streams. Surface water is important for its contributions to the economic, ecological, recreational, and human health of the community. This is particularly true for coastal Mississippi where much of the economy is driven by its proximity to the Gulf of Mexico and the wealth of recreational opportunities and seafood resources that it provides.

Watersheds are defined by natural hydrological boundaries in an area and represent the basic units for assessing and managing water resources. Human activity in watersheds often affects the quality of the waterbodies in the watershed. This is particularly true in the case of accidents or spills that drain to the nearest waterbody. Erosion from an area where the ground has been disturbed can also impact nearby waterbodies with sediment. General land use changes can also affect waterbodies. For example, an agricultural area that has been developed into an urban area will have greater incidence of storm water runoff that carries pollutants from the land surface into nearby waterbodies—the undeveloped agricultural area would have allowed more water to absorb into the soil. The cumulative effects of numerous changes in a watershed can negatively affect its water quality.

This section provides an overview of the existing and historical conditions of surface water resources in the coastal Mississippi watershed study area and the subwatersheds that comprise it. This study also provides information on the current and historical pollutant loads for the subwatersheds.

4.8.2.1 Location and Description

The Mississippi coastal watershed study area, hydrologic unit code (HUC) 03170009, covers 1,293,842 acres and drains southern Mississippi to the Gulf of Mexico. Much of the watershed study area falls within Hancock and Harrison counties, with smaller contributions from Jackson, Pearl River, Lamar, and Stone counties. Figure 4–8.1 outlines the coastal Mississippi watershed and its contributing counties.

There are 10 subwatersheds within the coastal Mississippi watershed—Upper Wolf River, Lower Wolf River–Cane Creek, Upper Jourdan River, Rotten Bayou, De Lisle, Bayou La Croix, Biloxi River, Tuxachanie Creek, Turkey Creek–Old Fort Bayou, and the Islands (Figure 4–8.1). (Each subwatershed is described in detail below.) Bay St. Louis and Biloxi Bay are the dominant surface water features in the Mississippi coastal watershed. For purposes of this water resources assessment, the defined project study area groups the 10 subwatersheds into 3 primary watersheds—Bay St. Louis, Biloxi Bay, and The Islands.

The major cities within the coastal Mississippi watershed are Gulfport and Biloxi, both located on the southern border of Biloxi Bay. Waveland, Bay St. Louis, Pass Christian, Long Beach, D'Iberville, Ocean Springs, and Gautier are other large municipalities in the coastal Mississippi watershed.

4.8.2.2 Tributaries

There are four major tributaries in the coastal Mississippi watershed: Jourdan River, Wolf River, Biloxi River, and Tchoutacabouffa River (Figure 4–8.1). Headwaters for these rivers generally are located in the northern part of the watershed and discharge into either Bay St. Louis or the Figure 4–8.1 (4H2O1) Back Bay of Biloxi before ultimately flowing into the Gulf of Mexico. Mill, Catahoula, and Hickory Creeks flow into the Jourdan River, followed by Bayou Bacon, Rotten Bayou, and Bayou La Croix before the Jourdan River flows into Bay St. Louis. Murder Creek flows into Wolf River, which then flows into Bay St. Louis. Saucer Creek flows into the Biloxi River and is joined by the Little Biloxi River on the way to Biloxi Bay. Tuxachanie Creek, Bayou Costapia and Cypress Creek flow into the Tchoutacabouffa River, which flows into Biloxi Bay. In addition, several smaller tributaries located along the Mississippi Coast that flow into Biloxi Bay. These include Turkey Creek, Bernard Bayou, and Old Forest Bayou.

LEGEND

- ▲ Water Quality Monitoring Station
- ⊕ USGS Gaging Station
- Beach Monitoring Station
- Sediment Sampling Station
- Point Source Discharge
- Mine
- Town
- Dam
- Beach
- River
- County
- Watershed Study Area

Source: MSDMR-CRMP, 2001; USEPA, 2001.

Coastal Mississippi Watersheds and Monitoring Stations

Figure 4.8-1

4.8.2.3 Topography

Elevations in the coastal Mississippi watershed study area range from sea level to approximately 420 feet (0 to 128 meters) above sea level. Much of the upper watershed consists of gently rolling to hilly terrain; the coastal area in the lower watershed is flat (USGS, 2001a).

4.8.2.4 Flows and Exchanges

Historically, the U.S. Geological Survey has maintained flow gauges at various locations throughout the coastal Mississippi watershed. Only two of those gauges, one on the Wolf River near Landon (02481510) and the other on the Biloxi River at Wortham (02481000), have periods of record that include the 1972–2000 study period. Figure 4–8.1 presents the locations and numbers of those gauges. Analysis of the historic flow records available at each of these stations was performed to determine the range of flow conditions and the average flows at each station. A summary of these results is presented in Table 4.8–1. Flows at the Wolf River stations, which drains 197,000 acres, are considerably higher than at the Biloxi River station, which only drains 61,400 acres, although the mean unit flow per acre is the same, 0.003 cfs/acre. Both stations exhibit similar seasonal flow patterns, with the highest flows occurring from January through March and the lowest flows occurring in the months of June and October (Table 4.8–2).

Table 4.8–1
USGS Flow Stations in the Coastal Mississippi Watershed

USGS Gauge	Latitude	Longitude	Station Name
USGS02481000	30.558	89.119	Biloxi River at Wortham, MS
USGS02481510	30.484	89.272	Wolf River near Landon, MS

Table 4.8–2
Statistics on USGS Flow Stations[1]

Station	Dates of Analysis	Minimum	Maximum	Mean	Median	7Q10
02481000	10/1/1952 to 9/30/2000	1.2	9,860	196	65	2.5
02481510	8/1/1971 to 9/30/2000	11.0	18,700	625	266	45

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
02481000	320.0	343.4	330.4	260.8	182.7	105.7	122.0	133.2	157.2	69.7	111.9	219.8
02481510	1,035.3	1,080.4	1,058.3	942.2	667.0	325.3	403.6	381.4	414.5	221.1	378.4	639.6

[1] All flow values are in cubic feet per second (cfs).

4.8.2.5 Watersheds

4.8.2.5.1 Bay St. Louis Watershed

The Bay St. Louis watershed drains more than 560,000 acres of southwestern Mississippi. As discussed in section 4.2.3.1, land use in the watershed includes agriculture, silviculture, aquaculture, residential development, urban development, and both light and heavy industrial development. Designated uses for waterbodies in the watershed include primary and secondary recreation, fish and wildlife propagation, commercial fishing and shellfish harvesting, and industrial water supply (Wicker et al., 1992).

The Bay St. Louis watershed discharges on average 1,700 cfs of water into the Mississippi Sound. The bay has a 2-foot tidal range with relatively long flushing times in the upper estuaries (USGS, 1978, cited in Wicker et al., 1992).

4.8.2.5.1.1 Bayou La Croix (HUC 03170009130)

The Bayou La Croix subwatershed is located along the western side of Bay St. Louis. The population level is characterized as "unpopulated" to "moderately populated." Large increases in population are not expected in the existing unpopulated areas (situated in the northwestern portion of the subunit) because of land use restrictions associated with a NASA test facility. Some population increases are expected west of Waveland and outside of the city of Bay St. Louis as a result recreational, community, and urban expansion. Except for the city of Bay St. Louis, nearly all of the populated area is unsewered and all of the subunit contains soils that are classified unsuitable or poor for proper functioning of septic tank systems (Wicker et al., 1992). The primary land cover types in the watershed are wetlands or other surface waterbodies (42 percent), undeveloped forest (35 percent), and barren land (15 percent).

Five point source discharge permits are located in this subwatershed including the Waveland Sewage Treatment Facility (Table 1 in Appendix C). No mines, but one dam is located in the subwatershed (see Figure 4.8–1). The major sources of nonpoint source pollution are erosion associated with poor forestry practices, inadequate sewage treatment, and storm water runoff (Wicker et al., 1992). As shown in Table 4.8-3, several waterbodies in the subwatershed are listed on the state's list of impaired waters (commonly referred to as the "303(d)" list) (USEPA, 2001a).

4.8.2.5.1.2 De Lisle (HUC 03170009120)

The De Lisle subwatershed is located along the north coast of Bay St. Louis. The largest municipality in the subwatershed is the town of De Lisle. The primary land cover types in the subwatershed are wetlands or other surface waterbodies (45 percent) and undeveloped forest (29 percent). In the year 2000, there was one industrial point source discharger and a titanium mine located in the subwatershed (see Figure 4.8–1 and Table 4.8–4). No dams are located in the subwatershed. As shown in Table 4.8-5, several waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a).

Table 4.8–3
Listed Impaired Waters in Bayou La Croix Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS114JE-1998	Jourdan-DA	Nutrients, pathogens, organic enrichment/low dissolved oxygen
MS115BCE-1998	Bayou Caddy-DA	Unknown toxicity, siltation, nutrients, organic enrichment/low dissolved oxygen
MS115BLCE-1998	Bayou La Croix	Unknown toxicity, siltation, pathogens, nutrients, organic enrichment/low dissolved oxygen
MS115C04M-1998	St. Louis Bay coastline	Pathogens
MS115EBE-1998	Edwards Bayou	Pathogens
MS115JOBE-1998	Joes Bayou	Pathogens
MS115WBE-1998	Watts Bayou	Pathogens
MS118MBE-1998	Mallini Bayou-DA	Nutrients, pathogens, organic enrichment/low dissolved oxygen

Source: USEPA, 2001a.

Table 4.8–4
Mine Locations

Mine Name	County	Type	Current Status	Waterbody	Extracted
Biloxi River					
Necaise Dredge	Harrison	Surface	Past Producer	St. Louis Bay	Sand and Gravel
Shaw Pit	Harrison	Surface	Producer	St. Louis Bay	Sand and Gravel
De Lisle Plant (Ti)	Harrison	Surface	Past Producer	St. Louis Bay	Sand and Gravel
Wolf River Dredge	Harrison	Surface	Intermittent Producer	St. Louis Bay	Sand and Gravel
Landon Road Sand Pit	Stone	Offshore	Producer	Pascagoula River	Sand and Gravel
Alma Ladner Pit	Stone	Surface	Past Producer	Pascagoula River	Sand and Gravel
Edwards Pit	Stone	Surface	Producer	St. Louis Bay	Sand and Gravel
De Lisle					
Saucier Pit	Hancock	Processing Plant	Producer	-	Titanium
Lower Wolf River-Cane Creek					
Fore Concrete Products Inc.	Hancock	Surface	Producer	St. Louis Bay	Sand and Gravel
Bell Pit	Harrison	Offshore	Producer	St. Louis Bay	Sand and Gravel
Smith Pit	Pearl River	Surface	Producer	Lower Pearl River	Sand and Gravel

Table 4.8–4
Mine Locations (continued)

Mine Name	County	Type	Current Status	Waterbody	Extracted
Turkey Creek-Old Fort Bayou					
Lott Pit	Harrison	Surface	Past Producer	St. Louis Bay	Sand and Gravel
Gulf Paving Inc.	Harrison	Surface	Producer	St. Louis Bay	Sand and Gravel
Upper Jourdan River					
Parker Pit	Hancock	Surface	Producer	St. Louis Bay	Sand and Gravel
Upper Wolf River					
Silver Run Pit	Stone	Offshore	Producer	St. Louis Bay	Sand and Gravel

Source: USEPA, 1998b.

Table 4.8–5
Listed Impaired Waters in De Lisle Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS114C01M-1998	Bay St. Louis coastline near De Lisle	Pathogens
MS114DLE-1998	Bayou De Lisle-DA	Pathogens
MS114M1-1998	Unnamed tributary of Bayou De Lisle	Biological impairment
MS114M2-1998	Bayou De Lisle -Segment 2	Biological impairment
MS114M4-1998	Bayou De Lisle -Segment 4	Biological impairment
MS115JOBE-1998	Joes Bayou	Pathogens
MS115JM1(E)-1998	Jourdan River-DA	Pathogens
MS115M1(E)-1998	Jourdan River	Pathogens

Source: USEPA, 2001a.

4.8.2.5.1.3 Lower Wolf River–Cane Creek (HUC 03170009090)

The Lower Wolf River–Cane Creek subwatershed is located northeast of Bay St. Louis. The primary land cover types in the subwatershed are undeveloped forest (51 percent), barren land (28 percent), and agriculture (16 percent). Necaise is the largest municipality in the subwatershed. No point source dischargers are permitted for the subwatershed. Three sand and gravel mines are located in the subwatershed. Nine dams are located in the subwatershed. Nonpoint source pollution associated with improperly treated sewage and storm water runoff along the Wolf River is a primary source of contaminants (Wicker et al., 1992).

The soils in this subwatershed are rated between poor and fair to good for proper functioning of septic systems. There are no recorded sewage collection systems in the subwatershed (Wicker et al., 1992).

Designated water uses for this subwatershed include primary and secondary recreation, fish and wildlife, threatened and endangered species, commercial fishing and shellfish harvesting, and

industrial water supply (Wicker et al., 1992). Two waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a). See Table 4.8–6 for the waterbodies and the parameters of concern.

Table 4.8–6
Listed Impaired Waters in Lower Wolf River–Cane Creek Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS111CE-1998	Crane Creek-DA	Pesticides, siltation, nutrients
MS111M1-1998	Wolf River	Pathogens

Source: USEPA, 2001a.

4.8.2.5.1.4 Rotten Bayou (HUC 03170009110)

The Rotten Bayou subwatershed is located on the northwestern side of Bay St. Louis. Primary land cover types within the subwatershed include forest (49 percent), barren land (29 percent), and agriculture (15 percent). Diamondhead is the largest municipality in the subwatershed. There are two permitted point source dischargers in this subwatershed; one is the Pecan Grove Sanitary Landfill. There are two dams, but no mines located in the subwatershed. One waterbody is listed on the state's list of impaired waters, Jourdan River-DA (MS113JE-1998), for pathogens, nutrients, and organic enrichment/low dissolved oxygen (USEPA, 2001a).

4.8.2.5.1.5 Upper Jourdan River (HUC 03170009100)

The Upper Jourdan River subwatershed is located on the northwestern side of Bay St. Louis. Primary land cover types within the subwatershed include forest (53 percent) and barren land (26 percent), because much of the area encompasses the NASA test facility and associated buffer zone. Caesar is the largest municipality in the subwatershed and only 1 percent of the land area is in urban development. The subwatershed has one permitted point source discharger; three sand and gravel mines; and seventeen dams. Nonpoint source pollution associated with improperly treated sewage and storm water runoff along the Jourdan River is a primary source of contaminants to this subwatershed (Wicker et al., 1992).

The subwatershed is sparsely populated with future growth likely constrained by land restrictions imposed by the NASA test facility. However, further growth in already populated areas could result in water quality degradation in the absence of propose planning (Wicker et al., 1992).

Most of the subwatershed contain soils that are rated fair-to-good with regard to proper functioning of septic tank systems. However, a small portion of the populated area is located on soil unsuitable for septic tank utilization; this area has no sewage collection system. Designated water uses for this subwatershed include primary and secondary recreation, fish and wildlife, threatened and endangered species, commercial fishing and shellfish harvesting, and industrial water supply (Wicker et al., 1992). As shown in Table 4.8-7, three waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a).

Table 4.8-7
Listed Impaired Waters in Upper Jourdan River Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS112E-1998	Jourdan River-DA	Pesticides, siltation, nutrients, organic enrichment/low dissolved oxygen
MS112E1-1998	Catahoula Creek	pH, biological impairment, organic enrichment/low dissolved oxygen
MS112M1-1998	Jourdan River	Pathogens

Source: USEPA, 2001a.

4.8.2.5.1.6 Upper Wolf River (HUC 03170009080)

The Upper Wolf River is located in the northernmost area of the coastal Mississippi watershed study area in Pearl River, Stone, and Lamar counties. Primary land cover types are forest (57 percent) and barren land (31 percent), with less than 1 percent urban development. Poplarville is the largest municipality in the subwatershed.

There are two permitted point source dischargers, one sand and gravel mine, and 23 dams in the subwatershed. As shown in Table 4.8–8, two waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a).

Table 4.8–8
Listed Impaired Waters in Upper Wolf River Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS110ME-1998	Murder Creek-DA	Siltation
MS110WE-1998	Wolf River-DA	Pesticides, siltation, nutrients, organic enrichment/low dissolved oxygen

Source: USEPA, 2001a.

4.8.2.5.2 Biloxi Watershed

The Biloxi Bay subwatershed drains more than 486,000 acres of southeastern Mississippi. This area includes portions of Stone, Harrison, and Jackson counties. Land use in the subwatershed includes agriculture, silviculture, aquaculture, residential development, urban development, and light and heavy industrial development. Designated water uses in the watershed include primary and secondary recreation, fish and wildlife propagation, commercial fishing and shellfish harvesting, and industrial water supply (Wicker et al., 1992).

The Biloxi Bay watershed discharges 1,400 cfs of water into the Mississippi Sound and potentially affects water quality throughout the sound. Nearshore water quality is primarily affected by land use practices within the coastal zone (Wicker et al., 1992).

4.8.2.5.2.1 Biloxi River (HUC 03170009140)

The Biloxi River subwatershed is located northwest of Biloxi Bay and is the largest subwatershed in the coastal Mississippi watershed study area (172,680 acres). The primary land cover types within the subwatershed are forest (65 percent) and barren land (22 percent). A portion of the subwatershed is designated as the De Soto National Forest. Municipalities in the subwatershed include Saucier, Howison, and McHenry.

Five point source dischargers have been permitted in this subwatershed, including the Mississippi Power Company. Seven sand and gravel mines are located in the subwatershed. Twenty-eight dams are also located in the subwatershed, including the dam forming Scarborough Lake, which is listed as a potential hazard to downstream areas.

Nonpoint source pollution associated with improperly treated sewage and storm water runoff along the Biloxi River is a primary source of contaminants to this subwatershed. No sewage collection systems were identified for this area. The subwatershed is sparsely populated. Soils range from poor or fair to good with regard to suitability for septic systems (Wicker et al., 1992).

Designated water uses for the subwatershed include secondary recreation, fish and wildlife propagation, threatened and endangered species propagation, commercial fishing and shellfish harvesting, and industrial water supply (Wicker et al., 1992). Three waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a). Table 4.8–9 lists the waterbodies and the parameters of concern.

Table 4.8–9
Listed Impaired Waters in Biloxi River Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS116M1-1998	Saucier Creek	Pathogens
MS116M2-1998	Biloxi River	Pathogens
MS116M3-1998	Little Biloxi River	Pathogens

Source: USEPA, 2001a.

4.8.2.5.2.2 Turkey Creek–Old Fort Bayou (HUC 03170009160)

The Turkey Creek–Old Fort Bayou subwatershed is located along the Mississippi Sound and extends from Bay St. Louis in the west to the boundary with the Pascagoula River watershed in the east. This is the second-largest subwatershed in the coastal Mississippi drainage (157,730 acres). The primary land cover types are forest (40 percent), urban development (23 percent), and barren land (15 percent). This is the most densely populated portion of the coastal Mississippi watershed, large municipalities include Pass Christian, Long Beach, Gulfport, Biloxi, D'Iberville, and Ocean Springs. Also located in the subwatershed are the Gulfport-Biloxi International Airport, Gulfport Naval Reservation, and Keesler Air Force Base.

There are 39 permitted point source dischargers and two sand and gravel mines located in the subwatershed (Table 1 in Appendix C). Eight dams are also located in the subwatershed, including

the dam that forms Golf Course Lake which is listed as a potential hazard to downstream areas. Nonpoint source pollution associated with storm water runoff is a source of contaminants in the subwatershed. More than half of the subwatershed is sewered (Wicker et al., 1992).

Soil suitability for septic tanks range from poor to fair-to-good. Designated water uses for the subwatershed include primary and secondary recreation, fish and wildlife propagation, and commercial fishing and shellfish harvesting (Wicker et al., 1992). Several waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a). Table 4.8–10 lists the waterbodies and the parameters of concern.

Table 4.8–10
Listed Impaired Waters in Turkey Creek–Old Fort Bayou Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS119BCUE-1998	Bayou Cumbest	Nutrients, pathogens
MS118BBM1-1998	Turkey Creek	pH, pathogens
MS118BBM2-1998	Bernard Bayou – Segment 2	Pathogens
MS118BBM3(E)-1998	Bernard Bayou	Priority organics, metals, nonpriority organics, total toxics
MS118BBM3-1998	Bernard Bayou – Segment 3	Nutrients, organic enrichment/low dissolved oxygen, pathogens
MS118BBM4-1998	Bernard Bayou – Segment 4	Pathogens
MS118BBM5(E)-1998	Industrial Seaway	Priority organics, total toxics, nonpriority organics
MS118BBM5-1998	Industrial Seaway	Nutrients, organic enrichment/low dissolved oxygen
MS118BPE-1998	Bayou Portage – DA	Nutrients
MS118C01M-1998	Bay St. Louis coastline near Pass Christian	Pathogens
MS118C02M-1998	Mississippi Sound coastline from Pass Christian to Biloxi	Pathogens
MS118C05M-1998	Mississippi Sound coastline from Ocean Springs to Gautier	Pathogens
MS118CO3M-1998	Back Bay of Biloxi coastline – Segment 3	Pathogens
MS118CO4M-1998	Back Bay of Biloxi coastline – Segment 4	Pathogens
MS118E03M-1998	Biloxi Bay	Pathogens
MS118E04M(E)-1998	Graveline Bay	Nutrients, organic enrichment/low dissolved oxygen
MS118EO1M-1998	Big Lake	Pathogens
MS118EO2M2-1998	Back Bay of Biloxi	Pathogens

Table 4.8–10
Listed Impaired Waters in Turkey Creek–Old Fort Bayou Subwatershed (continued)

Identification Number	Waterbody	Parameter(s) of Concern
MS118GBE-1998	Graveline Bayou – DA	Nutrients, pathogens, organic enrichment/low dissolved oxygen
MS118HBE-1998	Heron Bayou	Nutrients, habitat alterations, pathogens, siltation, turbidity
MS118M1(E)-1998	Old Fort Bayou	Pathogens
MS118TBM(E)-1998	Tidewater Bayou	Siltation, organic enrichment/low dissolved oxygen, toxics, nonpriority organics, pathogens, priority organics, metals, pH
MS119C03M-1998	Deer Island coastline	Pathogens
MSMSSOUNDM(E)-1998	Mississippi Sound	Toxics, pH, arsenic
MSMSSOUNDM-1998	Mississippi Sound	Organic enrichment/low dissolved oxygen
MSSTLUBAYM-1998	Bay St. Louis	Pathogens

Source: USEPA, 2001a.

4.8.2.5.2.3 Tuxachanie Creek (HUC 03170009150)

The Tuxachanie Creek subwatershed is located north of Biloxi Bay. The primary land cover types within the subwatershed are forest (72 percent) and barren land (17 percent). The majority of the subwatershed is designated as the De Soto National Forest and a portion of the Mississippi Sandhill Crane National Wildlife Refuge is located in the subwatershed. Latimer is the largest municipality in the subwatershed. Four point source dischargers have been permitted in the subwatershed. There is one dam, but no mines located in the subwatershed. Soils range from poor to fair-to-good with respect to suitability for septic tanks. The subwatershed is sparsely populated. Designated water uses for the subwatershed include primary and secondary recreation, fish and wildlife propagation, threatened and endangered species propagation, commercial fishing and shellfish harvesting, and industrial water supply (Wicker et al., 1992). As shown in Table 4.8-11, two waterbodies in the subwatershed are listed on the state's list of impaired waters (USEPA, 2001a).

Table 4.8–11
Listed Impaired Waters in Tuxachanie Creek Subwatershed

Identification Number	Waterbody	Parameter(s) of Concern
MS117M1-1998	Tchoutacabouffa River	Pathogens
MS117M2-1998	Tuxachanie Creek	Pathogens

Source: USEPA, 2001a.

4.8.2.5.3 The Islands Watershed

The Islands watershed covers more than 88,500 acres off the coast of Mississippi, including Cat Island and Ship Island. Approximately 85,684 acres are surface water and fewer than 3,000 acres are land. No point source dischargers, mines, dams, or listed impaired waterbodies are located in the subwatershed.

4.8.2.6 Beaches

There are numerous swimming beaches in coastal Mississippi. These beaches extend along the Mississippi coast for 26 miles in Hancock, Harrison, and Jackson counties (Figure 4–8.1). The beaches are popular recreation destinations for residents and tourists. Mississippi established a Beach-Monitoring Task Force in 1998 composed of the Mississippi Department of Environmental Quality, the Department of Health, the Department of Marine Resources, and the Gulf Coast Research Laboratory. The task force has been responsible for monitoring the Mississippi coast since in 1999.

4.8.2.7 Sediment Quality

Sediment quality was analyzed using National Sediment Inventory (NSI) data to determine the general condition of the submerged sediments in the coastal Mississippi. Many metals and chemicals that enter the surface water system settle out into submerged sediments. Contaminated sediments can affect human health through a variety of ways, including direct exposure during recreation in waterbodies and consumption of fish and wildlife species that have bioaccumulated metals or chemicals from the sediments. Direct exposure to contaminated sediments can have adverse effects on the marine biota as well. This section summarizes available data for sediments in the coastal Mississippi watershed and reports on the conditions found and trends over time.

4.8.3 Pollutant Loads

Pollutants enter the coastal Mississippi watershed by various mechanisms, including the following:

- Watershed runoff entering the surface waterbodies directly and draining to the Mississippi Sound. These loads are reflective of the land uses in the various subwatersheds.
- Storm water runoff carrying pulsed pollutant loadings.
- Flows from combined sewer overflows (CSO) and sanitary sewer overflows (SSO). These point sources are common sources of the pathogens that cause beach and shellfish bed closures following storms.
- Permitted point sources discharging to surface waterbodies.
- Runoff from areas with failing septic systems.

4.8.3.1 Watershed Loads

Table 1 in Appendix D presents a detailed breakout of the land cover type distribution for each subwatershed in the watershed study area. The land cover types are presented in Table 1 (Appendix

D) were consolidated into five primary categories—forest, agriculture, urban, barren, and wetlands—for analysis of potential watershed loads (Table 4.8–12). Table 4.8–13 provides a summary of the land use distribution in the coastal Mississippi watershed study area Forest, surface water, and barren land are principal land uses. An examination of the acreage distribution shows that the overall coastal Mississippi watershed is relatively undisturbed. Approximately 43 percent of the watershed study area is undeveloped deciduous, evergreen, mixed forest, bottomland forest, swamp, or savanna. Approximately 24 percent is surface waterbodies.

Table 4.8–12
Land Cover Groupings

Original Land Cover	Grouped Land Cover
Medium Density Urban Land	Urban
High Density Urban Land	Urban
Transportation	Urban
Cropland/Pasture/Grassland	Agriculture
Deciduous/Mixed/Bottomland Hardwood Forest/Swamp	Forest
Pine Forest/Savanna	Forest
Scrub/Shrub/Cutover/Barren	Barren
Emergent Wetland	Wetland
Surface Water/Other	Not Used

Table 4.8–13
2000 Land Cover Distribution in Each Subwatershed (acres)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland	Total
Bay St. Louis						
Bayou La Croix	9,031	2,077	44,444	18,808	9,934	84,294
De Lisle	1,779	1,297	6,076	2,174	3,320	14,646
Lower Wolf River–Cane Creek	2,502	15,732	48,775	26,883	1,345	95,237
Rotten Bayou	2,143	5,636	18,357	10,735	278	37,149
Upper Jourdan River	1,662	26,262	76,995	37,480	457	142,856
Upper Wolf River	873	14,843	76,490	41,033	9	133,248
Biloxi Bay						
Biloxi River	5,054	15,640	111,666	38,395	748	171,503
Turkey Creek–Old Fort Bayou	36,319	14,003	62,690	22,978	5,856	141,846
Tuxachanie Creek	4,685	9,373	112,799	27,039	998	154,894
The Islands	0	0	698	1,348	823	2,869

Note: Surface water is not included in the land cover categories and its acreage is not included in the total acreage.
Source: MARIS, 2000.

The remaining 33 percent is primarily barren land (18 percent), with 8 percent agriculture and less than 5 percent of the land is used for residential or commercial purposes. Approximately 2 percent of the land is emergent wetlands.

A quantitative determination of the relative impact of various actions on water quality within the coastal Mississippi watershed requires the development of a baseline loading condition for the coastal areas so that the coastal water quality can be evaluated relative to various watershed development options. To develop the baseline loading condition, loading ratios for specific land uses were identified from literature values. The study *Characterization of Nonpoint Sources and Loadings to Corpus Christi Bay National Estuary Program Study Area* by the Corpus Christi Bay National Estuary Program (January 1996) and pollutant loading ranges for various land uses in *Fundamentals of Urban Runoff Management* (August 1994) were the main sources of the loading ratios. The ratios were normalized to the production of the pollutant of concern from land use with the greatest contribution of that pollutant.

Public comments received during the scoping phase of this project identified pathogens, sediment deposition, and low dissolved oxygen as issues of high concern for coastal Mississippi. The listed impaired waters in most of the subwatersheds in the area are listed based on pathogens, siltation, nutrients, organic enrichment/low dissolved oxygen, and metals as parameters of concern.

Using the land cover distributions from Table 4.8–13 and applying the associated loading ratios, the average annual percent contribution for each land use was calculated for the subwatersheds in the coastal Mississippi watershed. The attributes used with this calculation (e.g., similar nature, grade, soil type) were kept constant. Although these calculations do not produce actual predictions of pathogen or sediment loads, they are reasonable for identifying percent of contribution and represent a good baseline for comparative purposes. Point sources are not included in these calculations; they represent only the impact attributable to nonpoint sources.

Table 4.8–14 presents the yield of pathogens by land cover type relative to urban land use. Table 4.8–15 presents the percent contribution of pathogens per land cover type for each subwatershed. In both the Bay Saint Louis watershed and the Biloxi Bay watershed, most of the pathogens are produced by urban land uses, with agricultural and barren land uses also contributing a significant portion of the total pathogens.

Table 4.8–14
Yield of Pathogens by Land Cover Type Relative to Urban Land

Land Use	Pathogens
Urban	100
Agriculture	11.4
Forest	9.5
Barren	11.4
Wetland	7.2

Source: CCBNEP, 1996.

Table 4.8–15
2000 Pathogen Contribution by Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	46.41	1.22	21.70	11.02	19.66
De Lisle	8.58	6.26	29.30%	10.48	45.39
Lower Wolf River–Cane Creek	2.60	16.36	50.71	27.95	2.38
Rotten Bayou	36.95	11.08	30.08	21.11	0.77
Upper Jourdan River	1.15	18.19	53.33	25.96	1.37
Upper Wolf River	5.99	11.60	49.81	32.07	0.53
Biloxi Bay					
Biloxi River	23.02	8.12	48.30	19.93	0.63
Turkey Creek–Old Fort Bayou	75.58	3.32	12.39	5.45	3.26
Tuxachanie Creek	23.77	5.42	54.36	15.64	0.82

Table 4.8–16 presents the yield of sediment by land use relative to agricultural land use. Table 4.8–17 presents the percent contribution of sediment per land use type for each subwatershed.

Table 4.8–16
Yield of Sediment by Land Cover Type Relative to Agricultural Land

Land Use	Sediment
Agriculture	100
Urban	49
Forest	35
Barren	35
Wetland	19

Source: CCBNEP, 1996.

Sediment loading from land to streams is influenced primarily by soil type, topography, climate, and land use. Keeping all other factors constant, a change in land use distribution within a watershed can have a considerable effect on the sediment loading to its waterbodies by means of changing the amount of sediment that is available for transport by runoff. The agricultural land use yields significantly more sediment per unit area than any other land use or cover type. The urban land use also has a high sediment yield per unit area. The contribution from urban land is due mostly to construction activities. In general, an increase in human activities (disturbed land) along with a decrease in land cover (e.g., from vegetation or infrastructure) will increase the sediment available for transport.

Table 4.8–17
2000 Sediment Contribution Per Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	11.42	5.36	40.16	16.99	26.06
De Lisle	12.74	18.95	31.07	11.12	26.13
Lower Wolf River–Cane Creek	2.79	35.86	38.91	21.45	0.99
Rotten Bayou	6.18	33.18	37.83	22.12	0.70
Upper Jourdan River	1.21	38.90	39.91	19.43	0.55
Upper Wolf River	0.76	26.22	47.29	25.37	0.36
Biloxi Bay					
Biloxi River	3.49	22.03	55.04	18.93	0.52
Turkey Creek–Old Fort Bayou	27.00	21.24	33.29	12.20	6.27
Tuxachanie Creek	3.76	15.36	64.68	15.50	0.70

Table 4.8–18 presents the yield of biological oxygen demand for a 5-day period (BOD_5) by land use relative to urban land use. Table 4.8–19 presents the percent contribution of BOD_5 per land use type for each subwatershed.

Table 4.8–18
Yield of BOD_5 by Land Cover Relative to Urban Land

Land Use	BOD_5
Urban	100
Agriculture	4
Forest	6
Barren	6
Wetland	6

Source: CCBNEP, 1996.

Carbon inputs from plant matter, pet waste and trash can influence BOD_5 loading from urban land use to streams.

Table 4.8–20 presents the yield of total nitrogen by land cover type relative to urban land use. Table 4.8–21 presents the percent contribution of total nitrogen per land use type for each subwatershed.

Table 4.8–19
2000 BOD_5 Contribution Per Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	56.10	0.52	16.56	7.01	19.81
De Lisle	61.54	1.80	12.61	4.51	19.54
Lower Wolf River–Cane Creek	32.04	8.06	37.48	20.66	1.76
Rotten Bayou	51.61	5.43	26.54	15.52	0.90
Upper Jourdan River	17.14	10.83	47.63	23.18	1.22
Upper Wolf River	10.18	6.92	53.47	28.68	0.75
Biloxi Bay					
Biloxi River	34.16	4.23	45.27	15.57	0.78
Turkey Creek–Old Fort Bayou	83.83	1.29	8.68	3.18	3.01
Tuxachanie Creek	34.49	2.76	49.82	11.94	0.99

Table 4.8–20
Yield of Total Nitrogen by Land Cover Type Relative to Urban Land

Land Use	Total Nitrogen
Urban	100
Agriculture	99
Forest	53
Barren	96
Wetland	53

Source: CCBNEP, 1996.

Total nitrogen loading from land to streams is influenced by the use of fertilizers, presence of animal waste, and faulty septic systems, as well as by natural sources. Urban, agricultural, and barren land are the primary contributors. Nitrogen is typically the limiting nutrient in salt water systems; therefore, it was analyzed as an indicator for eutrophication and depressed dissolved oxygen levels.

Table 4.8–22 presents the yield of total phosphorus by land cover type relative to urban land use. Table 4.8–23 presents the percent contribution of total phosphorus per land use type for each subwatershed.

Total phosphorus loading from land to streams is influenced by the use of fertilizers, presence of animal waste, and industrial applications, as well as by natural sources. Urban and agricultural land are the primary contributors. Phosphorus is typically the limiting nutrient in freshwater systems; therefore, it was analyzed as an indicator for eutrophication.

Table 4.8–21
2000 Total Nitrogen Contribution Per Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	11.17	2.54	29.13	22.33	34.83
De Lisle	13.32	9.61	24.11	15.62	37.34
Lower Wolf River–Cane Creek	3.53	21.95	36.44	36.38	1.71
Rotten Bayou	7.63	19.87	34.64	36.69	1.18
Upper Jourdan River	1.58	24.65	38.68	34.11	0.99
Upper Wolf River	0.91	15.30	42.20	41.00	0.59
Biloxi Bay					
Biloxi River	4.30	13.17	50.33	31.34	0.87
Turkey Creek–Old Fort Bayou	31.04	11.85	28.40	18.86	9.85
Tuxachanie Creek	4.64	9.20	59.25	25.73	1.18

Table 4.8–22
Yield of Total Phosphorus by Land Cover Type Relative to Urban Land

Land Use	Total Phosphorus
Urban	100
Agriculture	63
Forest	10
Barren	21
Wetland	10

Source: CCBNEP, 1996.

Table 4.8–24 presents the yield of cadmium by land cover type use relative to urban land use. Table 4.8–25 presents the percent contribution of cadmium per land use type for each subwatershed.

Cadmium's relative loading is nearly equal for urban, agricultural, forest, and barren land uses, although the actual loading for all land uses is minimal. Cadmium is a byproduct of zinc, lead, and copper smelting; incineration of municipal waste; and burning of fossil fuels. Cadmium is also found in plastics, pigments, batteries, phosphate fertilizers, and metal plating (USEPA, 2001c).

Table 4.8–23
2000 Total Phosphorus Contribution Per Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	37.56	5.44	18.48	16.42	22.10
De Lisle	38.66	17.76	13.20	9.92	20.45
Lower Wolf River–Cane Creek	10.80	42.79	21.06	24.37	0.99
Rotten Bayou	21.76	36.07	18.65	22.90	0.63
Upper Jourdan River	4.89	48.70	22.66	23.17	0.58
Upper Wolf River	3.29	35.16	28.76	32.40	0.40
Biloxi Bay					
Biloxi River	14.72	28.70	32.53	23.49	0.56
Turkey Creek–Old Fort Bayou	62.18	15.10	10.73	8.26	3.72
Tuxachanie Creek	18.56	13.37	44.69	22.49	0.89

Table 4.8–24
Yield of Cadmium by Land Cover Type Relative to Urban Land

Land Use	Cadmium
Urban	100
Agriculture	80
Forest	80
Barren	80
Wetland	1

Source: CCBNEP, 1996.

Table 4.8–25
2000 Cadmium Contribution by Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	14.71	2.71	57.91	24.51	0.16
De Lisle	18.83	10.98	51.44	18.40	0.35
Lower Wolf River–Cane Creek	3.31	16.64	51.60	28.44	0.02

Table 4.8–25
2000 Cadmium Contribution by Land Cover Type for Each Subwatershed (percent) (continued)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Rotten Bayou	7.16	15.07	49.07	28.70	0.01
Upper Jourdan River	1.46	18.39	53.91	26.24	0.00
Upper Wolf River	0.82	11.12	57.31	30.75	0.00
Biloxi Bay					
Biloxi River	3.67	9.09	64.91	22.32	0.01
Turkey Creek–Old Fort Bayou	31.28	9.65	43.19	15.83	0.05
Tuxachanie Creek	3.78	6.04	72.74	17.44	0.01

Table 4.8–26 presents the yield of chromium by land cover type relative to urban land use. Table 4.8–27 presents the percent contribution of chromium per land use type for each subwatershed.

Table 4.8–26
Yield of Chromium by Land Use Relative to Urban Land

Land Use	Chromium
Urban	100
Agriculture	83
Forest	83
Barren	83
Wetland	1

Source: CCBNEP, 1996.

Table 4.8–27
2000 Chromium Contribution by Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	14.26	2.72	58.23	24.64	0.16
De Lisle	18.27	11.06	51.80	18.53	0.34
Lower Wolf River–Cane Creek	3.19	16.66	51.66	28.47	0.02
Rotten Bayou	6.92	15.11	49.20	28.77	0.01
Upper Jourdan River	1.40	18.40	53.94	26.26	0.00
Upper Wolf River	0.79	11.13	57.33	30.75	0.00

Table 4.8–27
2000 Chromium Contribution by Land Cover Type for Each Subwatershed (percent) (continued)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Biloxi Bay					
Biloxi River	3.54	9.10	65.00	22.35	0.01
Turkey Creek–Old Fort Bayou	30.49	9.76	43.69	16.01	0.05
Tuxachanie Creek	3.64	6.05	72.84	17.46	0.01

Chromium's relative loading is nearly equal for urban, agricultural, forest, and barren land although the actual loading for all land uses is minimal. Chromium is highly corrosive resistant and is used in automotive parts, batteries, electroplating, and pigments (MPCA, 1999).

Table 4.8–28 presents the yield of copper by land use relative to urban land use. Table 4.8–29 presents the percent contribution of pathogens per land use type for each subwatershed.

Table 4.8–28
Yield of Copper by Land Cover Type Relative to Urban Land

Land Use	Copper
Urban	100
Agriculture	10
Forest	10
Barren	20
Wetland	1

Source: CCBNEP, 1996.

Table 4.8–29
2000 Copper Contribution by Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	51.48	1.18	25.33	21.44	0.57
De Lisle	59.61	4.35	20.36	14.57	1.11
Lower Wolf River–Cane Creek	17.44	10.97	34.01	37.49	0.09
Rotten Bayou	32.01	8.42	27.44	32.09	0.04

Table 4.8–29
2000 Copper Contribution by Land Cover Type for Each Subwatershed (percent) (continued)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Upper Jourdan River	8.53	13.48	39.51	38.46	0.02
Upper Wolf River	4.80	8.15	42.00	45.06	0.00
Biloxi Bay					
Biloxi River	19.84	6.14	43.84	30.15	0.03
Turkey Creek–Old Fort Bayou	74.67	2.88	12.89	9.45	0.12
Tuxachanie Creek	20.99	4.20	50.54	24.23	0.04

Urban land use is the primary contributor of copper. Possible sources of copper include alloys, wiring, tubing, springs, roofing, gears, biocides, heat exchangers, marine fittings and propellers, and marine corrosion–resistant assemblies.

Table 4.8–30 presents the yield of zinc by land cover type relative to urban land use. Table 4.8–31 presents the percent contribution of zinc per land use type for each subwatershed.

Table 4.8–30
Yield of Zinc by Land Cover Type Relative to Urban Land

Land Use	Zinc
Urban	100
Agriculture	15
Forest	5.6
Barren	5.6
Wetland	1

Source: CCBNEP, 1996.

Zinc loading from land to streams is influenced primarily by urban land uses. Possible sources of zinc include insecticides, fungicides, alloys, paints, pigments, and wire coating; zinc is also used as an additive in rubber products and gasoline (MIT, 2002c).

4.8.3.2 Point Source Discharges

Figure 4.8–1 presents the locations of permitted point source discharges within the coastal Mississippi watershed (HUC 03170009). Table 1 in Appendix C presents the identification numbers, names, locations, receiving waters, and average design discharges for each. Most of the dischargers are located near populated areas of the watershed, particularly in the Turkey Creek–Old Fort Bayou subwatershed.

Table 4.8–31
2000 Zinc Contribution by Land Cover Type for Each Subwatershed (percent)

Subwatershed	Urban	Agriculture	Forest	Barren	Wetland
Bay St. Louis					
Bayou La Croix	69.56	2.40	19.17	8.11	0.77
De Lisle	72.06	7.88	13.78	4.93	1.34
Lower Wolf River–Cane Creek	27.45	25.90	29.98	16.52	0.15
Rotten Bayou	46.37	18.30	22.26	13.01	0.06
Upper Jourdan River	13.84	32.78	35.88	17.47	0.04
Upper Wolf River	9.02	23.00	44.24	23.73	0.00
Biloxi Bay					
Biloxi River	31.97	14.84	39.55	13.60	0.05
Turkey Creek–Old Fort Bayou	83.93	4.85	8.11	2.97	0.14
Tuxachanie Creek	33.63	10.09	45.34	10.87	0.07

4.8.3.3 Water Quality

Water quality data from 1998 to 2000 was provided by the MDEQ. Existing water quality was evaluated on twenty-four monitoring stations within the coastal Mississippi watershed (Table 4.8–32). These monitoring stations were selected for analyses based on the amount of data available, the length of time that water quality has been monitored, and geographic distribution in the coastal Mississippi watershed. Figure 4.8–1 presents the locations of the stations. Most of the monitoring stations are located in the coastal study area for this EIS (i.e., Turkey Creek–Old Fort Bayou subwatershed). No monitoring data were available for the Islands subwatershed. Since the Islands subwatershed does not drain to the area of interest of this EIS and there are no available water quality data, it is not discussed further in this section.

Table 4.8–32
Water Quality Sampling Station Locations

Station Number	Station Location	Use Classification
Bayou La Croix		
02481667	Jourdan River at I-10 near Kiln	Recreation
02481675	St. Louis Bay near Bay St. Louis at Highway 90	Shellfish Harvesting
639SLB01	St. Louis Bay near Bay St. Louis off Cowand Point	Shellfish Harvesting
Biloxi River		
02480990	Biloxi River near Wortham	Fish and Wildlife
02481050	Saucier Creek at Wortham	Fish and Wildlife
02481100	Little Biloxi River near Lyman	Fish and Wildlife

Table 4.8–32
Water Quality Sampling Station Locations (continued)

Station Number	Station Location	Use Classification
De Lisle		
02481527	Wolf River near De Lisle	Recreation
Lower Wolf River–Cane Creek		
02481510	Wolf River near Landon	Recreation
Turkey Creek–Old Fort Bayou		
024812665	Bernard Bayou at Handsboro Bridge at Handsboro	Fish and Wildlife
02481270	Back Bay of Biloxi at Popps Ferry near Biloxi	Shellfish Harvesting
02481287	St. Martin Bayou NE of D'Iberville	Fish and Wildlife
02481289	St. Martin Bayou at mouth near D'Iberville	Fish and Wildlife
024812975	Old Fort Bayou near Fontainbleau above KOA	Fish and Wildlife
02481300	Back Bay of Biloxi at Ocean Springs	Shellfish Harvesting
02481310	Bayou Portage at Cuevas	Fish and Wildlife
02481325	Bayou Portage at Henderson Avenue near De Lisle	Fish and Wildlife
302540088511000	Old Fort Bayou at Mile 0 (024812998)	Fish and Wildlife
639SLB02	St Louis Bay near De Lisle off Mallini Point	Shellfish Harvesting
640BBYB01	Biloxi Bay near Ocean Springs	Shellfish Harvesting
640BBYB02	Biloxi Bay (Davis Bayou) at Ocean Springs	Shellfish Harvesting
646BBB04	Back Bay of Biloxi at Biloxi off Clay Point	Shellfish Harvesting
Tuxachanie Creek		
02480350	Tchoutacabouffa River near Latimer	Recreation
02480500	Tuxachanie Creek near Biloxi	Recreation
Upper Jourdan River		
02481660	Jourdan River near Bay St. Louis	Recreation

Data from the 24 monitoring stations were analyzed for the parameter list presented in Table 4.8–33. The data were collected from 1998 to 2000 and provide a good representation of water quality conditions over various seasons. Table 4.8–19 also lists the Mississippi water quality standards that apply for each parameter where applicable.

Tables 1 through 24 in Appendix E present summaries of the water quality data from sample analyses for the 24 selected stations within the watershed. The tables present the number of observations, minimum value, maximum value, arithmetic mean, geometric mean, 25th percentile value, and 75th percentile value. If values exceed state standards for more than 25 percent of the observations, it is thought to be a possible indication of a water quality concern (unless the number of samples taken is small [i.e., three or fewer]). In cases where there are only a few observations made or cases where there are numerous observations with only a few individual data points exceeding state standards, no water quality problems are assumed due to the limited results. Water quality within the coastal Mississippi watershed is generally considered to be satisfactory for the designated uses.

Table 4.8–33
Water Quality Standards for Coastal Mississippi

Parameter	Units	Water Quality Standard
Water Temperature	ºC	<32.2 ºC
pH	SU	6.5> and <9
Alkalinity	mg/L as $CACO_3$	
Conductivity	µohms/cm	<1,000 µohms/cm (fresh water)
Chlorides (Cl)	mg/L	<60 mg/L
Secchi Depth	m	>0.2 m[c]
Turbidity	NTU	<100 NTU[c]
Total Dissolved Solids	mg/L	<1,500 mg/L (fresh water)
Total Suspended Solids	mg/L	<80 mg/L[c]
Fecal Coliform Bacteria (shellfish harvesting)	MPN/100ml	43 MPN/100ml[b]
Fecal Coliform Bacteria (recreation)	MPN/100ml	400 MPN/100ml[b]
Fecal Coliform Bacteria (fish and wildlife)	MPN/100ml	400 MPN/100ml [b] (May to Oct.) 4,000 MPN/100ml [b] (Nov. to April)
Total Nitrogen	mg/L	
NH_3 + NH_4-N, Total	mg/L as N	<1.1 mg/L
NO_2 + NO_3-N, Total	mg/L	<1 mg/L[c]
Organic Nitrogen	mg/L	
Total Kjeldahl Nitrogen	mg/L as N	<1.5 mg/L[c]
Total Phosphorous	mg/L as P	<0.2 mg/L[c]
Ortho Phosphorous, Total	mg/L	
Dissolved Oxygen	mg/L	>4 mg/L
BOD5	mg/L	<5 mg/L[c]
Chlorophyll *a*	mg/cubic meter	<10 mg/cubic meter[c]
Arsenic, Total Recoverable[d]	µg/L	<344 µg/L (fresh water) <69 µg/L (salt water)
Cadmium, Total Recoverable[a]	µg/L	<1.8 µg/L (fresh water) <44 µg/L (salt water)
Chromium, Total Recoverable[d]	µg/L	<311 µ/L (fresh water)
Copper, Total Recoverable[a]	µg/L	<9.92 µ/L (fresh water) <2.9 µg/L (salt water)
Iron, Total	µg/L	
Lead, Total Recoverable[a]	µg/L	<34 µg/L (fresh water) <235 µg/L (salt water)

Table 4.8–33
Water Quality Standards for Coastal Mississippi (continued)

Parameter	Units	Water Quality Standard
Mercury, Total Recoverable	µg/L	<2.5 µ/L (fresh water)
		<2.1 µg/L (salt water)
Zinc, Total Recoverable[a]	µg/L	<65 µ/L (fresh water)
		<92 µg/L (salt water)
Phenols	µg/L	<300 µ/L

[a] Calculated at a hardness of 50mg/L ($CACO_3$).
[b] For waters classified for shellfish harvesting, the median fecal coliform MPN of the water shall not exceed 14 per 100ml, and not more than 10 percent of the samples shall ordinarily exceed an MPN of 43 per 100 ml in those portions or areas most probably exposed to fecal contamination during most unfavorable hydrographic and pollution conditions.
For waters classified for recreation, fecal coliform shall not exceed a geometric mean of 200 per 100ml nor shall more than 10 percent of the samples examined during any month exceed 400/100ml.
For waters classified for fish and wildlife during the months of May through October, fecal coliform shall not exceed a geometric mean of 200/100ml nor shall more than 10 percent of the samples examined during any month exceed 400/100ml. For the months of November through April, fecal coliform shall not exceed a geometric mean of 2,000/100ml, nor shall more than 10 percent of the samples examined during any month exceed 4,000/100ml.
[c] Acceptable Target Level.
[d] USEPA National Water Quality Criteria

4.8.3.3.1 Physical Characteristics

Total chloride in water, pH, specific conductance, and water temperature provide information on the physical characteristics within the watershed. Tables 1 through 24 in Appendix E present summaries of the physical characteristics for 24 of the stations within the watershed. At seven of the 24 monitoring stations, pH values are below the state of Mississippi water quality standards. For most of the monitoring stations this is thought to be due to the presence of wetlands in those areas. Wetlands contain naturally high levels of tannic acids and have lower pH values than other freshwater areas. Low pH values, such as those observed in the data, are not expected to indicate a water quality problem in lowland areas with wetlands present. However, monitoring station 02480350 in the Tuxachanie Creek subwatershed has pH values ranging from 4.48 to 7.90, with an average value of 6.06. This station does not occur in an area dominated by wetlands.

Sixteen of the monitoring stations in the Mississippi CSA watershed have high values for specific conductance when compared to the state freshwater standard for specific conductance. Many of the stations with these high values occur in open water (i.e., salt water) areas that do not fall under the purview of fresh water standards. The other stations occur in areas where fresh water and salt water mix and naturally result in water quality characteristics with high specific conductance. The high values seen in the data from 1998–2000 are not unexpected because of their observation in salt water areas or in salt water/fresh water mixing zones. However, monitoring station 024812975 in the Turkey Creek–Old Fort Bayou has specific conductance values ranging from 18 to 22,787 µohms/cm with an average value of 5,372. It is possible that salt water and fresh water mixing occurs at the station, but the exact cause of these values is unclear.

4.8.3.3.2 Pathogens

Sources of fecal coliform loading in the Mississippi CSA watershed include runoff from agricultural areas, failing septic systems, CSO, SSO, and other sources associated with urban and residential land uses. Storm water runoff carries high loads of pathogens directly into surface waterbodies, including the Gulf of Mexico. These high loads have caused swimming beach and shellfish bed closures. Following rainfall, oyster reefs may be temporarily closed to oystering when poor water conditions exist, and there is a standing advisory against swimming at beaches for 24 hours following "significant" rainfall.

The state of Mississippi has set a fecal coliform standard for the various designated uses in the state's waters (shellfish harvesting, recreation, fish and wildlife propagation) (see Table 4.8–19). An analysis of the water quality data from 1998 to 2000 shows that the fecal coliform concentrations generally fall within the acceptable state standards (Appendix E). Monitoring station 02481287 in the Turkey Creek–Old Fort Bayou subwatershed has fecal coliform values that exceed the state standards. Fecal coliform values range from 61 to 2,700 CFU/100 ml. It is thought that these elevated values may be due to the presence of a nearby pasture or medium-intensity urban development.

4.8.3.3.3 Sediment

Total nonfiltrable residue, total dissolved residue, and turbidity provide information on the sediment loads in the watershed. Total nonfiltrable residue and turbidity are indicators of soil runoff into a waterbody. Total dissolved residue is composed of inorganic salts (e.g., calcium, magnesium, potassium, sodium, bicarbonates, chlorides, sulfates) and small amounts of organic matter that are dissolved in water. Concentrations of total dissolved residue in water vary considerably in different geological regions due to differences in solubilities of minerals and proximity to salt water.

In general, the sediment loads in the watershed do not exceed water quality standards. However, an analysis of water quality data from 1998 to 2000 shows that state standards for total dissolved residue (Appendix E) were exceeded at nine of the monitoring stations. This is thought to be due to the presence of wetlands or salt water in these areas. Wetlands contain naturally high levels of tannic acids and have higher total dissolved solid values than other freshwater areas. Open water (i.e., salt water) also naturally contains high levels of dissolved solids (e.g., chlorides). Total dissolved residue values such as those observed in the data do not necessarily indicate a water quality problem in lowland areas with wetlands present or in open water areas.

4.8.3.3.4 Eutrophication

Biological oxygen demand, nitrogen levels, phosphorus levels, dissolved oxygen, and secchi depth provide information on the nutrient loads in the Mississippi CSA watershed. Water quality data for the period 1998 to 2000 indicate that the nitrogen and phosphorus concentrations generally fall within the state standards. Data collected at monitoring station 024812665 in the Turkey Creek–Old Fort Bayou subwatershed hade total phosphorus values above the state standard. The values ranged from 0.07 to 0.26 mg/L with an average value of 0.19. These values could be caused by urban runoff from nearby developed areas. Most freshwater waterbodies are phosphorus limited. Having high phosphorus levels could result in eutrophication of the waterbodies in the area.

4.8.3.3.5 Metals

Arsenic, cadmium, chromium, copper, lead, mercury, and zinc were analyzed to provide information on metal loads in the coastal Mississippi watershed. The data from the period 1998 to 2000 indicate that occasionally an individual value will be high for cadmium and copper, but in general the values are within the acceptable state standards and are not thought to be a water quality issue in the watershed. It is possible that elevated levels of copper are due to wood preservatives leaching out of docks or from techniques used to control nuisance aquatic plant species.

4.8.3.3.6 Organics

Twelve of the monitoring stations had water quality data that included phenols. Phenols data were analyzed to provide information on loading of organics in the coastal Mississippi watershed. All of the phenols data fell within the acceptable state standards.

4.8.3.4 Beaches

The contiguous Mississippi Sound coastline has a designated use of recreation. Given that designation, Mississippi water quality standards for pathogens state that fecal coliform counts cannot exceed a geometric mean of 200 per 100 ml and that no more than 10 percent of the samples examined during any month can exceed 400 per 100 ml.

The coastal Mississippi bathing beaches are monitored weekly for water quality. MDEQ and the Gulf Coast Research Laboratory work in conjunction year-round to collect water samples. Samples are collected from 22 monitoring stations, 19 of which are located in the project study area for this EIS (Figure 4.8–1). Water samples are tested for fecal coliform, *Eschericia coli*, and *enterococci*. From March through October, 4 to 5 samples per week are collected. During the period from November to February, samples are collected 2 to 4 days per week. Appendix F presents the provisional data from the Mississippi beach monitoring for the years 2000, 2001, and 2002 (USM COMS, 2002a). The data presented include the bacteria counts, monthly geometric mean, monthly number of exceedances, and monthly percent of exceedances.

Based on the fecal coliform counts found in the water quality samples, management decisions are made on whether to close the bathing beaches or to issue an advisory. There is a standing advisory against swimming at beaches for 24 hours following a “significant” rainfall. The public is also advised not to swim near storm drains present along the coast (NRDC, 2001). In 1999, Mississippi beaches were closed twice for a total of 9 days. In 2000, the beaches were also closed twice for a total of 60 days. In 2001, Mississippi beaches were closed 15 times for a yearly total of 99 days. Beach closings information is presented in Table 4.8–34 and Appendix F (NRDC, 2001; USEPA, 2002; USM COMS, 2002b).

Common sources of fecal coliform cited as potential sources of pollution for Mississippi’s beaches include combined sewer overflows, sanitary sewer overflows, breaks in pipes, storm water, runoff, wildlife, and boat discharges (NRDC, 2001; USEPA, 2002).

Table 4.8–34
Mississippi Beach Closures (1999–2001)

Monitoring Station	Dates	Advisory or Closing	Total Number of Days Posted	Source(s)
Harrison County				
N/A	6/24/99–6/30/99	Closing	6	Break in sewer pipeline
N/A	8/13/99–8/16/99	Closing	3	Break in sewer pipeline
Station 11	6/20/00–8/4/00	Closing	45	Sewage leaking from pipe break in RV Park
Station 12	7/7/00–7/21/00	Closing	15	CSO (failure of lift station)
Station 13	4/11/01–4/15/01	Closing	4	Unknown
Station 12	4/11/01–4/15/01	Closing	4	Unknown
Station 12A	4/12/01–4/15/01	Closing	3	Unknown
Station 11	4/14/01–4/18/01	Closing	4	Unknown
Station 6	5/9/01–5/14/01	Closing	5	Unknown
Station 12A	5/11/01–5/17/01	Closing	6	Unknown
Station 7	5/11/01–5/18/01	Closing	7	Unknown
Station 11	6/14/01–6/18/01	Closing	4	Unknown
Station 12A	6/14/01–7/9/01	Closing	26	Sewer line blockage/break
Station 10	6/15/01–6/17/01	Closing	2	Unknown
Station 9	6/25/01–7/9/01	Closing	15	Unknown
Station 7	6/28/01–7/2/01	Closing	5	Unknown
Station 13	6/29/01–7/2/01	Closing	4	Sewer line
Station 12A	8/31/01–9/5/01	Closing	6	Storm water runoff
City of Ocean Springs				
Station 15	6/14/01–6/18/01	Closing	4	SSO

Sources: USEPA, 2002; USM COMS, 2002b

4.8.3.5 Sediment Quality

Evaluating the current baseline conditions for the year 2000 is not possible. No known sediment data from 2000 exist to evaluate the current sediment chemistry conditions for coastal Mississippi.

4.8.4 Mississippi Coastal Study Area Watersheds – Historical Analysis

4.8.4.1 Historical Conditions

Water quality data for the period 1970 to 1998 were obtained from the USEPA STOrage and RETrieval (STORET) database system. STORET includes sampling data collected by the MDEQ, U.S. Geological Survey, and other federal and state agencies sampling water quality in the coastal Mississippi watershed. Historical water quality was evaluated the 24 monitoring stations previously identified in Section 4.8.2 (Figure 4.8–1). Monitoring data was analyzed for two historic time periods, 1972–1974 and 1992–1994. The 1972–1974 time period is anticipated to show the water quality conditions in the coastal Mississippi watershed prior to most development in the area. The 1992–1994 time period is anticipated to show the water quality conditions prior to casino development in the area. Water quality data were available for six of the monitoring stations for the 1972–1974 period and for 10 of the monitoring stations for the 1992–1994 period.

Data from the monitoring stations were analyzed for the same parameters analyzed above in the baseline conditions description. For the historical time periods it is important to note that water quality sampling procedures and equipment have changed dramatically over the past 20 years. Some historic data, particularly metals data, are suspect by current standards. The following section describes the water quality conditions for the 1972–1974 and 1992–1994 time periods. Tables in Appendix E contain summaries to the historical water quality data.

4.8.4.1.1 Physical Characteristics

Tables included in Appendix E present summaries of the physical characteristics for 1972–1974 and 1992–1994 where data are available. The data from 1972–1974 show that occasionally an individual value can be high for chloride, but in general the values are within the acceptable state standards and are not thought to be a water quality issue in the watershed. It would be expected to see high chloride values in open water area or areas where fresh water and salt water mix.

During the period of 1972–1974, one of six monitoring stations was found to have pH values that exceeded state standards. Station 02481270 in the Turkey Creek–Old Fort Bayou subwatershed had pH values ranging from 5.9 to 7.1 with an average value of 6.33. During the period of 1992–1994, 6 of 10 monitoring stations were found to have pH values that exceeded state standards. For most of the monitoring stations this is thought to be due to the presence of wetlands in those areas. Wetlands contain naturally high levels of tannic acids and have lower pH values than other freshwater areas. Low pH values such as those observed in the data are not expected to indicate a water quality problem in lowland areas with wetlands present. However, monitoring station 02480350 in the Tuxachanie Creek subwatershed had pH values ranging from 4.38 to 5.88 with an average value of 5.10. The station does not occur in an area dominated by wetlands.

For the period 1992–1994, 3 of 10 monitoring stations had high values for specific conductance when compared to the state freshwater standard for specific conductance. Two of the stations with these high values are located in open water (i.e., salt water) areas that do not fall under the purview of fresh water standards. The other station is located in an area where fresh water and salt water mix and naturally result in water quality characteristics with high specific conductance. The high values seen in the data are not unexpected due to their observation in salt water areas or in salt water/fresh water mixing zones.

4.8.4.1.2 Pathogens

An analysis of the water quality data from 1972–1974 shows that the fecal coliform concentrations generally occurred within the acceptable state standards. Two of six monitoring stations had fecal coliform values that exceeded the state standards. Monitoring stations 02481270 and 02481300 in the Turkey Creek–Old Fort Bayou subwatershed had fecal coliform values ranging from 99 to 1,040 CFU/100 ml and 129 to 380 CFU/100ml, respectively, with average values of 418 and 217 CFU/100 ml respectively. The waterbodies at these monitoring stations are designated as shellfish harvesting waters. The high fecal coliform values observed could be due to storm events (e.g., CSOs, SSOs, storm water runoff) or discharge of primary treated sanitary wastewater. For the period of 1992–1994, all of the samples taken at the 10 water quality monitoring stations were within the state standards.

4.8.4.1.3 Sediment

For both the 1972–1974 and 1992–1994 periods, total nonfiltrable residue, total dissolved residue, and turbidity values were found to be within acceptable state standards.

4.8.4.1.4 Eutrophication

Biological oxygen demand, nitrogen levels, phosphorus levels, dissolved oxygen, and secchi depth values were analyzed from historical data. For the 1972 to 1974 time period, all samples taken at six water quality monitoring stations were within acceptable state water quality standards for the eutrophication parameters. An analysis of the data from the 1992 to 1994 time period show that the eutrophication parameters generally occur within the state standards. Monitoring station 024812665 in the Turkey Creek–Old Fort Bayou subwatershed was observed to have total phosphorus values above the acceptable state standard. The values range from 0.09 to 0.43 mg/L with an average value of 0.23. These values could be caused by urban runoff from nearby developed areas.

4.8.4.1.5 Metals

Arsenic, cadmium, chromium, copper, lead, mercury, and zinc data were analyzed to characterize historic concentration levels of metals levels in the Mississippi CSA watersheds. The data from 1972 to 1974 indicate only a few exceedances of water quality standards for copper. In general, concentration levels were within the acceptable state standards and were not considered to be a water quality problem. Data for the period 1992 to 1994 also indicated that periodically, concentrations of copper reached elevated levels, but the number of observations was small. Monitoring station 02481325 in the Turkey Creek–Old Fort Bayou subwatershed had values ranging from 20 to 67 with an average value of 37.5 for four observations that were made. Cadmium concentration levels during the period 1992 to 1994 on occasion also reached elevated levels but were for the most part within the acceptable state standards and are not thought to be a water quality issue in the watershed. Elevated levels of copper may be due to wood preservatives leaching out of docks or from techniques used to control nuisance aquatic plant species.

4.8.4.1.6 Organics

An analysis of the data from 1972 to 1974 included samples tested for 4,4 DDT (dichlorodiphenyltrichloroethane), aldrin, chlordane, endrin, heptachlor, total PCBs, and toxaphene. Only single observations were available for each of these organics and no exceedances of state water

quality standards were observed. In fact, the readings were all at or below detection limits. No organics data were available for the 1992 to 1994 time period.

4.8.4.1.7 Beaches

In 1999, the Gulf Coast Research Lab began collecting and analyzing water samples for Mississippi's beach areas. Prior to 1999, no known beach monitoring data is available. Without this information it is not possible to analyze the historic water quality conditions of Mississippi's beaches or determine if trends attributable to casino development exist.

4.8.4.1.8 Sediment Quality

Sediment quality data from 1980 to 1993 were obtained from the USEPA NSI database. (No data were available prior to 1980 or after 1993 in the NSI database.) The NSI database contains sediment chemistry data and related biological data from more than 21,000 sampling stations located in 1,363 of the 2,111 watersheds in the continental United States including the Mississippi CSA watershed (USEPA, 2001a). Sediment quality data from 1970 to 1998 were also obtained from the USEPA STORET database system (USEPA, 2001b). The STORET database includes sampling data collected by the MDEQ, U.S. Geological Survey, and other federal and state agencies sampling water quality in the coastal Mississippi watershed. Sediment quality data in the STORET database are limited as it primarily contains water quality information. Sediment quality data were only available for the period of 1972 to 1977.

Monitoring data were analyzed for two time periods, 1972–1977 and 1990–1993. The 1972–1977 time period shows sediment quality conditions in the coastal Mississippi watershed prior to most development in the area. The 1990–1993 time period indicates the sediment quality conditions prior to casino development in the area. Tables in Appendix G contain summaries of the historical sediment quality data.

Sediment samples from STORET and the NSI database were analyzed for the parameter list presented in Table 4.8–35. Table 4.8–35 also lists the acceptable NOAA sediment quality mean-effects guideline for each parameter. Currently no published sediment standards exist.

Table 4.8–35
Sediment Quality Mean Effects Guidelines for Coastal Mississippi

Parameter	Units	Sediment Quality Guideline
Arsenic	mg/Kg	<70
Cadmium	mg/Kg	<9.6
Chromium, total	mg/Kg	<370
Copper	mg/Kg	<270
DDT, total	µg/Kg	<46
Lead	mg/Kg	<220
Mercury	mg/Kg	<0.71
Nickel	mg/Kg	<52
PAH, total	mg/Kg	<45
PCB, total	µg/ Kg	<180
Silver	mg/Kg	<3.7

Source: NOAA, No date.

Tables 1 through 4 in Appendix G present summaries of the 1972–1977 data for the coastal Mississippi watershed. Sediment samples were not collected at the same location over time; they were collected randomly over space and time within the larger coastal Mississippi watershed. Therefore, data in the tables are grouped by each subwatershed where sampling occurred, including Bayou La Croix, Lower Wolf River–Cane Creek, Upper Jourdan River, and Turkey Creek–Old Fort Bayou. Tables 5 through 8 in Appendix G present summaries of the 1990–1993 data for the coastal Mississippi watershed. Data in the tables is also grouped by each subwatershed where sampling occurred, including Bayou La Croix, De Lisle, Turkey Creek–Old Fort Bayou, and The Islands/Mississippi Sound. Figure 4.8–1 presents the monitoring stations per subwatershed for the 1972–1977 and 1990–1993 time periods. Tables 1 through 8 in Appendix G present the number of observations, minimum value, maximum value, arithmetic mean, geometric mean, 25th percentile value, and 75th percentile value. In general, the sediment samples do not exceed the NOAA sediment quality guidelines and sediment quality appears to be satisfactory for the area. The sediment quality conditions for metals and organics are discussed below.

Metals. Arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, and zinc data were analyzed to characterize historic metal concentration levels in the sediments of the Mississippi CSA watershed. Generally the data from 1972–1977 and 1990–1993 fall within NOAA sediment quality guidelines. However, 14 sediment samples exceeded the NOAA guideline for cadmium. These samples came from Bayou La Croix, Lower Wolf River–Cane Creek, and Turkey Creek–Old Fort Bayou. Cadmium is a byproduct of zinc, lead, and copper smelting; incineration of municipal waste; and burning of fossil fuels. Cadmium is also found in plastics, pigments, batteries, phosphate fertilizers, and metal plating (USEPA, 2001c). Two sediment samples exceeded the guideline for mercury in 1977 in the Turkey Creek–Old Fort Bayou subwatershed and one sediment sample exceeded the guideline for arsenic in 1990 in the Mississippi Sound. Mercury is found in thermometers, barometers, pressure sensing devices, batteries, lamps, lubrication oils, and paint manufactured prior to 1990 (USEPA, 2001d). Arsenic is found in wood preservatives, microelectronics, semiconductors, and coal-burning residues (USEPA, 2001e).

Organics. Total DDT, total PAH (polynuclear aromatic hydrocarbons), and total PCB (polychlorinated biphenyl) data were analyzed to characterize historic chemical loading trends in the sediments of the Mississippi CSA watershed. The concentration levels from 1972–1977 and 1990–1993 fall within NOAA sediment quality guidelines.

4.8.4.2 Historical Trends

It was not possible to identify reliable water quality trends based on the data from the time periods of 1972–1974, 1992–1994, and 1998–2000. Therefore, additional water quality information from STORET (1970–1998) and MDEQ (1998–2000) was analyzed for trends. These data included data collected for the 24 water quality monitoring stations selected for the years in between the three target dates (1972, 1992, and 2000). In general, even taking into consideration data from these additional monitoring years, the trends are weak.

4.8.4.2.1 Physical Characteristics

No trends in total chloride were found (Appendix H–Figure 1a). One exceedance was observed in the Upper Jourdan River subwatershed in 1972. One exceedance was observed in the Biloxi River subwatershed in 1998. High total chloride levels were observed at sampling stations located in open water areas of the Turkey Creek–Old Fort Bayou subwatershed, as is expected.

Data on pH values were also evaluated to identify any trends during the past 30 years (Appendix H–Figures 2a and 2b). The data indicate a slight increase in pH values in the Lower Wolf River–Cane Creek (1975–2001), Biloxi River (1992–2001), and Tuxachanie Creek subwatersheds (1993–2001). The range of pH values has increased over time for all of the subwatersheds, possibly indicating increased productivity associated with eutrophication (e.g., higher algal concentrations).

Specific conductivity and water temperature data was also analyzed for historic trends. No trends were observed for these water quality parameters.

4.8.4.2.2 Pathogens

An analysis of the in-stream water quality data indicated a slightly decreasing trend in pathogens in the Bayou La Croix subwatershed, but there were historic exceedances (Appendix H–Figure 3a). During 1975–1985, 11 percent of the samples exceeded 400 CFU/100ml. From 1986–1992, 5 percent of the samples exceeded 400 CFU/100ml. During the period of 1993–1998, 10 percent of the samples exceeded 400 CFU/100ml.

Historical water quality data shows a slightly increasing trend in pathogens in the Lower Wolf River–Cane Creek subwatershed. During the period of 1975–1985, 12.5 percent of the samples exceeded 400 CFU/100ml. During the period of 1986–1992, 46 percent of the samples exceeded 400 CFU/100ml. During the period 1993–1998, 36 percent of the samples exceeded 400 CFU/100ml.

There was no observed trend in pathogens for the Upper Jourdan subwatershed, but there were many exceedances from 1974–1998. During the period 1974–1985, 21 percent of the samples exceeded 400 CFU/100ml. During the period 1986–1992, 22 percent of the samples exceeded 400 CFU/100ml. During the period 1993–1998, 26 percent of the samples exceeded 400 CFU/100ml.

An analysis of the in-stream water quality data indicated no trend in pathogens in the Biloxi River subwatershed, but there were historic exceedances from 1993–1998 (Appendix H–Figure 3b). No pathogen data were available before 1992.

An analysis of the in-stream water quality data indicated a slightly decreasing trend in pathogens in the Turkey Creek–Old Fort Bayou subwatershed, but there were historic exceedances. There are different water quality standards for waterbodies in this subwatershed; 400 CFU/100ml for recreation waters and 43 CFU/100ml for shellfish harvesting waters. During 1974–1985, 17 percent of the samples exceeded 400 CFU/100ml and 68 percent of the samples exceeded 43 CFU/100ml. From 1986–1992, 23 percent of the samples exceeded 400 CFU/100ml and 68 percent exceeded 43 CFU/100ml. During the period of 1993–1998, 16 percent of the samples exceeded 400 CFU/100ml and 53 percent of the samples exceeded 43 CFU/100ml.

No trends were observed for pathogens in the Tuxachanie Creek subwatershed. Exceedances were observed in 1993, 1994, 1997, and 1998. No pathogen data were available for this subwatershed prior to 1992.

A separate analysis assessed the potential for the production of pathogens (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis indicated that pathogen levels had the potential to increase from 1972–2000 for all subwatersheds. This is due mostly to the increase in urban land uses (Figures 4a and 4b in Appendix H and Figure 4.8–2).

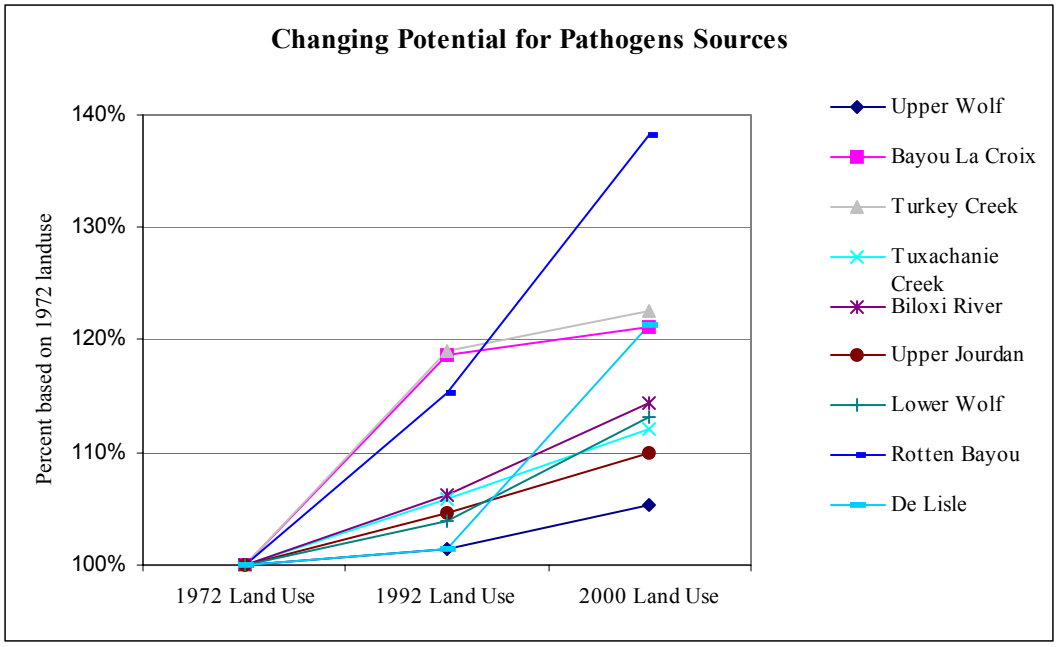


Figure 4.8–2. Increasing Potential for Pathogens Available for Transport to Surface Waters Due to Changes in Land Use.

Figure 4.8–2 shows the trend for pathogens potentially available for transport to surface waters due to changes in land use for each subwatershed. It does not represent changes of actual in-stream pathogen loads. This analysis does not factor in the expected die-off rate of pathogens, and assumes that all pathogens are available for loading in the waterbodies. In reality, pathogen loading will depend on timing of storm events, die-off rates, and the presence of BMPs in the area. Actual in-stream pathogen loads based on available data were discussed above.

4.8.4.2.3 Sediment

There were insufficient data available to determine a trend in in-stream sedimentation parameters. Therefore, a separate analysis assessed the potential for the production of sediment (total contribution basis) based on land use changes. This analysis indicated that the amount of sediment available for erosion (attributable to specific land uses) increased from 1972 to 2000 for five watersheds (De Lisle, Lower Wolf, Rotten Bayou, Upper Jourdan, and Turkey Creek–Old Fort Bayou) (Figure 4.8–3). The total potential for available sediment has increased since 1972 because of an increase in the scrub-shrub/cutover/barren and urban land use types (Figures 5a and 5b in Appendix H). Soil erosion from construction activities and agricultural runoff are thought to be among the largest contributors.

Four subwatersheds (Bayou La Croix, Upper Wolf, Biloxi River and Tuxachanie Creek) show an increasing trend in sediment potential from 1972 to 1992 and then a decreasing trend from 1992 to 2000 (Figures 5a and 5b in Appendix H and Figure 4.8–3). This decrease from 1992 to 2000 is likely the result of decreased contribution from agricultural lands. The end result is a decrease in the total production of sediment due to changes in land use.

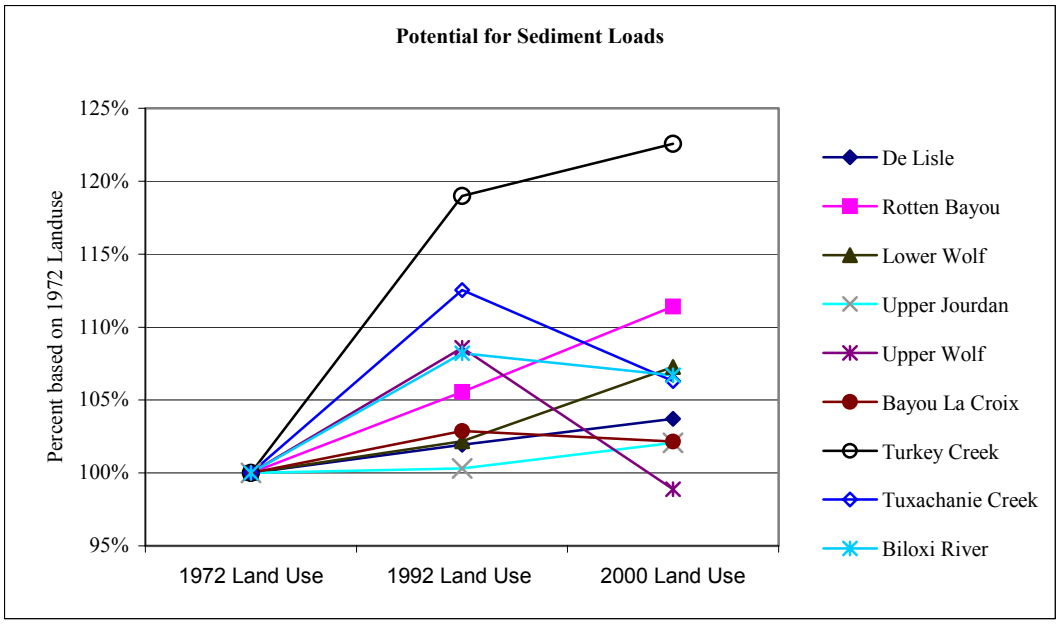


Figure 4.8–3. Trends for Sediment Available for Transport to Surface Waters Due to Changes in Land Use.

Figure 4.8–3 shows the trend for sediment available for transport to surface waters due to changes in land use for each subwatershed. It does not represent changes of actual in-stream sediment loads. This analysis does not factor in expected channel erosion due to scouring or possible settling. In reality, loading will depend on timing of storm events and the presence of BMPs in the area. Actual in-stream sediment loads based on available data were discussed above.

4.8.4.2.4 Eutrophication

An analysis of the in-stream water quality data indicated a slightly decreasing trend in total nitrite and nitrate in the Upper Jourdan River subwatershed (Appendix H–Figure 6a). No other trends were observed for the other subwatersheds. Individual exceedances were observed in the Bayou La Croix, Upper Jourdan River, and the Biloxi River subwatersheds. Three exceedances were observed in the Turkey Creek–Old Fort Bayou subwatershed.

Total ammonia levels were analyzed for historic trends. No trends were observed for the Bayou La Croix, Lower Wolf River–Cane Creek, Biloxi River, or Turkey Creek–Old Fort Bayou subwatersheds (Appendix H–Figures 7a and 7b). A slight increase in ammonia levels was observed for the De Lisle subwatershed. Slight decreases were observed in the Upper Jourdan River and Tuxachanie Creek subwatersheds. Individual exceedances were observed in the Bayou La Croix and Upper Jourdan River subwatersheds. In the Turkey Creek–Old Fort Bayou subwatershed six exceedances in ammonia levels were observed (Appendix H–Figure 7b). This included recent exceedances at four separate monitoring stations (1999 and 2000). In the Lower Wolf River–Cane Creek subwatershed, one monitoring station (02481510) had elevated ammonia readings. This same station has had moderately high nitrite/nitrate levels and very high pathogen readings over time. The area near the sampling station is developed and it is possible that the elevated levels of ammonia and pathogens are due to failing septic systems in the area.

In-stream water quality data were analyzed for trends in total Kjeldahl nitrogen (TKN). No trends were observed for Bayou La Croix and Turkey Creek–Old Fort Bayou subwatersheds (Appendix H–Figures 8a and 8b). In the Upper Jourdan River subwatershed, a slightly decreasing trend in TKN was observed except for occasional exceedances that may be attributable to a nearby point source discharger. The Lower Wolf River–Cane Creek subwatershed also appears to show a slight decrease in TKN, although six exceedances were observed over time. A decreasing trend was observed for the Biloxi River subwatershed, with one exceedance observed in 1993. The Tuxachanie Creek subwatershed appears to have a slightly decreasing trend in TKN. In the Turkey Creek–Old Fort Bayou subwatershed, there were numerous exceedances over time with four extremely high values observed in the late 1980s.

A separate analysis reviewed the potential for the production of total nitrogen (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis shows that production of total nitrogen has had an increasing potential from 1972 to 2000 for all subwatersheds. This is due mostly to the increase in urban land uses (Figures 9a and 9b in Appendix H and Figure 4.8–4).

Figure 4.8–4 shows the trend for total nitrogen available for transport to surface waters due to changes in land use for each subwatershed. It does not represent changes of actual in-stream total nitrogen loads. This analysis does not factor in expected decomposition, and assumes that all of the nitrogen is available for loading in the waterbodies. In reality, loading will depend on timing of storm events, decomposition, particle settling, and the presence of BMPs in the area. Actual in-stream total nitrogen loads based on available data were discussed above.

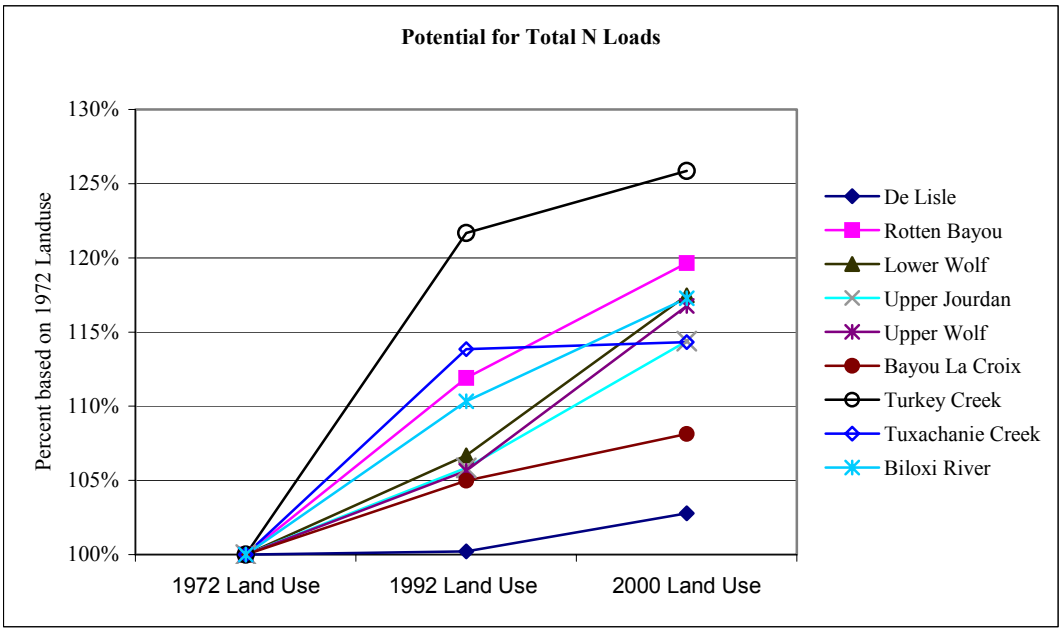


Figure 4.8–4. Trends for Total Nitrogen Available for Transport to Surface Waters Due to Changes in Land Use.

Dissolved oxygen values were analyzed for historic trends (Appendix H–Figures 10a and 10b). No trends were observed for Bayou La Croix, Lower Wolf–Cane Creek, Upper Jourdan River, Biloxi River, Turkey Creek–Old Fort Bayou, and Tuxachanie Creek subwatersheds. A wider range of

percent saturation has been measured in Turkey Creek–Old Fort Bayou since 1997. This may be due to eutrophication in the waterbodies; it is often seen in developed watersheds (Holland et al., 1997). There appears to be a slightly increasing trend in percent saturation of dissolved oxygen in the De Lisle subwatershed (Appendix H–Figure 10a). This may warrant further investigation.

A separate analysis reviewed the potential for the production of BOD_5 (total contribution basis) based on land use changes. BOD_5 was evaluated because of its utilization of dissolved oxygen within a waterbody. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis shows that production of BOD_5 has had an increasing potential from 1972 to 2000 for all subwatersheds, due mostly to changes in urban land uses (Figures 11a and 11b in Appendix H and Figure 4.8–5).

Figure 4.8–5 shows the trend for BOD_5 available for transport to surface waters due to changes in land use for each subwatershed. It does not represent changes of actual in-stream BOD_5 loads. This analysis does not factor in expected decomposition, and assumes that all of the BOD_5 is available for loading in the waterbodies. In reality, loading will depend on timing of storm events, decomposition, particle settling, and the presence of BMPs in the area.

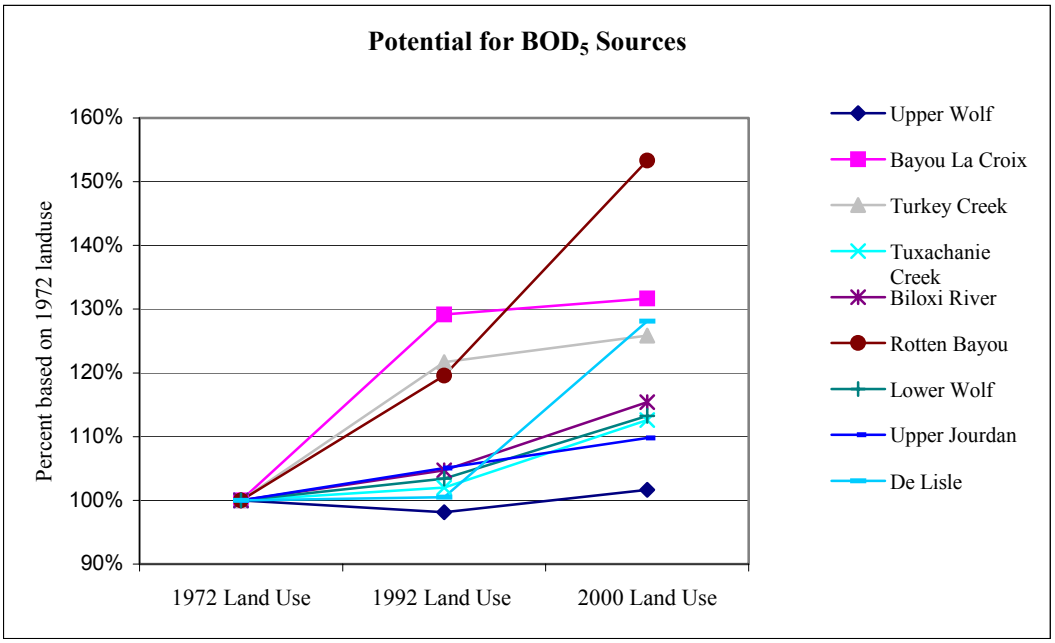
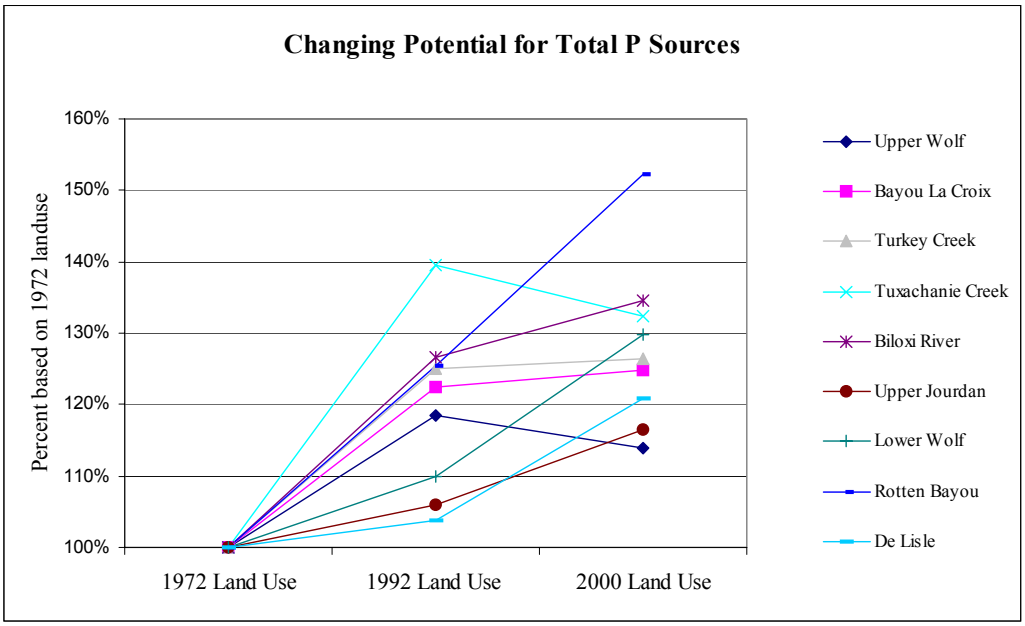


Figure 4.8–5. Trends for BOD_5 Available for Transport to Surface Waters Due to Changes in Land Use.

In-stream water quality data were analyzed for trends in total phosphorus (Appendix H–Figures 12a and 12b). Slightly decreasing trends were observed in the Bayou La Croix subwatershed, with numerous historic exceedances. The Lower Wolf River–Cane Creek subwatershed has a possible slight increase in values. There were six exceedances observed for the subwatershed. Slightly decreasing values were observed for the Upper Jourdan River subwatershed, but there were numerous measurements above the water quality standard. No trends were observed in the Biloxi River subwatershed. An increasing trend was observed in the Turkey Creek–Old Fort Bayou subwatershed with numerous exceedances over time. An increasing trend was also observed for the Tuxachanie Creek subwatershed, including eight exceedances since 1997.

Figure 4.8–6. Trends for Total Phosphorus Available for Transport



to Surface Waters Due to Changes in Land Use.

A separate analysis reviewed the potential for the production of total phosphorus (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis shows that production of total phosphorus has had an increasing potential from 1972 to 2000 for all but two subwatersheds (Upper Wolf and Tuxachanie Creek). This is due mostly to the increase in urban land uses (Figures 13a and 13b in Appendix H and Figure 4.8–6).

Two subwatersheds (Upper Wolf and Tuxachanie Creek) show an increasing trend in total phosphorus potential from 1972 to 1992 and then a decreasing trend from 1992 to 2000 (Figure 4.8–6). This decrease from 1992 to 2000 is caused by the decreased contribution of agricultural lands. The end result is a decrease in the total production of total phosphorus due to changes in land use.

Figure 4.8–6 shows the trend for total phosphorus available for transport to surface waters due to changes in land use for each subwatershed. It does not represent changes of actual in-stream total phosphorus loads. This analysis does not factor in expected decomposition, and assumes that all of the phosphorus is available for loading in the waterbodies. In reality, loading will depend on timing of storm events, decomposition, resuspension, and the presence of BMPs in the area. As discussed in the actual in-stream total phosphorus loads above, Tuxachanie Creek was found to have an increasing trend in total phosphorus since 1997. Our predicted decrease (Figure 4.8–6) during that same time period may be due to the commission of resuspension or to naturally occurring phosphorus sources.

4.8.4.2.5 Metals

Two types of analyses were performed to identify changes in actual metal concentration levels and the potential for increase in metal loadings from changes in land use. The analysis to estimate changes in potential loadings does not factor in expected settling or adherence to submerged sediments, and assumes that all of the metal is available for loading in the waterbodies. In reality, metal loadings are dependent upon timing of storm events, settling, adherence to submerged sediments, and the presence of BMPs in the area.

In-stream water quality data were analyzed for trends in total arsenic (Appendix H–Figures 14a and 14b). No trends were observed for any of the subwatersheds. Most readings were at or below the detection level.

Total cadmium levels were analyzed for historic trends. No trends were observed for the Bayou La Croix, Upper Jourdan River, Biloxi River, Turkey Creek–Old Fort Bayou, or Tuxachanie Creek subwatersheds (Appendix H–Figures 15a and 15b). A slight decrease in total cadmium levels is possible for the Lower Wolf River–Cane Creek subwatershed, but lower levels of detection available with modern sampling and analysis techniques may have influenced these values. Increased readings in total cadmium were observed at various sampling stations in the Turkey Creek–Old Fort Bayou subwatershed in 1992.

A separate analysis reviewed the potential for the production of cadmium (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis indicated that production of cadmium has had an increasing potential from 1972 to 2000 for all subwatersheds except for Upper Wolf and Tuxachanie Creek subwatersheds. The increasing trend is due mostly to the increase in urban land uses (Figures 16a and 16b in Appendix H and Figure 4.8–7). For Upper Wolf and Tuxachanie Creek no trend was projected—although there is a slight fluctuation in the projection for Tuxachanie Creek, this is considered negligible.

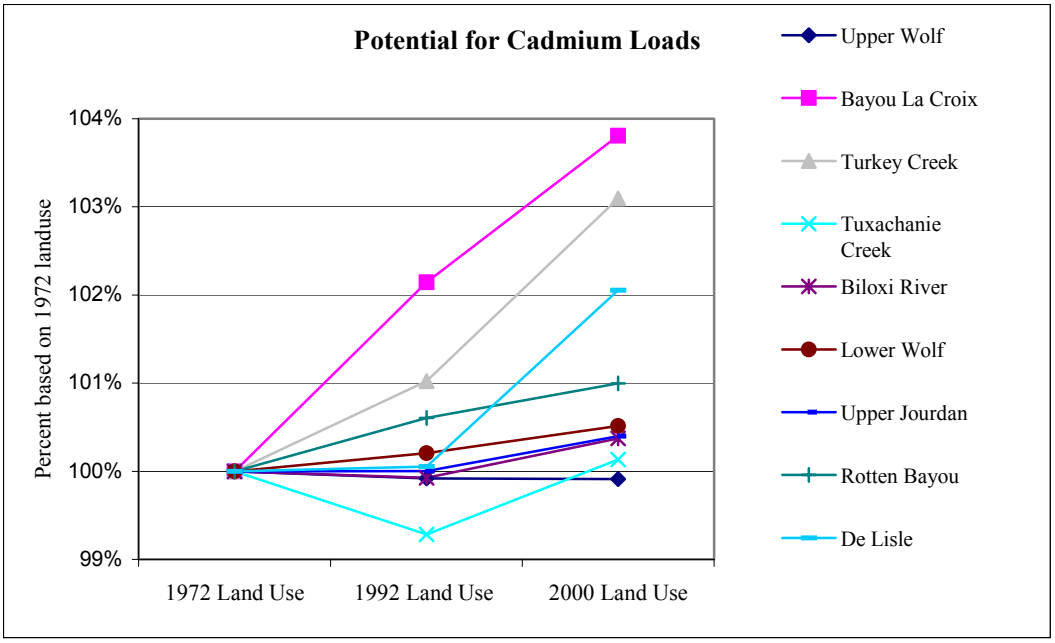


Figure 4.8–7. Trends for Cadmium Available for Transport to Surface Waters Due to Changes in Land Use.

Figure 4.8–7 shows the trend for cadmium available for potential transport to surface waters due to changes in land use for each subwatershed. Actual in-stream cadmium loads based on available data were discussed above.

An analysis of the in-stream water quality data indicated no definite trend in total chromium in the Bayou La Croix, Upper Jourdan River, Biloxi River, Turkey Creek–Old Fort Bayou, and Tuxachanie Creek subwatersheds (Appendix H–Figures 17a and 17b). A slightly decreasing trend was observed in the Lower Wolf River–Cane Creek subwatershed. In the Bayou La Croix subwatershed, monitoring station 639SLB01 had high values in 1998 and 1999, and station 0248167 had high values in the 1970s. Turkey Creek–Old Fort Bayou water quality data show high values at several monitoring stations in 1998 and 1999.

A separate analysis reviewed the potential for the production of chromium (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis shows that production of chromium has had an increasing potential from 1972 to 2000 for all subwatersheds except for Upper Wolf and Tuxachanie Creek subwatersheds. The increasing trend is due mostly to the increases in urban land uses (Figures 18a and 18b in Appendix H and Figure 4.8–8). For Upper Wolf and Tuxachanie Creek no trend was projected—although there is a slight fluctuation in the projection for Tuxachanie Creek, this is considered negligible.

Figure 4.8–8 shows the trend for chromium available for potential transport to surface waters due to changes in land use for each subwatershed. Total copper levels were analyzed for historic trends (Appendix H–Figures 19a and 19b). A decreasing trend was observed for Bayou La Croix and Turkey Creek–Old Fort Bayou. No trend was observed for the Lower Wolf River–Cane Creek and Upper Jourdan subwatersheds. Each, however, had an individual exceedance in 1993. No trends were observed in the Biloxi River or Tuxachanie Creek subwatersheds.

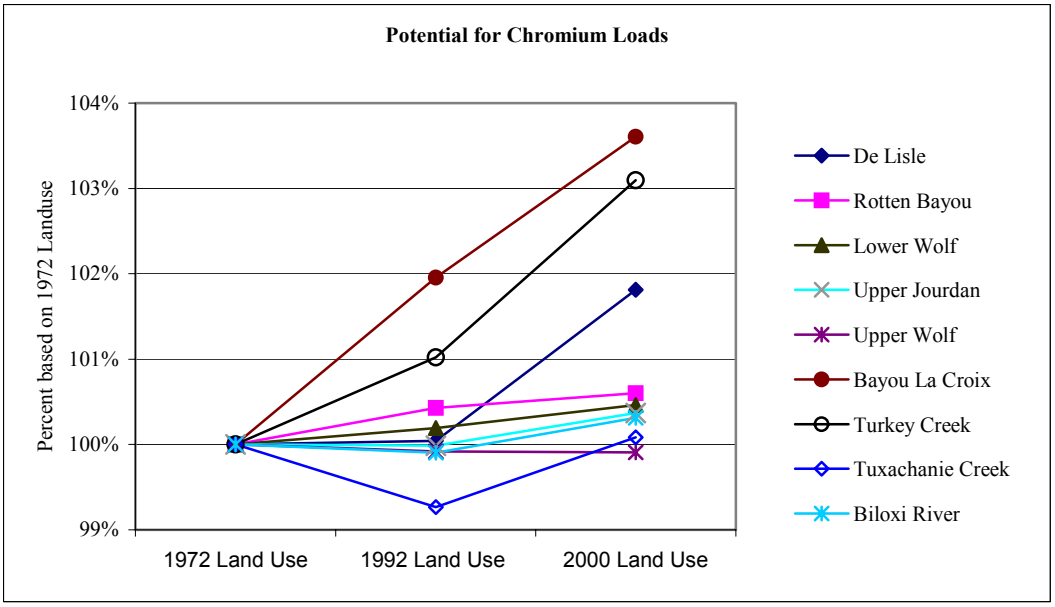


Figure 4.8–8. Trends for Chromium Available for Transport to Surface Waters Due to Changes in Land Use.

A separate analysis reviewed the potential for the production of copper (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land

distribution for 1972 and 1992.) This analysis indicated that production of copper has had an increasing potential from 1972 to 2000 for all subwatersheds. The increasing trend is due mostly to the increase in urban land uses (Figures 20a and 20b in Appendix H and Figure 4.8–9). This increase was not directly observed in the data. Many of the samples were at or below the level of detection of 5µg/L. For samples measured at 5µg/L, an increase as small as 2 µg/L would represent a 140 percent increase as shown in Figure 4.8–9 below.

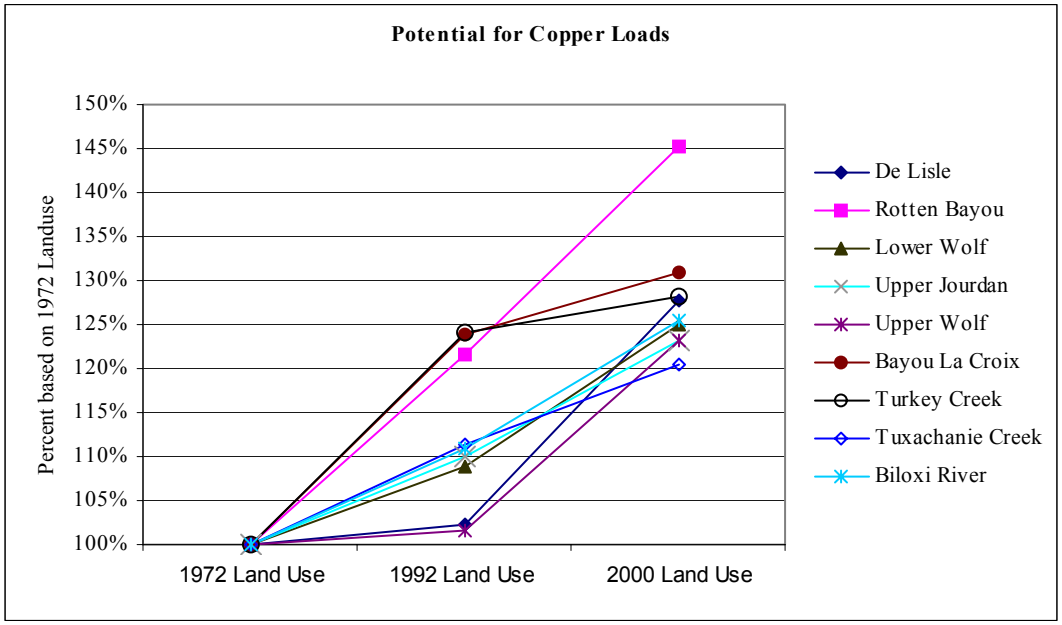


Figure 4.8–9. Trends for Copper Available for Transport to Surface Waters Due to Changes in Land Use.

Figure 4.8–9 shows the trend for copper available for transport to surface waters due to changes in land use for each subwatershed. In-stream water quality data were analyzed for trends in total lead (Appendix H–Figures 21a and 21b). No trends were observed for any of the subwatersheds. One reading exceeded the water quality standard in 1991 in the Upper Jourdan River subwatershed. In the Turkey Creek–Old Fort Bayou subwatershed, high values were measured from 1991 to 1993, but the levels have since dropped to the level of detection or below (Appendix H–Figure 21b).

Total mercury levels were analyzed for historic trends (Appendix H–Figures 22a and 22b). No trends were observed for any of the subwatersheds. Most readings were at or below the detection level.

An analysis of the in-stream water quality data indicates a slightly decreasing trend in total zinc in the Bayou La Croix, Lower Wolf River–Cane Creek, and Turkey Creek–Old Fort Bayou subwatersheds (Appendix H–Figures 23a and 23b). No trends were observed in the Upper Jourdan River, Biloxi River, and Tuxachanie Creek subwatersheds.

A separate analysis reviewed the potential for the production of zinc (total contribution basis) based on land use changes. (See Tables 2 and 3 in Appendix D for a detailed breakout of land distribution for 1972 and 1992.) This analysis shows that production of zinc has had an increasing potential from

1972 to 2000 for all subwatersheds except for Upper Wolf. The increasing trend is due mostly to the increase in urban land uses (Figures 24a and 24b in Appendix H and Figure 4.8–10). Upper Wolf shows a slight increase from 1972 to 1992 and then a decreased potential from 1992 to 2000. This change in potential can be attributed to the shift from agricultural land to barren land after 1992.

Figure 4.8–10 shows the trend for zinc available for transport to surface waters due to changes in land use for each subwatershed. The trend predicted for zinc loads in the Upper Wolf subwatershed appears to mirror the estimated changes in agricultural land use, which appeared to increase from 1972 to 1992, but then decreased from 1992 to 2000. The zinc loadings may be correlated to the use of insecticides and fungicides in those areas.

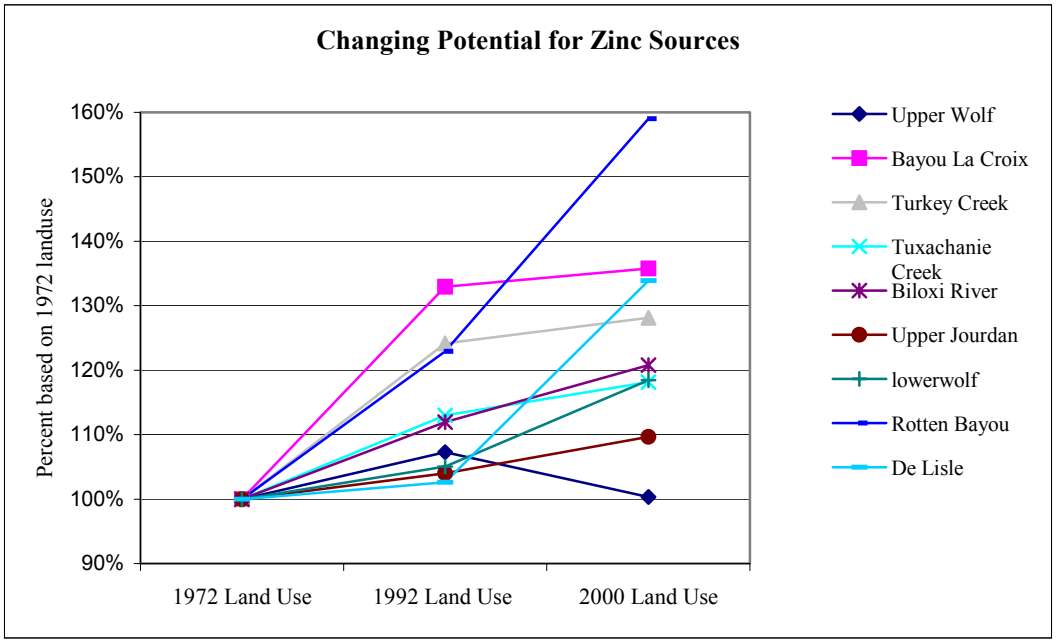


Figure 4.8–10. Trends for Zinc Available for Transport to Surface Waters Due to Changes in Land Use.

4.8.4.2.6 Organics

There are insufficient data for evaluating trends in levels of organic chemicals. The majority of the organics data were collected in the early 1970s.

4.8.4.2.7 Beaches

Since no beach monitoring data are available before 1999, it is not possible to determine whether historic trends exist.

4.8.4.2.8 Sediment Quality

The entire set of sediment quality data collected from STORET (1972–1977) and NSI (1980–1993) was analyzed for trends. All samples for a given parameter in the Mississippi CSA watershed were grouped together. In general, the trends are weak. It is not possible to assess the effect of gaming and other large-scale development on sediment quality in coastal Mississippi. Gaming development in the CSA began in 1992 and the data available in STORET and NSI only extend to 1993. Trends for 1972 to 1993, however, are presented in Figures 1 through 12 in Appendix I and described below.

Metals. Arsenic concentrations show a slightly decreasing trend in the Turkey Creek–Old Fort Bayou subwatershed. Despite several samples exceeding the sediment quality guidelines for cadmium, a slightly decreasing trend was also observed in Bayou La Croix. Chromium data indicate an increasing trend in the Bayou La Croix subwatershed. Chromium is highly corrosive resistant and it is used in automotive parts, batteries, electroplating, and pigments (MPCA, 1999).

Copper concentrations show a decreasing trend in the Mississippi Sound. Possible sources of copper include alloys, wiring, tubing, springs, roofing, gears, biocides, heat exchangers, marine fittings and propellers, and marine corrosion-resistant assemblies (MIT, 2002a). Lead concentrations appear to be slightly decreasing in the Turkey Creek–Old Fort Bayou subwatershed and the Mississippi Sound. Lead is found in batteries, pumps, castings, pipes, alloys, paint pigments, and solder. Prior to 1990 it was also found in some gasoline varieties (CDC, 2002; MIT, 2002b).

No trends were observed in mercury, nickel, or silver concentrations in sediment samples in the coastal Mississippi watershed. Nickel, similar to chromium, is highly corrosion-resistant and is used in automotive parts, batteries, electroplating, and pigments (MPCA, 1999). Silver is used in photofinishing, printing, dyes, ceramics, glass manufacturing, solder and brazing alloys, germicides, and paints and pigments. It is also used in water purification (Spectrum Laboratories, 2002).

Zinc concentrations show an increasing trend in the Bayou La Croix subwatershed and a decreasing trend in the Mississippi Sound. Possible sources of zinc include insecticides, fungicides, alloys, paints, pigments, and wire coating. It is also used as an additive in rubber products and gasoline (MIT, 2002c).

Organics. No trends were observed in DDT concentrations. DDT use has been prohibited in the United States since 1972, except in the case of public health emergencies. Because DDT adheres strongly to soil particles, it moves very slowly into ground water resources (ATSDR, 1995).

A decreasing trend in PAHs was observed in the Mississippi Sound. (PAHs are a group of over 100 different chemicals that are formed during the incomplete burning of oil, gas, coal, and other substances.) They often enter the water through discharges from industrial and wastewater treatment plants. Most PAHs do not dissolve easily and settle to the bottoms of waterbodies. While PAHs adhere tightly to soil particles, they may migrate through the soil into ground water resources (ATSDR, 1996).

A slightly decreasing trend in PCB concentrations was observed in the Turkey Creek–Old Fort Bayou subwatershed. (PCBs are mixtures of up to 209 individual chlorinated compounds.) Manufacture and use of PCBs in the United States was banned in 1977, but products produced before that date may contain them. PCBs bind strongly to soil particles and do not readily break down; thus they may remain in the sediment for very long periods (ATSDR, 2001).

4.8.4.3 Summary

Various water quality parameters have been analyzed over time to indicate if any distinct changes have occurred since gaming development began in 1992. No obvious changes to water quality in the surface water resources of the Mississippi CSA watershed have been observed since that date.

The potential for pathogen generation was expected to increase by 10 to 20 percent for all subwatersheds from 1972 to 2000 (except Upper Wolf Creek and Rotten Bayou, where 5 and 40 percent increases had been expected, respectively). The raw data show that only Bayou La Croix, Lower Wolf and Upper Jourdan have increasing trends. Several other subwatersheds, however, experienced exceedances of water quality standards. Although the raw data do not mirror the predicted increase they, do show periodic high fecal coliform concentrations. Increasing beach closures between 1999 and 2001 due to high measured in-stream fecal coliform concentrations have been noted.

Sediment generation was expected to increase by up to 10 percent for all subwatersheds, except for Upper Wolf and Turkey Creek–Old Fort Bayou. Generation of sediment in the Upper Wolf subwatershed was expected to remain relatively unchanged, and that in Turkey Creek–Old Fort Bayou was expected to increase by 23 percent. Since there are limited historical sediment data available to track actual in-stream trends, these predicted sediment increases may serve as a valuable resource for decisionmakers. In the absence of actual data, the sediment predictions provide an indicator for subwatersheds with a potential for sedimentation problems.

Dissolved oxygen, phosphorus, nitrogen (ammonia, nitrates, and TKN) and pH are all indicators of eutrophication. A widening range of dissolved oxygen and pH were observed between 1972 and 2000 in many subwatersheds where data were available, indicating a possible increase in algal growth and waterbody stressors. There were increases in total phosphorus in Lower Wolf, Turkey Creek–Old Fort Bayou, and Tuxachanie Creek. These increases were also predicted, based on land use changes in these subwatersheds. All subwatersheds were expected to have a 10 to 35 percent increase in total phosphorus between 1972 and 2000, except for Rotten Bayou where a 52 percent increase was expected. A predicted increase in nitrogen based on land use was not mirrored in the raw data, although there were numerous exceedances in ammonia, nitrates and TKN for many of the subwatersheds. Utilization of nitrogen in fresh water depends on the availability of phosphorus. The measured increases in phosphorus levels would increase algal activity, thereby allowing more nitrogen to be utilized by algae and not remain within the water column. Historic increases in nitrogen and phosphorus have been at a rate, however, where the subwatersheds appear to have been able to remain within balance.

For many of the subwatersheds, it was predicted that metal concentrations would increase in the water column due to increased urbanization. In actuality, for many of the metals, slightly decreasing trends were observed between 1972 and 2000. Metal concentrations within the sediment were measured at acceptable levels except for Bayou La Croix, which had elevated chromium and zinc levels.

The Turkey Creek subwatershed appears to be the most stressed subwatershed within the study area; it has the greatest number of impaired waterbodies on the state's list of impaired waters. Turkey Creek–Old Fort Bayou subwatershed contains approximately 11 percent impervious surfaces. Literature supports that after a watershed reaches 10 percent imperviousness, its hydrologic function and ecological health are altered and will become impaired. The monitoring data collected for the Turkey Creek subwatershed and the parameters of concern listed on the list of impaired waters corroborate that increased imperviousness has impacted waterbodies in this subwatershed.

As described above, there may be discrepancies when comparing trends in actual monitoring data to potential amounts of pollutants available to a waterbody. High values were measured for many pollutants, which indicates that the coastal Mississippi watershed is becoming stressed but has so far successfully been able to maintain an ecosystem balance. As development occurs, additional imperviousness could negatively affect water quality, as waterbodies become over-stressed and thus unable to maintain an ecosystem balance.

4.9 COASTAL PROCESSES

4.9.1 Coastal Processes—Baseline Conditions

The study area for this resource area is bounded by the Mississippi Sound to the southeast and includes those tidally influenced portions of the Mississippi coastline to the northwest. Along the southern edge of the Mississippi Sound is a string of low-lying barrier islands. These barrier islands reduce the penetration of long swells arising out of the Gulf of Mexico, resulting in reduced wave energy within the sound. The wave height is relatively low with a mean tidal range of 1.47 ft as evident at NOAA Tide Station #8747766 located at the Waveland Marina in Waveland (CO-OPS, 2002). The Mississippi coastal area is noted for not having under-tow currents or deep drop offs.

Many natural processes influence shoreline changes, including waves, tides, littoral currents, water depth, coastal subsidence, and severe storm events, all of which are part of coastal processes. Any human activity that modifies or disturbs these natural processes can directly or indirectly add to or compound these natural processes.

Beaches along the Mississippi coast extend for 26 miles from about Bay St. Louis in the west to Pascagoula in the east. These beaches are periodically replenished with sand. The Belle Fontaine headland in Jackson County is considered to be the only remaining natural beach on the Mississippi mainland coast. The beach is formed by natural sand deposition provided from longshore currents. However, as residents in the area have armored coastal areas to protect their homes, the natural sand source has been altered and the beach is now suffering from sand deficiency (Oivanki and Suhayda, 1994).

4.9.1.1 Coastline Changes

The Gulf Coast is generally considered to be a low-energy area except during the hurricane season (Thurman, 1991). Natural changes to the coastline are episodic, associated with major storms and flooding events. High energy, short duration storm events, such as hurricanes and tropical storms are particularly devastating to the Mississippi coast where storm frequency is high and ground elevation is relatively low. Storm impacts vary based on their intensity rating and location of landfall. Storm impacts also vary depending on whether the storm makes landfall at high tide or low tide and the location of the onshore and offshore winds relative to the eye of the hurricane (Landreneau, 2000).

High waters and wave action associated with such severe storms are known to remove sand dunes from their given locations and displace large amounts of sand. Other less obvious processes that can have an impact on the coastline include coastal landform type, wind induced currents, tidal flow, channel bathymetry, and residual tidal circulation. The natural coastal erosion rate for Mississippi is 6 cm per year. The natural erosion processes may be impacted by human induced changes particularly as coastal areas become more developed.

4.9.1.2 Wind Effects

Wind speed and direction directly influence the generation of waves within the Mississippi Sound that propagate into Biloxi Bay and Bay St. Louis. Although wind is the dominant source of energy within the Sound, it may or may not play a major role within the bays of concern. For example, wind would play an integral part in an estuary with a deep channel, such as a shipping channel, alongside a shallow embayment. The wind driven steady circulation of the shallow bay will interact with the tidal currents in the deep channel. The wind's influence will vary dependent upon location within the bays.

4.9.1.3 Circulation

Coastal Mississippi circulation is influenced by many factors, including the movement of water in the Gulf of Mexico. The exchange of water between the Gulf of Mexico and the Mississippi Sound is strongly influenced by the series of barrier islands to the south. The loop current in the Gulf of Mexico, which has a counterclockwise circulation, causes a net westerly flow through the sound. This long shore circulation or drift affects those near the mouths of the bays and along the open coast.

The bathymetry and channel configurations of the estuaries of the Mississippi Sound have a direct bearing on their circulation. Variations in channel depth and configuration control the circulation patterns in a given waterbody. Filling and development in these estuary areas will ultimately have the same effect as changing the channel configurations and may have as much of an impact as dredging a channel in the area. Changes to those dimensions may alter the circulation patterns but are very site-specific and should be addressed for each specific location.

4.9.1.4 Human Changes to the System

Groins, jetties, riprap, seawalls, and breakwaters are common physical means of coastline protection. These techniques offer limited to no protection against storm-driven waves and many times result in destruction of other areas. Groins and jetties are generally built perpendicular to the coast and are used to trap sand and sediment and protect harbor entrances. Riprap is used to armor an area and protect it from coastal erosion. Seawalls are built parallel to the coast to stabilize eroding shorelines and protect coastal developments from wave action. Breakwaters are similar to jetties; they are constructed perpendicular to the coast and trap sand that would normally be moved by longshore drift off the coast (Thurman, 1991).

Many of these techniques are currently in use along the Mississippi coast. The Round Island Lighthouse located 3 miles south of Pascagoula has been the location of numerous attempts to avert natural erosion processes. The historic lighthouse has been stabilized with riprap (1990), and a breakwater was constructed in 1997 to protect it from erosion (Miller, no date). Numerous jetties are in place along the coast, including those at Long Beach Harbor and Gulfport Small Craft Harbor. Breakwaters are also in use. A breakwater was placed in the Mississippi Sound as part of a mitigation project to protect salt marsh habitat at the Chevron Pascagoula Refinery outfall (MSU, CREC, no date).

4.9.2 Coastal Processes—Historical Analysis

Mississippi's 44-mile coastline suffered through nine hurricanes during the period of 1899 through 2000. Hurricanes are categorized according to the Saffir/Simpson intensity index (Category 1 to

Category 5). Mississippi hurricanes have had the following intensities: one hurricane was Category 1 (74 to 95 MPH winds and 4- to 5-foot storm surge), two were Category 2 (96 to 110 MPH winds and 6- to 8-foot storm surge), five were Category 3 (111 to 130 MPH winds and 9- to 12-foot storm surge), and one was Category 5 (winds greater than 155 MPH and storm surge greater than 18 feet). The landfall frequency (storms per year) for the state is 0.09, and the return period for hurricanes is 11.3 years. The Mississippi coastline was also affected by 24 tropical storms (39 to 73 MPH winds) during the period of 1899 to 2000. Tropical storm frequency (storms per year) is 0.24 for Mississippi with a return period of 4.3 years (Landreneau, 2000).

Notable hurricanes affecting coastal Mississippi during the study period (1972 to present) include Hurricane Frederic (1979), Hurricane Elena (1985), Hurricane Opal (1995), Hurricane Denny (1997), and Hurricane Georges (1998). The most intense hurricane to hit the coastal Mississippi area, however, was Hurricane Camille in 1969. This was a Category 5 hurricane with a storm surge peaking at 24 feet above mean sea level at Pass Christian. Extreme tidal surges were measured in Bay St. Louis (18 feet above MSL) and the Back Bay of Biloxi (approximately 15 feet above MSL). Tides were measured at 13 to 17 feet above MSL from Jordan River (Waveland) to Old Fort Bayou (Ocean Springs) (DeAngelis and Nelson, 1969; NCDC, 2002).

Each storm has had its own unique effect on the coastal Mississippi area. Sand dune removal and sand displacement from severe storms, as well as natural erosion and deposition processes have occurred over time. Human alteration of natural processes in the Gulf Coast area have occurred throughout the last century and specific projects would need to be evaluated individually for their effect on the Mississippi coastline.

4.10 BIOLOGICAL RESOURCES

The Biological Resources section provides information on the terrestrial vegetation, wetlands, aquatic resources (fish, plants, invertebrates, and habitats), and threatened and endangered species of the Mississippi CSA. Information on these topics was gathered from state agencies, The Nature Conservancy, federal agencies, aerial photographs, and GIS coverages.

Accuracy in establishing either quantitative or qualitative trend information for biological resources is difficult to attain. While the availability of information on biological resources has increased during the past decades—because public understanding of the importance of ecological systems and concern over habitats, species, and general environmental health have increased—the information does not lead to concise conclusions. Changes in the intensity and the sophistication with which data on biological resources and systems have been collected during the past 30 years present a challenge in making comparisons between data from the 1970s and the 1990s. As an example, wetland data have been collected by various agencies for many years and each agency has used either a different data collection method or a different wetland classification system, and that has resulted in widely differing estimates of the number of acres of the various types of wetlands. Direct comparisons of the different data sets to determine wetland gain or loss is, therefore, impossible. The best information that can be derived from the different data sets is that on gross trends—toward loss or gain—without assuming precision of any quantitative estimated derived. Conversely, data on fish and shellfish species populations, on which an industry and the livelihoods of many people in coastal Mississippi depend, have been collected more consistently over time and, therefore, more accurate year-to-year comparisons can be made. Despite these data deficiencies, a fairly accurate picture of the biological environment of coastal Mississippi has been developed. Land use and land coverage data provide important information on how the vegetation and habitats in the region have changed over the years. The ensuing subsections present both quantitative and qualitative information on historical trends in

terrestrial and aquatic species, the amount and distribution of habitats in the region, and the threats to the region's biological resources.

4.10.1 Terrestrial Vegetation

The Mississippi CSA is in the Temperate Deciduous Forest Biome (Eleuterius, 1998). Hancock, Harrison, Jackson counties are in the Coastal Pine Meadows physiographic region, sometimes referred to as the Coastal Terraces. Hot summers, mild winters, and abundant rainfall (usually 40 to 60 inches per year) falling mostly during the spring and summer months support a diverse assemblage of herbaceous plants, shrubs, and trees (Eleuterius, 1998).

Brief descriptions of plant communities identified that are likely to occur within the land use types identified in the 2000 land use map (Figure 4.2–1) are presented below. The plant community descriptions give an overview of the common plant species native to the Mississippi CSA. Delineating geographic boundaries of forest types and natural communities is made difficult due to natural variation and is of limited utility for planning purposes except on a very small scale (for example, on-site wetland delineation to protect wetlands).

4.10.1.1 Upland Deciduous Forest

Upland deciduous forests occur in generally cool and moist areas, and they burn much less frequently than pine forests or mixed forests. Deciduous forests can be found on upper river terraces, slopes, and coves, and infrequently on flooded stream bottoms. Some deciduous forests support tree species that are in the extreme southern portions of their ranges. Scattered pockets of forest dominated by American beech (*Fagus grandifolia*) and southern magnolia (*Magnolia grandiflora*) are thought to be relicts of Pleistocene ice age conditions in the East Gulf Coastal Plain, and they contain many species found in northern forests in addition to species endemic to southern Mississippi. Oaks (*Quercus* spp.), maples (*Acer* spp.), blueberry shrubs (*Vaccinium* spp.), greenbriar vines (*Smilax* spp.), and many spring wildflower species are common in beech and magnolia forest communities (Natureserve Explorer, 2002).

Seepage areas in pine-dominated uplands also can support deciduous forest. The tree canopy in these areas is variable with tulip poplar (*Liriodendron tulipifera*), swamp black gum (*Nyssa biflora*), and southern magnolia (*Magnolia virginiana*) in the overstory, but sweetgum (*Liquidambar styraciflua*), loblolly pine (*Pinus taeda*), and red maple (*Acer rubrum*) can make up a significant portion of the canopy. Seepage areas often have well-developed shrub and herbaceous layers (Natureserve Explorer, 2002). Blueberries, sweet gallberry (*Ilex coriacea*), pepperbush (*Clethra alnifolia*), buttonbush (*Cephalanthus occidentalis*), ferns (*Osmunda* spp., *Woodwardia* spp.), and peat moss (*Sphagnum* spp.) are common.

Oak forests are often found on moist slopes in the East Gulf Coastal Plain. Tree species often dominant in the canopy are white oak (*Quercus alba*), water oak (*Quercus nigra*), laurel oak (*Quercus hemisphaerica*), tulip poplar, sand hickory (*Carya pallida*), white ash (*Fraxinus americana*), and American elm (*Ulmus americana*) (Natureserve Explorer, 2002). Shade-tolerant species persist as medium and small trees in the mid-story. Magnolias (*Magnolia* spp.), American beech, paw paw (*Asimina triloba*), American holly (*Ilex opaca*), and flowering dogwood (*Cornus florida*) are often found in oak forests. Shrubs and woody vines are numerous. Woody vines represented are grapevine (*Vitis rotundifolia*), Virginia creeper (*Parthenocissus quinquefolia*), poison ivy (*Toxicodendron radicans*), greenbriar, and cross-vine (*Bignonia capreolata*). Herbaceous vegetation is usually sparse and not well developed.

4.10.1.2 Upland Mixed Forest

Upland mixed forests are mostly mid-successional secondary forests found on drier sites that have been subject to timber harvest and fire suppression. The canopy is a mix of loblolly pine (*Pinus taeda*) and assorted hardwoods such as southern red oak (*Quercus falcata*), white oak, post oak (*Quercus stellata*), and black oak (*Quercus velutina*). Small trees are well represented in this forest type. Flowering dogwood, hop-hornbeam (*Ostrya virginiana*), black cherry (*Prunus serotina*), winged elm (*Ulmus alata*), and sourwood (*Oxydendrum arboreum*) are commonly observed. Shrubs include witch hazel (*Hamamelis virginiana*), wax myrtle (*Myrica cerifera*), and blueberry. Grapevine and longleaf spikegrass (*Chasmanthium sessiliflorum)* are often dominant in the understory (Natureserve Explorer, 2002).

Slash pine (*Pinus elliottii*) upland flatwoods are found on barrier islands and also in mainland locations very near the water. Most remaining examples of this community are considered threatened by fragmentation, development, and fire suppression (Natureserve Explorer, 2002). The canopy varies from open to closed, and may support a mix of slash pine and longleaf pine (*Pinus palustris*). Live oak (*Quercus virginiana*), sand live oak (*Quercus geminata*), laurel oak (*Quercus hemisphaerica*) are common in the subcanopy. Typical understory species are similar to those found in coastal shrublands and include yaupon (*Ilex vomitoria*), saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), greenbriar, blueberry, and grapevine.

4.10.1.3 Upland Pine Forest

Dry longleaf pine sandhill woodland is found on well-drained sandy soils. Lakeland soils often support dry longleaf pine forests. Fire suppression, development, and conversion to pine plantation have degraded or destroyed most of this forest type in the Southeast (Natureserve Explorer, 2002). Surviving examples are mostly found on military lands and national forests. In the presence of prescribed fire or natural wildfires, longleaf pine covers from 10 to 30 percent of the overstory. The size and density of understory oaks such as turkey oak (*Quercus laevis*), blue-jack oak (*Quercus incana*), sand live oak, and sand post oak (*Quercus margaretta*), are variable and would be expected to depend on the effects of periodic fires. Herbaceous species include little bluestem (*Schizachyrium scoparium*), three-awn grass (*Aristida* spp.), and broom snoutbean (*Rhynchosia cytisoides*).

Areas with wetter soil conditions can support forests dominated by longleaf pine and southern red oak. This forest type occurs on somewhat poorly drained to well-drained loamy soils with clay layers in the B horizon, such as Benndale, Cahaba, Smithdale, Petal, and Susquehanna. Species more common in wetlands can occur in patches where clay content in the soil is high. Longleaf pine is the canopy dominant. Beneath the pine canopy, some hardwoods can be co-dominant in the canopy depending on the frequency and intensity of the fire regime. Hardwood trees can include southern red oak, water oak, flowering dogwood, black gum (*Nyssa sylvatica*), and red bay (*Persea borbonia*). Shrubs are blueberries, hollies (*Ilex* spp.), wax myrtle, and horse sugar (*Symplocos tinctoria*). The herbaceous layer is very diverse and often well developed with grasses (*Aristida* spp., *Schizachyrium* sp.), forbs, sunflowers (Asteraceae), and meadow-beauty (*Rhexia alifanus*) (Natureserve Explorer, 2002).

4.10.1.4 Upland/Wet Scrub/Shrub

Wet scrub-shrub plant communities include shrublands dominated by black willow (*Salix nigra*) and buttonbush. This plant community type is found on the wet shorelines of lakes and ponds, particularly reservoirs and farm ponds, and is dominated by fast-growing species such as black willow, sweetgum, and red maple (*Acer rubrum*). The shrub layer features dense, almost pure stands of buttonbush and little else (Natureserve Explorer, 2002).

Gulf Coast barrier islands and barrier spits can support stunted oak and yaupon shrublands. These scrub-scrub habitats are most often located on rises surrounded by black needlerush (*Juncus roemarianus*) salt marshes and have been reported from the Gulf Islands National Seashore (Natureserve Explorer, 2002). Stunted slash pine may be present in the overstory, but most cover will be in a shrub layer dominated by yaupon, live oak, sand live oak, wax myrtle, saw palmetto, and salt bush (*Baccharis halimifolia*).

One common wetland shrub community is the black titi (*Cliftonia monophylla*)–shining fetterbush (*Lyonia lucida*)–blaspheme-vine (*Smilax laurifolia*) shrubland. This shrub community occurs in wetlands larger than 300 ha (741 acres) that remain flooded for extensive periods of time (Natureserve Explorer, 2002). Peat soils between 1 to 2 meters deep form in these shrublands. Black titi is the dominant shrub, but occasional longleaf or slash pine trees may be present, especially in transition zones. Herbaceous cover is patchy and not well developed. Herb species might include pitcher plants (*Sarracenia* spp.), bladderwort (*Utricularia* sp.), and beakrush (*Rhynchospora* sp.). Peat moss is common in the ground layer and is an important component of peat soils. Fire is not common in this community, although shrublands are probably more common because of logging and fire suppression in recent years (Natureserve Explorer, 2002).

4.10.1.5 Upland/Wet Cutover Land/Burned Land

Upland areas that have been cutover or burned are identified by remote sensing as having been recently subject to removal of vegetation because of timber harvest or wildfire. Under normal conditions, these areas would be expected to undergo succession from herbaceous and shrub species to mature forest as the landscape naturally revegetates or is manually replanted.

4.10.1.6 Upland/Wet Sand/Barren Land

These areas have been identified as having significant amounts of exposed mineral soil. Naturally occurring beaches are common near the coast and may support some dune grasses and scattered small shrubs. Disturbed areas in inland habitats not yet supporting vegetative cover might also appear as this land use type.

4.10.1.7 Bottomland Hardwood Forest/Swamp

Bottomland hardwoods are tree species that grow vigorously in frequently flooded and saturated soils. Swamps are wetlands in which large and medium-sized trees are dominant. Away from the coast, extensive areas of bottomland hardwoods are found along the Pearl and Pascagoula Rivers.

Water tupelo (*Nyssa aquatica*)–swamp blackgum forests are found in swamps and floodplains. Bald cypress (*Taxodium distichum*) can also be present, but it seldom occupies more than 25 percent of the canopy (Natureserve Explorer, 2002). Other tree species are green ash (*Fraxinus pennsylvanica*),

black willow, and ironwood (*Carpinus caroliniana*). These swamp forests are submerged at least several months of the year. Shrubs and herbs are not common. Fetterbush (*Leucothoe racemosa*) and titi are sometimes present in the shrub layer Lizard's tail, poison ivy, crossvine, planer tree (*Planera aquatica*), and pepper-vine (*Ampelopsis arborea*) are found in the ground layer.

Smaller patches of bottomland hardwood forest occur in swampy habitats along small, seepage-fed streams. Swamp blackgum-sweetbay (*Magnolia virginiana*)–bayberry (*Morella* spp.) communities dominate dense swamp forests in these habitats. Slash pine may be present, although it has often been removed by timber harvest. Canopy species often include red maple, sweetgum, tulip poplar, and loblolly pine. Shrubs are fetterbush (*Lyonia lucida*), titi (*Cyrilla racemiflora*), and pepperbush. The herbaceous layer is scattered and features clumps of ferns (*Osmunda* spp. and *Woodwardia* spp.). Other herbaceous species are sedges (*Carex* spp.), beakrushes, and lizard's tail. The endangered plant species Louisiana quillwort (*Isoetes louisianensis*) is known from this plant community (Natureserve Explorer, 2002).

4.10.1.8 Wet Pine Forest/Pine Savannah

The canopy of this wet pine savannah plant community contains longleaf pine and slash pine. The shrub stratum features clumps of gallberry (*Ilex glabra*) or other wetland shrub species. The ground layer is dominated by a well-developed community of diverse carnivorous plants such as pitcher plants (*Sarracenia alata*, *Sarracenia psittacina*) and sundews (*Drosera* sp.) that trap and digest insects to obtain nutrition not otherwise available in highly acidic wetland soils. Because pitcher plant bogs are generally found in wet pine savannahs, the names are used somewhat interchangeably. Other plants known from this community are toothache grass (*Ctenium aromaticum*), beakrush (*Rhynchospora chapmanii*), gulf chaffhead (*Carphephorus pseudoliatris*), numerous sunflowers (Asteraceae), milkworts (*Polygala* spp.), forbs, and sedges. (Natureserve Explorer, 2002). The Mississippi sandhill crane is found in this habitat type in its wildlife refuge in coastal Jackson County.

4.10.1.9 Emergent Wetlands

Wetlands lacking trees or dominant woody vegetation are frequently called marshes. Marshes are dominated by emergent vegetation, which is herbaceous vegetation that grows above the waterline most of the year. Freshwater marshes are found in the lower portions of river systems, usually between forested wetlands and deepwater habitats. Spikerushes (*Eleocharis* spp.), bullrushes (*Scirpus* spp.), sedges, wild rice (*Zizania aquatica*), lizard's tail, marsh fleabane (*Pluchea purpurascens*), and knotweeds (*Polygonum* spp.) are found there (Eleuterius, 1998). Marshes studied by Eleuterius (1972) "showed a progressive increase in vascular plants from saline to freshwater."

Intermediate and brackish marshes are found in tidal areas with higher concentrations of salt. Saltwater concentrations vary over the course of the year. Brackish marshes have higher salt concentrations than intermediate marshes. In the brackish zone there is some overlap between species characteristic of freshwater and saltwater marshes, although some plants are found in this zone exclusively (Eleuterius, 1998). These plants include black needlerush (*Juncus roemerianus*), common reed (*Phragmities communis*), sawgrass (*Cladium jamaicense*), knotweed (*Sagittaria lancifolia*), and cordgrass (*Spartina patens*, *Spartina alterniflora*). The most common tidal marsh in coastal Mississippi consists of extensive stands of black needlerush (MDMR, 1998a).

Salt marsh (saline marsh) is found in areas with nearly full-concentration seawater. These marshes have black needlerush, various cordgrass species, sea lavender (*Limonium carolinianum*), and salt

marsh aster (*Aster tenuifolius*). Hypersaline salt flats have only the most salt-tolerant vegetation. Annual glasswort (*Salicornia bigelovii*), sea blites (*Suaeda linearis*), and saltwort (*Batis maritimus*) are known from these areas.

4.10.1.10 Historical Trends

As described in the land use section, natural vegetation cover types generally decreased while developed land increased in the Mississippi CSA. Agricultural acreage declined slightly from 1992 to 2000 (Table 4.10–1). It is difficult to determine the trend in agricultural land from 1972 to 1992 due to limitations of the data. For example, the 1972 data set shows an unexpectedly low acreage of agricultural lands, which could be due to some borderline pasture or grassland areas having been classified as pine forest/savanna. Section 5.2.1.1 and Appendix O provide more detail on the land use data sets and their limitations. Natural areas decreased from 1972 to 1992 as forests and wetlands were converted to agriculture and developed land, but some of that acreage was regained from 1992 to 2000. The amount of agricultural land loss from 1992 to 2000 corresponds well with increases in natural and developed land in the same period. No significant changes in surface water acreage occurred.

Table 4.10–1
Land Use, Coastal Counties (combined)

	1972 (acres)	1992 (acres)	2000 (acres)	% Change 1972–1992	% Change 1992–2000	% Change 1972–2000
General View						
Developed	59,682	81,439	90,203	36.5	10.8	51.1
Natural	1,017,639	932,905	940,686	-8.3	0.8	-7.6
Agricultural	68,061	116,701	101,724	71.5	-12.8	49.5
Detailed View						
Medium Density Urban Land	34,922	47,898	50,170	37.2	4.7	43.7
High Density Urban Land	13,695	18,223	24,571	33.1	34.8	79.4
Transportation	11,064	15,317	15,461	38.4	0.9	39.7
Cropland/Pasture/Grassland	68,061	116,701	101,724	71.5	-12.8	49.5
Deciduous Forest/Mixed Forest/Bottomland Forest/Swamp	262,916	302,288	295,601	15.0	-2.2	12.4
Pine Forest/Pine Savannah	595,885	386,766	352,510	-35.1	-8.9	-40.8
Scrub-Shrub/Cutover/Barren	75,871	183,141	236,848	141.4	29.3	212.2
Emergent Wetland	82,966	60,709	55,726	-26.8	-8.2	-32.8
Inland Fresh Water	12,577	12,577	12,577	No change	No change	No change
Surface Water/Other	497,064	511,401	509,832			
Total	1,655,024	1,655,024	1,655,024			

Source: MARIS, 1992 and 2000; USGS and EPA, 1992, USGS, 1972.

Although pine forest/pine savannah is the most abundant terrestrial cover type in coastal Mississippi, it also shows the largest loss over all time periods. There were nearly 600,000 acres of pine forest/pine savannah in 1972, but by 2002 there were only slightly more than 350,000 acres of pine forest remaining. It is likely that some of the pine forest acreage became scrub-shrub/cutover/barren land following timber harvest from 1972 to 1992. There is also a strong possibility that widespread fire suppression during that time allowed hardwood trees to grow and become dominant over pines; deciduous forest increased by about 40,000 acres from 1972 to 1992.

Scrub-shrub/cutover/barren areas showed the largest increase from 1972 to 2000 in both absolute acreage and percent growth. A 212 percent increase in shrub-scrub/cutover land from 1992–2000 could be attributed to timber harvest, although old fields reverting to forest would also appear as the shrub-scrub cover type on remote sensing images. A great deal of flux between cutover land, pine forest, and deciduous forest would be expected over the years because of the interplay between plant succession, fire, and human activities such as timber harvest.

The percentage losses in emergent wetlands were nearly as large as the percentage losses in pine forest, although the acreage loss of emergent wetlands is almost an order of magnitude less than that of pine forest. The rate of emergent wetland loss from 1972 to 1992 was approximately 1,100 acres per year when averaged over 20 years. The rate of emergent wetlands loss was less—approximately 600 acres per year—from 1992 to 2000. Emergent wetland loss was due to numerous factors, including urban development, infrastructure expansion, and geomorphic processes such as erosion and sea level rise, and the apparent loss (based on remote sensing data) is partially real and partially an artifact of the data collection method. A more thorough assessment of wetland trends from 1972 to 2000 is presented below.

4.10.2 Wetlands

4.10.2.1 Introduction

Wetlands are areas where soil saturated with water is the dominant environmental factor that determines the types of plant communities that can successfully establish themselves and thrive. There is a wide variety of wetland types because of local and regional differences in soils, topography, climate, hydrology, water chemistry, vegetation, and other factors, including human disturbance, all of which play a part in determining the characteristics of a wetland community. Wetlands are found from the tundra to the tropics and on every continent except Antarctica.

For regulatory purposes under the Clean Water Act, the term *wetlands* is defined as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas."

Two general categories of wetlands are distinguished: Coastal or tidal wetlands and inland or nontidal wetlands. Coastal or tidal wetlands in the United States, as their name suggests, are found along the Atlantic, Pacific, Alaskan, and Gulf coasts. They are closely linked to estuaries, where the tide mixes seawater with fresh water. Inland or nontidal wetlands are most common on floodplains along rivers and streams (riparian wetlands), in isolated depressions surrounded by dry land (for example, prairie potholes), along the margins of lakes and ponds, and in other low-lying areas where groundwater intercepts the soil surface or where precipitation sufficiently saturates the soil (vernal pools and bogs). Inland wetlands include marshes and wet meadows dominated by herbaceous plants, swamps

dominated by shrubs, and wooded swamps dominated by trees. Certain types of inland wetlands are common to particular regions of the country. For instance, bottomland hardwood swamps are common in the south.

Many wetlands are seasonal (they are dry one or more season every year). The quantity of water present and the timing of its presence in part determine the functions of a wetland and its role in the environment. Even wetlands that appear dry at times for significant parts of the year, such as vernal pools, provide critical habitat for wildlife adapted to breeding exclusively in such areas.

Recently, scientists have begun to understand the important functions that wetlands perform. Wetlands do things that no other vegetation type does, including cleaning water, abating floods, controlling shoreline erosion, providing recreation opportunities, and supplying natural products.

- Wetlands intercept surface water runoff from upland areas and filter it before it reaches open water. As runoff water passes through a wetland, the wetland vegetation extracts nutrients and some pollutants and traps sediment that would clog waterways and harm fish and amphibian egg development.

- Wetlands trap and slowly release surface water, rain, snowmelt, groundwater and floodwaters. Trees, root mats, and other wetland vegetation slow the speed of floodwaters and disperse them over a floodplain. This combined water storage and braking action lowers the height of floods and reduces erosion.

- Wetlands within and downstream of urban areas counteract the rate and volume of surface water runoff from pavement and buildings, which are much greater than under natural conditions.

- Wetlands at the margins of lakes, rivers, bays, and the ocean protect shorelines and stream banks from erosion. Wetland plants hold soil in place with their roots, absorb the energy of waves, and intercept the flow of stream or river currents.

- Wetlands provide harborage for more than one-third of the United States' threatened and endangered species, and provide shelter, food, or some other life necessity for nearly half of our threatened and endangered species.

- Wetlands are important to the natural history of many of the Nation's fishing and shellfishing industry species, a catch that is valued at $15 billion a year. In the Southeast, for example, nearly all the commercial catch and more than half of the recreational harvest are fish and shellfish that depend on the estuary-coastal wetland system.

- Wetlands have recreational, historical, scientific, and cultural values. More than half of all U.S. adults hunt, fish, watch birds, or photograph wildlife. They spend nearly $60 billion annually on these activities. Others use wetlands for hiking and boating.

Wetlands are an important resource in coastal Mississippi because of their important functions. Pressure to develop coastal Mississippi could affect wetlands adversely and disproportionately because of their predominance in the region. Within the three coastal Mississippi counties, the southern, tidal-influenced strip of coastal land, categorized as "Gulf Atlantic Coastal Flats," wetlands historically have covered nearly 60 percent of the land. These coastal wetlands are the pine savannahs and pitcher plant bogs. North of the coastal area is the Gulf Atlantic Rolling Plain, where wetlands

are predominately bottomland hardwoods. These wetlands also could be affected adversely by rapid coastal development due to pressure to convert them to pine plantations and other land uses.

This section discusses the extent and distribution of emergent wetlands in the Southeast and coastal Mississippi in 2000 and assesses wetland changes in the region over the past 20 to 30 years. The information is examined for the coastal watersheds in Mississippi, at the county level, and within the CSA for this EIS. Wetlands of other types, particularly those in bottomland forests and pine forest/savannah communities, are not discussed in terms of historical trends and distribution because the nature of the data on wetlands does not permit separating wetland and non-wetland areas within these community types.

The land cover type "wetland" is defined differently by different agencies, so there is not always agreement between surveys as to the amount of wetlands in an area and how the wetlands should be categorized. Also, as technology has developed, surveys for wetlands have been done using different inventory methods. These factors lead to an inability to directly compare the results of one survey to those of another. Overall trends in the amount and loss of wetlands can be developed, however, by finding similarities in the findings of separate surveys. By examining information on wetlands in Mississippi across counties, watersheds, and within the coastal study area, it is easier to spot trends and to determine more precisely where the region's wetlands have been affected.

4.10.2.2 Baseline Conditions

Emergent wetlands in 2000 in the coastal Mississippi counties, watersheds, and coastal study area are described here. Bottomland forest and pine forest/savannah community types also contain wetlands, but the data used for this analysis did not distinguish between wetlands and uplands within these two community types, so any discussion of changes in acreages over time and into the future would be unsubstantiated by the data.

Emergent wetland acreage decreased in all three coastal counties, as shown in tables 4.10–2 and 4.10–3. Jackson County had the largest loss of emergent wetlands (16,300 acres; 37 percent) between 1972 and 2000. During the same period, Hancock County lost 7,200 acres or 26 percent of its emergent wetlands, and Harrison County lost 3,600 acres, or 35 percent or its emergent wetlands. Assessing wetland losses at the watershed level reveals that more than two-thirds of the remaining emergent wetlands were in the Bay St. Louis watershed in 2000, which was a larger ratio than in 1972 due to a larger relative loss of emergent wetlands from 1972 to 2000 in the Biloxi Bay watershed (Table 4.10–3). Of the 24,000 acres of emergent wetlands in the two watersheds in 2000, almost 96 percent, or 23,000 acres, were located in the CSA (emergent wetlands are primarily associated with the estuaries). This percentage has largely remained the same over the years. The data show that the CSA had 94.7 percent of emergent wetlands in 1972 and 95 percent of them in 1992. Because most emergent wetlands are found along the coast, that is where the greatest loss occurred: Ninety-four percent of all emergent wetlands lost within the two watersheds were lost within the coastal study area.

Table 4.10–2
Distribution of Emergent Wetlands by County, 1972 to 2000

	1972 Acreage	1992 Acreage	2000 Acreage
Emergent Wetland			
Jackson County	44,630	39,126	28,280
Harrison County	10,455	8,626	6,820
Hancock County	27,881	24,869	20,626

Table 4.10–3
Distribution of Emergent Wetlands by Watershed and Coastal Study Area, 1972 to 2000

	1972 Acreage	1992 Acreage	2000 Acreage
Emergent Wetland			
Bay St. Louis Watershed	21,603	20,249	16,059
Biloxi Bay Watershed	12,881	10,961	7,866
Coastal study area	32,656	28,947	22,863

4.10.2.3 Historical Look at Wetland Loss, Nationwide and in Mississippi

Wetlands are a dominant land cover type in the southeastern United States. Forty-seven percent, or 48.9 million acres, of wetlands in the conterminous United States are in the Southeast[3] (Table 4.10–4). Wetlands cover 16 percent of the Southeast, whereas they account for only 5 percent of the land of the lower 48 states (Hefner et al., 1994). The types of wetlands of the Southeast and the amount of each are tabulated below. The term "palustrine" refers to inland or nontidal wetlands and "estuarine" refers to coastal or tidal wetlands.

From the 1780s to the 1980s, the United States lost more than one-half of its wetlands (USEPA, 2001b). Mississippi lost more than 4.9 million acres, an estimated 59 percent, of the wetlands the state had in the 1780s (Johnston, 1994). The nationwide rate of wetland loss was particularly high from the 1950s to the 1970s, but has since decreased.

The Southeast had 51.2 million acres of wetlands in the mid-1970s and 48.9 million acres in the mid-1980s, a decrease of 2.3 million acres (Hefner et al., 1994). During this period, an average of 259,000 acres of wetlands were lost per year in the Southeast, which represented 89 percent of wetland losses in the United States. Most losses (62 percent) in the Southeast during the period occurred in the Gulf-Atlantic Coastal Flats, which in Mississippi covers a narrow band of coastal land.

[3] Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee.

Table 4.10–4
Wetlands of the Southeastern United States, Mid-1980s

Major Land Classifications in the Southeastern United States	
Uplands	250,300,000 acres
Deepwater Habitats	15,800,000 acres
Wetlands	48,900,000 acres
Wetland Classifications	
Palustrine	44,600,000 acres
Forested	32,800,000 acres
Emergent	5,800,000 acres
Scrub/Shrub	4,600,000 acres
Non-vegetated	1,300,000 acres
Estuarine	4,300,000 acres
Emergent	3,100,000 acres
Forest/Shrub	700,000 acres
Non-vegetated	500,000 acres

Source: Hefner et al., 1994.

A detailed assessment of wetland loss and gain from the mid-1980s through 1997 specific to the Southeast is not available, but wetland gain and loss for the period in the United States has been assessed by the USFWS (Table 4.10–5) (Dahl, 2000). During the period, an average annual loss of 58,500 acres occurred in the United States, resulting in a total loss of 644,000 acres, or 0.606 percent of the wetlands that remained in the mid-1980s. Of the total loss, 521,000 acres, or 81 percent of all wetlands lost were lost in the Southeast. Nationally, wetland losses during the period were due to urban development (30 percent), agriculture (26 percent), silviculture (23 percent), and rural development (21 percent). Programs such as the Wetlands Reserve Program, administered by the Natural Resources Conservation Service (NRCS) of the U.S. Department of Agriculture, and state, local, and private initiatives on agricultural lands have helped reduce the rate of wetland loss recently (NRCS, 2001).

Table 4.10–5
Wetland Losses in the United States, Mid-1980s to 1997

U.S. Wetland Losses (Mid-1980s–1997)	644,000 acres[1]
Average Annual Loss	58,500 acres
Estuarine Wetlands	2 percent of all wetland losses
Loss due to:	*Proportion of Estuarine Wetland Loss:*
Urban Development	43 percent
Fill and Spoil Deposition	30 percent
Saltwater Intrusion	12 percent

Table 4.10–5
Wetland Losses in the United States, Mid-1980s to 1997 (continued)

Palustrine Wetlands	98 percent of all wetland losses
Loss due to:	*Proportion of Palustrine Wetland Loss:*
Urban Development	30 percent
Agricultural	26 percent
Silviculture	23 percent
Rural Development	21 percent

[1]Equivalent to a loss of 0.606 percent of wetlands that were present in the mid-1980s. The loss rate during this period was 20 percent of the loss rate of the mid-1970s to mid-1980s.

Source: Dahl, 2000.

According to NRCS, Mississippi had a total of 4,492,600 acres of palustrine wetlands and 53,400 acres of estuarine wetlands in 1997, for a total of 4,546,000 acres of wetlands (NRCS, 2001).

4.10.2.4 Specific Wetland Losses (from Corps Permitting Records, 1992–2000)

According to records of Corps permits from the Mobile District for large projects (projects that affected more than 5 acres of wetlands) from 1992 to 2000, most wetlands have been lost in the coastal area (Table 4.10–6). The areas near Biloxi, Gulfport, and Ocean Springs lead with the most permitted activities that affected wetlands and the most wetland acres lost to permitted development.

Table 4.10–6
Individually Permitted Large Wetland Losses by Location, 1992–2000

Location	Number of Permits	Loss (acres)	Habitats Affected
Gulfport	13	386.5	pine savannah, pine flatwoods, forested
Ocean Springs	7	168.5	pine savannah, pine flatwoods
Biloxi	5	104.0	forested, pine flatwoods
Long Beach	4	69.9	forested, pine savannah, pine flatwoods
D'Iberville	2	15.0	forested, pine flatwoods
Bay St. Louis	2	12.3	forested, pine flatwoods
Waveland	1	10.0	pine savannah
Kiln	1	8.2	pine flatwoods
Pass Christian	1	7.5	pine flatwoods
Gautier	1	7.2	pine savannah, pine flatwoods
Totals	37	789.1	pine savannah, pine flatwoods, forested

Source: USACE, 2001.

Corps individual permits from January 1, 1992, through May 1, 2000, were reviewed and acreages of wetlands affected under the permits were tallied. Table 4.10–6 shows the locations of the wetlands affected and the types of wetlands affected. All wetlands affected under Mobile District Corps individual permits were in pine flatwoods, pine savannah, and forested areas. A total of 789.1 acres of wetlands were affected under individual permits from 1992 to 2000. Note, however, that the Corps did not distinguish stream impacts from wetland impacts at the time, and it is uncertain from information contained in the permit applications or permits what quantity of the impacts attributed to wetlands were actually to streams and small drains.

Examined by year (Table 4.10–7), there is no clear trend of decreasing acreage of wetlands affected under individual permits from 1993 to 2000. Wetland losses in 1997 and 1998, for instance, exceed losses in most previous years, and 1999 and 2000 losses are each more than 1996 and 1994 losses.

Table 4.10–7
Corps Individual Permits by Year

Year	Number of Permits Issued	Acreage Affected
1993	1	212.0
1994	4	45.7
1995	7	128.1
1996	3	18.4
1997	7	145.3
1998	10	146.8
1999	3	85.6
2000	3	76.5

Source: USACE, 2001.

An examination of mitigation required under Mobile District Corps individual permits shows that 1,085.3 acres of wetlands were to be restored or enhanced, 174.1 acres were to be created, and 1,400.8 acres were to be preserved or managed in compensation for acres lost (Table 4.10–8). Although mitigation of a specified number of acres is usually required in a permit, mitigating lost wetland function is also important. The actual amount of mitigation, in either acreage or wetland functional replacement, that has occurred successfully is unknown. Follow-up monitoring and mitigation reporting does occur, but the information from this source is incomplete because not all mitigation sites can be visited and extensive and long-term monitoring would be necessary to ensure the success of mitigation projects.

The National Research Council (NRC) notes in a recent report (NRC, 2001) that there are shortcomings with performance expectations in some permits. Permits for wetland loss contain performance criteria for mitigating the loss, and the NRC report shows that in some instances performance criteria were met but mitigation projects were poorly designed or implemented, the mitigation site was located where the hydrology necessary to support a wetland community of plants and animals was not present, or the hydrology was insufficient to replace the functions of the lost wetlands. Furthermore, permit conditions often specify that monitoring occur for 5 years, while some

Table 4.10–8
Mitigation Required Under Individual Permits (acres) (USACE, 2001)

Location/Permittee	Preserve/Manage	Create	Restore/Enhance
Gulfport	474.5	50.3	376.0
Long Beach	207.6	13.4	64.6
Biloxi	161.9	12.2	59.9
Ocean Springs	178.8	36.6	237.3
Diamondhead	3.9		6.0
Woolmarket	56.1	10.0	10.3
Bay St. Louis	3.1	32.3	30.1
Bayou Caddy	0.1	0.5	8.8
Bernard Bayou		0.2	
Flat Branch		5.2	
Waveland	31.2		13.2
D'Iberville	57.7	1.5	47.5
Van Cleave	8.8	3.1	
Gautier	61.4	2.0	11.1
Hancock County	1.0		89.0
Coastal MS	80.5		
Pass Christian	19.4	0.7	44.6
Kiln			84.0
Perlington	2.0		
Fountainbleu		3.8	
Harrison County	26.8	2.4	3.0
Jackson County	20.0		
MS Highway 63	2.0		
Orange Grove	4.1		
Total	**1,400.8**	**174.1**	**1,085.3**

Source: USACE, 2001.

wetlands require up to 20 years to become fully functioning. Without an equally long monitoring program, the success of mitigation is unknown.

Wetland restoration is generally easier, less costly, and more successful than wetland creation. Restoration sites generally have the soils, seed banks, and hydrology necessary to recreate a functioning wetland, while wetland creation sites are often unsuited in soil type and hydrology to support a wetland community and wetland functions. For these reasons, created wetlands usually require more intervention and engineering to be successful. Wetland preservation is an effective mitigation technique because functionally important wetlands or wetlands that offer unique assemblages of plants and animals can be set aside from development permanently.

Wetland mitigation can occur at the site of the wetland impact, elsewhere within the watershed where the impact occurs, or within a different watershed. On-site, in-kind mitigation is not always preferred. Wetland losses due to development within urban or suburban areas are often best mitigated elsewhere in the watershed. Urban and suburban areas can be sites of pollutant generation and runoff, which could create problems with mitigation success. Future development in urban and suburban areas can threaten the success of wetlands created or restored within them. Also, development often alters the hydrology of an area, and that lowers the likelihood of mitigation succeeding.

An approach to wetland mitigation that is better than on-site mitigation is a watershed approach. Wetlands have been lost in both watersheds of concern to this project, and wetlands situated in different parts of watersheds serve different functions. Riparian wetlands located downstream in a watershed are generally more important in flood attenuation, while small, isolated wetlands might be more important to the survival of some species of plants and animals. A watershed approach to wetland mitigation involves assessing the historical loss of wetlands within the watershed, the functions of all wetland types within the watershed and where those functions have been lost, and planning mitigation where those functions are most needed and where mitigation has the best chance of long-term success. In many cases this might mean replacing wetlands that are being lost with wetlands of a different type in a different location. Landscape analysis of multiple watersheds in a region could reveal that one or more wetland functions are vitally needed in one watershed and mitigation in it for wetlands lost in another watershed might be appropriate.

Table 4.10–9 provides information on nationwide permit (NWP) 26 issuances for 1992 to 2000. During that period, 54 permits were issued in Hancock County, 235 in Harrison County, and 151 in Jackson County, totaling 440 permits. NWP 26 permits were issued for impacts of less than 10 acres of waters, including wetlands, prior to 1996, with a requirement for preconstruction notification (PCN) and wetland delineation if the activity was to affect from 1 to 10 acres, and no requirement for PCN or wetland delineation if the activity was to affect less than 1 acre. After 1996, NWP 26 permits were issued for activities affecting 3 acres or less, with no PCN or wetland delineation requirement for activities affecting less than 1/3 acre. The Corps estimates that 75 percent of all environmental impacts that result from activities permitted under all of the nationwide permits are authorized under NWP 26 (Copeland, 1999). Mobile District Corps data indicate that 90 percent of all NWP 26 actions involve areas of less than 3 acres (Copeland, 1999).

NWP 26 permits issued prior to 1996 numbered 101, with an additional 339 permits issued after 1995. In the three counties, 87 percent, 76 percent, and 75 percent of NWP 26 permits were issued after 1995 (Table 4.10–9). One might expect that more individual permits would have been issued after 1995 and fewer NWP 26 actions would have occurred after 1995, given the change in acreage limits for NWP 26 from 10 acres to 3 acres, but this does not appear to be the case.

GIS data from USGS and the state of Mississippi indicate that emergent wetlands decreased in all three counties from 1972 to 1992 (Table 4.10–10).

Emergent wetlands decreased in both watersheds from 1972 to 2000. Over the 18-year period, GIS data show a loss of 10,500 acres of emergent wetlands entirely or almost entirely within the coastal study area. These data are presented in Figure 4.10–1.

Table 4.10–9
Number of Nationwide Permits 26 Issued by County and Location, 1992–2000

	Hancock County	Harrison County	Jackson County
"No Waterway" Permits:	49	192	132
One Permit Issued For:	La Terre, Jackson Marsh, Jourdan River	Biloxi Bay, Big Lake, Flat Creek, Lake Serene, Back Bay of Biloxi, Fritz Creek Bay, St. Louis, Bayou Johnson, Mallini Bayou, Sandy Creek, Young Bayou, Mill Creek, Wolf River, Canal No. 2	Fort Bayou, Robertson Lake, Graveline Bay, Tchoutacabouffa, Woodman Branch, Cypress Creek, Bayou Casotte, Perigal Creek, Talla Bayou, Fort Bayou Creek, Franklin Creek, Simmons Bayou, Heron Bayou
Two Permits Issued For:	Orphan Creek	Parker Creek, Cypress Creek, Palmer Creek, Turkey Creek, MS Sound	Bayou St. Pierre, Old Fort Bayou, MS Sound
Three Permits Issued For:		Biloxi River	
Total Permits Issued and Pre-1996 Permits, in "( )"	54 (7)	235 (58)	151 (36)
Pre-1996 as Percentage of County Total:	13%	25%	24%

Source: USACE, 2001.

Table 4.10–10
Area of Emergent Wetlands, 1972 to 2000
(thousand acres)

	Hancock County			Harrison County			Jackson County		
	1972	**1992**	**2000**	**1972**	**1992**	**2000**	**1972**	**1992**	**2000**
Emergent Wetland	27.9	24.9	20.6	10.5	8.6	6.8	44.6	39.1	28.3
	Coastal Study Area: Total, and % of Total in Watersheds-in "()"[1]			**Bay St. Louis Watershed**			**Biloxi Bay Watershed**		
	1972	**1992**	**2000**	**1972**	**1992**	**2000**	**1972**	**1992**	**2000**
Emergent Wetland	32.7 (94.8%)	29.0 (92.9%)	22.9 (95.4%)	21.6	20.2	16.1	12.9	11.0	7.9

[1] For instance, there were 32.7 thousand acres of emergent wetlands in the coastal study area in 1972, which was 94.8% of the total of emergent wetlands in the Bay St. Louis and Biloxi Bay watersheds.
Note: All numbers in thousands, rounded to nearest 100.
Source:1972 data: USGS, 1972; 1992 data: MARIS, 1992; USGS and EPA, 1992.; 2000 data: MARIS, 2000.

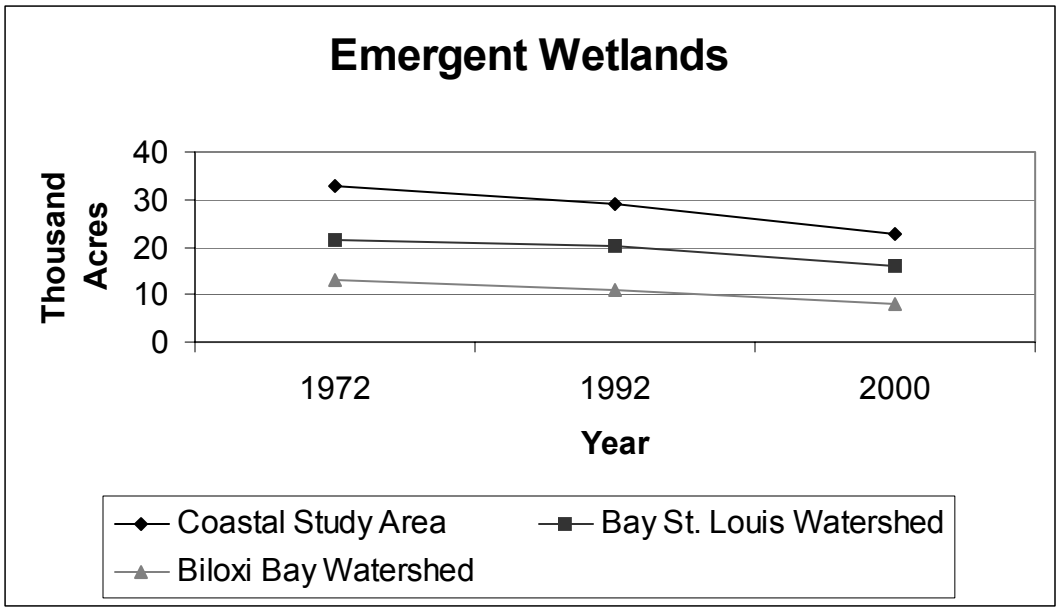


Figure 4.10–1. Emergent Wetland Community Type Changes, 1972–2000.

Comparisons of the county data to the watershed and coastal study area data are not possible because the boundaries of the two areas are not the same. However, the eastern and western boundaries of the coastal study area correspond with the eastern and western watershed area boundaries, so the coastal study area data is a subset of the watershed data. Examining these data, it is seen that the coastal study area had the same percentage of emergent wetlands in the two watersheds in 1972 as it did in 2000 (94.8 percent of emergent wetlands in 1972 and 95.4 percent of emergent wetlands in 2000) (Table 4.10–11).

Nearly all losses of emergent wetlands in the two watersheds have been in the coastal study area, which is not surprising because nearly all emergent wetlands in the two watersheds are in the coastal study area (see Figure 4.10–1). Note, however, that a large expanse of emergent wetlands occurs in Jackson County outside the coastal study area and the two watersheds. Within the three-county area, losses of emergent wetlands in Jackson County accounted for approximately half of the losses from 1972 to 1992 and two-thirds of the losses from 1992 to 2000.

According to the GIS data for emergent wetlands, from 1992 to 2000, 17,000 acres were lost within the three counties, 7,300 acres were lost in the two watersheds, and 6,100 acres of the latter loss occurred within the coastal study area. According to the records of individual permits issued during the same time period, none of the wetland types affected by the permitted activities were emergent wetlands.

Table 4.10–11
Change in Extent of Emergent Wetlands, 1972 to 2000
(thousand acres)

	Emergent Wetlands		
	'72–'92	**'92–'00**	**Ratio[2]**
Hancock County	-3.0	-4.2	1.4
Harrison County	-1.8	-1.8	1.0
Jackson County	-5.5	-10.8	2.0
County Total	-10.3	-16.9	1.6
Bay St. Louis Watershed	-1.4	-4.2	3.0
Biloxi Bay Watershed	-1.9	-3.1	1.6
Watershed Total	-3.3	-7.3	2.2
Coastal Study Area	-3.7	-6.1	1.6
Coastal Study Area Change as % of Watershed Total:	113.3%	83.5%	0.7

[1] "Ratio" is the size of the '92-'00 loss (gain) relative to the '72–'92 loss (gain). Ratios more than 1.0 indicate a '92–'00 rate higher than the '72–'92 rate.
Note: All numbers in thousands, rounded to nearest 1000.

4.10.2.5 Summary

Wetlands are a predominate land cover type in the Southeast and in Mississippi, and they perform many vital functions. Most of the permitted wetland losses in the three coastal Mississippi counties have occurred in the coastal area, i.e., the Gulf Atlantic Coastal Flats, and most permitted losses from 1992 to 2000 occurred near Biloxi, Gulfport, and Ocean Springs. Mitigation for wetlands affected by permitted activities has been required as restoring or enhancing existing or damaged wetlands, preserving or managing existing wetlands, or creating new wetlands. Wetland losses under NWP 26 or due to natural causes such as sea level rise, or both, might be as large as or larger than those under individual permits.

It is unknown exactly how many acres of wetlands have been restored, created, or preserved under required mitigation. Mitigation has been required near the site of wetland loss, within the watershed where the wetland loss occurs, and in neighboring watersheds. All of these are viable approaches for compensating wetland losses. The success of a mitigation project depends on the suitability of the site for wetland development, and the location for mitigation is best selected within landscape and watershed contexts.

In the two watersheds, emergent wetlands—one of the numerous types of wetlands in coastal Mississippi—occur almost exclusively in the coastal study area. They decreased by 3,300 acres from 1972 to 1992 and by 7,200 acres from 1992 to 2000, for a total loss of approximately 30 percent within the two-watershed area.

4.10.3 Aquatic Resources

The aquatic resources that will be addressed in this section are the groups of living resources that spend either all or a portion of their life cycle in the estuarine and nearshore waters of coastal Mississippi. Categories of aquatic resources include submerged aquatic vegetation, such as seagrasses, finfish, and shellfish (e.g., oysters, crabs, shrimp). Seagrasses are the primary producers of the coastal waters and provide both a source of food and shelter for many estuarine-dependent species, such as seatrout and shrimp. The finfish and shellfish stocks of the northern Gulf of Mexico constitute some of the most significant recreational and commercial fisheries in the United States. Therefore, it is very important that the condition and integrity of the aquatic habitat in this region of the Gulf be preserved and, if possible, enhanced.

The study area in which the description of aquatic resources applies includes the estuarine and nearshore waters located off the Mississippi coastal counties of Hancock, Harrison, and Jackson. Specifically, this area includes the brackish waters of Biloxi and St. Louis Bays, as well as the waters of the Mississippi Sound extending a few miles south of Cat and Ship Islands. This summary is based primarily on existing data available through related literature and documents available for the Mississippi Sound region and through previous investigations.

4.10.3.1 Baseline Conditions

The coastal zone along the southeastern mainland of the United States encompasses more than 2,799 miles of coastline, 29,900 miles of tidal shoreline, and 300 estuarine systems. The estuaries in the Southeast contain about 17.2 million acres of marsh and other estuarine habitat and 5.1 million acres of intertidal areas. These wetlands comprise about 83 percent of the coastal wetlands in the coterminous United States. The Southeast Region contains most of the Nation's mangrove swamps and seagrasses.

Conserving coastal habitats is important in that approximately 98 percent of all Gulf of Mexico and 94 percent of all southeast Atlantic commercial landings are dependent on coastal habitats. These resources provide significant economic and social benefits. In addition to food production, wetlands and coastal habitats provide many other useful benefits such as storm protection, flood prevention, erosion protection, aesthetics, waterfowl and furbearer production, recreation, and other benefits. These benefits, according to some estimates, can be as high as $82,000 per acre per year.

The coastal wetlands of Mississippi Sound, St. Louis Bay, Biloxi Bay, Pascagoula Bay, and the tidal Pascagoula River provide the resource base for commercial and marine recreational fishing and tourism in Mississippi. The dockside value of commercial fish landings in Mississippi was almost $42 million in 1995. Recreational fisheries also play an important role in the state's economy. In 1991, 500,000 people spent more than $236 million fishing in Mississippi's waters, generating almost $14 million in state sales tax, resulting in $131 million in earnings, and supporting more than 8,000 jobs. Approximately one-quarter of the recreational fishing occurs in coastal waters. Communities such as Moss Point, Pascagoula, Gautier, Ocean Springs, Biloxi, Long Beach, Gulfport, Pass Christian and Bay St. Louis all depend on fishing to support their local economies (NMFS, 2002).

Mississippi's coastal wetlands provide critical nursery areas for many species of fish and shellfish. Menhaden and shrimp, the most important commercial species, depend on estuarine wetlands for protection and food when they are juveniles. The relationship between a fishery and wetlands has been very effectively demonstrated for the shrimp fishery. Research has shown that the productivity of shrimp fisheries is directly related to the amount of vegetated area in an estuary. The more

wetlands there are in an estuary, the more shrimp the estuary will produce. Shrimp landings account for more than half of the value of Mississippi commercial fisheries, which is why Mississippi shrimp fishermen, facing declining harvests in some areas, have joined other Gulf of Mexico shrimpers in becoming supporters of efforts to conserve and restore coastal wetlands. Another example of fisheries' dependence on wetlands is found in the menhaden fishery, whose total landings (Atlantic and Gulf of Mexico) have decreased by 26 percent in the past decade. Menhaden are dependent on wetlands for nursery habitat and the detrital food chain. The regional management plan for Gulf menhaden cites the loss of coastal wetlands as one of the principal threats to that fishery.

Mississippi's coastline is under significant development pressure. By the mid-1980s Mississippi had lost approximately 59 percent of its wetlands. The Clean Water Act and the state's coastal wetlands protection statute provide legal protection against the loss of wetlands, but recent studies have determined that, nevertheless, wetlands in coastal states such as Mississippi have been lost at an alarming rate. The loss of wetlands in Mississippi affects not only Mississippi's fisheries but also the fisheries of all of the Gulf of Mexico states, from Texas to Florida. Strong efforts to protect the state's wetlands are needed to avoid additional wetland loss, which would adversely affect the fisheries that depend on those wetlands and the communities that depend on the fishing industry.

The following sections discuss the aquatic, estuarine, and marine resources in the Mississippi Sound and Back Bays region of the study area.

4.10.3.2 Aquatic Plants

Aquatic plants include phytoplankton, periphyton, and vascular plants. Phytoplankton play an important role as a supportive or base source for the food chain. Phytoplankton communities include numerous diatoms (e.g., *Coscinodiscus* sp., *Thalassiosire* sp., *Pleurosigma* sp., and *Staurones* sp.), dinoflagellates (*Noctiluca* sp., *Ceratium* sp., *Pendinium* sp., *Dinophysis* sp.), and blue-green algae, *Trichodesmium*. Many algal species are periphytic upon the seagrasses, while others are attached to emergent plants or hard structures such as oyster reefs. Algal occurrences vary depending on various ecological conditions (salinity, turbidity, temperature, and light quality and photoperiod). During years of relatively high salinity, marine algal species occur in great abundance and are concentrated in the southern part of the sound, where the water remains relatively calm and high in salinity (MDMR, 1998a).

Submerged aquatic vegetation (SAV), vascular plants rooted in the underwater substrate whose leaves remain below the water surface during the growing season, is an important aquatic plant resource in the sound. In the Mississippi Sound, this ecological community component consists primarily of various species of seagrass and plays several important roles in the ecosystem. Seagrass exhibits rapid growth, is highly productive, and provides food and shelter for numerous organisms. Seagrass also promotes stabilization of sediments and maintains an active environment for nutrient cycling (Zieman and Zieman, 1989).

Four species of seagrasses have been found in the Mississippi Sound: shoal grass (*Halodule wrightii*), turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and the infrequently found seagrass *Halophila engelmanii* (USACE, Mobile District, 2000). Seagrass beds are found predominantly along the north side of the barrier islands but have occurred in smaller beds near the beach (MDMR, 1998a). Historically, the northern shorelines of Ship, Horn, and Petit Bois Islands had supported populations of four seagrasses, but these areas were shown to support only beds of shoal grass during a 1998 study (Moncrieff et al., 1998). Eleuterius (1973) found well-developed grass beds in the past at Round and Cat Islands, whereas Moncrieff and others (1998) found only

populations of shoal grass west and north of Cat Island and no seagrasses in the waters surrounding Round Island. Additional submerged aquatic plants have been found in the vicinity of the bays and include widgeon grass (*Ruppia maritime*) and American wildcelery (*Vallisneria americana*) (MDMR, 1998; Moncrieff et al., 1998).

Mississippi has experienced a loss of nearly half of the seagrass acreage that was present in 1967 through 1968 and has lost all but one of its marine seagrass species. Only shoal grass exists in any type of measurable acreage in the Sound (Moncrieff et al., 1998).

Because seagrass beds play a critical role as nursery habitat for larval and juvenile stages of fish and invertebrates, their decline has a profound effect on these species (Moncrieff et al., 1998). Reductions in the seagrass habitats adversely affects not only the fauna in direct proximity to the seagrass beds but also the detrital export from the grassbeds and the food source for other fauna not directly inhabiting the SAV beds.

Causes of SAV decline include natural causes such as disease, storm events, salinity fluctuations, and hypoxic events coupled with declining water quality caused by anthropogenic eutrophication (Moncrieff et al., 1998). In 1969 a distributional survey was conducted to determine the location of seagrass and macrophytic marine algal beds in Mississippi Sound (Eleuterius, 1972). As a result of Hurricane Camille in 1969, these data have since been used as the baseline from which future assessments could be evaluated. The 1969 study prior to the hurricane indicated that approximately 8,093 hectares (20,000 acres) of submerged aquatic vegetation (SAV) were located in the Mississippi Sound area. Results of surveys conducted after the hurricane indicated that 4,727 hectares (11,676 acres) of SAV were lost as a result of erosion and sedimentation directly related to Hurricane Camille and the persistent low-salinity water resulting from discharged flood waters (Eleuterius and Miller, 1976). By 1975 vascular seagrasses had been reduced to 33 percent and algal cover had been reduced by 41 percent. Additional losses of seagrass beds from 1971 to 1975 occurred as a result of the prolonged exposure to low salinity-water during the springs and winters of those years.

Moncrieff and others (1998) determined that the seagrass beds in Mississippi Sound are threatened by the cumulative effects of natural events and anthropogenic activities in the coastal marine environment. The primary causes for this decline are most likely water quality, extended periods of depressed salinity, and physical disturbances such as tropical storms and hurricanes. In 1973, 67.6 percent of potential seagrass habitat was vegetated; however this amount was reduced to 13.4 percent by 1992 (Eleuterius, 1973; Moncrieff et al., 1998). The loss of previously vegetated areas in Mississippi Sound that are considered potential seagrass habitat totals 54.2 percent (Moncrieff et al., 1998).

As mentioned in previous sections, nearly half of the seagrass acreage that was present in 1967 through 1968 has been lost, and only one marine seagrass species, shoal grass (*Halodule wrightii*), remains in any type of measurable acreage in the Sound. Data from past and recent seagrass mapping illustrate the magnitude of decline in coverage (Table 4.10–12). The magnitude of previously vegetated areas that still fall within the regions delimited as potential seagrass habitat are also presented.

The seagrasses in Mississippi Sound are threatened by the cumulative effects of both natural events and anthropogenic activities in the coastal environment. The primary factors that have contributed to the decline of seagrass populations in the Mississippi Sound are an overall decline in water quality, physical loss of habitat, decreased availability of light, extended periods of depressed salinity, and

Table 4.10–12
Comparison of Estimated Areas of SAV During 1969 and 1992, and Potential Seagrass Habitat (PSGH) Currently Available

Location	1969 Acres	1992 Acres	PSGH Acres
Buccaneer State Park	206	55	316
Cat Island	598	169	5,128
Ship Island	1,536	253	1,603
Dog Keys Pass	2,079	0	1,149
Horn Island	1,690	530	4,350
Petit Bois Island	1,690	364	1,810
Point-aux-Chenes Bay	1,306	627	534
Total	12,982	1,998	14,890

Source: Moncrieff et al., 1998

physical disturbances such as tropical storms and hurricanes. Seagrass habitat loss in the sound coincides with areas where rapid coastal erosion and massive long-term movement of sand have occurred (Moncrieff et al., 1998). The development of the coastal area is likely to result in indirect and cumulative adverse affects on seagrass beds by contributing to elevated nutrient levels, higher sediment loads, and the introduction of contaminants, leading to degraded water quality.

The adverse effects from natural perturbations, as evident by the catastrophic effects from Hurricane Camille on the seagrass beds, have been substantial and long-lasting. Continued physical loss of habitat, fluctuating salinity, and declining water quality will weaken the condition of existing beds and inhibit the revegetation of those areas that represent potential seagrass habitat. All growth scenarios are likely to exacerbate the condition and integrity of the seagrass beds in Mississippi Sound; however, the greatest devastation has come from natural perturbations such as tropical storms and hurricanes.

4.10.3.3 Aquatic Invertebrates

Aquatic invertebrates in the Mississippi Sound and Back Bay include crustaceans, mollusks, and worms. Aquatic invertebrates occur in the water column (zooplankton), in or on the substrate bottom (benthic organisms), and on surfaces such as plants and oyster reefs (epifauna).

The zooplankton community is represented by a variety of taxa and can be divided into temporary (meroplankton) and permanent (holoplankton) plankton. Meroplankton is composed of the development stages of benthic and nektonic (capable of swimming independently of currents) invertebrates and some fishes. The meroplankton in the Sound is characteristically seasonal and corresponds to the spawning habits of local species. Species diversity and numbers are greatest during the warmer months when large numbers of crustacean, molluscan, and echinoderm larvae are present. Holoplanktonic representatives spend their entire life cycle as plankton. Crustaceans, especially copepods, are the most important holoplankters in the Sound and play an important role in the food chain (MDMR, 1998a).

Epifaunal and benthic organisms are also important components of the Mississippi Sound and Back Bay ecosystems. These organisms serve as an important food source for higher level consumers such

as crabs, shorebirds, shrimp, and fish. Epifaunal species include barnacles, sponges, bryozoans, and hydrozoans. Benthic organisms include polychaetes, gastropod and bivalve mollusks, amphipods, isopods, echinoderms, crabs, and shrimps (McLelland et al., 1998).

Benthic communities vary depending on the substrate bottom types present in the area. Substrate bottom types in the sound vary between nearshore and offshore (subtidal) areas. Nearshore and subtidal bottoms vary from sand to muddy sand to mud. Subtidal bottoms consist primarily of soft mud sediments. The Back Bay consists primarily of mud bottoms (Christmas, 1973: Wieland, 1994).

In the sound, nearshore sand bottoms typically exhibit the lowest species diversity with a wide range of densities from the highest to the lowest. Offshore muddy sand bottoms have been found to exhibit four times the mean station density of mud habitats and the highest species richness of the sound bottom habitats characterized by Wieland (1994). Mud bottoms in Back Bay also exhibit high species diversity and support large numbers of benthic organisms (Wieland, 1994). All bottom habitats in the Mississippi Sound and Back Bay provide an important food source to animals higher in the food web (MDMR, 1998a).

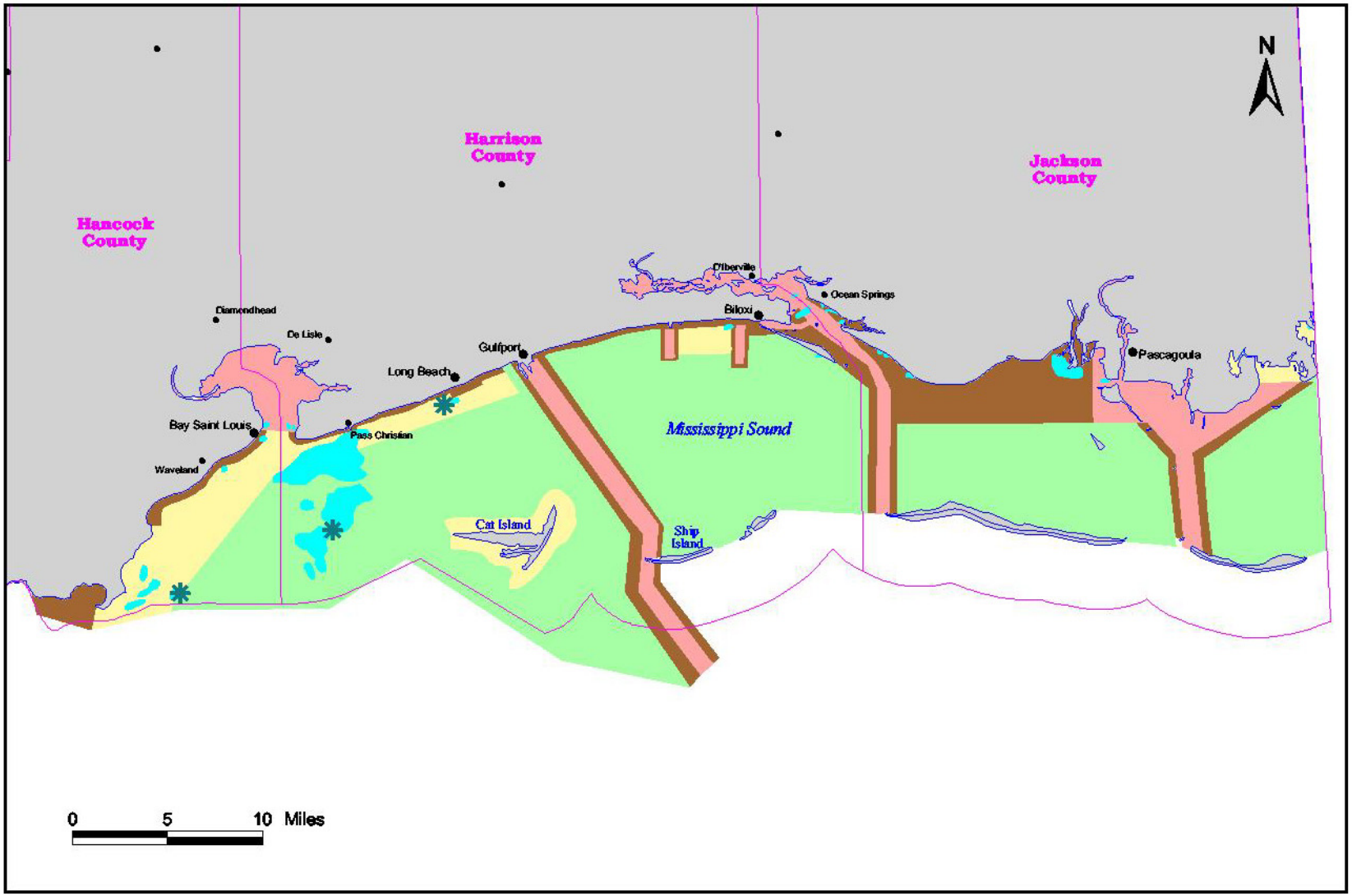
Commercially important invertebrate species in the Mississippi coastal waters consist of brown shrimp (*Penaeus aztecus*), pink shrimp (*P. duorarum*), white shrimp (*P. setiferus*), blue crab (*Callinectes sapidus*), and the eastern oyster (*Crassostrea virginica*) (MDMR, 1998a). The condition and commercial value of these fisheries is discussed in detail in Section 4.10.3.4. Oyster reefs, as a solid substrate, also provide preferable habitat and shelter for numerous other species (Wieland, 1994). Wells (1961) cataloged 303 species associated with oyster reef structures. Figure 4.10–2 illustrates the location of oyster reefs off the coast of Mississippi.

4.10.3.4 Commercial Fisheries

The coastal wetlands and estuaries of the Gulf of Mexico provide habitat for an estimated 95 percent of the finfish and shellfish species landed in the Gulf and 85 percent of the recreational catch of finfish (Thayer and Ustach, 1981, as cited in Guillory et al., 2001). The commercial fisheries of the Gulf comprise 18 percent of the Nation's total commercial landings and support the most valuable shrimp fishery in the United States (Guillory et al., 2001). In addition, the Gulf's wetlands, coastal estuaries, and barrier islands support large populations of wildlife (e.g., waterfowl, shorebirds); play a significant role in flood control and water purification; and lessen wind damage and storm surges from hurricanes (Guillory et al., 2001).

There are four major fisheries in which Mississippi producers and processors participate—shrimp, crabs, oysters, and finfish. The annual landings for finfish and shellfish (oysters, shrimp, crabs) for 1972 through 2000 are presented in Table 4.10–13 and Figure 4.10–3.

From 1972 to 1992, combined annual landings of commercial fish species averaged 308,180,817 pounds per year (Table 4.10–13). The average annual landings for the period of 1993 through 2000 declined by 36 percent to 198,480,568 pounds. Shellfish landings actually increased 29 percent from 12,373,066 pounds (1972 to 1992) to 15,943,231 pounds (1993 to 2000). However, finfish, which represent the majority of fish landings, decreased by 38 percent from 295,807,751 pounds to 182,537,337 pounds.



LEGEND

- Oyster Bed
- Oyster Reef (from Wetlands Use Plan)
- County Boundary

Classified Shellfish Areas Harvesting Status

- Approved
- Conditionally Approved
- Restricted
- Prohibited

Sources: CEI, 1999; NOAA/NOS/SPO, 1999.

Oyster Reefs

Figure 4.10-2

Table 4.10–13
Annual Landings (Pounds) of Commercial Fish Species in Mississippi

Year	Annual Landings (pounds)		Total Combined Landings
	Finfish	Shellfish	
1972	245,947,200	10,710,200	256,657,400
1973	261,456,100	6,128,000	267,584,100
1974	293,617,800	7,359,500	300,977,300
1975	299,495,700	6,261,900	305,757,600
1976	277,757,300	10,403,200	288,160,500
1977	299,108,100	13,884,700	312,992,800
1978	303,650,200	10,912,868	314,563,068
1979	323,799,910	10,119,863	333,919,773
1980	270,119,710	8,748,347	278,868,057
1981	199,317,750	10,699,489	210,017,239
1982	320,099,915	13,835,808	333,935,723
1983	369,886,500	15,106,591	384,993,091
1984	415,747,044	16,439,069	432,186,113
1985	420,070,954	19,456,193	439,527,147
1986	358,092,803	15,537,483	373,630,286
1987	384,989,359	14,016,661	399,006,020
1988	281,212,969	13,458,930	294,671,899
1989	253,808,839	17,311,787	271,120,626
1990	273,476,333	15,796,368	289,272,701
1991	202,119,555	12,344,793	214,464,348
1992	158,188,726	11,302,646	169,491,372
Average 1972–1992	**295,807,751**	**12,373,066**	**308,180,817**
1993	171,552,250	12,499,685	184,051,935
1994	209,482,409	10,702,677	220,185,086
1995	126,917,973	17,979,571	144,897,544
1996	148,952,514	13,409,768	162,362,282
1997	163,870,143	16,525,185	180,395,328
1998	191,596,013	19,066,823	210,662,836
1999	249,368,030	18,177,848	267,545,878
2000	198,559,363	19,184,292	217,743,655
Average 1993–2000	**182,537,337**	**15,943,231**	**198,480,568**

Source: NMFS, 2000.

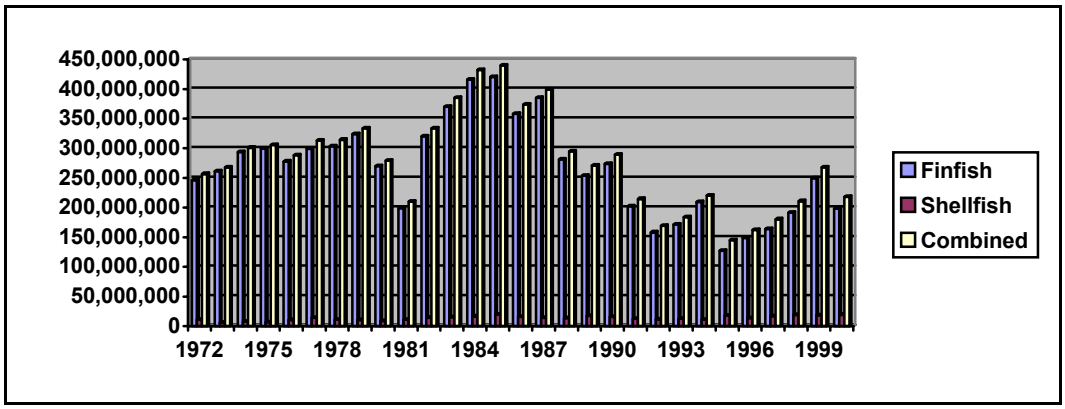


Figure 4.10–3 Annual Landings (pounds) of Commercial Fish Species in Mississippi

4.10.3.5 Fish Species

Estuaries provide food, refuge from predation, and habitat and serve as essential nursery grounds for a wide variety of economically important fishes and invertebrates (USEPA, 1999). As a result, the economic viability of the commercial and recreational fisheries of the Gulf of Mexico, in general, and Mississippi in particular, is also estuary-dependent. The decline of fisheries can result from habitat loss and degradation or from overfishing. As the carrying capacity of an estuary declines, the fish stocks that inhabit it can no longer support fishing levels that were previously sustainable. Therefore, the status of fishery resources can be used as an indicator to assess the suitability of estuarine habitat for sustaining those fisheries (USEPA, 1999).

The Cooperative Gulf of Mexico Estuarine Inventory and Study (GMEI) observed 251 fish species in its estuarine study area from a list of 294 fish species from Mississippi estuaries and continental shelf waters off Mississippi (Christmas, 1973). The bay anchovy (*Anchoa mitchilli*), Gulf menhaden (*Brevoortia patronus*), Atlantic croaker (*Micropogon undulates*), spot (*Leiostomus xanthurus*), butterfish (*Perilus burti*), and sand seatrout (*Cynoscion areanarius*) composed 93 percent of the total number of fish collected. Over 93 percent of the fish caught were in the families Engraulidae (bay anchovy), Clupeidae (Gulf menhaden), and Sciaenidae (seatrout and spot).

Fish landed in Mississippi waters are of commercial importance and may be separated into industrial bottomfish (fish used in oil and meal), food fish, and recreational fish. Most of the fish in these categories depend on the estuarine waters of the Mississippi Sound and Back Bay to complete their life cycles. Approximately 75 percent of the commercial fish landings in the United States, 98 percent in the Gulf of Mexico, and more than 98 percent of Mississippi's seafood species, including the commercially important invertebrate species, are estuary dependent species (MDMR, 1998a; Stedman and Brown, 2000). Industrial bottomfish consist of Atlantic croaker, spot, sand seatrout, and a variety of other fish. At one time, bottomfish supported a thriving pet food industry; however, declining catch rates and economic profitability led to the demise of this industry in the 1980s. Although the catch is much reduced, a small fishery still exists. The Atlantic croaker is the single most important component of the bottomfish catch (MDMR, 1998a).

Long-term yields of commercial shrimp species are directly related to the quantity and quality of intertidal habitat. Studies of shrimp productivity and the area of estuarine vegetation in wetlands between Louisiana and Florida exhibit a positive and linear relationship (Turner, 2000).

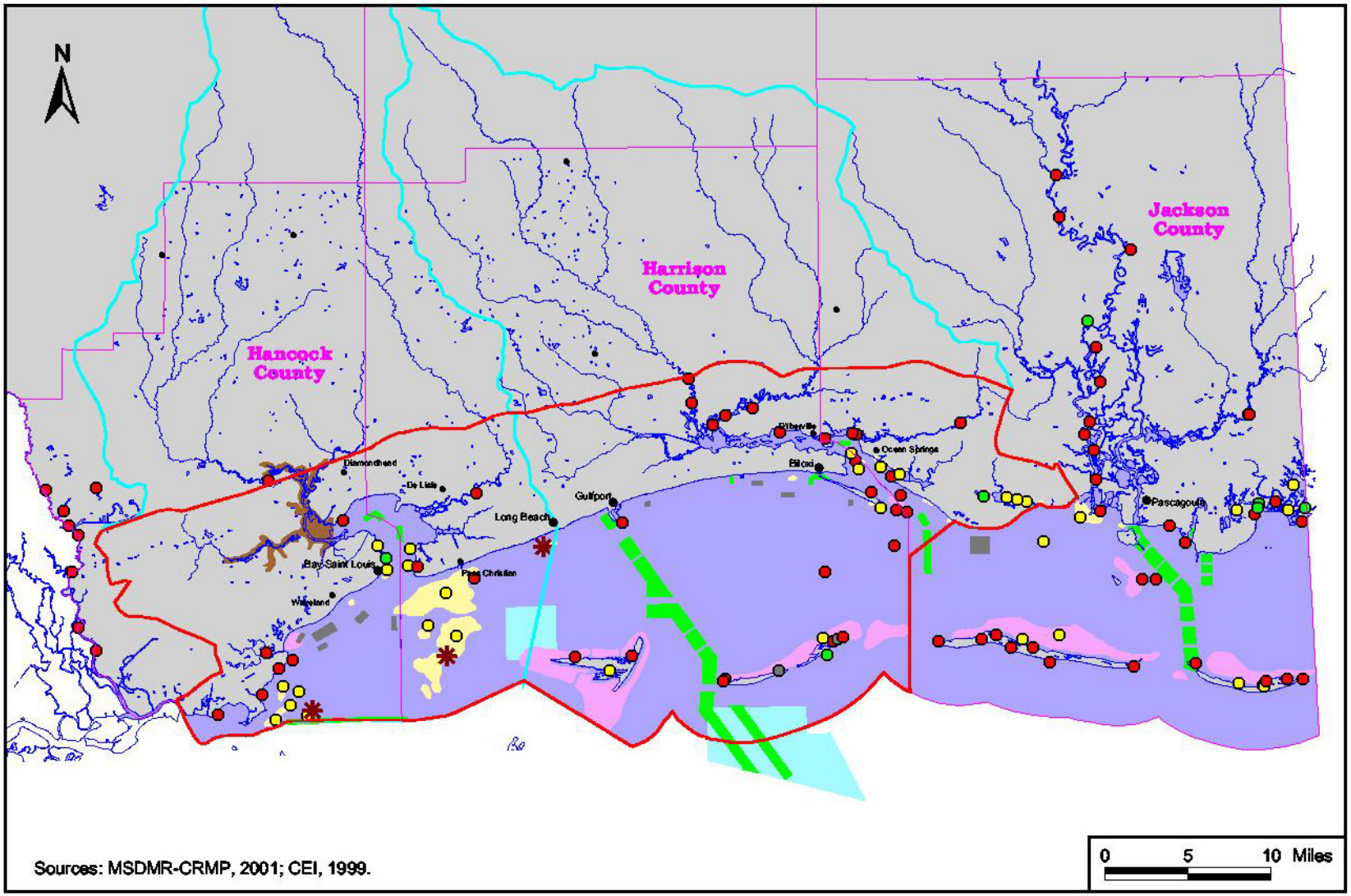
The commercial seafood industry in Mississippi involves about 2,400 regular fishermen onboard more than 1,400 fishing vessels and boats (Posadas, 2000). In 1998 the total ex-vessel value of all fishery products landed in Mississippi totaled more than $48 million. Shrimp composed 68 percent; menhaden, 19 percent; oysters, 6 percent; foodfish, more than 5 percent; and blue crab, less than 1 percent (Posadas, 2000). The Gulf menhaden supports a large and important fishery in Mississippi. Menhaden are processed locally into fishmeal and oil, which are used in poultry and swine feeds, cosmetics, and margarine. Menhaden also provide a source of food for many birds and fish.

The volume of the commercial seafood harvest over the past 10 years have averaged 214 million pounds. The fleet of commercial fishing vessels has declined by 30 percent from about 2,000 operating units in 1989 to more than 1,400 units in 1998. As one would expect, there has also been a subsequent decline in the number of commercial fishermen over the past 10 years. A reduction in shoreside infrastructure facilities is responsible for the decline in the commercial fishing fleet, and the continued increase in fuel costs has had, and will continue to have, serious deleterious effects on the size and composition of the commercial fishing fleet (Posadas, 2000).

Recreational fishing is also important to the economy of Mississippi (USEPA, 1999). Food and recreational fish consist of striped mullet (*Mugil cephalus*), spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), southern kingfish (*Menticirrhus americanus*), sheepshead (*Archosargus probatocephalus*), black drum (*Pogonias cromis*), and southern flounder (*Paralichthys lethostigma*). Although many recreational fish species are exclusively offshore, some use estuaries for a major part of their life cycle. For example, speckled sea trout spawn over seagrass beds, but they are known to travel offshore, and red drum (*Sciaenops ocellatus*) spawn in estuaries where the young develop for 2 to 3 years before moving offshore (USEPA, 1999). Table 4.10–14 provides some harvest statistics for commonly caught recreational species. A comprehensive illustration of the distribution of aquatic biological resources in the current study area is provided in Figure 4.10–4.

4.10.3.5.1 Finfish

The finfish industry in Mississippi is composed of two segments: menhaden and edible finfish (Posadas, 2001). The state's menhaden industry is centered in Pascagoula and is responsible for Mississippi's fifth-place national ranking in total pounds of seafood landed. The Gulf fishing fleet contains approximately 50 large vessels owned by individual processing firms. Major products include fish meal, used primarily in animal feeds, and fish oils. Mississippi landings average about 55 million pounds valued at $2.7 million annually. The menhaden fishery is one of the United States' oldest and most valuable fisheries, with landings dating to the late 1800s. The fishery can be separated into two components: the reduction fishery and the bait fishery. Landings for the reduction fishery greatly overshadow bait landings. Wet reduction of menhaden yields three products: fish meal, fish oil, and condensed fish solubles. Menhaden meal is a valuable ingredient for animal feeds. For example, the poultry industry is heavily dependent on fish meal to improve feed efficiency and produce maximum growth rates. Menhaden oil is used both in this edible form as well as in non-consumptive products such as paints, plastics, and resins.



Sources: MSDMR-CRMP, 2001; CEI, 1999.

LEGEND

- Coastal Study Area
- Watershed Study Area
- County Boundary
- Water

Environmentally Sensitive Areas

- Vertebrate Animal
- Vascular Plant
- Natural Community
- Other
- Oyster Beds

Wetland Use Plan, Coastal Waters

- C - Commercial Fisheries & Recreational Marinas
- G, S-3 - Leased Wetlands
- P-2 - Preservation (Seagrass)
- S-1 - Oyster Reefs
- S-2 - Leased Wetlands for Oyster Cultivation
- S-3 - Leased Wetlands for Other Purposes
- S-4 - Dredged Disposal and Spoil Areas

Aquatic and Marine Resources

Figure 4.10-4

Table 4.10–14
Frequently Encountered Recreational Fish Species – 1998

Species	Number Caught (thousands)	Number Harvested (thousands)	Pounds Harvested (thousands)	Number Released (thousands)	Mean Length (harvested fish)
Speckled Seatrout	776	332	443	444	15.1 inches
Sand Seatrout	660	540	316	120	12.0 inches
Red Drum	193	64	469	129	25.9 inches
Red Snapper	136	38	147	98	17.4 inches
Southern Flounder	134	116	191	18	14.6 inches

Source: NMFS, 1998.

Mississippi is a very small producer of edible finfish obtained commercially, with fewer than 30 individuals participating full-time (Posadas, 2001). More than 300 commercial licenses are sold annually for the harvest of edible finfish, however, indicating many part-time participants. In addition, trawlers catch foodfish incidental to shrimping and industrial fishing. Total foodfish landings average about one million pounds annually.

While seafood landings in Mississippi are significant, the bulk of economic activity is generated by the processing sector. Much of the seafood processed in Mississippi is landed in other Gulf states. There are 32 processing plants and 22 wholesale operations in Mississippi, employing about 1,300 people. A study by Mississippi State University's Coastal Research and Extension Center documents the total economic impact of the Mississippi seafood industry: $489 million annually, including $256 million in income and about 28,000 man-years of employment (Posadas, 2001).

4.10.3.5.2 Shrimp

Brown and white shrimp, and in smaller quantities, pink and red shrimp, constitute the commercial shrimp fishery of the northern Gulf of Mexico (Turner, 2000). Shrimp in the Gulf are dependent on estuaries as larvae, differing from northern species, which live in deep water and do not migrate into estuaries. Annual harvests of brown and white shrimp depend on survival to the juvenile age; therefore, survival in the estuary may be the most important factor affecting the adult populations of these species (Turner, 2000). Although estuarine salinity and temperature affect postlarval survival, the long-term yields of the fishery is directly related to the quality and quantity of intertidal habitat. Turner (2000) illustrated the strong, positive linear relationship between shrimp productivity and the area of estuarine vegetation in wetlands of the coastal states from Louisiana to Florida. Conversely, there is no obvious relationship between harvest and the area of estuarine open water, suggesting that the limits on populations are established while the species is young, when shrimp are in or near wetlands (Turner, 2000).

Although the food-rich environment of estuaries benefits shrimp, it is the shelter from predation that is the most important benefit of living in wetlands (Turner, 2000). The movement of larger predators is restricted in the shallow waters, and the physical structure of the marsh make prey detection and

capture of shrimp difficult. Laboratory and in-the-field experiments on predator-prey interactions have demonstrated that shrimp mortality increases with the loss of wetland structure.

Although there has been a 20 percent loss of wetlands over the past 65 years, the fisheries of the northern Gulf of Mexico apparently have not declined from this loss of habitat. Gulf-wide shrimp landings have remained steady despite wetland loss.

Mississippi seafood businesses annually process about 60 million pounds of shrimp, 80 percent of which comes from other Gulf states or is imported. The shrimp fishery is estimated to have an annual economic impact of $200 to $250 million. The annual shrimp harvests from 1972 through 2000 are presented in Table 4.10–15 and Figure 4.10–5.

Table 4.10–15
Annual Landings of Shrimp

Year	Landings (pounds)
1972	7,936,400
1973	3,681,000
1974	5,415,900
1975	4,044,600
1976	7,551,300
1977	10,576,400
1978	8,285,958
1979	8,533,093
1980	5,966,741
1981	8,363,469
1982	9,962,288
1983	10,633,211
1984	12,809,284
1985	16,614,562
1986	13,031,543
1987	12,508,253
1988	12,404718
1989	16,533,979
1990	15,245,557
1991	11,785,387
1992	10,148,414
Average 1972–1992	**10,096,765**
1993	10,509,379
1994	8,742,282
1995	15,409,913

Table 4.10–15
Annual Landings of Shrimp (continued)

Year	Landings (pounds)
1996	10,384,191
1997	12,339,047
1998	16,082,974
1999	14,461,132
2000	14,739,944
Average 1993–2000	**12,840,358**

Source: NMFS, 2000.

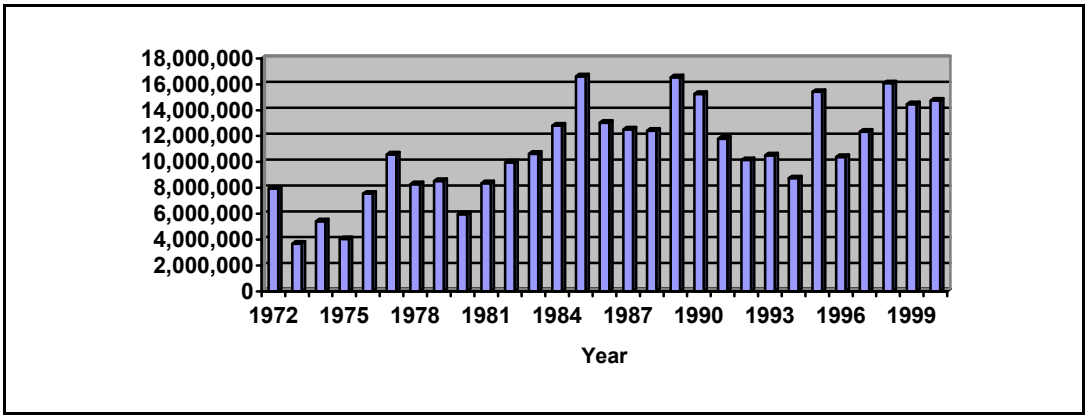


Figure 4.10–5 Annual Landings of Shrimp (pounds)

4.10.3.5.3 Oysters

The American oyster (*Crassostrea virginica*) is one of the more valuable resources of the Mississippi Gulf Coast, however, Mississippi oystermen are getting less for their catch in recent times reflecting a sharp increase in production and loss of market share (MDMR, 2001; Posadas, 2001). Annual oyster production is highly variable from year to year due primarily to natural environmental fluctuations. Many of Mississippi's most productive areas have been closed to harvest due to increased pollution associated with coastal development. Due to variability in production, anywhere from 200 to 700 oyster licenses are sold annually in Mississippi and approximately 80 percent of the oysters processed here are harvested in other Gulf states.

Oysters are found in shallow waters that rapidly change in temperature and salinity. Oyster production in Mississippi now depends on the 17 natural oysters reefs that are managed by the Mississippi Department of Marine Resources in waters that have been approved safe for shellfish harvest by the Commission on Marine Resources (Posadas, 2001). Approximately 97 percent of the commercially harvested oysters in Mississippi come from the reefs in the western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs. Mississippi's major oyster reefs are concentrated along the extreme western part of the Mississippi Sound, south of Pass Christian. The fresh water coming into the Sound from the Pearl River keeps the salinity at a level favorable for oysters. Some reefs are scattered across the rest of the coastline, but don't have the same flow of fresh water as those on the western side of the state.

The first record of landings in 1880 showed 62,000 pounds, amounting to three percent of the total recorded for the Gulf of Mexico in that year. The maximum landings—12,894,000 pounds in 1937—accounted for 53 percent of the Gulf total. The minimum—23,000 pounds in 1952—accounted for 0.2 percent of the Gulf production (Christmas, 1973). Recorded landings increased sharply in 1960 with more efficient management, and reached 4,829,000 pounds (21 percent of Gulf production) in 1964. Since that time the state has accounted for 13 to 17 percent of Gulf oyster landings (Christmas, 1973). See Figure 4.10–6.

Reefs are located along the coast across the entire state with the largest reefs near the western boundary. According to a 1966 survey, there were 9,786 acres of oysters. At that time there were

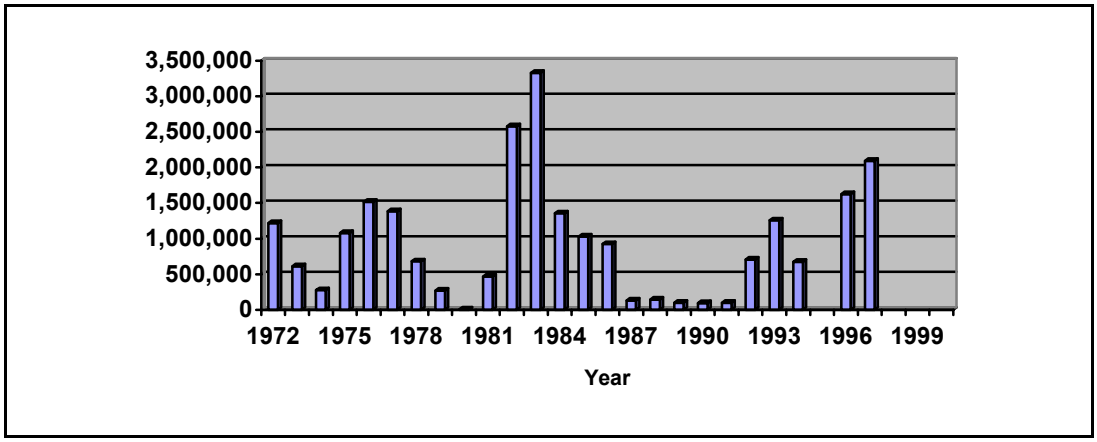


Figure 4.10–6 Annual Landings of Oysters (pounds)

582 acres of planted oyster beds. Additional acreage has been planted. Table 4.10–16 shows the area of known reefs in 1966.

Table 4.10–16
Oyster Reefs in Mississippi —1966

Name	Natural Area	Planted Area	Total Area
Point St. Joe	740	---	740
St. Louis Bay	170	82	252
Pass Christian	7,180	500	7,680
Biloxi Bay	350	---	350
Ocean Springs	180	---	180
Deer Island	4	---	4
Graveline Bayou	5	---	5
West Pascagoula	540	---	540
Bangs Lake	20	---	20
Point aux Chenes Bay	10	---	10
Middle Bay	5	---	5
Total	**9,203**	**582**	**9,786**

Source: Christmas, 1973.

Mississippi oyster harvests, as documented by the National Marine Fisheries Service from 1972 to 2000, are presented in Table 4.10–17. The 1999 harvest, the most recent harvest reported by the state, shows it to be an excellent year in both quality and quantity (Coblentz, 2000a). Scott Gordon, biological program coordinator with the Department of Marine Resources in Biloxi, said the state had landed more than 276,000 sacks by March 31. A sack, a measurement of 1.98 cubic feet, weighs about 105 pounds and yields about 1 to 1.25 gallons of shucked oysters.

Table 4.10–17
Annual Landings of Oysters—1972–2000

Year	Landings (pounds)
1972	1,220,400
1973	611,500
1974	276,600
1975	1,080,700
1976	1,516,300
1977	1,386,000
1978	682,430
1979	272,100
1980	6,936
1981	467,070
1982	2,575,970
1983	3,329,245
1984	1,356,890
1985	1,030,487
1986	925,153
1987	131,088
1988	144,676
1989	99,992
1990	96,230
1991	101,136
1992	706,872
Average 1972–1992	**857,989**
1993	1,257,771
1994	674,110
1995	No data
1996	1,623,778
1997	2,093,148
1998	No data
1999	No data
2000	No data
Average 1993–2000	**Insufficient data**

Source: NMFS, 2000.

The 1999 yield was the sixth highest yield in 20 years. The season opened Oct. 12 and closed in May. The environmental conditions in 1999 were more favorable to oyster harvest than in 1998. In 1999, there were not as many problems with reef closings as there were in 1998 resulting from the El Nino rains (Coblentz, 2000a).

Following rainfall, oyster reefs may be temporarily closed if poor water conditions exist. Excess rain causes bacteria to runoff into the water; since oysters are filter feeders, they concentrate the substances found in the water. The state water quality standard for shellfish growing areas is the strictest state water quality standard, even higher than for swimming.

Mississippi River flooding and the opening of the Bonnett Carre Spillway northwest of New Orleans can spell disaster for oyster harvests. Louisiana's Bonnett Carre Spillway is opened to prevent flooding in New Orleans and to protect levees (Coblentz, 2000b). The spillway diverts about 14 percent of the Mississippi River into Lake Pontchartrain at a rate of 240,000 cubic feet per second. Lake Pontchartrain flows into Lake Borgne, which empties into the Gulf of Mexico. Through this path, the fresh waters of the flooding Mississippi River dilute the brackish waters of the Mississippi and Louisiana Sounds. Given proper conditions and enough time, part of the Gulf of Mexico from the mouth of the Mississippi River eastward, then becomes freshwater.

Oysters grow in brackish water, but can survive in freshwater for about one week before they start dying (Coblentz, 2000b). If the spillway stays open long enough to lower the salinity of the Sound, it will cause oyster deaths. While this creates a short-term disaster, the diluted saltwater means good news later. The oyster harvest has been declining for more than 100 years in the Gulf because of the lack of freshwater. With the spillway closed, freshwater cannot flow into the marshes east of the Mississippi River as it did before levees were built in the 1930s. Instead, brackish areas where oysters and young fish grow become too salty, thereby decreasing the productivity of the oysters and increasing the productivity of oyster pests.

The added freshwater should restore the natural balance. Historically, when the spillway has been opened, there is an immediate loss of production followed by three to five years of record oyster production. The spillway has been opened just eight times in its 66 years.

Bays control the amount of water that passes through the spillway. The last time it was opened, May 20, 1983, all 350 bays were opened. As of March 27, 2000, the Corps had opened 298 bays at a rate of 15 to 40 a day. The spillway will probably stay open for a month, thereby reducing the Mississippi River flood crest, currently at 16.8 feet, by a foot and a half to two feet.

Currently, it is not possible to predict what affect the open spillway will have on oyster production, since the Sound also receives freshwater from the Pearl, Biloxi, and Wolf Rivers, and smaller rivers as well. The Corps is conducting a $500,000 monitoring program of shellfish and other fish in the affected area to determine the open spillway's effects on productivity.

4.10.3.5.4 Blue Crabs

The blue crab, *Callinectes sapidus*, and its smaller cogener, the gulf crab, *Callinectes similes*, are abundant in Mississippi coastal waters (Perry, 1975). About 200 commercial crab licenses are sold annually in Mississippi, but only about 60 fishermen trap crabs. The other licenses are sold to allow for incidental harvest in other fisheries (Mississippi State University, 2003).

The life history of the estuarine-dependent blue crab involves a complex cycle of planktonic, nektonic, and benthic stages, which occur throughout the estuarine-nearshore marine environment (Guillory et. al. 2001). Females migrate from hyposaline waters to higher-salinity water to spawn and hatch their eggs. Males usually remain within the estuary during their entire postsettlement life. The high degree of natural variation and proximity to human activities make estuaries the weakest link in the life cycle of the blue crab (Guillory et al., 2001). Human population and industrial growth along the southeast coast is responsible for the alteration and destruction of estuarine habitats; however, the effects of this development on estuarine productivity are largely undocumented.

Dredging for sand, gravel, and oyster shell directly alters the bottom and may also change local current patterns, leading to erosion or siltation of productive habitats. Destruction of wetlands through development of waterfront properties results directly in loss of productive habitat acreage and in the reduction of detrital production (Guillory et al., 2001). Orth and van Montfrans (1990) established a quantitative relationship between blue crab production and habitat. Turner and Boesch (1988) found evidence of decreased fishery production following wetland losses and increased fishery production following gains. Estuarine tidal creeks, salt marshes and grass beds are the most sensitive habitats occupied by blue crabs (Guillory et al., 2001).

Reportedly, marsh loss of 7.3 percent occurred from the early 1950s through 1978 (27,977 ha to 25,937 ha) (Meyer-Arendt, 1989). Since that time, the quality of marsh habitat has deteriorated due to increased bulkheading, channelization, and changes in upland drainage patterns and buffering/filtering capacities due to commercial and residential development. In addition, seagrass coverage has declined by 40 to 50 percent since 1969 (Moncrieff et. al., 1998). Additional impacts to estuarine habitat include declining water quality and accelerated dredge and fill activities for shoreline development.

With the exception of the post World War II period when more than 5 million pounds were landed, landings were stable and generally fluctuated between one to two million pounds until 1987 when they declined (Guillory et al., 2001). Blue crab landings averaged 1,712,000 pounds for the 20-year period of 1953 to 1972 (Perry, 1975). Yearly landings varied from a low of 907,000 pounds in 1962 to a high of 3,003,000 pounds in 1959. Landings were higher than the 1,712,000 pound average for 9 of the 20 years. Historical fishery statistics show peak landings for the state during 1945 (5,639,000 pounds) and 1948 (5,503,000 pounds) (Perry, 1975).

Annual landings from 1972 to 1992 averaged 1,378,831 pounds (Table 4.10–18, and Figure 4.10–7). Average annual landings from 1993 through 2000 declined markedly to 524,383 pounds; however, the reduced landings can be attributed to social, economic, and regulatory changes that have taken place in the fishery rather than major declines in stock abundance. The average number of blue crab trappers declined from 61 during the 1970s and 1980s to 42 during the 1990s (Guillory et al., 2001).

These accounts of the landings do not include crabs taken in local waters and landed in neighboring states, nor those taken on a subsistence or recreational basis.

4.10.3.6 Essential Fish Habitat (EFH) Assessment

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established a new requirement to describe and identify "essential fish habitat" (EFH) in each fishery management plan. This act sets forth a new mandate for the National Marine Fisheries Service (NMFS), regional fishery management councils (FMCs), and other federal agencies to identify and protect important marine and anadromous fish habitat. The

Table 4.10–18
Annual Landings of Blue Crabs

Year	Landings (pounds)
1972	1,362,400
1973	1,814,500
1974	1,667,000
1975	1,136,600
1976	1,334,800
1977	1,918,600
1978	1,942,300
1979	1,312,650
1980	2,759,600
1981	1,866,550
1982	1,297,100
1983	1,139,690
1984	2,250,342
1985	1,648,901
1986	1,302,812
1987	1,374,048
1988	863,395
1989	669,366
1990	394,228
1991	455,684
1992	444,892
Average: 1972–1992	**1,378,831**
1993	253,463
1994	171,667
1995	320,844
1996	408,525
1997	684,598
1998	593,182
1999	922,544
2000	840,243
Average: 1993–2000	**524,383**

Source: NMFS, 2000.

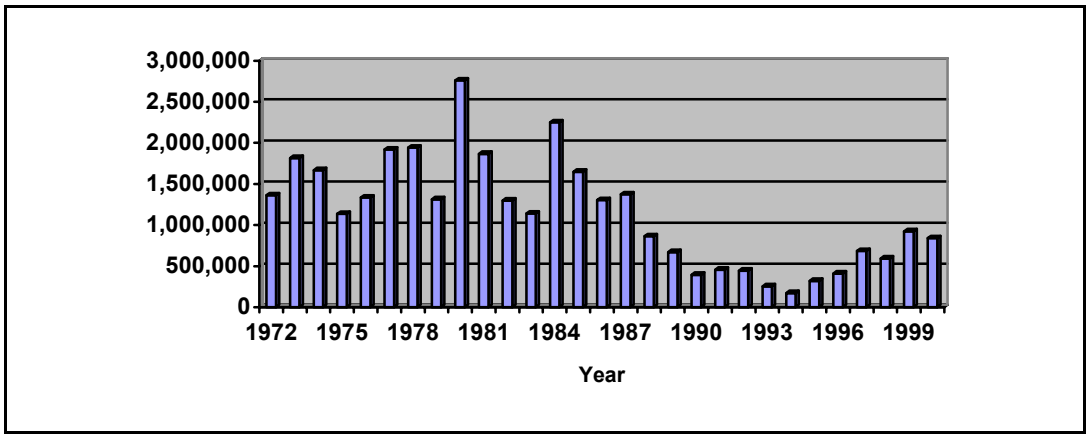


Figure 4.10–7 Annual Landings of Blue Crabs—1972–1999 (pounds)

EFH provisions of the act support maintenance of sustainable fisheries, which is one of the overall management goals for the nation's marine resources.

As defined in the interim final rule (62 FR 66551), "Essential fish habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: 'Waters' include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include aquatic areas historically used by fish where appropriate; 'substrate' includes sediment, hardbottom, structures underlying the waters, and associated biological communities; 'necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and 'spawning, breeding, feeding, or growth to maturity' covers a species' full life cycle."

National Marine Fisheries Service (NMFS) guidelines call for the analysis of existing information at four levels of detail to identify and describe EFH (GMFMC, 1998). At Level 1, the presence/absence of distributional data available for some or all portions of the geographic range of the species; at Level 2, habitat-related densities of the species that are available; at Level 3, growth, reproduction, or survival rates within habitats that are available; and at Level 4, production rates by habitat that are available. The guidelines also call for applying this information in a risk-adverse fashion to ensure adequate areas are protected as EFH of managed species.

The available information is only Level 1 for most of the managed species in the Gulf of Mexico. Level 2 information exists for the selected species that occur in estuaries. That is, a relative abundance of information is available to allow mapping of estuarine areas where the species are rare, common, abundant, and highly abundant. For purposes of this analysis, EFH is defined as everywhere that the managed species commonly occur, and is described based on distributional information. Research should help increase knowledge to higher analytical levels and perhaps better define and describe EFH in the future.

Fish species that might be affected by changes in EFH (including commercially important invertebrates), have been identified by the Gulf of Mexico Fishery Management Council as managed species, (and have been found in Mississippi Sound and Back Bay), are identified in Table 4.10–19.

The distribution and relative abundance of the managed species within EFH of the Mississippi Sound and Back Bay region is illustrated in the maps provided in Appendix J.

4.10.3.6.1 EFH in Mississippi Sound

Given the broad definition of EFH, the extensive estuarine distribution of the managed species, and NMFS guidance to be risk adverse in the face of uncertainty, all of the estuarine systems of the Gulf of Mexico are considered habitat for fish managed by the Gulf of Mexico Fishery Management Council (NMFS, 1998). Thus, EFH includes all waters and substrates (mud, sand, shell, rock, and associated biological communities) within these estuarine boundaries, including the sub-tidal vegetation (seagrasses and algae) and adjacent tidal vegetation (marshes).

Table 4.10–19
Species Potentially Affected by Impacts to Essential Fish Habitat

Common Name	Scientific Name
Red Drum	*Sciaenops ocellatus*
Gray Snapper	*Lutjanus griseus*
Spanish Mackerel	*Scomberomorus cavalla*
Brown Shrimp	*Penaeus aztecus*
Pink Shrimp	*Penaeus duorarum*
White Shrimp	*Penaeus setiferus*
Gulf Stone Crab	*Menippe adina*
Stone Crab	*Menippe mercenaria*

Source: GMFMC, 1998

Estuaries provide essential habitat for many species, serving primarily as nursery areas for juveniles and also as seasonal habitat for adults. Emergent vegetation found in marsh is an integral part of the estuarine ecosystem, serving as nursery grounds for larvae, postlarvae, juveniles and adults of many species, most notably the brown shrimp (NMFS, 1998). Marshes also export nutrients to adjacent waters; provide an important water quality function in the form of secondary and tertiary waste treatment through removal and recycling of inorganic nutrients; serve as an important buffer against storms by absorbing energy of storm waves and acting as a water reservoir, thus reducing damage farther inland; and serve an important role in global cycles of nitrogen and sulfur (Gosseling et al., 1974; Turner, 1977; Thayer et al., 1975; Zimmerman et al., 1984).

In 1968, there were approximately 26,237 hectares (ha) (64,805 acres) of mainland marsh identified in south Mississippi, of which 24,853 ha (61,389 acres) were dominated by *Juncus roemerianus* (black needlerush) (NMFS, 1998). *Spartina alterniflora* (oyster grass), *Spartina patens* (wiregrass) and *Scirpus olneyi* (threecorner grass) composed the remaining acreage. Tidal marsh is most extensive in the Pascagoula and Pearl River areas, with areas of 5,400 ha (13,340 acres) and 3,522 ha (8,700 acres) respectively. Saltmarsh on the barrier islands covered 860 ha (2,126 acres).

As with emergent vegetation, submerged vegetation is extremely important to fisheries production and is often populated by diverse and abundant fish faunas (NMFS, 1998). The relative abundance and diversity of submerged vegetation, which is found along most of the Gulf coast, depends mainly on bottom type, turbidity, salinity, water temperature, bottom slope, and tidal range (NMFS, 1998). Seagrasses and the epiphytic algae, benthic fauna and flora associated with seagrasses provide shelter

and food to fishes, and are also used by many species as nursery grounds. Turner (1977) related shrimp yield to total acreage of intertidal vegetation present in adjacent estuaries.

Discontinuous beds of shoal grass (*Halodule wrightii*), turtle grass (*Thalassia testudinum*), and manatee grass (*Syringodium filiform*) can be found north of the islands, and shoal grass has also been found in the sandy substrates east of Pascagoula (Point-aux-Chenes Bay) and near Bayou Caddy in western Mississippi Sound. Widgeon grass (*Ruppia maritime*) dominates the area near the mainland, and is also found in low-salinity ponds and lagoons on Horn and Cat Islands. Stands of benthic algae occur north and south of Cat Island, and tape grass (*Vallisneria americana*) can be found throughout the Sound.

Marshland is being lost through subsidence, erosion, sediment and freshwater deficits, channelization, and rising mean sea level. Aggravating factors contributing to marshland losses include management for agriculture, flood control, and wildlife habitat. Pollution from agricultural, municipal, and industrial activities (including widespread oil and gas production) produces additional habitat degradation.

4.10.3.6.2 EFH Alterations of Particular Concern

Ninety-eight percent of the region's commercial seafood is estuary-dependent; therefore a major concern is the maintenance of Mississippi's vast estuarine habitats to allow for the continued production of commercial species. Economically valuable commercial species such as red drum and shrimp show use of Mississippi Sound and associated bays during various phases of their life history (NMFS, 1998).

The Mississippi Coastal Zone has been subject to increased developmental pressure in recent years. Approximately 20,188 ha of mainland marshes have been filled for industrial and residential purposes since 1930. More recently, however, the Wetlands Protection Act (enacted in 1973) has done much to effect a policy of zero wetlands loss in the state.

Implementation of proposed regional sewage treatment systems would significantly improve water quality by eliminating many failing or nonfunctional septic systems. In addition, the opening of the Bonnett Carre Freshwater Diversion structure west of New Orleans is a periodic event that profoundly influences the level of nutrients and the salinity of Mississippi Sound (NMFS, 1998). The flood structure, which is operated by the U.S. Army Corps of Engineers, resulted in a discharge rate as high as 7,000 m^3/s (250,000 cfs) from the Mississippi River into neighboring Lake Pontchartrain and into the Sound during a 1979 spillway opening.

The eight openings of the spillway since its construction in 1931 have been is generally beneficial to the fisheries in the long term because of the influx of nutrients from the diverted waters (NMFS, 1998). Short-term impacts include high turbidity, increased concentrations of chlorophyll *a*, increased fecal and total coliform counts, high oyster mortalities, and temporary displacement of certain stenohaline species. In addition, the sudden influx of nutrient-laden cold freshwater into the estuarine environment can also adversely impact any species sensitive to abrupt changes in salinity or temperature. Such and influx can also adversely affect the emigration of shrimp postlarvae if it occurs during spring months.

A major concern is the decline in area covered by seagrass in the Mississippi Sound (NMFS, 1998), which in 1975 was approximately 54 percent of that found in 1969, and losses have continued. It is expected that regulations prohibiting any trawling or other commercial fishing activity within one

mile of the barrier islands (i.e., Ship, Horn, and Petit-Bois) will reduce trawl-related impacts to the seagrass beds.

Other actions that should stabilize influence to the habitats of Mississippi Sound and minimize encroachment into sensitive estuarine areas include the development of the Grand Bay Savannah National Estuarine Research Reserve and the implementation of a Coastal Preserves program by the Mississippi Department of Marine Resources (NMFS, 1998). The reserve encompasses approximately 18,000 acres of shallow-water open bay, estuarine subtidal, and intertidal marsh, pine–flatwood maritime forest, pine flatwoods and pine savannah habitats. Of this, approximately 10,000 acres are owned by the state and 6,000 acres by the U.S. Fish and Wildlife Service.

4.10.3.6.3 EFH Loss Rates and Trends in Mississippi

Port development and gaming development are two of the most significant factors affecting the loss of EFH and wetlands in the Mississippi CSA (GMFMC, 1998). As discussed in section 4.1, the gaming industry has stimulated economic and population, in the Mississippi CSA. State law requires that specific gaming facilities be located in navigable waters; therefore estuarine resources are typically directly and indirectly impacted. The evolution of the gaming industry has led to increased demand for on-site facilities consisting of hotels, parking lots, theaters, marinas, and restaurants. The secondary effects from gaming development, including residential and commercial developments within the watersheds are having an adverse cumulative effect on estuarine resources.

Mississippi's major port at Gulfport involves major estuarine resources issues for maintenance and expansion. Maintenance issues involve open water and diked disposal, and expansion issues involve impact to bottomland hardwoods, Mississippi Sound bottoms, and wetland fringe areas (GMFMC, 1998).

Between 1981 and 1996, the NMFS received and reviewed 1,653 proposals that could potentially affect EFH in Mississippi, which has a small coastal area relative to the rest of the state. A subsample of 185 of the projects reviewed by the NMFS involved 2,193 acres of various wetland habitat types. Most of the acreage associated with projects received for review involved various industrial developments. The greatest number of projects reviewed involved various shoreline modifications, mainly bulkheading and backfilling. Maintenance dredging of federally maintained navigation channels also involves a substantial amount of acreage. A related major maintenance-dredging feature involves a technique called thin-layer disposal: spreading a thin layer of material over a larger area, rather than placing the sediment in smaller mounds. Thin-layer disposal is proposed for material dredged from the channel to Gulfport Harbor. At the request of the NMFS and other resource agencies, the Corps of Engineers initiated a demonstration project to assess the impacts of thin-layer disposal of dredged material on fishery resources. This process will likely be a continuing dominant activity in Mississippi for many years.

4.10.3.6.4 Threats to Essential Fish Habitat

Depending on future growth rates in the CSA, the expansion of facilities and infrastructure required to meet the increasing population could adversely affect wetlands, shoreline, and adjacent contiguous lands. A significant threat facing fishery production is the loss of habitat through natural and human-related causes. A list of categories and individual threats associated with those categories is provided in Table 4.10–20.

Table 4.10–20
Threats to Essential Fish Habitat

Physical Alterations
Navigation projects, ports, marinas, and maintenance dredging
Canals, ditches, levees and embankments
Tidal water control structures
Pipeline crossings and rights-of-way
Impoundments and alteration of freshwater inflow
Industrial/commercial operations
Housing developments
Oil and gas operations in the Gulf of Mexico
Agriculture and silviculture practices
Water Quality Issues
Point source discharges
Hydromodifications
Non-point source runoff
Hypoxia "dead zones"
Entrainment, impingement and thermal cooling water discharges
Hazardous waste management
Petroleum products and operations
Chemical contaminant spills
Atmospheric deposition
Ocean dumping
Biologic Alterations
Blooms (toxic and nontoxic)
Introduction of exotic species
Viruses and other disease organisms
Zebra mussels
Edible brown mussels
Mammals
Fishes and other vertebrates
Other vertebrates
Wetland and aquatic plants

Source: GMFMC, 1998.

4.10.4 Threatened and Endangered Species

4.10.4.1 Introduction

The Endangered Species Act (ESA) was passed in 1973 to address concerns about the decline in populations of many unique wildlife species. Supporters of the ESA argued that America's natural heritage was of aesthetic, ecological, educational, recreational, and scientific value to the Nation and therefore worthy of protection. The purpose of the ESA is to rebuild populations of protected species and conserve "the ecosystems upon which endangered and threatened species depend" (USFWS,

2001a). The law offers two classes of protection for rare species in decline: endangered or threatened. Endangered means a species is in danger of extinction throughout all or a significant portion of its range. Threatened status indicates a species is likely to become endangered within the foreseeable future. All species of plants and animals, except pest insects, are eligible for listing as endangered or threatened (USFWS, 2001a).

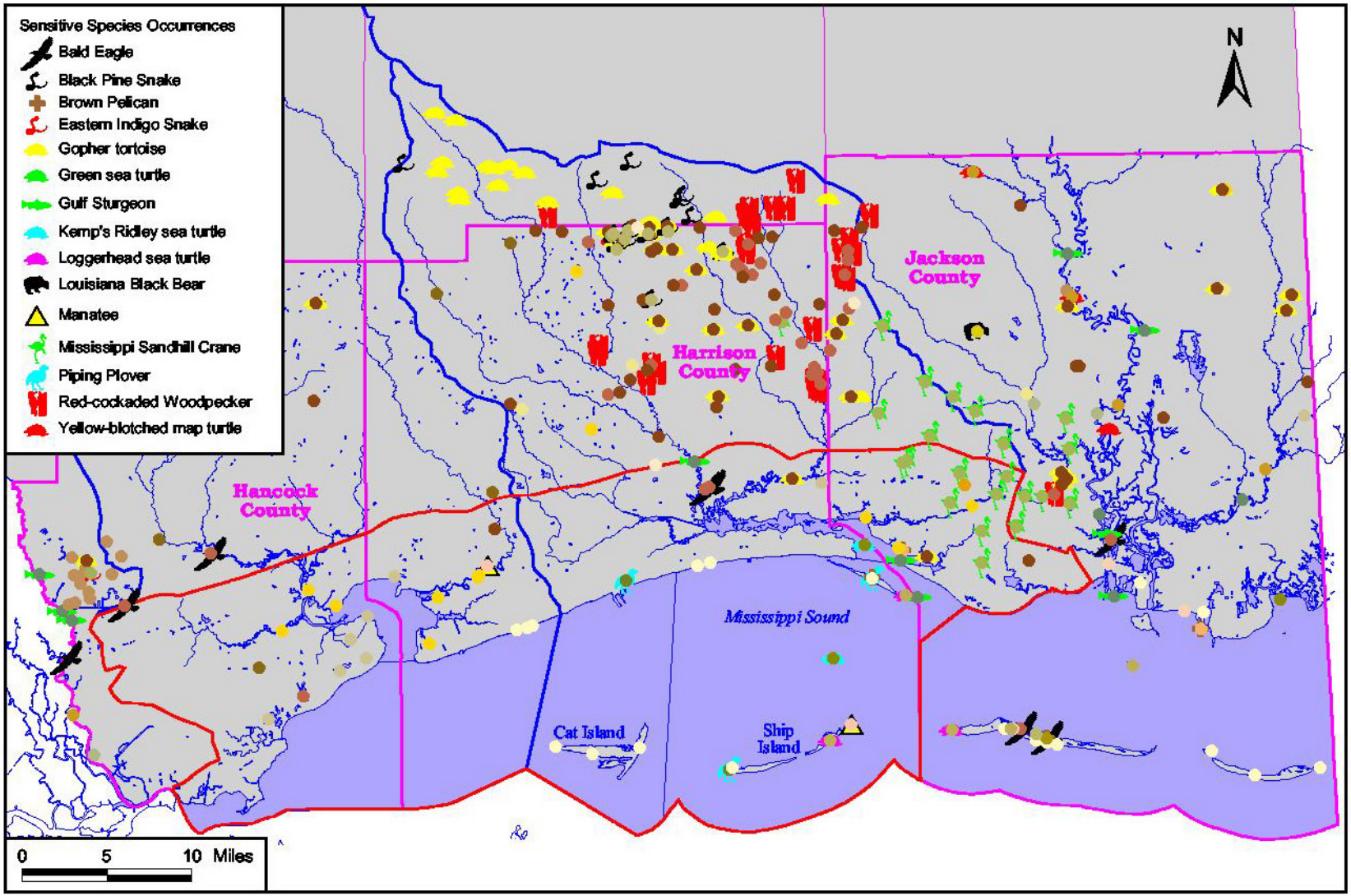
The U.S. Fish and Wildlife Service (USFWS), which is within the Department of the Interior, and the National Marine Fisheries Service (NMFS), within the Department of Commerce, are jointly responsible for administering the ESA. The USFWS has cognizance over terrestrial and freshwater organisms, while NMFS is primarily responsible for marine species. As of January 31, 2001, 1,244 species were listed as either threatened or endangered under the ESA. All federal agencies are required to protect threatened and endangered (T&E) species while carrying out projects and to preserve T&E species habitats on federal land. The USFWS and NMFS also coordinate T&E species conservation efforts with state agencies and private landowners. Ideally, with sufficient protection under the ESA, the T&E species populations will recover to the point at which they no longer need protection under the act. To facilitate this process, a team of experts develops a recovery plan that describes the steps needed to restore the species to health.

Under the ESA it is illegal to "take" T&E species. As defined in the ESA, the term "take" means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." The Secretary of the Interior, through regulations, defined the term "harm" in this passage as "an act that actually kills or injures wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering" (USFWS, 2001a). Because most T&E species are not significantly hunted or collected, habitat degradation is the primary reason for population declines in listed species.

The ESA contains provisions for designation of "critical habitat" for listed species when deemed essential for the conservation and recovery of a species. Critical habitat includes geographic areas "on which are found those physical or biological features essential to the conservation of the species and which may require special management considerations or protection" (USFWS, 2001a). Areas not occupied by the species at the time they are listed as threatened or endangered but which are considered essential to the conservation of the species can be designated as critical habitat. Critical habitat designations are limited to federal agency actions, or to federally funded or permitted activities.

4.10.4.2 Baseline Conditions

Coastal Mississippi is home to 20 federally listed threatened, endangered, or candidate species, including four taxa found nowhere else in the world. Federally listed species known to occur within the project area shown on Figure 4.10–8 and are listed in Table 4.10–21. Several other endangered species are known from marine habitats in the Gulf of Mexico outside the project area. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), hawksbill sea turtle (*Eretmochelys imbricata*), and leatherback sea turtle (*Dermochelys coriacea*). These endangered marine species might be occasional visitors to the project area, but are unlikely to be affected by proposed actions in the project area. Coordination with USFWS and NMFS required under the ESA is ongoing. Copies of the agency consultation letters are provided in Appendix K.



LEGEND

Coastal Study Area

County Boundary

Note: The following sensitive species are present in coastal Mississippi but not depicted on this figure because up-to-date information was not available: Alabama red bellied turtle; Least tern; Louisiana quillwort; Mississippi gopher frog; and Pearl darter.

Source: MARIS, 2001.

Sensitive Species

Figure 4.10-8

Table 4.10–21
Federally Listed Rare, Threatened, and Endangered Species

Common Name	Scientific Name	Status	County	Habitat
Alabama red-bellied turtle	*Pseudemys alabamensis*	LE	Harrison, Jackson	Submerged aquatic vegetation in brackish coastal rivers; freshwater reaches
Bald eagle	*Haliaeetus leucocephalus*	LT	Hancock, Harrison, Jackson	Shorelines near open water
Black pine snake	*Pituophis melanoleucus ssp. lodingi*	C	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Brown pelican	*Pelecanus occidentalis*	LE	Hancock, Harrison, Jackson	Feeds over water in coastal areas, nests on small islands.
Eastern indigo snake	*Drymarchon corais couperi*	LT	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Gopher tortoise	*Gopherus polyphemus*	LT	Hancock, Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Green sea turtle	*Chelonia mydas*	LT	Hancock, Harrison	Shallow coastal waters with SAV and algae, nests on open beaches.
Gulf sturgeon,	*Acipenser oxyrhynchus desotoi*	LT	Hancock, Harrison, Jackson	Migrates from large coastal rivers to coastal bays and estuaries
Kemp's ridley sea turtle	*Lepidochelys kempii*	LE	Hancock, Harrison, Jackson	Nearshore and inshore coastal waters, often in salt marshes
Loggerhead sea turtle	*Caretta caretta*	LT	Hancock, Harrison, Jackson	Open ocean; also inshore areas, bays, salt marshes, ship channels, and mouths of large rivers
Louisiana black bear	*Ursus americanus luteolus*	LT	Hancock, Harrison, Jackson	Bottomland hardwood forest; frequently ranges into other habitats
Louisiana quillwort	*Isoetes louisianensis*	LE	Hancock, Harrison, Jackson	Small blackwater streams with sand and gravel substrate and forest cover
Manatee	*Trichechus manatus*	LE	Hancock, Harrison	Fresh and salt water in large coastal rivers, bays and estuaries.
Mississippi gopher frog (proposal under review)	*Rana capito sevosa*	PE	Harrison	Fire-dependent, upland longleaf pine forests; open, ephemeral upland pools

Table 4.10–21
Federally Listed Rare, Threatened, and Endangered Species (continued)

Common Name	Scientific Name	Status	County	Habitat
Mississippi sandhill crane	*Grus canadensis pulla*	LE	Jackson	Wet pine savannah
Pearl darter (Pascagoula River System)	*Percina aurora*	C	Jackson	Rivers and large creeks with sand and gravel bottoms and flowing water.
Piping Plover	*Charadrius melodus*	LT	Hancock, Harrison, Jackson	Barrier islands and coastal beaches
Red-cockaded woodpecker	*Picoides borealis*	LE	Harrison, Jackson	Fire-dependent, upland longleaf pine forests
Yellow-blotched map turtle	*Graptemys flavimaculata*	LT	Jackson	Rivers and large creeks with habitat suitable for basking

LT = listed threatened, LE = listed endangered, C = candidate for listing, PE = proposed endangered
Source: Mann, 2000.

4.10.4.2.1 Alabama Red-bellied Turtle

The Alabama red-bellied turtle (*Pseudemys alabamensis*) is a relatively large freshwater turtle with a carapace (top shell) length of up to 33 cm (13 inches). The plastron (bottom shell) is orange to red in color; the carapace is olive green, brown, or black, accompanied by distinct vertical markings in yellow, orange or red. The Alabama red-bellied turtle is distinguished from other similar species by the stripes of color on its head, and also the shape of the upper jaw (USFWS, 1989). This turtle primarily feeds on aquatic plants and is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (Mann, 2001). In Alabama, the turtle is known from the lower reaches of the Alabama River and its tributaries in Baldwin and Mobile Counties. In Mississippi, recent surveys have located Alabama red-bellied turtles in the lower reaches of the Old Ft. Bayou, Escatawpa, and Pascagoula Rivers in Jackson County, and Tchoutacabouffa and Biloxi Rivers in Harrison County (Mann, 2001).

The Alabama red-bellied turtle was listed as endangered by the USFWS on 16 June 1987; it is threatened by low reproductive success and taking of adult turtles. Although adult turtles spend most of their time feeding and basking in submersed aquatic vegetation, they must return to land to lay eggs. Disturbance of nests and destruction of eggs has been identified as major threats to the population; local residents collect eggs and live turtles for food. Recreational use of natural sand beaches have also disturbed nests and dredge spoils areas such as Gravine Island in Alabama (USFWS, 1989). Feral pigs, crows, and fire ants also raid nests to eat turtle eggs. Some collection of Alabama red-bellied turtles for the pet trade still persists, as does trawling to collect turtles for food. Some turtles are harvested accidentally by commercial fishermen in nets, traps, and trawls. Recovery efforts include learning more about the life history of the species; protecting nests in recreational areas; preventing destruction of aquatic vegetation used for basking, cover, and food; preventing taking of eggs and adult turtles through law enforcement; and educating the public about turtle conservation.

4.10.4.2.2 Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is a familiar bird of prey with a wingspan of 6 to 7 feet. Adult birds feature a black body with a distinctive white head and tail, while juvenile birds are mostly brown with lighter patches on the wings and tail. The bald eagle's primary food is fish, but it will also feed opportunistically on rodents, birds, and carrion. Bald eagles nest in trees near large bodies of water. Some nests are used year after year. Bald eagles are known throughout most of the United States and Canada. Bald eagles have been observed in Back Bay of Biloxi and St. Louis Bay on the Mississippi Gulf Coast (Mann, 2000).

The bald eagle is currently listed by the USFWS as threatened and has been proposed for delisting. Before it was banned in the United States, the pesticide DDT was responsible for weakening the shells of eagle eggs and dramatically reducing reproductive success for the species. In recent years, the bald eagle population has rebounded in the lower 48 states. While still considered rare in many areas, bald eagle nests and eagle sightings have become much more common. Bald eagles are vulnerable to human disturbance while nesting and rearing young. USFWS (1987) guidelines recommend limiting noise and activities such as timber harvest, construction, and using chemicals harmful to wildlife in a zone extending 1500 feet from the nest. Development of multi-story buildings in areas between eagle nesting and feeding areas should be restricted in an area up to a mile from the nest. Building new commercial and industrial sites, using chemicals toxic to wildlife, and building new roads that might facilitate access to the nest should also be restricted up to a mile from a bald eagle nest (USFWS, 1987).

4.10.4.2.3 Black Pine Snake

The black pine snake (*Pituophis melanoleucus lodingi*) is one of 15 subspecies of a widespread snake species commonly called bullsnake or gopher snake. This non-venomous snake with black or dark brown scales and a reddish or white snout can grow up to 8.3 feet in length (Jordan, 1998). Black pine snakes feed on small mammals, but will also take other vertebrates such as birds, lizards and other snakes. The black pine snake was once known in longleaf pine forests from extreme southeastern Louisiana, east to southern Mississippi, to extreme southwestern Alabama (Jordan, 1998). Recent surveys have found the highest concentration of black pine snakes in DeSoto National Forest in Mississippi, including habitat in Harrison County (USFWS, 2001b). The snakes are known from eight other Mississippi counties and three counties in Alabama. Black pine snake is believed to be extirpated from Louisiana (Natureserve, 2001a), and has been listed as a candidate for protection under the ESA.

Black pine snakes require well-drained, upland longleaf pine forest with few shrubs and abundant herbaceous vegetation. Historically, these conditions were maintained with frequent wildfires. Longleaf pine forests were once abundant in the southeastern United States, but have been reduced to less than 5% of their former range (USFWS, 2001b). Degradation, fragmentation, and fire suppression of upland longleaf forests is thought to be responsible for the decline of black pine snakes (Natureserve, 2001a). Conversion of upland habitats to urban development, agriculture, and pine plantation have made habitat unsuitable for the species. Pine snakes avoid forests with a dense mid-story shrub layer, which is often the result of fire suppression (USFWS, 2001b). There is evidence that the snakes use the underground portions of rotting pine stumps for shelter. Modern forestry practices that remove stumps and downed trees before replanting threaten the survival of black pine snakes (Natureserve, 2001a). Direct human impacts such as roadkill, shooting, and collecting black pine snakes for the pet trade are thought to be significant threats to the snake's survival (USFWS, 2001b

4.10.4.2.4 Brown Pelican

The brown pelican (*Pelecanus occidentalis*) is a large brown and gray seabird with a characteristic long bill attached to an expandable pouch used for capturing prey. Brown pelicans can reach up to 8 pounds and have wingspans of more than 7 feet (USFWS, 2001c). These birds are known from marine environments in coastal areas of the United States; they feed by diving for small fish. Breeding pairs use small coastal islands for nesting, building nests in trees or on the ground. The brown pelican suffered dramatic population losses during the middle of the 20th century because DDT poisoning impaired reproductive success. Since DDT use was banned in the United States, brown pelican populations have increased or stabilized. In the Southeastern United States, the brown pelican is considered endangered only in Mississippi and Louisiana (USFWS, 2001c). Threats to brown pelicans include disturbance of nesting colonies, entanglement in fishing gear, oil and toxic chemical spills, severe storms, heavy tick infestations, and unpredictable food availability (USFWS, 2001c).

4.10.4.2.5 Eastern Indigo Snake

The Eastern indigo snake (*Drymarchon corais couperi*) is a large constrictor, usually 5 to 7 feet in length, with a heavy black body and red or orange on the chin and throat. This snake actively forages along wetland edges to feed on rodents, birds, reptiles, and amphibians. In coastal Mississippi, Eastern indigo snakes prefer high, dry, mature pinelands dominated by longleaf pine (*Pinus palustris*), wiregrass (*Aristida stricta*), and turkey oak (*Quercus laevis*). They are often found in association with gopher tortoise, using gopher tortoise burrows for shelter. The species is most abundant in peninsular Florida and south Georgia, although scattered populations persist in coastal Mississippi, Alabama, the Florida panhandle, and coastal South Carolina (Natureserve, 2001b).

The eastern indigo snake is listed threatened by the USFWS. Species decline is thought to be directly related to the loss of mature longleaf pine forest in the Southeast coastal plain. Much of this habitat has been converted to pine plantation stocked with species other than longleaf pine. In other areas, fire suppression has allowed hardwood trees to invade and become dominant in former mature longleaf pine forests. The decline in the Eastern indigo snake may also be related to the decline in the gopher tortoise. Fewer gopher tortoises create fewer burrows, reducing shelter for the Eastern indigo snake as well as many other vertebrates and invertebrates. Research indicates that Eastern indigo snakes might require large areas of contiguous habitat in excess of 10,000 acres in order to thrive. Efforts are underway to restore longleaf pine forests in the southeastern United States and maintain these areas with prescribed fire. Commercial collection of these snakes for the pet trade (now illegal) has also caused the species to decline. However, Eastern indigo snakes are able to reproduce in captivity, which might facilitate captive breeding programs to reintroduce the species to appropriate habitat (Natureserve, 2001b).

4.10.4.2.6 Gopher Tortoise

The gopher tortoise (Gopherus polyphemus) is a terrestrial turtle with a carapace (top shell) length between 15 to 37 cm (USFWS, 1990a). The carapace is dark brown to gray-black, and often worn smooth from moving through the deep burrows it digs for shelter. The gopher tortoise is found in the southeastern coastal plain from Louisiana to South Carolina, although it is rare and scattered throughout its range. Gopher tortoises can live for several decades. Depending on habitat quality, it may take between 10 and 20 years for tortoises to become sexually mature. Egg laying and nesting takes place in the spring months. Clutch size is usually between 5 and 9 eggs. Nest predation is

high, with roughly 90 percent of gopher tortoise nests destroyed by predators such as raccoons, armadillos, and opossums. Predation on hatchling tortoises is also very high. Research indicates that hatchling mortality rates of more than 90 percent are not unusual (Natureserve, 2001c).

Gopher tortoises are found in a variety of upland habitats. The best tortoise habitat consists of open upland woodlands with well-drained sandy soils suitable for easy burrowing. An open tree canopy lets in sunlight necessary for the growth of grasses and herbaceous plants on which the gopher tortoise feeds (USFWS, 1990a). Sunlight is thought to be necessary for tortoise basking thermoregulation, and also for egg incubation while nesting (Natureserve, 2001c). Periodic low-intensity fires have been observed to be beneficial to maintaining gopher tortoise habitat. In the western part of its range, including Mississippi, gopher tortoises inhabit xeric longleaf pine–scrub oak forests located on sand ridges. They may also found on the edges of crop fields, in pastures, and power line right-of-ways (USFWS, 1990a).

The gopher tortoise has been listed threatened by the U.S. Fish and Wildlife Service. The species population has undergone an 80 percent decline in the past 100 years (Natureserve, 2001c). Decline is expected to continue because of habitat elimination and fragmentation. In the early 20th Century, gopher tortoises were collected for food. This problem has decreased, although tortoises continue to be adversely impacted by rattlesnake collectors who pour toxic substances down gopher tortoise burrows in order to flush out resident rattlesnakes. Road kill is also a persistent problem for adult turtles (Puckett and Franz, 2001). The most frequently cited reason for gopher tortoise decline throughout its range is loss of habitat. Conversion of pinelands to agricultural lands has reduced gopher tortoise habitat in Mississippi (Natureserve, 2001c). Fire suppression in longleaf pine natural communities has resulted in an increase in shrub cover and a decrease in herbs and grasses used for food. Throughout its range, conversion of open woodlands to dense slash pine plantation monocultures has eliminated large tracts of suitable habitat. In Florida, urbanization has also eliminated gopher tortoises and tortoise habitat.

4.10.4.2.7 Green Sea Turtle

The green sea turtle (*Chelonia mydas*) was listed as endangered/threatened on July 28, 1978. The breeding population off Florida and the Pacific coast of Mexico is listed as endangered while all others are threatened (NMFS, 2001). Green Sea Turtles range throughout the Atlantic, Pacific, and Indian Oceans, primarily in tropical regions and shallow waters (except during migration), inside reefs, bays, and inlets. The green sea turtles are attracted to lagoons and shoals with abundant marine grass and algae on which the turtles feed.

Green sea turtles have been observed in the Mississippi Sound. In fact, a juvenile green sea turtle was captured in the mouth of Back Bay of Biloxi several years ago (Mann, 2000; Mann, T. 2003. Personal comm.). The turtles are not known to nest on the Mississippi coast or barrier islands, but might be attracted to seagrass beds as a food source in nearshore waters (Gunter, 1981).

Exploitation of green sea turtle nesting grounds either by human interference or pollution poses the greatest threat to these turtles. The greatest cause of decline in green turtle populations is commercial harvest for eggs and food in nesting areas outside the United States. Incidental catch during commercial shrimp trawling is a continuing source of mortality that adversely affects recovery in North America (NMFS, 2001). Today, turtle excluder devices (TEDs) pulled by shrimp boats help reduce mortality from net entanglement.

4.10.4.2.8 Gulf Sturgeon

The Gulf sturgeon (*Acipenser oxyrhynchus desotoi*) was listed throughout its range as a threatened subspecies on September 30, 1991. The gulf sturgeon, considered a subspecies of the Atlantic sturgeon (*Acipenser oxyrhynchus*), is an anadromous fish, migrating from salt water into large coastal rivers. Historically, the Gulf sturgeon occurred in rivers from the Mississippi River to the Suwanee River, and in bays and estuaries from Florida to Louisiana. Little is known about current population levels outside the Suwanee, Apalachicola and Pearl Rivers, but they are thought to have declined from historic levels (USACE, Mobile District, 2000).

Adult fish spend 8 to 9 months each year in rivers and 3 to 4 of the coolest months in estuarine gulf rivers. In the Suwanee River, adult sturgeons frequent areas near the mouths of springs and cool water rivers during the summer months. Adult fish tend to congregate in deeper waters of rivers with moderate currents and sandy and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats (Mason and Clugston, 1993). The adult gulf sturgeon is known to spend the fall and winter months in the estuary of the Mississippi Sound and migration routes extend from the Sound to the Back Bay of Biloxi. Occurrences of the gulf sturgeon have been documented by the MSNHP database within the Mississippi Sound, Biloxi River, and Pascagoula River area. The gulf sturgeon is known to spawn in the Pearl River system. Major threats to this rare, primitive species include physical barriers (e.g., locks and dams) to spawning grounds, habitat loss, and poor water quality.

On March 19, 2003, USFWS and NMFS designated 14 geographic areas among the Gulf of Mexico rivers and tributaries as critical habitat for the Gulf sturgeon (FR Vol. 68, No. 53). These 14 geographic areas encompass approximately 2,783 river kilometers (1,739 river miles) and 6,042 square kilometers (2,333 square miles) of estuarine and marine habitat. In Mississippi, the critical habitat includes 632 kilometers of the Pearl River, including Bogue Chitto, and 203 kilometers of the Pascagoula River, including the Leaf, Bouie, Chickasawhay, and Big Black Creek tributaries (FR Vol. 68, No. 53).

4.10.4.2.9 Kemp's Ridley Sea Turtle

The Kemp's Ridley sea turtle *(Lepidochelys kempii)* was listed as endangered throughout its range (Gulf of Mexico and Atlantic Ocean) on December 2, 1970, and its status has remained unchanged. The Kemp's Ridley population has declined since 1947 (when an estimated 42,000 females nested in one day) to a nesting population of approximately 1,000 in the mid-1980s. The decline of this species was primarily due to human activities including collection of eggs, fishing for juveniles and adults, killing adults for meat and other products, and direct take for indigenous use. In addition to these sources of mortality, Kemp's Ridley have been subject to high levels of incidental take by shrimp trawlers. Kemp's Ridley turtles are occasionally caught on fishing hooks and incidentally injured by recreational anglers and boaters (Mann, personal communication, 2003). Today, under strict protection, the population appears to be in the earliest stages of recovery. The increase can be attributed to two primary factors: full protection of nesting females and their nests in Mexico, and the requirement to use TEDs in shrimp trawls both in the United States and Mexico (NMFS, 2001).

The major habitat for Kemp's Ridley sea turtle is the nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters outside of the nesting season. Kemp's ridley sea turtles are often found in salt marsh habitats; the majority nest on approximately 4.9 miles of beach between Barra del Tordo and Ostional in the state of Tamaulipas, Mexico. It is the only known major nesting beach in the world for this turtle.

4.10.4.2.10 Loggerhead Turtle

The loggerhead turtle (*Caretta caretta*) was listed as threatened throughout its range on July 28, 1978 (43 FR 82808), and its status has not changed. The loggerhead sea turtle is widely distributed throughout its range and may be found hundreds of miles out to sea as well as in inshore areas such as bays, lagoons, salt marshes, creeks, ship channels, and the mouths of large rivers (USACE, Mobile District, 2000). Loggerheads are known to migrate over long distances, with tagged specimens having been recaptured 1,200 to 1,500 miles from the point of release. Loggerheads are seen annually inshore in the Mississippi Sound, but are more commonly seen offshore in the proximity of oil rigs (Mann, personal communication, 2003). Most recent evidence suggests that the number of nesting females in South Carolina and Georgia may be declining, while the number of nesting females in Florida appears to be stable. Until the 1970s, loggerhead turtles were commercially harvested for their meat, eggs, leather, and fat. Its meat and leather are not as valuable as the green sea turtle, and its shell is of less value than the hawksbill. However, in places where regulations are not enforced, the harvest of turtle meat and eggs remains a problem. Because of their feeding behavior and their habit of wintering in shallow waters, loggerheads, along with Kemp's Ridley sea turtles, are more likely to be caught in large shrimp trawl nets and drown. Today, Turtle Excluder Devices (TEDs) pulled by shrimp boats help reduce mortality from net entanglement by allowing turtles to escape from the nets (TPWD, 2001). However, loggerhead turtles are hooked by recreational fishermen offshore near oil rigs and are frequently injured by being struck by boats and boat propellers (Mann, personal communication, 2003).

Loggerheads are capable of living in a variety of environments, such as in brackish waters of coastal lagoons and river mouths. During the winter, they may remain dormant, buried in the mud at the bottom of sounds, bays, and estuaries. The major nesting beaches are located in the southeastern United States, primarily along the Atlantic coast of Florida, North Carolina, South Carolina, and Georgia. As of 1981, there was no record of loggerhead turtles nesting in Mississippi, although a small group of these turtles were seen swimming off the western end of Horn Island in 1976. MS Heritage Program data includes a record for loggerhead turtle southeast of Deer Island (Mann, 2000).

Loggerheads are know to nest annually in small numbers on the Gulf Island National Seashore in Mississippi, with one nest being documented on the mainland beach and one nest several years ago on Round Island (Mann, personal communication, 2003).

4.10.4.2.11 Louisiana Black Bear

The Louisiana black bear (*Ursus americanus luteolus*) is one of 16 subspecies of American black bear. Black bears are large, bulky mammals that can grow to more than 600 pounds. The Louisiana black bear differs from other subspecies by having a longer, narrower skull and larger molar teeth (USFWS, 1995). The Louisiana black bear was listed as threatened in its former range of Louisiana, southern Mississippi, and eastern Texas on January 7, 1992. Other black bear species that could occur in this area are treated as threatened due to similarity of appearance. Black bears are opportunistic omnivores that rely heavily on plant foods such as acorns and berries. Bears are also known to eat insects and carrion, and to raid garbage cans, agricultural crops, and bee hives (USFWS, 1995).

Louisiana black bears typically inhabit bottomland hardwood forests, but may also use other habitat types, especially when food is available. Bottomland hardwood forests feature the food sources and denning sites that are necessary for successful bear reproduction. Many different species of hardwood trees, shrubs, vines, and herbaceous plants provide food at different times of the year.

Large hollow trees common in swamps provide ideal dens for winter hibernation and birthing young. Reproducing populations of Louisiana black bear are thought to be restricted to two large bottomland hardwood forest areas in Louisiana (USFWS, 1995). The Tensas River Basin and Atchaflaya River Basin support several reproducing sub-populations of bears. Louisiana black bears can range long distances in search of food and have been sighted far from the Tensas and Atchaflaya River Basins. Bottomland hardwood forests along lower Pearl River and lower Pascagoula River have suitable habitat that might be occupied by Louisiana black bears (USFWS, 1995). It is difficult to determine whether bears seen outside Louisiana are reproducing females, or only wandering subadult bears. There has been at least one confirmed sighting of a female with cubs in Mississippi, and USFWS monitoring data indicate that females will cross the Mississippi River from Louisiana to Mississippi (Rummel, 2002).

Habitat loss is thought to be the primary threat to the survival of the Louisiana black bear. Former bear habitat had been reduced by 80 percent within its historic range by 1980 (USFWS, 1995). Remaining bear habitat has been fragmented and degraded; degraded habitats often do not provide sufficient food for bears. As bears travel in search of food, they are more likely to come into conflict with humans, and human-related mortality is thought to pose a direct threat to Louisiana black bears. Education programs and strong penalties for poachers have been implemented to help reduce intentional harm to bears (USFWS, 1995). Land acquisition and bottomland hardwood forest restoration efforts are underway to increase habitat available to bears. Fewer than 160 Louisiana black bears were thought to exist in breeding habitats in Louisiana in 1995 (USFWS, 1995).

4.10.4.2.12 Louisiana Quillwort

Louisiana quillwort (*Isoetes louisianensis*) is a primitive seedless wetland plant with a grass-like appearance, although it is actually more closely related to ferns. It has many simple, hollow leaves 2 to 3 mm wide and up to 40 cm long. Quillworts reproduce by producing spores in special structures embedded in the leaves. The Louisiana quillwort is restricted to gravel bars and sandy soils in or near shallow blackwater creeks and overflow channels in narrow riparian woodlands or bayheads in pine flatwoods and upland longleaf pine vegetative communities (USFWS, 1996). This species has been documented in the Pleistocene High Terraces ecoregion in southern Mississippi. Louisiana quillwort was discovered in southeastern Louisiana in 1972. In 1996 it was known from a handful of sites in southeastern Louisiana and in two Mississippi counties, Jackson and Perry (USFWS, 1996). Recent survey work however, has discovered this plant in more than 50 locations spread over 10 Mississippi counties (Natureserve, 2001d).

Louisiana quillwort is listed as endangered by the U.S. Fish and Wildlife Service. Threats to quillwort populations include timber harvest, sand and gravel mining, construction, and other activities with potential to alter the hydrology of small stream habitats (Natureserve, 2001d). Louisiana quillwort is adapted to dynamic stream environments in which natural processes scour and redeposit individual plants and spores on constantly changing gravel bars and sandy streambanks. This species has not been observed to grow on silt substrates even when other habitat factors are appropriate (USFWS, 1996).

4.10.4.2.13 Manatee

The West Indian or Florida manatee (*Trichechus manatus*) was listed as an endangered species in 1967 (under a law that preceded the Endangered Species Act of 1973) throughout all or a significant portion of its range (USFWS, 2001g). The manatee also is protected at the federal level under the Marine Mammal Protection Act of 1972.

The manatee (sometimes called sea cow) is found primarily along the coast of Florida. Most adult manatees are about 10 feet long and weigh 800 to 1,200 pounds, although some larger than 12 feet and weighing as much as 3,500 pounds have been recorded. These "gentle giants" have a tough, wrinkled brown-to-gray skin that is continuously being sloughed off. Hair is distributed sparsely over the body. With stiff whiskers around its mouth, the manatee's face looks like a walrus without tusks.

Manatees spend their lives moving between freshwater, brackish, and saltwater environments. They prefer large, slow-moving rivers, river mouths, and shallow coastal areas such as coves and bays. Great distances may be covered as the animals migrate between winter and summer grounds. During the winter, the United States' manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During summer months, manatees may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico. Manatees are known to migrate through the study area, and several have been rescued in the study area during cold weather outbreaks (USFWS, personal communication, 2003). In fact, one or more manatees have been seen annually in Mississippi waters each year for the past decade (Mann, personal communication, 2003).

Manatees are adversely impacted by collisions with boats, crushing and drowning in canal locks, harassment by skin divers and boaters, entanglement in fishing line, toxins ingested during red tide (toxic algae bloom) events, and destruction of seagrass beds for boating facilities. Manatee population trends are poorly known, but deaths are thought to have increased steadily (6.1 percent a year, exponential regression, 1976 to 1991). Mortalities from collisions with watercraft are up 10.3 percent a year from 21 percent of all deaths in 1976—1980 to 29 percent in 1986—1991. Deaths of dependent calves are up 12 percent a year, from 14 percent to 24 percent of all deaths. The manatee has difficulty rebounding from these threats because of its late breeding maturity and its low reproductive rate. In general, the birth rate is not able to keep up with manatees killed by boats. The combination of high mortality rates and low reproductive rates have led to serious doubts about the species' ability to survive in the United States.

4.10.4.2.14 Mississippi Gopher Frog

The Mississippi gopher frog (*Rana capito sevosa*) is a medium-sized, stocky frog with brown, black, or gray coloration and many dark spots and warts. Adult frogs reach approximately 3 inches in body length. These frogs spend considerable time underground in abandoned gopher tortoise burrows, mammal burrows, and under tree stumps (USFWS, 2000). Mississippi gopher frogs breed in isolated ponds surrounded by sandy, upland, longleaf pine forest. Breeding ponds only fill with water after substantial winter rains; Mississippi gopher frogs, therefore, do not reproduce successfully in drought years. The Mississippi gopher frog population has been reduced to approximately 100 known individuals near one breeding pond in Harrison County, Mississippi. Development projects in the vicinity of the pond have severed movement corridors that formerly helped sustain the frog population and otherwise have deteriorated remaining frog habitat. The species was at one time

known from coastal counties and parishes from the Mississippi River in Louisiana east to the Mobile River in Alabama (USFWS, 2000).

The Mississippi gopher frog was listed as endangered under an August 2001 agreement between the President, the Interior Department and several environmental groups to rapidly list 29 species in critical danger of extinction (Llanos, 2001). Threats to the last remaining frog population include inbreeding, local changes in hydrology, fire suppression, sedimentation, toxic chemical runoff, and habitat destruction and fragmentation. The last remaining breeding pond used by the species is located within 656 feet (200 m) of a proposed highway, housing development, and golf course (USFWS, 2000).

4.10.4.2.15 Mississippi Sandhill Crane

Mississippi sandhill crane (*Grus canadensis pulla*) is a large wading bird similar in appearance to herons and other cranes. Sandhill cranes have gray feathers with long legs and neck. Adult sandhill cranes have a red patch on the forehead (USFWS, 2001d). The Mississippi sandhill crane is a non-migratory subspecies of sandhill crane found only in Jackson County, Mississippi. Most sandhill cranes are migratory, but there are three recognized subspecies that do not migrate: Florida sandhill crane (*Grus canadensis pratensis*), Cuban sandhill crane (*Grus canadensis nesiotes*), and Mississippi sandhill crane. Somewhere between 110 to 120 Mississippi sandhill cranes existed in the wild in 2000 (Natureserve, 2001e). A USFWS captive breeding program has been successful in reintroducing several breeding cranes to the Mississippi Sandhill Crane National Wildlife Refuge. These cranes are found in wet and dry open forests and savannahs with longleaf pine, slash pine, and cypress (*Taxodium ascendens*) Mississippi sandhill cranes feed on live prey such as amphibians, worms and insects. At certain times of the year the cranes also eat plant foods such as corn, roots, tubers, and pecans. Mississippi sandhill cranes reproduce slowly, raising only one chick per year. Hatching success is low, and very few young birds have been observed. Low population levels and inbreeding might be responsible for low hatching success and a high rate of disease in Mississippi sandhill cranes (USFWS, 2001d).

Critical habitat for the Mississippi sandhill crane covers about 26,000 acres in Jackson County. The main threat to the survival of this subspecies is loss and fragmentation of habitat. Conversion of open forests to dense pine plantation, fire suppression, encroachment of residential and commercial developments, roads that facilitate access to and fragment crane habitat, and chemical spraying on roadsides all contribute to population decline (Natureserve, 2001e; USFWS, 2001d). These cranes are territorial when nesting. Nests can be separated by a half mile or more. If the Mississippi sandhill crane population recovers, more suitable habitat will be needed so that adult cranes have space to hatch and rear young. Habitat maintenance, which requires occasional fire—either prescribed or wild, is increasingly difficult with the encroachment of suburbia and urban areas on crane habitat.

4.10.4.2.16 Pearl Darter

The pearl darter (*Percina aurora*) is a small fish in the perch family that usually grows to just over 2 inches in length. It has a blunt nose, horizontal mouth, large eyes placed high on the head, and a black spot on the caudal fin. Pearl darters have been collected in rivers and large creeks with moderate current and sand and gravel substrates. It is not found in deep, sluggish pools, lacustrine environments, or headwater creeks with insufficient flow. Chironomids and small crustaceans probably make up a large part of pearl darter diet (USFWS, 2001e).

Never considered abundant, the pearl darter was once found in both the Pearl and Pascagoula River systems. It has not been collected in the Pearl River system since 1973. The pearl darter is thought to be restricted to 88 river miles of the Pascagoula River watershed (USFWS, 2001e). The pearl darter has the potential to occur in the Pascagoula River and its tributaries in Jackson County. Threats to the pearl darter include sedimentation from forestry and development in the watershed, permitted industrial and municipal discharges of toxic chemicals and sewage, sand and gravel mining, and proposed impoundments for reservoirs. Sand and gravel mining activities are ongoing in the Pascagoula River system. In-stream mining not only removes substrates preferred by the pearl darter, it also delivers sediment to aquatic habitats downstream. Holes in river channels left by sand and gravel mining activities function similar to lake habitats, which pearl darters avoid (Natureserve, 2001f).

4.10.4.2.17 Piping Plover

The piping plover *(Charadrius melodus)* is a small, stocky, sandy-colored bird resembling a sandpiper. The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the base of its neck. Like other plovers, it runs in short starts and stops. When still, the piping plover blends into the pale background of open, sandy habitat on outer beaches where it feeds and nests. The bird's name derives from its call notes, plaintive bell-like whistles which are often heard before the birds are seen.

The piping plover is listed as a federally threatened species within the watershed of the Gulf Coast as listed in the Federal Register, December 11, 1985. The piping plover breeds on sandy or pebble coastal beaches of Newfoundland and southeastern Quebec to North Carolina. These birds winter primarily on the Atlantic coast from North Carolina to Florida, although some migrate to the Bahamas and West Indies. Decline in piping plover populations has been linked to loss of breeding habitat. Shoreline development, river flow alteration, river channelization, and reservoir construction have all led to loss of breeding habitat. The piping plover is a federally threatened and state endangered shorebird. All piping plovers are considered threatened species under the ESA when on their wintering grounds. The piping plover winters along the Gulf coast but does not nest in Mississippi. The Mississippi Natural Heritage Program (MSNHP) database indicates three over-wintering sightings of piping plovers: one along the beaches of Gulfport, one on Deer Island, and one on Ship Island.

Several factors are contributing to the decline of the piping plover along the Atlantic coast Commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers to nest and feed. Human disturbance often curtails breeding success. Foot and vehicular traffic may crush nests or young. Excessive disturbance may cause the parents to desert the nest, exposing eggs or chicks to the summer sun and predators. Interruption of feeding may stress juvenile birds during critical periods in their development.

Pets, especially dogs, may harass the birds. Developments near beaches provide food that attracts increased numbers of predators such as raccoons, skunks, and foxes. Domestic and feral cats are also very efficient predators of plover eggs and chicks. Stormtides may inundate nests.

Piping plovers winter in coastal areas of the United States from North Carolina to Texas. Piping plovers begin arriving on the wintering grounds in July, with some late-nesting birds arriving in September. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990; Drake 1999a, 1999b). The international piping plover winter censuses of 1991 and 1996 located only 63 percent and 42 percent

of the estimated number of breeding birds, respectively (Haig and Plissner 1992; Haig and Plissner 1993). Of the birds located on the United States wintering grounds during these two censuses, 89 percent were found on the Gulf Coast and 8 percent were found on the Atlantic Coast.

4.10.4.2.17.1 Critical Habitat for the Piping Plover

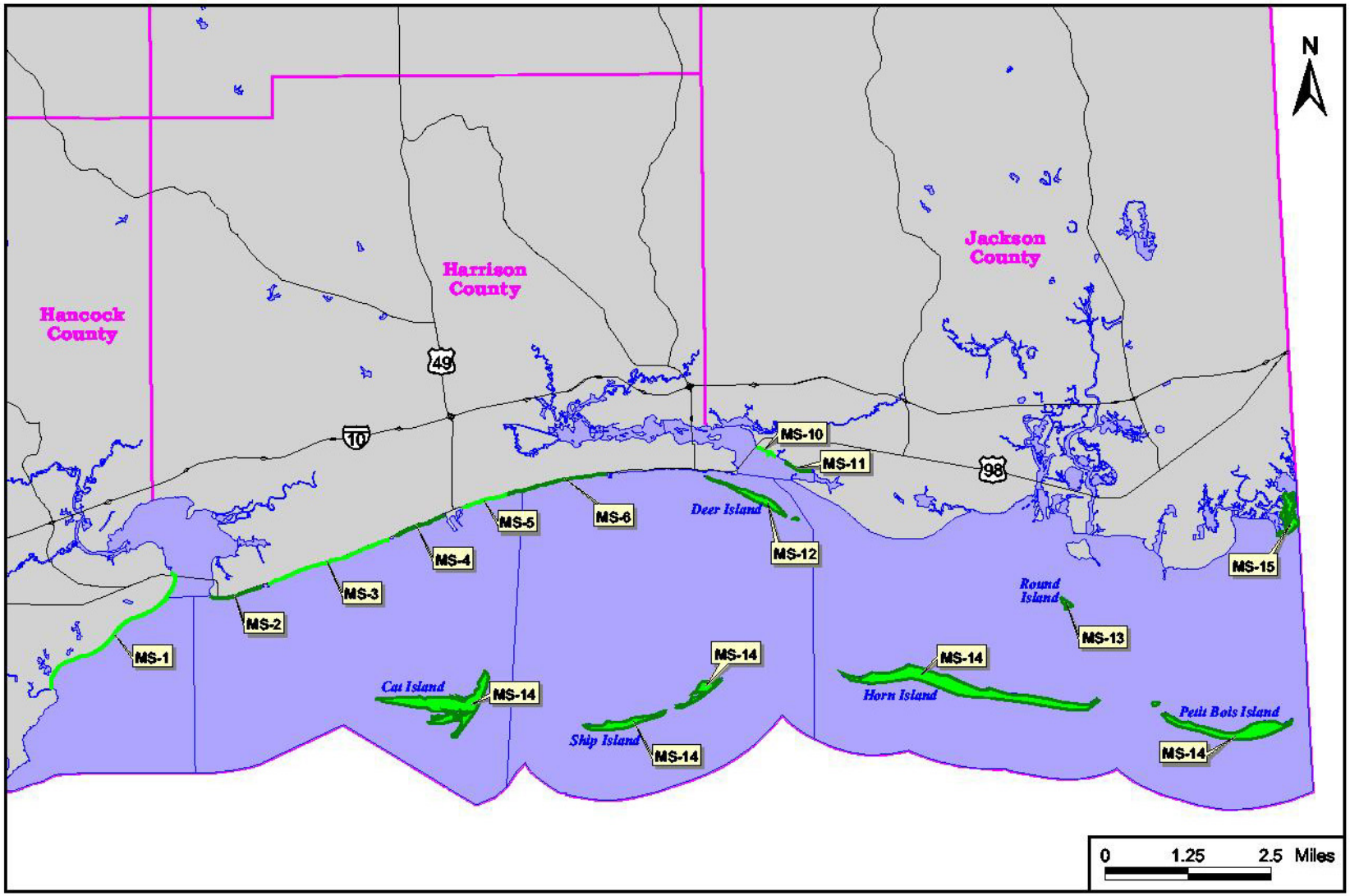
On August 9, 2001, the U.S. Fish and Wildlife Service designated 137 areas along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas as critical habitat for the wintering population of the piping plover. This includes approximately 2,891.7 kilometers (1,798.3 miles) of mapped shoreline and approximately 66,881 ha (165,211 acres) of mapped area along the Gulf and Atlantic coasts and along margins of interior bays, inlets, and lagoons.(USFWS, 2001h)

Critical habitat identifies specific areas that are essential to the conservation of a listed species, and that may require special management considerations or protection. The primary constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in coastal areas that support intertidal beaches and flats (between annual low tide and annual high tide) and associated dune systems and flats above annual high tide. Section 7 of the act requires federal agencies to ensure that actions they authorize, fund, or carry out are not likely to adversely modify designated critical habitat. As required by section 4 of the act, USFWS considered economic and other relevant impacts prior to making a final decision on what areas to designate as critical habitat (USFWS, 2001h).

4.10.4.2.17.2 Critical Habitat Designation/Land Ownership

The critical habitat areas contained within the conservation units described below constitute USFWS's best evaluation of areas needed for the conservation of the wintering piping plover. The USFWS may revise critical habitat through a rulemaking process if new information becomes available. Figure 4.10–9 identifies the general locations of the designated critical habitat for the wintering piping plover along the Mississippi coast.

USFWS calculated linear distances of critical habitat shoreline (in kilometers and miles) by ownership for the state of Mississippi. In addition, state-level values of area in hectares and acres were calculated for the critical habitat units by ownership (Table 4.10–22). Ownership for both the shoreline and units were broken into three classes (Federal—Federally owned lands, State—state owned lands, and Other—non-Federal or non-state mapped lands). Assignment of ownership was based on existing digital state-level managed/protected lands geodata set (GIS data set) where possible. If no existing digital data were available, ownership was assigned based on other data sources. Detailed descriptions of critical habitat units for the piping plover are provided in Table 4.10–23.



Piping Plover Critical Habitat Unit Designations

Source: USFWS, 2001.

Figure 4.10-9

Table 4.10–22
Approximate Land Area of Designated Critical Habitat Units for Wintering Piping Plover (Rows)

Land Owner	Shoreline Ownership In Hectares (acres)	Shoreline Ownership In Kilometers (miles)
Federal	2,376 (5,870)	98.2 (61.4)
State	0 (0)	0 (0)
Other	1,479 (3,655)	105.9 (66.2)
Total	3,855 (9,525)	204.1 (127.6)

USFWS, 2001i

Table 4.10–23
Piping Plover Critical Habitat in Mississippi

Map Unit	Description
MS-1	Lakeshore through Bay St. Louis. 41 ha (101 ac) in Hancock County. This unit extends from the north side of Bryan Bayou outlet and includes the shore of the Mississippi Sound following the shoreline northeast approximately 15.0 km (9.3 mi) and ending at the southeast side of the Bay Waveland Yacht Club. The landward boundary of this unit follows the Gulf side of South and North Beach Boulevard and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-2	Henderson Point. 34 ha (84 ac) in Harrison County. This unit extends from 0.2 km (0.12 mi) west of the intersection of 3rd Avenue and Front Street and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.4 km (2.7 mi) to the west side of Pass Christian Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned
MS-3	Pass Christian. 77 ha (190 ac) in Harrison County. This unit extends from the east side of Pass Christian Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 10.5 km (6.5 mi) to the west side of Long Beach Pier and Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW and the seaward boundary is MLLW. The shoreline of this unit is privately owned.

Table 4.10–23
Piping Plover Critical Habitat in Mississippi (continued)

Map Unit	Description
MS-4	Long Beach. 38 ha (94 ac) in Harrison County. This unit extends from the east side of Long Beach Pier and Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.4 km (2.7 mi) to the west side of Gulfport Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-5	Gulfport. 39 ha (96 ac) in Harrison County. This unit extends from the east side of Gulfport Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.8 km (3.0 mi) to the west side of the groin at the southern terminus of Courthouse Road, Mississippi City, MS. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-6	Mississippi City. 62 ha (153 ac) in Harrison County. This unit extends from the east side of the groin at the southern terminus of Courthouse Road, Mississippi City, MS, and includes the shore of the Mississippi Sound following the shoreline northeast approximately 7.9 km (4.9 mi) to the west side of President Casino. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-7	Beauvoir in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-8	Biloxi West in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-9	Biloxi East in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-10	Ocean Springs West. 11 ha (27 ac) in Jackson County. This unit extends from U.S. 90 and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.9 km (1.2 mi) to the Ocean Springs Harbor inlet. The landward boundary of this unit follows the Bay side of Front Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-11	Ocean Springs East. 7 ha (17 ac) in Jackson County. This unit extends from the east side of Weeks Bayou and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.8 km (1.1 mi) to Halstead Bayou. The landward boundary of this unit follows the Bay side of East Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-12	Deer Island. 194 ha (479 ac) in Harrison County. This unit includes all of Deer Island, where primary constituent elements occur to the MLWW . Deer Island is privately owned

Table 4.10–23
Piping Plover Critical Habitat in Mississippi (continued)

Map Unit	Description
MS-13	Round Island. 27 ha (67 ac) in Jackson County. This unit includes all of Round Island to the MLWW and is privately owned.
MS-14	Mississippi Barrier Islands. 3,168 ha (7,828 ac) in Harrison and Jackson Counties. This unit includes all of Cat, East and West Ship, Horn, Spoil, and Petit Bois Islands where primary constituent elements occur to MLLW. Cat Island is privately owned, and the remaining islands are part of the Gulf Islands National Seashore.
MS-15	North and South Rigolets. 159 ha (393 ac) in Jackson County, MS, and 12 ha (30 ac) in Mobile County, AL. This unit extends from the southwestern tip of South Rigolets Island and includes the shore of Point Aux Chenes Bay, the Mississippi Sound, and Grand Bay following the shoreline east around the western tip, then north to the south side of South Rigolets Bayou; then from the north side of South Rigolets Bayou (the southeastern corner of North Rigolets Island) north to the northeastern most point of North Rigolets Island. This shoreline is bounded on the seaward side by MLLW and on the landward side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. Approximately 4.4 km (2.7 mi) are in Mississippi and 2.9 km (1.8 mi) are in Alabama. Almost half the Mississippi shoreline length is in the Grand Bay National Wildlife Refuge.

USFWS 2001i

4.10.4.2.18 Red-Cockaded Woodpecker

Red-cockaded woodpeckers (*Picoides borealis*) are small- to medium-sized woodpeckers 18 to 20 cm long, with a 35 to 38 cm wingspan. White spots on black feathers give the bird a "ladder- back" appearance. Red-cockaded woodpeckers have a white cheek patch on either side of the head, as well as a black cap. Male woodpeckers have thin red streaks on the cheeks that are barely visible (Natureserve, 2000). Red-cockaded woodpeckers nest and forage in mature pine stands frequently burned to promote an open understory and thick herbaceous layer. Research indicates that red-cockaded woodpeckers excavate nest cavities in pines 60 years or older (USFWS, 1998a). The birds were once abundant in pinelands throughout the southeastern United States, but fire suppression, subsequent hardwood encroachment, conversion to short-rotation pine plantations, and development have eliminated most suitable habitat.

The red-cockaded woodpecker is listed by the USFWS as endangered throughout its range. Scattered populations exist from southeastern Oklahoma to southern Virginia, south to Florida and eastern Texas. In Mississippi, red-cockaded woodpeckers have been reported in Harrison and Jackson Counties.

4.10.4.2.19 Yellow-Blotched Map Turtle

The yellow-blotched map turtle (*Graptemys flavimaculata*) is a small turtle that gets its name from the distinctive yellow blotches on its carapace (top shell). The turtle has a greenish-black body covered with yellow stripes. The plastron (bottom shell) is yellow to tan in color. Adult male turtles have been observed with carapace length between 3.5 to 4.8 inches, while the normally larger female turtles have been observed with carapace length of 4.1 to 8.5 inches (USFWS, 1993). Several prominent spine-like projections extend from the top of the carapace. Yellow-blotched map turtles are endemic to the Pascagoula River system. They live in the main channels of rivers and large creeks; they have also been observed in oxbow lakes (USFWS, 1993). These turtles have been observed in the Pascagoula and Escawtawpa Rivers in Jackson County. Yellow-blotched map turtles avoid small streams where the surface of the water is shaded by bank vegetation. Aquatic insects and snails are thought to make up a large part of the turtles' diet. Turtles often bask on snags and logs that have fallen in the water. Nesting occurs during the summer months on sandbar beaches (USFWS, 1993).

Yellow-blotched map turtle populations in the upper Pascagoula watershed have been in decline since the early 1990s. Navigation improvement projects to remove logs and snags from the Pascagoula river have taken away structures needed by the turtles for basking (USFWS, 1993). Snag removal has also adversely impacted populations of the turtles' invertebrate prey that use snags as habitat. Gravel mining activities in the watershed have increased sedimentation and further impacted aquatic invertebrate populations. Four reservoirs and ongoing channel modification projects in the Pascagoula River system have altered or eliminated sandbars that turtles use for nesting. These small, colorful turtles are illegally collected for the pet trade, and basking turtles are used for target practice by some individuals (USFWS, 1993). Some turtles have been observed to drown in illegal catfish traps.

Water pollution is a serious problem in some Pascagoula River tributaries. Permitted industrial and municipal effluents degrade water quality (USFWS, 1993). Brine discharge from oil fields and a dioxin spill that once prompted a fishing ban in the Pascagoula River have also impacted river water quality. Sedimentation and water pollution are threats to aquatic invertebrates, a main food source for the turtles. Food availability is thought to be a limiting factor for turtle populations. Nest predation is likely to average between 90 and 100 percent, typical for similar turtle species. Few juvenile turtles were observed in a 1989 survey. Reproduction might be impaired by lack of nesting habitat, exclusion of the turtles from suitable nesting beaches by excessive human presence, or effects of chemical pollutants on turtle reproductive biology. Direct and indirect adverse impacts to yellow-blotched map turtles would be expected from point and non-point source discharges of toxic chemicals, brine, sewage, and sediment to the Pascagoula River system (USFWS, 1993).

4.10.4.3 Historical Trends

4.10.4.3.1 Introduction

There are fourteen threatened and endangered species that use terrestrial or freshwater aquatic habitats, known from the three coastal counties in Mississippi. Several of these species are endemic to Mississippi or the Gulf Coast, while others migrate long distances to breed or winter in coastal Mississippi. Population declines in some of these species are linked to effects of habitat loss, taking for food or pets, or water pollution in Mississippi. In other species, declines have been linked to phenomena outside the study area. Because most threatened and endangered species are rare,

population information is difficult to obtain. A review of current literature shows most of the populations of listed species appear to be in decline or have stabilized at levels below what many scientists believe will ensure the long-term survival of the species. Populations of two listed bird species—the bald eagle and brown pelican—appear to be increasing throughout the Southeast as effects of the now-banned pesticide DDT decrease with time. Although most of the listed species have habitat requirements more specific than the land use categories in the land use analysis, some useful conclusions can be drawn from the available data.

4.10.4.3.2 The Period of 1972 through 1992

Land area in Hancock, Harrison, and Jackson counties combined (excluding surface water) is just over 1.1 million acres. From 1972 to 1992, the largest land use change observed was a loss of more than 200,000 acres of pine forest. At the same time, agricultural lands and shrub-scrub and cutover land together increased by slightly more than 150,000 acres. Deciduous forest cover increased by about 40,000 acres. Urban land and land devoted to transportation infrastructure increased by more than 20,000 acres, while emergent wetlands declined by about the same amount. Overall, natural land cover declined by approximately 8 percent from 1972 to 1992, while agricultural and shrub-scrub lands increased by more than half, and urban land by a third.

The decline of frequently burned, open-canopy longleaf pine woodlands has occurred throughout the southeastern United States in the past century. From 1972 to 1992, just over 200,000 acres of pine forest (including wet pine savannah) were lost in the three-county study area. Loss and fragmentation of mature pine forests are thought to be caused by a combination of fire suppression, hardwood encroachment, timber harvest, conversion to short-rotation pine plantations, and development (USFWS, 1990a). Part of the observed increase by 40,000 acres of deciduous forest might be explained by fire suppression and hardwood encroachment in pine forests. The loss of the once-dominant longleaf pine forest has been implicated in the population declines for a number of now threatened or endangered species in the Southeast, including several species known from Hancock, Harrison, and Jackson Counties. Black pine snake, eastern indigo snake, gopher tortoise, Mississippi gopher frog, and red-cockaded woodpecker are all in some way dependent on frequently burned, open-canopy pine woodlands, and are in decline because of loss and fragmentation of their habitats throughout their range. Similarly, the population of the Mississippi sandhill crane that forages and breeds only in coastal wet slash pine savannah has been reduced to just over 100 birds. Population declines that led to the listing of these species were observed before 1992, and in many instances were underway before 1972.

Although habitat loss is frequently cited as a major cause for localized extinction of endangered species, the effects of habitat fragmentation are in many cases equally important. From 1972 to 1992, land use analysis shows losses of pine forests and emergent wetlands. Likewise, increases were observed in cutover land, shrublands, and deciduous forest, which reflects conversion of pine forest to these other types. Large areas of pine forest and wetlands have been fragmented into smaller habitats that are in many cases less suitable for the long-term survival of many species. For example, research indicates that eastern indigo snakes might require large areas of contiguous habitat in excess of 10,000 acres in order to thrive (Natureserve, 2001b). Habitat fragmentation undoubtedly increased during the period from 1972 to 1992, and has been implicated as one of many continuing cumulative adverse impacts to threatened and endangered species.

Many species are listed as threatened or endangered for reasons beyond habitat loss and fragmentation, however. Trends in human behavior can be also be significant to population dynamics of threatened and endangered species. Many of the federally listed reptiles in coastal

Mississippi were at one time collected for the pet trade or for food. For example, Alabama red-bellied turtle eggs and adults have been collected for food by local residents (USFWS, 1989). Gopher tortoises were also collected for food during the mid-20th century (USFWS, 1990a), and eastern Indigo snakes were collected for the pet trade (Natureserve, 2001b). The taking of listed reptiles and turtle eggs probably continued up until the time most the species were protected under the ESA in the 1980s. Illegal and accidental take is still likely to occur into the future, but take has been observed to decline as exploitable species become scarcer and more difficult to locate (USFWS, 1989).

Land use in urban and agricultural settings has indirect effects upon the rest of the watershed. For example, pesticides and herbicides can run off agricultural lands and leave residues in nearby streams and wetlands. The pesticide DDT was implicated in the drastic population declines of the bald eagle and brown pelican in the middle part of the 20th century. Since DDT was banned, bald eagle and brown pelican populations have rebounded. Although the effects of DDT appear to be waning, other pollutants are thought to be responsible for declines in some aquatic species in the three-county study area. For example, populations of yellow-blotched map turtle and pearl darter are thought to have been adversely impacted by point and non-point source discharges of toxic chemicals, brine, sewage, sediment, discharge from oil fields, and a dioxin spill (USFWS, 1993). Some of these sources of pollution could be reflected in the observed increases from 1972 to 1992 of more than 20,000 acres of urban and transportation land in the three-county area. Along with increases in urban land come increases in impervious surface, which increased by about 10,000 acres from 1972 to 1992. Impervious surface is known to increase the rate at which runoff reaches streams. Urban runoff is a known non-point source of sediment and chemical pollutants that can have adverse effects to aquatic life.

4.10.4.3.3 The Period of 1992 through 2000

The years 1992—2000 saw an increase of about 8,000 acres of urban land and about 50,000 acres of cutover/scrubland in the three-county study area. At the same time, the 1.1 million-acre three-county area lost about 15,000 acres of agricultural lands, about 6,000 acres of deciduous forest, about 5,000 thousand acres of emergent wetlands, and roughly 34,000 acres of pine forests. Losses in agricultural lands and deciduous forest represent a reversal from the observed increases in these land use types from 1972—1992. The rate of pine forest loss slowed by about half in the period 1992—2000, while the rate of increase in cutover/shrub land stayed about the same. It is likely that efforts to replant pine trees in timber production lands are catching up to the rate of timber harvest in the region. Under natural conditions there is some degree of change expected between cutover land, pine forest, and deciduous forest. Natural phenomena such as fires, floods, and hurricanes can dramatically rearrange the landscape. Also, species dominance in vegetative communities can change as old trees die and new trees of different species take their place. Forests, wetlands, and agricultural lands that are converted to urban uses tend to remain in urban use for long periods of time however and seldom change back to natural environments.

Agricultural lands were not considered “natural” for the purposes of this study. Some threatened and endangered species (such as the gopher tortoise and Louisiana black bear), however, have been observed foraging in pastures and field edges (USFWS, 1990a; USFWS, 1995). If left uncultivated, agricultural lands have the potential to revert to forests, floodplains, or other natural land use types. The small increase in natural lands seen from 1992 to 2000 in the three-county area most likely came at the expense of agricultural lands; agricultural lands lost about 15,000 acres during that time. That 15,000 acres was split to supply the acreage increases seen in natural and developed lands. Although

agricultural lands are not considered primary threatened and endangered species habitat, conversion of pastures and farms to urban lands represents a loss of land available for habitat restoration projects.

4.11 CULTURAL RESOURCES

4.11.1 Introduction

Cultural resources can include buildings or other structures; historic or prehistoric districts (such as the historic districts in Biloxi and Ocean Springs); archaeological sites such as Indian mounds or other remains of prehistoric life; objects such as statues or paintings; or sunken vessels (such as those that have been found in the Mississippi Sound). Traditional cultural properties can also be considered significant cultural resources because of their traditional religious or cultural importance to an Indian tribe or other traditional community. The National Historic Preservation Act of 1966 established the federal government's policy on historic preservation, as well as the national historic preservation program through which that policy is implemented. The National Historic Preservation Act also established the National Register of Historic Places, which is a list of important resources that experts have identified as significant to our national heritage. The National Register is the nation's official list of buildings, structures, objects, sites, and districts considered worthy of preservation because of their significance in American history, architecture, archaeology, engineering, and culture. The National Park Service maintains the list.

Resources on the National Register must meet criteria for evaluation established by the National Historic Preservation Act. Nominations to the National Register are submitted from each state by its State Historic Preservation Officer (SHPO). Resources are nominated and considered to be significant when they have integrity of location, design, setting, materials, workmanship, feeling, and association, and:

- They are associated with events that have made significant contributions to the broad patterns of our history;
- They are associated with the lives of persons who are significant in our past;
- They embody the distinctive characteristics of a type, period, or method of construction, represent the work of a master, or have high artistic value, or they represent a significant and distinguishable entity whose components might lack individual distinction; or
- They have yielded, or might be likely to yield, information important in prehistory or history.

Properties such as cemeteries or buildings that are less than 50 years old are usually not considered eligible for the National Register, but there are exceptions. For example, certain buildings associated with the Cold War are considered so important to our history that they are eligible for the National Register.

The National Environmental Policy Act, under which this document is being prepared, states that potential effects on cultural resources that are listed or might be eligible for listing on the National Register must be considered when federal agencies are considering an action such as the proposed action described in this EIS. This section discusses the prehistoric and historic context of the cultural resources in the project area, and provides a table that lists some of the area's historic structures. The

project area for cultural resources analysis is bounded to the north by a line 2 miles north of Interstate 10 and on the south by the Mississippi border. It is bounded on the west by the Louisiana border and on the east by the eastern edge of the Biloxi Bay watershed. The area includes most of Hancock, Harrison, and Jackson Counties; part of the Mississippi Sound; and Cat, Ship, and Deer Islands. The known cultural resources in the project area are discussed in this section. Possible impacts on these resources resulting from the proposed action are described in Section 5.11.

4.11.2 Baseline Conditions

Cultural resources in the project area considered eligible for listing on the National Register of Historic Places include historic standing structures, submerged shipwrecks, historic cemeteries, and prehistoric and historic archaeological sites. There are currently 298 known archeological sites within the project area (Table 4.11–1), including submerged shipwrecks and historic cemeteries. Of these, 63 sites or shipwrecks are listed on or eligible for the National Register, 80 have been determined ineligible by the Mississippi SHPO, and the remainder are potentially eligible. Sites whose National Register status is listed as "unknown" in the appendix might be eligible for listing. Because of the risk of looting, the specific locations of cultural resource sites are not shown in this document.

The potential for identifying additional buried archaeological sites and submerged historic shipwrecks in the project area is considered high, based on the number of known resources (Mississippi SHPO, 2001).

Many of the cultural resource sites contain shell middens, which are mounds of discarded shells that offer evidence of the early use of certain shellfish (mollusks). Some of the sites are prehistoric Indian mounds. The sites also include the remains of ancient villages, historic forts, campsites, and cemeteries. The sunken vessels that have been found include schooners, barges, and sailing vessels.

Table 4.11–1
Archaeological Sites Within the Project Area

Site Number	Site Name	National Register Status	Site Description	Time Period
Archaeological Sites in Hancock County				
22-Ha-502	Lakeshore Midden	Eligible	Shell midden	Unknown Prehistoric
22-Ha-505	Cowand Point	Eligible	Shell midden	Late Woodland
22-Ha-510	Joe's Bayou	Unknown	Village site, Shell midden	Middle Woodland
22-Ha-510	Joe's Bayou	Unknown	Village site, Shell midden	Historic Indian
22-Ha-512	Campbell Bayou I	Unknown	Processing camp area, no kitchen midden	Unknown Prehistoric
22-Ha-512	Campbell Bayou I	Unknown	Processing camp area, no kitchen midden	Unknown Prehistoric
22-Ha-519	Owen Heitzman	Eligible	Shell midden	Mississippian
22-Ha-520	Cedar Island	Eligible	Shell midden	Woodland
22-Ha-521	Carver Site	Eligible	Shell midden	Late Woodland
22-Ha-522	Bryan Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-524	Brush Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-525	Redfish Bayou	Eligible	Shell midden	Unknown Prehistoric
22-Ha-526	Ebeneezer Reese	Eligible	Shell midden	Unknown Prehistoric

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-527	East Side Jourdan River	Unknown	Shell midden	Mississippian
22-Ha-528	Ramsay Mound	Eligible	Flat top mound. Sank pit in top 15 years ago.	Unknown Prehistoric
22-Ha-536		Ineligible		Late Archaic
22-Ha-541	Gibbens	Ineligible	Chenier	Unknown Prehistoric
22-Ha-542	Lambert Site	Unknown	Light disturbance	Unknown Prehistoric
22-Ha-542	Lambert Site	Unknown	Light disturbance	Woodland: Middle, Late
22-Ha-543		Unknown		Unknown Prehistoric
22-Ha-543		Unknown		Unknown Prehistoric
22-Ha-544		Ineligible	Chenier	Historic
22-Ha-545		Ineligible	Estuary	Mississippian
22-Ha-546	Schaefer Mound	Eligible	Small conical mound	Middle Woodland
22-Ha-550	Diamondhead	Eligible	Large shell midden	Woodland
22-Ha-550	Diamondhead	Eligible	Large shell midden	Woodland: Middle, Late
22-Ha-551		Ineligible	Estuary	Unknown Prehistoric
22-Ha-553	#GCS-21	Unknown		Woodland: Middle, Late
22-Ha-554		Unknown	Must be real location of Ha-518	Historic
22-Ha-555	1	Unknown		Mississippian
22-Ha-556		Unknown		Unknown Prehistoric
22-Ha-557		Unknown	Ammunition magazine	Historic
22-Ha-558		Unknown	Subdivision; British soldiers reputedly buried there during War of 1812	Historic
22-Ha-581		Eligible	*Rangia* (clam) shell midden	Early Woodland, 2680 +/- 75 years before present
22-Ha-591		Eligible	Mounds: conical, pyramidal, indeterminate	Middle Woodland
22-Ha-593		Ineligible		Woodland
22-Ha-593		Ineligible		Woodland: Early
22-Ha-597		Ineligible		Late Archaic
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Unknown Prehistoric
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Woodland
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Woodland

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ha-605	B.W.Y.C.	Unknown	Material on shoreline on north peninsula of Yacht Club	Unknown Prehistoric
22-Ha-606	Cuevas Home	Unknown	Found during street construction, Diamondhead subdivision	Historic: 19th century
22-Ha-608	Rotten Bayou West	Unknown	Material eroded and scattered along bayou bank	Woodland
22-Ha-613		Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Woodland
22-Ha-614	Dix	Unknown		Woodland
22-Ha-614	Dix	Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Unknown Prehistoric
22-Ha-614	Dix	Unknown		Archaic: Late
22-Ha-626		Unknown		Woodland
Archaeological Sites in Harrison County				
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Unknown Prehistoric
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Unknown Prehistoric
22-Hr-500	Deer Island Shell Midden	Eligible	Shell midden	Historic: Early
22-Hr-501	Bayou Park Mound	Eligible	Mound	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Unknown Prehistoric
22-Hr-502	Oak Grove I, II, & II	Eligible	Shell midden, possible village or camp	Historic: 1719-1722
22-Hr-503		Eligible	Shell midden	Unknown Prehistoric
22-Hr-504	Irby	Eligible		Historic
22-Hr-504	Irby	Eligible		Unknown Prehistoric
22-Hr-505		Unknown	Eroded shell midden	Unknown Prehistoric
22-Hr-509	Back Bay Beach	Unknown	Shell ridge	Mississippian
22-Hr-510	Lopez Place	Unknown	Shell ridge	Unknown Prehistoric
22-Hr-511	Joe Moran	Unknown	Burials of Eastern European settlers	Historic
22-Hr-513	Old Fort Louis Site	Unknown	Old Fort Louis site	Unknown Prehistoric, Historic
22-Hr-515	Brodie II	Unknown		Unknown Prehistoric
22-Hr-516	Brodie I	Unknown		Unknown Prehistoric
22-Hr-517	O'Neal	Unknown		Unknown Prehistoric
22-Hr-518	Atcheson	Unknown		Unknown Prehistoric
22-Hr-520	Caron Site	Eligible	Dense *Rangia* (clam) midden, many sherds only	Mississippian
22-Hr-524	Fritz Site	Unknown		Mississippian

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-529	Jim Parker	Unknown		Woodland
22-Hr-531	Boiler Point, Cat Island	Unknown	Old village site	Unknown Prehistoric
22-Hr-532	Little Bay I, Cat Island	Unknown	Shell midden heap	Unknown Prehistoric
22-Hr-532	Little Bay I, Cat Island	Unknown	Shell midden heap	Woodland
22-Hr-533	Little Bay II, Cat Island	Unknown	Midden	Unknown Prehistoric
22-Hr-533	Little Bay II, Cat Island	Unknown	Midden	Unknown Prehistoric
22-Hr-536	Brodie III	Unknown		Woodland
22-Hr-537	Williams	Unknown		Mississippian
22-Hr-538	Acadian Bayou I	Unknown	Shell midden	Middle Woodland
22-Hr-539	Discovery Bay	Unknown	Shell midden	Middle Woodland
22-Hr-540	Leon	Unknown	Shell midden	Middle Woodland
22-Hr-541	De Metz Site	Eligible	Shell midden	Middle Woodland
22-Hr-542	Sutter Site	Eligible	Shell midden	Woodland
22-Hr-543	Cedar Bayou	Unknown	Low shell midden	Middle Woodland
22-Hr-544	DeLisle	Unknown		Late Woodland
22-Hr-545	Diane	Eligible	Small clam shell midden	Historic: French- 19th and 20th century
22-Hr-546	Dupont	Eligible	Shell midden; possible mounds	Middle Woodland
22-Hr-550	Carron	Unknown	Probably Marksville permanent station	Late Archaic
22-Hr-554	Jaycee Hill	Unknown	Apparently once a large station	Historic: mid-19th century
22-Hr-556	Alpha	Ineligible	Camp site	Unknown Prehistoric
22-Hr-565	Rail Spur #1	Ineligible		Unknown Prehistoric
22-Hr-566	Rail Spur #2	Ineligible		Unknown Prehistoric
22-Hr-567	Wreck of the Pelican	Unknown	Shipwreck: 1848 steamboat, the Pelican	Historic
22-Hr-571		Ineligible		Late Mississippi
22-Hr-572		Ineligible		Early Woodland
22-Hr-573		Unknown	Shell midden	Early Mississippi
22-Hr-574	DeLisle Cemetery	Unknown	Shell midden	Early Mississippi
22-Hr-575	Tom Parker	Unknown		Early Archaic
22-Hr-576		Unknown		Late Woodland
22-Hr-577		Unknown		Early Archaic
22-Hr-578		Unknown	Shell midden	Early Woodland
22-Hr-579		Unknown	Shell midden	Middle Mississippian
22-Hr-591	Godsey	Unknown	Issaquena phase shell midden	Unknown Prehistoric
22-Hr-591	Godsey	Unknown	Issaquena phase shell midden	Unknown Prehistoric
22-Hr-591	Godsey	Unknown	Issaquena phase shell midden	Unknown Prehistoric

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-591	Godsey	Unknown	Issaquena phase shell midden	Unknown Prehistoric
22-Hr-630		Ineligible		Woodland and Mississippian
22-Hr-630		Ineligible		Historic
22-Hr-631	Morse	Ineligible		Historic
22-Hr-632	AAA	Unknown	Shell midden	Woodland
22-Hr-633	AAE	Unknown	Shell midden	Late Archaic
22-Hr-634	AAD	Unknown	Shell midden	Woodland
22-Hr-635	Richard Site	Eligible	Burial and shell midden	Mississippian
22-Hr-636	Raymond Bass	Accepted 1987	Coal black midden and burial site	Historic: 1910-1920
22-Hr-638	French Warehouse	Accepted 1991	French warehouse-keepers' house	Historic, Unknown Prehistoric
22-Hr-638	French Warehouse	Accepted 1991	French warehouse-keepers' house	Historic, Unknown Prehistoric
22-Hr-639	Quarantine Station	Unknown		Archaic: Middle, Late
22-Hr-640	Ship Island Lighthouse	Unknown		Paleo-Indian: Late
22-Hr-641	Fort Massachusetts/GUIS 102	Unknown	Standing mid-19th century brick masonry fort	Historic
22-Hr-643		Ineligible	On small knoll adjacent to creek	Woodland
22-Hr-647	Biloxi Beach Loop	Unknown		Woodland: Middle, Late
22-Hr-647	Biloxi Beach Loop	Unknown		Unknown Prehistoric
22-Hr-647	Biloxi Beach Loop	Unknown		Woodland
22-Hr-659	Catchment No. 11	Ineligible		Woodland
22-Hr-673		Ineligible	$1m^2$-pit dug; 12 sherds at ca. –10 cm	Woodland
22-Hr-683	DeLisle West Shell	Eligible	Shallow shell midden	Unknown Prehistoric
22-Hr-684	Rusty Skillet	Ineligible		Woodland
22-Hr-685	Pine Hill Northwest	Ineligible	Disturbed by bulldozing	Woodland
22-Hr-686	Pine Hill Central	Ineligible	Destroyed by bulldozing	Unknown Prehistoric
22-Hr-690		Ineligible		Unknown Prehistoric
22-Hr-691		Ineligible		Woodland
22-Hr-740		Ineligible		Early Archaic
22-Hr-741		Unknown	Reported by informant; not field checked	Paleo-Indian: Middle
22-Hr-831		Ineligible		Woodland
22-Hr-843	Wreck of the Josephine	Accepted 2000	Sunken iron-hull sidewheeler shipwreck	Historic
22-Hr-844		Unknown		
22-Hr-845	Holley Cemetery/ "Sunkist" Cemetery	Unknown	Mid to late 19th-century family cemetery	Historic

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Hr-847		Ineligible		
22-Hr-848		Ineligible		
22-Hr-848		Ineligible		
22-Hr-857		Ineligible		Unknown Prehistoric
22-Hr-859	Schooner *Oleander*	Unknown	Sunken wreck of 1903 schooner *Oleander*	Historic
22-Hr-860	Cedar Lake 1	Unknown	Sunken vessel, possibly a schooner	Historic
22-Hr-861	Cedar Lake 2	Unknown	Sunken vessel, possibly a schooner	Historic
22-Hr-862	Cedar Lake 3	Unknown	Sunken wooden vessel, possibly a ferry barge	Historic
22-Hr-863	Schooner Graveyard	Unknown	10–15 sunken Biloxi-style schooner hulls	Historic
22-Hr 869		Ineligible		Unknown Prehistoric
22-Hr-870		Ineligible		Unknown Prehistoric
22-Hr-871		Ineligible		Unknown Prehistoric
22-Hr-872	Hamilton Cemetery	Ineligible		Unknown Prehistoric
22-Hr-878		Ineligible		Late Archaic
22-Hr-879		Ineligible		Unknown Prehistoric
22-Hr-880		Ineligible		Unknown Prehistoric
22-Hr-897	Florence Garden # 1	Ineligible		Archaic: Early, Middle
Archaeological Sites in Jackson County				
22-Ja-500	Point Aux Chenes	Unknown	3 mounds	Unknown Prehistoric
22-Ja-502	Green; Buena Vista	Eligible	Shell midden	Unknown Prehistoric
22-Ja-503	Graveline Mound	Accepted 1987	Rectangular ramped platform mound	Mississippian
22-Ja-503	Graveline Mound	Accepted 1987	Rectangular ramped platform mound	Unknown Prehistoric
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Mississippian
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Woodland: Middle, Late
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Historic: 19th century
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Unknown Prehistoric
22-Ja-504	Magnolia, Taneksanya	Eligible	Shell midden, at least 20 burials	Gulf Formational: Middle, Late
22-Ja-507	Gollotte, S.P. Starks~	Eligible	Low earth mound	Historic
22-Ja-530	Apple Street	Accepted 1985	Shell midden, no app. submidden feature	Woodland: Early, Late
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Unknown Prehistoric

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Historic: 18th century
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Mississippian
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Unknown Prehistoric
22-Ja-530	Apple Street	Accepted 1985	Shell midden, app. no submidden feature	Woodland: Early, Middle, Late
22-Ja-531	North Street; Elizabeth	Unknown		Late Mississippian
22-Ja-531	North Street; Elizabeth	Unknown		Historic: Early Colonial
22-Ja-531	North Street; Elizabeth	Unknown		Unknown Prehistoric
22-Ja-531	North Street; Elizabeth	Unknown		Archaic: Middle, Late
22-Ja-532	Soy Caphil Point	Unknown		Woodland: Middle, Late
22-Ja-534	Fort Maurepas I, Old Fort	Unknown		Gulf Formational: Late
22-Ja-535	Lemon	Unknown		Early Woodland
22-Ja-538	Fort Maurepas IB	Eligible		Woodland: Early, Middle, Late
22-Ja-539	Maurepas II	Eligible	Stake roots of old wall or bulkhead	Historic Indian
22-Ja-540	Ocean Springs I			Protohistoric~
22-Ja-542	Biloxi Bay Shipwreck	Eligible	Sunken wreck of 18th-century sailing vessel	Historic
22-Ja-553	Stone Site	Unknown		Late Mississippian
22-Ja-554	Old Shell Landing	Unknown	Shell midden	Historic
22-Ja-554	Old Shell Landing	Unknown	Shell midden	Late Archaic
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Mississippian
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Woodland: Middle, Late
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Middle Mississippian
22-Ja-555	Shepards Island	Unknown	Elevated area covered with shell midden	Late Woodland
22-Ja-556	Mrs. C.M. Shepard, B	Unknown	Thin shell midden	Late Mississippian
22-Ja-556	Mrs. C.M. Shepard, B	Unknown	Thin shell midden	Late Mississippian
22-Ja-557	Steve's Site	Unknown	Scattered shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Woodland: Middle, Late
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Late Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Middle Woodland
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Historic: 20th century

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-558	Cedar Point, Seacliff	Unknown	Oyster shell midden	Woodland
22-Ja-559	Camp Lamotte	Unknown	Heavy extensive oyster shell midden	Mississippian
22-Ja-559	Camp Lamotte	Unknown	Heavy extensive oyster shell midden	Late Woodland
22-Ja-569	Dolphin	Unknown		Mississippian
22-Ja-572	Winchester	Unknown	Large Marksville campsite	Middle Woodland
22-Ja-573	Blue Heron Bayou	Unknown	Camping area	Mississippian
22-Ja-590	Debbie T.	Unknown		Middle Woodland
22-Ja-591	Shepherds' Tree Farm	Unknown		Early Mississippian
22-Ja-591	Shepherds' Tree Farm	Unknown		Early Woodland
22-Ja-594	Porteaux Bay I	Ineligible		Mississippian: Early, Middle, Late
22-Ja-595	Point Ascot, Porteaux Bay II	Ineligible		Late Woodland
22-Ja-596	Porteaux Bay III	Ineligible		Historic: 19th century
22-Ja-597	Caldwell Home, Porteaux Bay IV	Ineligible		Middle Mississippian
22-Ja-598	Dundolph Home, Porteaux Bay V	Ineligible		Woodland: Middle, Late
22-Ja-599	Albert Tiblier	Ineligible		Historic
22-Ja-600	Bijou Tiblier Home, Porteaux #7	Ineligible		Woodland: Early, Middle
22-Ja-601	Scarbrough Saw Mill, Porteaux 8	Ineligible		Middle Woodland
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Historic
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Early Woodland
22-Ja-602	Graveline Mound #2	Unknown	Large sand mound	Late Archaic
22-Ja-610	Buena Vista	Ineligible		Middle Woodland
22-Ja-610	Buena Vista	Ineligible		Middle Mississippian
22-Ja-611	Swetman	Ineligible		Woodland
22-Ja-611	Swetman	Ineligible		Early Woodland
22-Ja-612	Marlin	Ineligible		Middle Woodland
22-Ja-619	Janice–Gulf Hills	Ineligible		Middle Mississippian
22-Ja-622	Tiblier	Ineligible		Late Woodland
22-Ja-623	Gulf Hills	Ineligible		Late Woodland
22-Ja-624	Riviera I–II	Ineligible		Late Woodland
22-Ja-626	Magnolia Bank, Four H Club	Unknown		Unknown Prehistoric
22-Ja-628	Eagle Point	Unknown	Buried remnant of Chenier-Bayou site	Unknown Prehistoric

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-629	Aunt Jennys	Eligible	Aunt Jenny's, Marksville Period campsite possible Marksville	Historic Indian: Early to Middle 18th century
22-Ja-629	Aunt Jennys	Eligible	Aunt Jenny's, Marksville Period campsite	Mississippian: Late
22-Ja-630	Stark Bayou I	Eligible		Mississippian: Middle, Late
22-Ja-635	Morning Site	Ineligible	Shell midden	Middle Mississippian
22-Ja-636	Picnic Site	Ineligible	Oyster shell midden	Protohistoric
22-Ja-637	Hilltop Site	Ineligible		Late Woodland
22-Ja-638	Upper Crossing Site	Ineligible		Late Mississippian
22-Ja-638	Upper Crossing Site	Ineligible		Middle Woodland
22-Ja-639	Office Site	Ineligible		Unknown Prehistoric
22-Ja-640	Desk Site	Ineligible		Unknown Prehistoric
22-Ja-641	Second Chance Site	Ineligible		Unknown Prehistoric
22-Ja-642	West Bank Site	Unknown		Woodland
22-Ja-643	Old Ladder Site	Unknown	Oyster shell midden	Archaic: Early
22-Ja-646		Unknown	Shell midden	Historic: 19th century
22-Ja-647	Belle Fountain Beach	Unknown		Historic Indian
22-Ja-648	Y	Unknown		Woodland
22-Ja-649	Tapp Site	Unknown		Woodland: Middle, Late
22-Ja-650	Brown Street Site	Ineligible		Late Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Unknown Prehistoric
22-Ja-651	Stone II	Eligible	Intact midden present	Late Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Woodland
22-Ja-651	Stone II	Eligible	Intact midden present	Historic
22-Ja-652	Seymour Lane	Ineligible	Small Late Woodland site	Late Woodland
22-Ja-653	Britt, Cedar Point	Unknown		Woodland, Historic
22-Ja-653	Britt, Cedar Point	Unknown		Unknown Prehistoric
22-Ja-654	Tyler Site	Unknown		Unknown Prehistoric
22-Ja-655	Carluse Bayou	Unknown		Unknown Prehistoric
22-Ja-656	Bilbo	Ineligible		Historic
22-Ja-657		Unknown		Mississippian
22-Ja-658		Unknown		Woodland: Middle, Late
22-Ja-658		Unknown		Gulf Formational: Late
22-Ja-659		Unknown		Historic
22-Ja-660		Unknown		Woodland
22-Ja-660		Unknown		Archaic
22-Ja-662	Guis 107	Ineligible		Late Woodland
22-Ja-663	Guis 106	Unknown		Woodland
22-Ja-672	CCC Training Camp	Unknown		Woodland

Table 4.11–1
Archaeological Sites Within the Project Area (continued)

Site Number	Site Name	National Register Status	Site Description	Time Period
22-Ja-673	Magnolia Park	Unknown		Woodland
22-Ja-673	Magnolia Park	Unknown		Mississippian
22-Ja-687	Cooking Ball Corner	Unknown		Mississippian
22-Ja-688	Mary Mahoney	Unknown	*Rangia* (clam) and oyster shell midden	Mississippian
22-Ja-689	Point Clear Pier	Unknown	Material apparently washing down from bluff	Woodland
22-Ja-689	Point Clear Pier	Unknown	Material apparently washing down from bluff	Unknown Prehistoric
22-Ja-695		Ineligible		Unknown Prehistoric
22-Ja-696		Ineligible		Late Archaic
22-Ja-697		Ineligible		Middle Archaic
22-Ja-697		Ineligible		Unknown Prehistoric
22-Ja-698		Ineligible	Material from eroded slope	Unknown Prehistoric
22-Ja-704		Ineligible		Early Archaic
22-Ja-704		Ineligible		Unknown Prehistoric
22-Ja-707		Unknown		Unknown Prehistoric
22-Ja-707		Unknown		Unknown Prehistoric
22-Ja-715		Ineligible		Woodland: Middle, Late
22-Ja-716		Ineligible		Mississippian
22-Ja-723	Oak North	Unknown	Intact deposits possible	Woodland
22-Ja-725		Unknown		Woodland
22-Ja-726		Unknown	Midden exposed in road cuts	Woodland
22-Ja-726		Unknown	Midden exposed in road cuts	Woodland
22-Ja-727		Unknown	Midden exposed in road cuts	Unknown Prehistoric
22-Ja-727		Unknown	Midden exposed in road cuts	Unknown Prehistoric
22-Ja-727		Unknown	Midden exposed in road cuts	Woodland
22-Ja-729	Graveline West Mounds	Eligible	2 mounds	Unknown Prehistoric
22-Ja-730	Graveline East Mounds	Eligible	3 mounds	Unknown Prehistoric
22-Ja-733		Ineligible		Unknown Prehistoric
22-Ja-734		Ineligible		Unknown Prehistoric

Source: Mississippi SHPO, 2001.

4.11.2.1 Prehistoric Period Resources

Archaeologists divide the prehistoric occupation in the Coastal Mississippi region into six major periods: the Paleo-Indian Period, which began around 10,000 B.C.; the Archaic Period; the Gulf Formational Period; the Woodland Period (Middle and Late); and the Mississippian Period, which ended in colonial times (the 1600s). Most of the resources from prehistoric times have been found

along the rivers, especially the river mouths, and on the barrier islands. It is worth noting, though, that most of the known sites were identified in surveys conducted at only limited locations and, therefore, their locations cannot predict exactly where other (currently unknown) sites might exist.

Paleo-Indian Period (circa [ca.] 10,000 B.C. to ca. 8,000 B.C.). The Paleo-Indian Period is the period with the earliest evidence of humans' existence in the New World. The climate during this time period was cooler than our present environment, and large animals, such as mammoth and sloth, flourished. Paleo-Indian peoples were nomadic hunters and gatherers who lived in small groups and ate wild plants and animals. This period is distinguished by a low population density with groups residing in seasonal or base camps. As a result, Paleo-Indian sites are rare and usually very small. The Paleo-Indian Period is also noted for diagnostic fluted projectile points and the exploitation of Pleistocene megafauna. Some artifacts from this period have been recovered from the Mississippi Sound area (Pearce and Mikell, 2000).

Archaic Period (ca. 8,000 B.C. to ca. 1,000 B.C.). The Archaic Period is divided into three time frames—Early, Middle, and Late. Between 10,000 B.C. and 5,000 B.C. substantial ecological changes occurred across the North American continent. These changes were accompanied by a shift from Paleo-Indian to Archaic traditions. During the Archaic Period the cold, dry climate that had existed during the Paleo-Indian Period changed to a warmer and wetter one. Deciduous (leafy) forests gradually replaced coniferous (evergreen) forests. Mammals present included white-tailed deer, turkey, bear, and smaller mammals and birds. Groups responded to these changes; archaeological evidence shows an increasing use of the new forested environment. Stone axes and fishing paraphernalia appear in larger numbers.

During the Late Archaic Period, the ecology and climate became much the same as they are today. The sea level rose, and the climate became wetter than that of the previous period. These changes led to greater floral and faunal diversity, accompanied by an increase in human population in response to this rich environment. Late Archaic sites are more common as a result of this population increase. Settlement patterns reconstructed by archaeologists indicate that sites were located on terraces, ridges, and bluffs above bodies of water that included rivers, creeks, and swamps. Sites are also found at the edges of floodplains and marshes, where edible plants and animals existed in large numbers and species were diverse. Some sites might now be submerged. Late Archaic sites can also include remains of larger "base camps" and shell middens. The Pearl River phase has been defined for the Late Archaic Period (Pearce and Mikell, 2000).

Gulf Formational Period (ca. 2,000 B.C. to ca. 100 B.C.). This period is identified by the first appearance of fired ceramics along the Gulf Coast, as well as the earliest mound construction. Based on size and artifacts recovered, some of the sites from this period represent a sedentary, possibly permanent, society. Two sites at the mouth of the Pearl River, the Claiborne and Cedarland Plantation sites, have large Early Gulf Formational components. Reflecting the Late Gulf Formational Period, the larger sites were replaced by more numerous but smaller sites representing smaller villages as well as food collection sites such as shellfish collection camps. Evidence of domesticated plants, including squash and bottle gourd, has been recovered at some sites dating to this period.

Woodland Period—Middle and Late (ca. 100 B.C. to A.D. 1100). The Woodland Period is represented in the project area by artifacts from the Middle and Late Woodland Periods. This period was similar to the Late Archaic Period in climate and ecology. Dramatic changes in social structure occurred at this time from somewhat egalitarian, nomadic hunter-gatherers who relied primarily on wild plants and animals, to more settled villagers who practiced agriculture. The remains of large villages reflect the change from nomadic to settled life. Burial mounds as well as evidence of far-

flung trade networks have been identified for this period. Archaeological remains include the appearance of stockaded villages, ceramic pottery, storage pits and hearths, and small triangular stone projectile points. According to Pearce and Mikell (2000, p. 16), the sites "are clustered along major rivers and usually located on high bluffs above the rivers or along tributary creeks above the floodplain and on coastal high ground near a freshwater source. Coastal sites are usually located in hardwood hammocks. Burial mounds are present on some larger village sites and isolated Woodland burial mounds are also known . . . ."

Mississippian Period (ca. A.D. 1200 to A.D. 1600). To date no artifacts or sites from the Early Mississippian Period phase have been identified in the project area. The Middle Mississippian Period has been identified for the Gulf Coast area. Artifacts include shell-, sand-, or grog- (crushed ceramic fragments) tempered pottery. (Tempering material is added to the clay during the manufacturing process to strengthen it when fired.) The groups living in the project area at this time were mainly hunters and gatherers along the coast and river valleys; they probably practiced horticulture as well. Sites, including the remains of small villages and camps, have been found along the coast and along the major rivers. Most of the sites in the region are coastal shell middens. Although the Mississippian Period was generally one of stratified societies with chiefdoms, evidence of those types of such large-scale settlements has not been found in the Coastal Study Area.

4.11.2.2 Historic Period Resources

The historic time periods are the Protohistoric Period and Historic Period, which date from colonial times (1600s) forward.

Protohistoric Period. The first contact between the Native Americans that lived in the project area and Europeans occurred during the Protohistoric Period. The first European to arrive was most likely Don Diego Miruelo, who probably sailed into the Mississippi Sound in 1516. Spanish explorers, likely including Cabeza de Vaca and Panfilo de Narvaez, were in the region during the 16th century as well.

Historic Period. In the 17th century French explorers began to arrive in the region, and soon French settlers also arrived, cleared the land, and built settlements. Pierre LeMoyne, Sieur d'Iberville, established the first French settlement at Old Biloxi (now Ocean Springs) in 1699. In 1723 Biloxi became the capital of the French colony. With the Treaty of Paris in 1763, the French abandoned the Mississippi coast to the English; in 1779 the English ceded the coast to Spain. With the Louisiana Purchase in 1812 the area became part of the United States; Mississippi became a state in 1817. The cultural influence of early French settlers of the project area continued over the years; a local form of French was spoken in the area until just before World War II (Moreton, 1998).

Historic Native Americans who lived in the project area region included the Pascagoula, Biloxi, Moctobi, Capinan, and Mobile peoples. The Apalachee also lived along the Pearl River during the 17th century (Pearce and Mikell, 2000). The Native Americans were decimated by disease and warfare associated with European contact, and by the 19th century very few remained in the region.

Early French settlements grew up around the waterways and developed into thriving port towns. The economy was centered on agriculture, including dairy, cattle, and poultry; timber harvesting (primarily yellow pine) and charcoal and tar production; sheep and wool production; and commercial fishing and oyster and shrimp processing (Hancock Bank, 1982; Sullivan, 1985). Tremendous oyster reefs lay offshore. In the mid-19th century the region also began to develop as a resort area. For example, Pass Christian was a summer retreat for plantation owners and wealthy citizens of Louisiana, Mississippi, and Alabama (Ellis, 1998). Many people came to escape yellow fever. In

addition, seafood factories became a mainstay of the area. The area's seafood industry continues to be important, although it has experienced a significant decline in recent years (Ellis, 1998).

During the Civil War the area's economy suffered because of the Federal blockade of southern ports. After the war, however, a number of transportation improvements were instituted. The New Orleans, Mobile & Chattanooga Railroad was constructed through the project area. With the railroad, truck farming expanded and farmers prospered through the early part of the 20th century (Alexander, 1998). A deep-water channel was completed at Gulfport in 1902 (Sullivan, 1985). The seafood industry was also stimulated by post-Civil War innovations in preserving and exporting seafood. As a result, the shrimping industry boomed (Hancock Bank, 1982). The region's lumbering business also thrived during this period. These traditional businesses continued into the present.

One nontraditional business that developed during the 1920s and continued through the Great Depression was bootlegging (MSDMR, 1998). Bootlegging grew in part because those out of work during the Depression turned to this means of supporting their families. Liquor was made in stills in isolated areas along the coast and sold locally or to bootleggers that brought the alcohol up the coast and to the west (for example, deliveries to Chicago by truck and rail). In addition to the locally made alcohol, rumrunners smuggled alcohol, including rum, from Cuba and other Caribbean ports. According to M.H. Powell (1998), "by the mid-1920s more illegal alcohol entered the United States through the Gulf Coast than any other point of entry, including Canada." Along with the bootlegging gambling casinos were built—in 1939, for example, the Broadwater Beach Hotel was constructed in Biloxi to accommodate gamblers. These hotels were the forerunners of today's coastal casinos and hotels.

Historic Architectural Resources. Numerous historic architectural resources are present in the project area. To date 62 standing structures, 14 historic districts, and one ship have been listed on the National Register of Historic Places. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis. Table 4.11–2 lists these resources and their locations.

Table 4.11–2
National Register Standing Structures and Historic Districts

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Hewes Building	2505 14th Street	10/7/1982		Gulfport	E298840 N3361212
Bailey House	1333 East Beach Blvd.	5/18/1984		Biloxi MRA	E321040 N3363630
E. Barq Pop Factory	224 Keller Ave.	5/18/1984		Biloxi MRA	E319590 N3363970
Biloxi's Tivoli Hotel	863 East Beach Dr.	5/18/1984		Biloxi MRA	E319980 N3363750
Bond House	925 West Howard Ave.	5/18/1984		Biloxi MRA	E318060 N3364110

Table 4.11–2
National Register Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Brunet-Fourchy House	138 Magnolia Street Mall	5/18/1984		Biloxi MRA	E318580 N3363805
Church of the Redeemer	Bellman Street	5/18/1984		Biloxi MRA	E319205 N3363725
Clemens House	120 West Water Street	5/18/1984		Biloxi MRA	E318650 N3363825
Gulf Coast Center for the Arts	138 Lameuse Street	5/18/1984		Biloxi MRA	E318740 N3363790
House at 121 West Water Street	121 West Water Street	5/18/1984		Biloxi MRA	E318635 N3363800
Nativity BVM Cathedral	West Howard Ave. and Fayard Street	5/18/1984		Biloxi MRA	E318310 N3364120
Peoples Bank of Biloxi	318 Lameuse Street	5/18/1984		Biloxi MRA	E318740 N3363980
Redding House	126 West Jackson Street	5/18/1984		Biloxi MRA	E318640 N3363950
Saenger Theater	416 Reynoir Street	5/18/1984		Biloxi MRA	E318420 N3364100
Scherer House	206 West Water Street	5/18/1984		Biloxi MRA	E318600 N3363850
Seashore Campground School	Leggett Dr. and Chalmers Street	5/18/1984		Biloxi MRA	E315540 N3363990
Suter House	165 Suter Pl.	5/18/1984		Biloxi MRA	E317580 N3364140
Glenn Swetman House	2770 Wilkes Ave.	5/18/1984		Biloxi MRA	E314340 N3363990
U.S. Post Office and Customhouse	2421 13th Street	3/19/1984	Second Renaissance Revival	Gulfport	E298910 N3361080
Beauvoir	200 West Beach Blvd.	9/3/1971	Raised cottage	Biloxi	E310470 N3364271
Harbor Square Historic District	Roughly bounded by L & N Railroad, 23rd Ave., 13th Street, and 27th Ave.	8/13/1985	Georgian Revival	Gulfport	E299130 N3361430

Table 4.11–2
National Register Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
West Beach Historic District	Roughly U.S. 90 between Rosell and Chalmers Ave.	5/18/1984		Biloxi MRA	E317300 N336428
Fort Massachusetts	South of Gulfport on Ship Island, in Gulf Islands National Seashore	6/21/1971		Gulfport	E309633 N3343836
Louisville and Nashville Railroad Depot at Ocean Springs	1000 Washington Ave.	12/31/1979	Picturesque Eclecticism	Ocean Springs	E324520 N3366030
Biloxi Lighthouse	On U.S. 90 at Porter Ave.	10/3/1973		Biloxi	E317350 N3363815
U.S. Post Office, Court house, and Custom house	216 Lameuse Street	1/30/1978		Biloxi	E318850 N3364000
Magnolia Hotel	137 Magnolia Street	3/14/1973		Biloxi	E318499 N3363826
Biloxi Garden Center	410 East Bayview Ave.	1/18/1973		Biloxi	E319145 N3365756
Beach Boulevard Historic District	Roughly bounded by Beach Blvd., Necaise Ave., Seminary Dr., 2nd and 3rd Streets	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E276620 N3357610
Main Street Historic District	Main Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274660 N3355910
Sycamore Street Historic District	Sycamore Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274580 N3355140
W.J. Quarles House and Cottage	120 and 122 East Railroad Street	10/16/1980		Long Beach	E293260 N3359470
Scenic Drive Historic District	Scenic Drive	5/7/1979		Pass Christian	E280840 N3354730

Table 4.11–2
National Register Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Washington Street Historic District	Washington Street	11/25/1980	Creole; shotgun	Bay St. Louis MRA	E274820 N3354920
Toledano-Philbrick-Tullis House	947 East Beach Blvd.	11/5/1976		Biloxi	E320310 N3363660
Milner House	720 East Beach Blvd.	7/31/1972		Gulfport	E301643 N3361965
Gillis House	513 East Beach Blvd.	7/7/1978	French Colonial	Biloxi	E319270 N3363730
Taylor House	808 North Beach Blvd.	11/21/1986		Bay St. Louis MRA	E275910 N3357170
Glen Oak-Kimbrough House	806 North Beach Blvd.	11/21/1986		Bay St. Louis MRA	E275920 N3357130
House at 407 East Howard Avenue	407 East Howard Ave.	7/17/1986			E319100 N3363980
Webb School/Gulf Coast Community Action Agency	300 Third Street	11/21/1986		Bay St. Louis MRA	E275100 N3354620
Taylor School	116 Leonard Street	1/15/1987		Bay St. Louis MRA	E275660 N3357520
Building at 242 St. and Charles Street	242 Street and Charles Street	11/25/1980		Bay St. Louis MRA	E274670 N3354500
Carter-Callaway House	916 State Street	4/20/1987		Ocean Springs MRA	E324810 N3365850
Cochran-Cassanova House	9000 Robinson Street	4/20/1987		Ocean Springs MRA	E324390 N3365870
Hansen-Dickey House	108 Shearwater Dr.	4/20/1987	Prairie Renaissance	Ocean Springs MRA	E325090 N3364460
House at 1112 Bowen Avenue	1112 Bowen Ave.	4/20/1987		Ocean Springs MRA	E324620 N3365610
House at 1410 Bowen Avenue	1410 Bowen Ave.	4/20/1987		Ocean Springs MRA	E324910 N3364570
Thomas Isaac Keys House	1017 DeSoto Ave.	4/20/1987		Ocean Springs MRA	E324630 N3365790

Table 4.11–2
National Register Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
O'Keefe-Clark Boarding House	2122 Government Street	4/20/1987		Ocean Springs MRA	E325815 N3365660
Old Farmers and Merchants State Bank	998 Washington Ave.	4/20/1987		Ocean Springs MRA	E324440 N3365870
Vancleave Cottage	1302 Government Street	4/20/1987		Ocean Springs MRA	E324770 N3365700
Sullivan-Charnley Historic District	Shearwater Dr. and Holcomb Blvd.	4/20/1987		Ocean Springs MRA	E326095 N3364000
Hermann House	523 East Beach Blvd.	5/18/1984		Biloxi MRA	E319340 N3363740
Pleasant Reed House	928 Elmer Street	1/11/1979	Shotgun house	Biloxi	E318940 N3364820
Saint John's Episcopal Church	NW corner of Rayburn and Porter Ave.	4/20/1987		Ocean Springs MRA	E324090 N3365600
Indian Springs Historic District	Iberville Street, Church Street, and Washington Ave. ,N	4/20/1987		Ocean Springs MRA	E324460 N3366460
Lover's Lane Historic District	Lover's Lane	6/9/1987		Ocean Springs MRA	E322980 N3366520
Bertuccini House and Barbershop	619–619A Washington Ave.	6/9/1987		Ocean Springs MRA	E324420 N3365590
Marble Springs Historic District	Along Iberville Ave., between Washington Ave., N, and Sunset Ave.	4/20/1987		Ocean Springs MRA	E324760 N3366610
Miss La-Bama	243 Front Beach Dr.	4/20/1987		Ocean Springs MRA	E323580 N3365123
Elmwood Manor	902 North Beach Blvd.	11/21/1986	French Colonial	Bay St. Louis MRA	E275850 N3357610
Delcastle	4010 Government Street	4/20/1987	Spanish Eclectic	Ocean Springs MRA	E329270 N3364070
Halstead Place	East Beach Dr.	4/20/1987		Ocean Springs MRA	E326970 N3363590

Table 4.11–2
National Register Standing Structures and Historic Districts (continued)

Name	Address	Date Listed on NRHP	Description	Location / Multiple Listing Name	UTM Coordinates (Zone 16)
Shearwater Historic District	Shearwater Dr.	8/24/1989		Anderson, Walter, MPS	E325090 N3364880
Ocean Springs Community Center	Washington Ave.	8/24/1989		Anderson, Walter, MPS	E324460 N3365520
Old Ocean Springs Historic District	Roughly bounded by Porter and Dewey Aves., Front Beach Dr., Martin Ave., Cleveland Street, and Rayburn Ave.	10/7/1987		Ocean Springs MRA	E324310 N3365660
Margaret Emilie (schooner)	1036 Fred Haise Blvd.	5/30/1989			E317352 N3363876
G.B. Dantzler House	1238 East Beach Blvd.	12/1/1989		Biloxi	E300765 N3361650
Fisherman's Cottage	138 Lameuse Street	3/9/1990	Creole Cottage	Biloxi MRA	E319190 N3365730
Old Ocean Springs High School	Magnolia and Government Street	8/2/1990	English Renaissance	Ocean Springs MRA	E325140 N3365660
Col. Alfred E. Lewis House	1901 Watersedge Dr.	10/16/1980		Walter Anderson MPS (AD) (Gautier)	E342400 N3359700
James Krebs House	4702 River Rd.	12/20/1991		Pascagoula MPS	E331575 N3361775
French Warehouse Site	Gulf Islands National Seashore	12/13/1991		Ocean Springs	E318150 N3346300
Brielmaier House	710 Beach Blvd.	9/28/1995		Biloxi MRA	E318830 N3363670
Onward Oaks	972 South Beach Blvd.	11/1/1996	Creole Cottage	Bay St. Louis MRA	E274730 N3353690
West Central Historic District	Roughly bounded by U.S. 90, Hopkins Blvd., Howard and Benachi Aves.	5/18/1984		Biloxi MRA	E317960 N3364195

Notes: MRA = multiple-resource area, a term used before 1984, when it was replaced with MPS.
MPS = multiple-property submission
Walter Anderson MPS = Walter Inglis Anderson (1903–1965) was a well-known artist who lived in the project area.
UTM = universal transverse mercator spatial coordinate system, serves to locate a place exactly in the world
Source: Mississippi SHPO, 2001.

4.11.2.3 Underwater Resources

Underwater resources in the project area include remains of prehistoric sites and of Protohistoric and Historic Period shipwrecks. To date, 13 shipwreck sites have been identified within the project area. One, the wreck of the *Josephine*, is listed on the National Register. The others are potentially eligible for listing. Shipwrecks in the Coastal Study Area could date from the colonial period (French, Spanish, and English) through the Civil War and into the early 20th century (McGahey, personal communication, 2001).

4.11.2.4 Native American Resources

To date, apart from archaeological sites, no Native American resources, including traditional cultural properties, have been identified in the project area. In accordance with the mandate of Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," the Corps initiated consultation with 12 federally recognized Native American tribes that have cultural interests in southern Mississippi. These tribes are listed in Table 4.11–3. Coordination letters were sent to the tribes in November 2001. Copies of the letters sent to the tribal leaders are provided in Appendix K. To date no responses have been received.

Table 4.11–3
Federally Recognized Indian Tribes Associated with Southern Mississippi

Muscogee (Creek) Nation of Oklahoma
Eastern Band of the Cherokee Nation
Choctaw Nation of Oklahoma
Tunica-Biloxi Tribe of Louisiana
Cherokee Nation of Oklahoma
Coushatta Tribe of Louisiana
Tribal Council of the Mississippi Band of Choctaw Indians
Miccosukee Tribe of Indians of Florida
Seminole Nation of Oklahoma
Seminole Tribe of Florida
Poarch Band of Creek Indians
The Chickasaw Nation

4.11.2.5 Previous Work in the Coastal Study Area

Several cultural resource surveys have been conducted in the past for a variety of projects in the study area. They are summarized here.

- In 1980 a survey was conducted for the route of proposed Interstate Highway, 110, to be located between Chartres Street, Biloxi, and U.S. Highway 90, in

Harrison County. No potentially significant cultural resources were identified in that project area (Hyatt, 1980).

- In 1987 a 75-mile-long cultural resources survey was conducted along a route paralleling the southern boundary of I-10, across Hancock, Harrison, and Jackson counties (Lauro, 1987 in Sims, 1999). No cultural resources were identified.

- In 1998 a reconnaissance-level survey of seven submerged vessels found in the Biloxi and Tchoutacabouffa Rivers, Harrison County, was conducted (Sims 1999).

- In 1998 a cultural resources survey was conducted in the project area of the proposed Broadwater Beach Resort Complex, in Biloxi, Harrison County (Lauro 1998; USACE, Mobile District, 2000). The survey found no archaeological sites in the project area, in part because of extensive disturbance associated with previous construction, including offshore dredging projects. The survey identified four standing structures within the viewshed of the Broadwater Complex project area: Beauvoir, the last home of Jefferson Davis; the Southern Memorial Park Cemetery; the Broadwater Beach Hotel, constructed in 1937 and greatly altered since then; and the Old Brick House, a historic home constructed in about 1850. The Old Brick House and Beauvoir are listed on the National Register; Beauvoir is also a National Historic Landmark.

- The Mississippi Gulf Coast Research Project, conducted a survey in the eastern portion of Harrison County and in all of coastal Jackson County south of I-10 (Mann, 2000).

- In 1999 a Phase I cultural resources survey was completed for five alternative routes proposed for the East Harrison County Connector (Mann, 2000). The proposed routes are located in the current project area and run roughly north-south from I-10 to I-90. Existing cultural resources site files were examined, and a total of about 22.4 miles were surveyed. The review of the site files identified a total of nine archaeological sites within 1 mile of the proposed alternative routes. Shovel tests were conducted at 30.48-meter intervals along the alternate routes; in areas with well-drained soils adjacent to flowing water, the spacing was 15 meters. Shovel tests were also conducted at 30-meter intervals along the centerline of each of the five routes. Structures identified in this survey include the Veterans Administration Center, which is eligible for the National Register. The remaining structures were recommended as ineligible. Three new prehistoric archaeological sites (22-Hr-881, 22-Hr-882, and 22-Hr-883) and two isolated artifacts were identified within the alternative routes.

- Finally, in 2000 a Phase IA survey (background/literature search, site file check) was conducted for a proposed fiber-optic line to run through Hancock, Harrison, and Jackson Counties (Pearce and Mikell, 2000). All together, 99 sites, including prehistoric shell middens, submerged vessels, and historic cemeteries were identified within a one-mile radius of that project area during the archival research. Six of the sites were adjacent to or within the cable corridor: 22-Ha-586, 22-Ha-527, 22-Hr-524, 22-Ja-568, 22-Ja-586, and 22-Ja-608. Site 22-Ja-608 was ineligible. Information for 22-Ha-586 is missing. Site 22-Ha-586 is

located near the Pearl River in a high-probability area. In a previous study, the remaining sites did not yield any cultural material. (The consultant completed a Phase I cultural resource excavation survey). Two high-probability areas were identified and one site was identified. One site was recommended as ineligible for NRHP listing. Site Ha-527 was identified as a Mississippian Period shell mound.

4.11.3 Historical Trends

Development along the Mississippi coast has affected both archaeological sites and standing structures, including individual structures and historic districts in the project area. Key issues are soil disturbance and construction. Soil disturbance affects archaeological sites, and construction of new buildings and associated infrastructure can affect the viewshed and "feel" of a historic building or district or cause demolition or alteration of historic buildings.

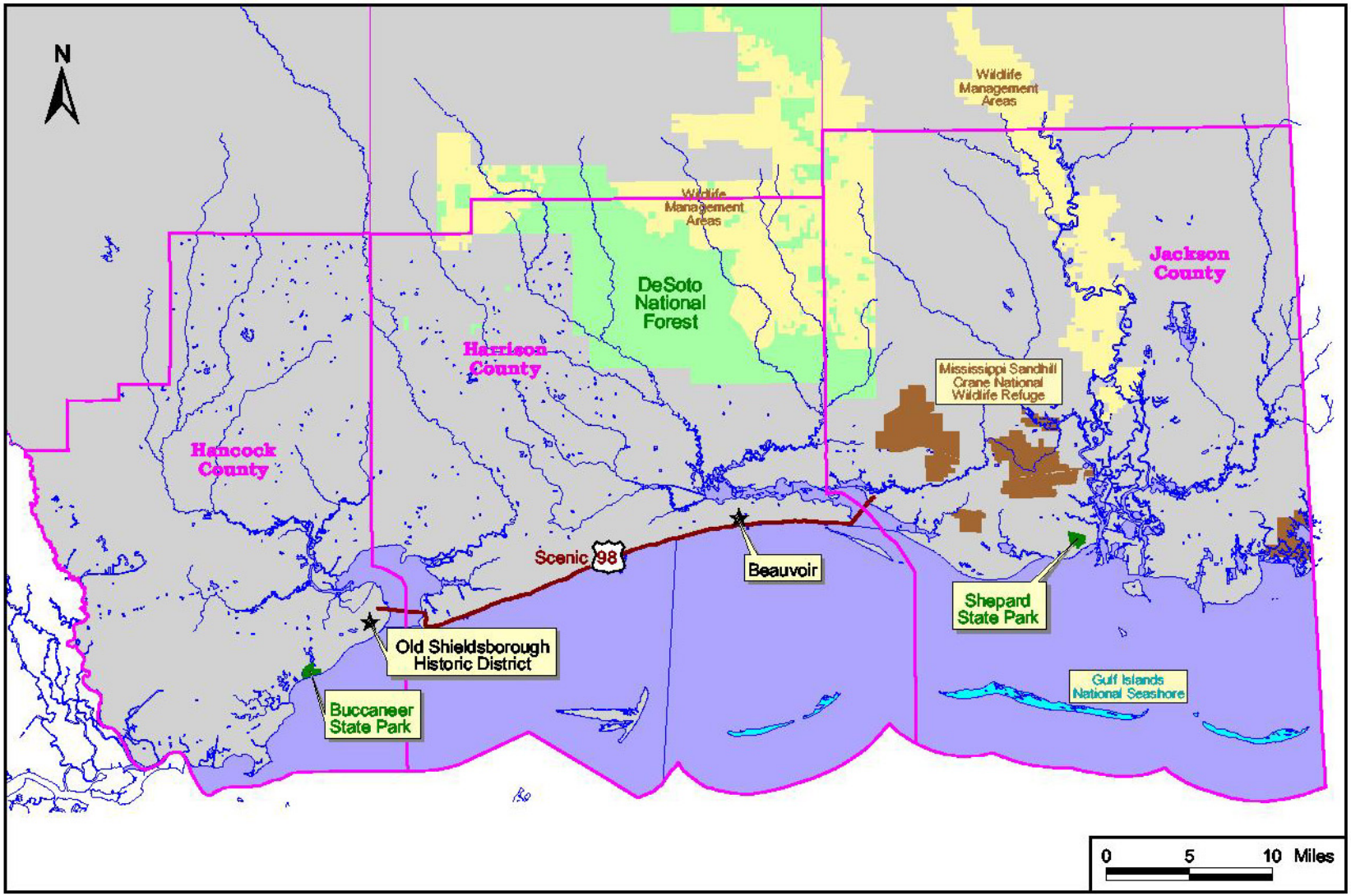
From the early 1970s to the present, construction in the project area has greatly increased. In fact, more development and construction has occurred in the three counties that are part of the project area than anywhere else in the state. Land use studies show that between 1972 and 2000 both medium-density and high-density urban land use areas increased by more than 90 percent in the study area; overall, developed land use increased by almost 70 percent during that period (MARIS, 1992, 2000; USGS, 1972; USGS and USEPA, 1992). This sizeable increase in developed land is caused in part by the casinos and related infrastructure, residential, and commercial construction. The development involves large areas of soil disturbance, which destroys archaeological sites. Development plans are endangering known and potential (predicted) archaeological sites. In addition, large multistory hotels and casinos have cut off the viewsheds of historic structures.

4.12 VISUAL AND AESTHETIC RESOURCES

4.12.1 Introduction

Visual and aesthetic resources are those natural resources, landforms, vegetation and man-made structures in the environment that generate one or more sensory reactions and evaluations by the observer, particularly pleasurable responses. These sensory reactions are traditionally categorized as visual, auditory, and olfactory responses—sight, sound and smell. The visual sense is so predominant in the observer's reaction and evaluation that visual resources are the focus of this section. To the extent their presence is perceivable, the other sensory stimulants of sound and smell will be addressed in the noise, air, and water quality sections.

In terms of visual resources, many places in the Mississippi Coastal Study Area have been recognized for their beauty and designated as such by Federal or State agencies. Recognition of aesthetic resources also occurs at local levels through zoning, planning, or other public means. While all significant scenic and aesthetic resources may not have yet been designated, for the purposes of this document, the following noteworthy visual and aesthetic resources are found in the Coastal Study Area (Figure 4.12-1).



LEGEND

- State Park
- Wildlife Management Area
- National Wildlife Refuge
- National Forest
- ★ Historic Site
- County Study Area
- National Seashore

Source: MARIS, 2001.

Noteworthy Visual and Aesthetic Resources

Figure 4.12-1

4.12.2 National Forest

De Soto National Forest. De Soto National Forest extends into the ROI, covering northern Harrison County and the far western part of Jackson County. The largest of Mississippi's six national protected woodlands, De Soto National Forest covers 501,000 acres stretching across a combination of "pinywoods" on gently rolling terrain and hardwood bottomlands.

4.12.3 National Seashore

Gulf Islands National Seashore. In Mississippi, the Gulf Islands National Seashore consists of five units: Horn Island, Petit Bois Island, East Ship Island, West Ship Island, and Davis Bayou. The islands are all barrier islands lying approximately 10 miles offshore; Horn and Petit Bois are wildlife sanctuaries. Davis Bayou is an aquatic wilderness consisting of 400 acres of salt marsh, bayous, and maritime forest located off US Hwy. 90 in Ocean Springs (Jackson County).

4.12.4 National Wildlife Refuges

Mississippi Sandhill Crane National Wildlife Refuge. The refuge consists of three separate land units totaling more than 19,000 acres. The Gautier, Ocean Springs, and Fontainebleau units in Jackson County all lay within the limited nesting range of the endangered Mississippi sandhill crane.

4.12.5 National or State Register of Historic Places

Numerous historic architectural resources are present in the project area. To date 62 standing structures, 14 historic districts, and one ship have been listed on the National Register of Historic Places. Historic districts have been designated in Biloxi, Ocean Springs, and Bay St. Louis. See Table 4.11–2 in the Cultural Resources Section for a list these resources and their locations.

4.12.6 State Parks

Buccaneer State Park. Buccaneer State Park, covering 398 acres, is located within the city limits of Waveland on Beach Boulevard in Hancock County.

4.12.7 State Historic District

Old Shieldsborough Historic District. Located in the Old Town section of Bay St. Louis in Hancock County.

While not formally designated as a state scenic highway, the AAA Tour Book for Mississippi mentions Beach Boulevard as "a scenic drive extending along the Gulf"; the book's Pascagoula listing identifies "scenic US 90 . . . hugging the shoreline as it moves west to Bay St. Louis" (AAA, 2001).

The ROI contains no rivers designated as national or state wild, scenic or recreational; nor any national parks; national monuments; national recreation areas; national natural landmarks; scenic areas of statewide significance; state or federally designated trails; state nature and historic preserve areas; state forest preserve; urban cultural parks; or other noteworthy visual or aesthetic resources.

4.12.8 Historical Trends

Over the past decade, Biloxi has added nine casino developments to its shoreline and Gulfport has added two casinos. The casinos in Biloxi are concentrated at the east point of the city at the mouth of Biloxi Bay, with others along the Back Bay of Biloxi. These areas had an urban character before the casinos arrived. However, the character of Biloxi where the casinos are located has changed from a waterfront primarily characterized by the fishing and seafood industry to one dominated by large, modern, well-lit buildings that lack a sense of connection to the maritime past. The Gulfport casinos are located along the coast in a less developed area, though Gulfport has seen enormous residential and retail growth since the casinos came to Mississippi. Even with the growth induced by the gaming industry, the historical and aesthetic character of much of the Mississippi coastline beyond the direct influence of the casino developments has been retained, though secondary growth due to the growth in the region has altered this character somewhat and continues to do so.

SECTION 5.0
ENVIRONMENTAL CONSEQUENCES

This section presents the environmental and socioeconomic consequences of implementing the alternatives evaluated in the EIS. The primary focus of this analysis is on the long-term (20-year) regional cumulative effects of Corps permitting actions in the coastal Mississippi region under various development scenarios and regulatory frameworks. The proposed action and alternatives evaluated in the EIS were discussed in Sections 2.0 and 3.0. Those alternatives carried forward for detailed consideration are presented below:

- ***No Action Alternative.*** Under the no action alternative, the Corps would continue to perform cumulative effects analysis for permits on an ad hoc basis and regional growth would continue to be managed as in the past. Essentially, the no action alternative represents the status quo and serves as a benchmark against which the proposed action can be evaluated.

- ***Proposed Action.*** Preparation of a comprehensive trends analysis and development and implementation of a special-purpose permit evaluation methodology constitute the proposed action described in Section 2.0. This is the Corps's preferred alternative for considering cumulative effects associated with the permitting of large-scale development projects in the coastal Mississippi region. It should be noted that it is beyond the jurisdiction of the Corps of Engineers to dictate the implementation of growth control and management measures. Therefore, the proposed action is primarily limited to the permitting process that is within the Corps's permitting authority, with consideration given to conservation measures that might be adopted as permit conditions and/or measures that might be adopted by other agencies. Nevertheless, it is clear that Corps permitting actions have had an indirect effect on regional growth, thereby contributing to regional cumulative effects. Thus, one of the purposes of this study is to gain a comprehensive understanding of the cumulative impact of large-scale projects approved by the Corps and to include this assessment when making future permitting decisions.

  The Corps would consider imposing additional permit conditions that are within its regulatory authority to reduce regional cumulative effects. Also, through this EIS process, the Corps has identified many other conservation measures that are beyond the regulatory authority of the Corps but that could be adopted by other entities to reduce regional cumulative effects.

  All of the conservation measures that might be implemented to reduce regional cumulative effects are referred to as Regional Conservation Practices (RCPs) in this EIS. The vast majority of these RCPs are measures that are beyond the regulatory authority of the Corps and thus cannot be applied as site-specific permit conditions. RCPs consist of a wide range of best management practices (BMPs), planning studies, and related actions for the conservation of coastal resources and the reduction of environmental and socioeconomic effects associated with development. RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. As part of the special-purpose methodology, RCPs might be implemented in two primary ways:

1. ***Formulate site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects.*** Upon the review of proposed large-scale development projects, the Corps of Engineers might formulate site-specific permit conditions based in part on RCPs (as identified within in each individual resource area that follows) to reduce environmental and/or socioeconomic effects.

2. ***By conducting the trends analysis and providing the results of this EIS, foster the adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implement mitigation/control measures to reduce cumulative effects.***

    - State and local regulatory authorities might elect to formulate new regulations based in part on RCPs to conserve coastal resources and reduce environmental and/or socioeconomic effects from development.

    - Federal, state, and local regulatory authorities, as well as nongovernmental organizations, might elect to conduct studies based in part on RCPs to provide a better understanding of the effects of development on coastal resources.

    - Federal, state, and local regulatory authorities, as well as nongovernmental organizations might elect to incorporate, in whole or in part, RCPs as part of ongoing and/or new coastal planning initiatives for the conservation of coastal resources.

    - Private entities might elect to formulate mitigation and BMP measures based in part on these RCPs in order to reduce environmental and/or socioeconomic effects associated with specific development projects.

The resource-specific RCPs are presented by resource in the sections to follow.

Given the uncertainty associated with predicting the condition of natural resources and socioeconomic conditions over the next 20 years, a comprehensive trends analysis was conducted to evaluate changes that could occur under different growth scenarios, as defined below. (A more detailed presentation is provided in Section 5.1.)

- ***Most-Likely Growth Scenario.*** This growth scenario simulates the "most-likely" condition of the Mississippi coastal area over the next 20 years. The scenario was derived using sophisticated economic and land development forecast modeling tools that predict changes that are most likely to occur given historical growth patterns over the past 30 years and the economic capacity of current operating systems (e.g., potential for current gaming operations to continue to grow as the system currently exists).

- ***High-Growth Scenario.*** The High-Growth Scenario simulates the condition of the Mississippi coastal area assuming that large-scale coastal projects, such as gaming operations, continue to grow at peak historical rates. Thus, this scenario projects growth at levels commensurate with growth rates from 1992 to 2000.

- ***Medium-Growth Scenario.*** The Medium-Growth Scenario simulates the condition of the Mississippi coastal area assuming that large-scale coastal projects, such as gaming operations, grow at half their historical rates (from 1992 to 2000).

- ***Low-Growth Scenario.*** The Low-Growth Scenario simulates regional cumulative effects of the coastal area assuming that large-scale coastal projects, such as gaming operations, have zero growth in economic output and that the rest of the economy continues to grow at a lower rate without the effects of induced growth from the gaming sector of the economy. As discussed in Section 5.1, this scenario results in economic activity that is only 1 percent below the Most-Likely Growth Scenario; therefore, the document will present the results for these two growth scenarios together.

By evaluating these growth scenarios, the trends analysis effectively captures the full range of economic impacts and cumulative effects of Corps permitting actions under reasonable maximum economic activity, as well as relatively stagnant economic conditions.

The sections that follow present for each resource area the technical approach for conducting the trends analysis, as well as a discussion of the condition of resources under each growth scenario. The consequences of implementing the no action alternative and proposed action follow the presentation of the growth scenarios. It should be noted that the growth scenarios essentially define the condition of resources in the year 2020 assuming that current regulatory controls remain in place. Thus, the growth scenarios define the range of possible conditions of resources under the no action alternative (i.e., the status quo).

5.1 SOCIOECONOMICS

This section presents the technical approach and results of the trends analysis and consequences analysis for socioeconomic conditions (Section 5.1.1); public services and safety (Section 5.1.2); environmental justice (Section 5.1.3), as required under Executive Order 12898; and the protection of children (Section 5.1.4), as required under Executive Order 13045.

5.1.1 Socioeconomic Conditions

5.1.1.1 Trends Analysis for Socioeconomic Conditions

This analysis of socioeconomic trends evaluates the potential impacts of a range of development scenarios on the coastal Mississippi regional economy. The analysis specifically focuses on how different development scenarios could affect the demographic and economic characteristics of the region during the study period 2000 – 2020, based on recent trends in development and economic forecast models. The economic region of influence (ROI) evaluated in this analysis encompasses Hancock, Harrison, and Jackson Counties. These are the counties that directly or indirectly experienced most of the socioeconomic impacts of development that occurred during the 1990s.

The Policy Insight Model of Regional Economic Models, Inc. (REMI) was selected to project economic conditions under a range of development scenarios. The REMI model serves two purposes in the study. First, it provides a baseline demographic and economic forecast for each of the three counties composing the ROI for the period 2000 – 2020. The REMI forecast is based on a 30-year historical database and takes into account national economic and demographic trends as well as regional-specific characteristics. In generating economic forecasts, the REMI model places a somewhat greater weight on more recent data than on older data to better capture

recent trends at both the regional and national levels. Second, the REMI model forecasts the impacts on that same ROI economy given future development growth scenarios. In this study, large-scale development scenarios are evaluated at High-, Medium-, or Low-Growth levels for large-scale developments along the Mississippi coast. It should be emphasized that these growth scenarios are narrowly defined to encompass different potential growth rates of key market sectors that drove development during the 1990s. These scenarios were compared against a baseline scenario that projects economic conditions over the 20-year period using historical economic growth patterns and economic relationships for all sectors of the regional economy. (Refer to the REMI model description provided in Appendix L.) The growth scenarios were then modeled to estimate the resulting deviations from this baseline. As noted earlier, the USACE permitting process could influence the rate and speed of future development where such development takes place in wetland areas.

5.1.1.2 Growth Scenarios

This section presents the projected economic conditions for the growth scenarios evaluated for the trends analysis.

5.1.1.2.1 Description of the Most-Likely (Baseline) Economic Growth Scenario

REMI generates a baseline forecast that projects the expected long-term growth of the ROI based on past and current trends and conditions. For this analysis, the REMI baseline forecast is the Most-Likely Growth Scenario. As shown in Table 5.1–1, the REMI baseline model forecasts a 17.5 percent increase in population over the 20-year study period.[1] This population increase equates to approximately 1 percent annual growth. In general, the model forecasts slower population growth toward the end of the forecast period than at the beginning. The model also predicts some disparities in growth rates among the three ROI counties. For example, Harrison County, the largest of the three ROI counties, is projected on average to have the slowest growth rate at 0.5 percent, whereas Hancock County, the smallest of the three counties, is forecast to have the highest annual growth rate at 1 percent.

Jackson County is projected to have the largest increase in absolute population, growing by about 33,000 between 2000 and 2020, an annual growth rate of 1 percent. Overall, the region's population is projected to increase by about 64,000 during the 20-year period from 2000 to 2020.

Table 5.1–1
Population Projections for the Most-Likely Growth Scenario (Baseline) for the Period from 2000 to 2020 (in thousands)

Region	2000	2005	2010	2015	2020	Total Growth (%)	Annual Growth Rate (%)
Hancock County	42.356	46.041	49.070	51.509	53.376	26.0	1.2
Harrison County	189.397	195.451	201.062	205.692	209.515	10.6	0.5
Jackson County	135.507	147.614	155.745	162.672	168.541	24.3	1.1
ROI	367.259	389.106	405.878	419.873	431.432	17.5	0.8

[1] For validation purposes, the REMI model's demographic projections were compared with the projections from two other independent models. Comparison data are presented in Appendix K.

In addition to the population projections, the REMI model provides projections for major economic indicators such as employment, personal income levels, and gross regional product (GRP). It also generates projections for a multitude of underlying economic variables that help determine final levels of economic output. These include labor productivity, capital stock levels, wage rates by industry, value of output by sector, and input cost factors such as fuel costs relative to the nation. These "secondary" variables can be used to detail how and why an economy is changing over time.

Employment by major sector provides a general but useful picture of how an economy is evolving. REMI baseline employment forecasts (for the Most-Likely Growth Scenario) are presented in Table 5.1–2. The REMI model projects a structurally stable economy, with each of the major sectors generating approximately the same proportion of workers in 2020 as in the year 2000. As described in Section 4.1, during the period 1970 to 2000, the region's economy underwent a significant structural change as manufacturing and government services employment declined while private sector services employment (including gaming employment[2]) significantly increased.[3] The model projects a continued but much more modest transition from manufacturing and other industrial sectors (mining and construction) to the trade and services sectors. As shown in the table, the service sector employment is projected to generate about 32 percent of all ROI jobs in the year 2020, less than a 3 percent increase over 2000. The REMI baseline projections thus imply that most of the transition from manufacturing and government-based employment has already taken place and that the future regional economy will remain primarily a services-based economy, albeit with a significant non-services component. It should be noted that Jackson County currently generates the vast majority of the region's manufacturing-based employment and is projected to continue to do so throughout the forecast period.

Table 5.1–2
Employment Projections for the Most-Likely Growth Scenario (Baseline) (in thousands)

	2000	2005	2010	2015	2020
Hancock County					
Manufacturing	1.562	1.398	1.343	1.438	1.549
Mining	0.017	0.014	0.013	0.013	0.014
Construction	1.483	1.470	1.415	1.376	1.352
Transportation and Public Utilities	0.552	0.565	0.573	0.593	0.609
Finance/Insurance/Real Estate	0.921	0.995	1.022	1.033	1.029
Retail Trade	2.774	2.997	3.062	3.044	2.998
Wholesale Trade	0.174	0.169	0.162	0.159	0.155
Services	7.361	8.341	9.081	9.775	10.409
Agriculture/Forestry/Fishing Services	0.279	0.321	0.349	0.383	0.416
Total Government	4.304	4.694	4.903	5.038	5.099
Farm	0.301	0.272	0.249	0.236	0.225
Total County Employment	19.727	21.236	22.171	23.089	23.855

[2] The REMI model used for this analysis is a 53-sector model and does not explicitly model the gaming sector. Instead, the analysis models impacts of changes to the "amusement and recreation" sector, which includes gaming activities.

[3] Although this characterization is accurate for all three counties in the ROI, the manufacturing sector remains an important contributor to the Jackson County economy.

Table 5.1–2
Employment Projections for the Most-Likely Growth Scenario (Baseline) (in thousands) (continued)

Harrison County					
Manufacturing	6.079	5.889	5.823	6.222	6.736
Mining	0.090	0.088	0.087	0.090	0.095
Construction	8.764	8.222	7.646	7.266	7.057
Transportation and Public Utilities	6.188	6.113	6.043	6.090	6.111
Finance/Insurance/Real Estate	6.817	7.131	7.155	7.102	6.999
Retail Trade	22.439	23.557	23.697	23.341	22.965
Wholesale Trade	3.082	2.849	2.646	2.563	2.472
Services	44.851	47.297	49.230	51.150	52.928
Agriculture/Forestry/Fishing Services	1.688	1.824	1.898	2.040	2.198
Total Government	30.866	34.309	35.779	36.406	36.690
Farm	0.357	0.322	0.295	0.280	0.267
Total County Employment	131.221	137.601	140.299	142.549	144.518
Jackson County					
Manufacturing	22.759	23.925	23.788	24.901	26.135
Mining	0.036	0.036	0.036	0.038	0.042
Construction	6.186	6.324	5.974	5.837	5.755
Transportation and Public Utilities	1.423	1.474	1.494	1.554	1.606
Finance/Insurance/Real Estate	2.814	3.013	3.050	3.085	3.086
Retail Trade	10.807	11.751	12.008	12.103	12.086
Wholesale Trade	0.914	0.839	0.769	0.759	0.742
Services	12.834	14.201	15.141	16.114	16.949
Agriculture/Forestry/Fishing Services	0.839	0.910	0.945	1.022	1.107
Total Government	12.764	14.500	15.332	15.784	16.051
Farm	0.459	0.415	0.379	0.360	0.343
Total County Employment	71.835	77.388	78.916	81.557	83.901
ROI					
Manufacturing	30.400	31.212	30.954	32.560	34.420
Mining	0.142	0.139	0.137	0.142	0.151
Construction	16.433	16.016	15.035	14.479	14.164
Transportation and Public Utilities	8.162	8.152	8.109	8.237	8.326
Finance/Insurance/Real Estate	10.552	11.139	11.227	11.220	11.114
Retail Trade	36.021	38.305	38.767	38.488	38.049
Wholesale Trade	4.171	3.857	3.577	3.481	3.369
Services	65.046	69.839	73.452	77.038	80.286
Agriculture/Forestry/Fishing Services	2.805	3.054	3.191	3.445	3.722
Total Government	47.935	53.503	56.014	57.228	57.839
Farm	1.118	1.009	0.922	0.877	0.834
Total Regional Employment	222.783	236.226	241.386	247.196	252.275

5.1.1.2.2 Description of the Low-, Medium-, and High-Growth Scenarios for the Trends Analysis

The economic trends analysis forecasts economic conditions for the regional economy under three different development growth scenarios: High Growth, Medium Growth, and Low Growth. These growth scenarios assume different levels of development in the three counties, based on changes in key market sectors that generated the highest levels of growth in the 1990s, such as the gaming industry. The analysis assumes that development patterns and restrictions would continue into the future (e.g., gaming would not be permitted in Jackson County).

It must be emphasized that the purpose of the economic trends analysis is not to accurately predict the future level of development but rather to establish reasonable upper and lower bounds of growth and to evaluate the resulting potential impacts on the regional economy within that range. Although a firm's plan to construct a new building or establishment is driven by financial and economic considerations, Corps permitting determinations can affect the timing and execution of that plan. Hence, Corps permitting decisions can indirectly affect growth patterns in the region through approval or disapproval of permit applications.

The growth scenarios used in the economic trends analysis are based on the development activity that occurred in the region during the period from 1992 to 1999. During this period, 14 casinos commenced operation in the region (13 in Harrison County and 1 in Hancock County). One casino (Lady Luck) has since relocated out of the region, and another was partially constructed but never opened. Although the development and expansion of the gaming industry in the region has not been continuous (no new casinos opened during 1995 and 1996), overall employment in the gaming sector increased from fewer than 2,000 workers in 1992 to more than 21,000 in 1999, including workers associated with casino hotels.[4] The last new major casino (Beau Rivage) began operating in 1999. Although there are plans for additional gaming development in the region (e.g., Broadwater Destination), it is unlikely that future development would exceed the rate of development achieved during the 1990s (adding the equivalent of another 13 casinos with the same levels of employment over an 8-year period). Therefore, the trends analysis uses an upper bound development rate that would equal that of the 1990s but would continue through the year 2020. Given the current economic outlook, using such a high growth rate would almost certainly capture the impacts of the most robust development scenario.

The Medium-Growth Scenario was selected based on a development rate of 50 percent of the High-Growth rate. The Low-Growth Scenario assumes that employment levels in high-growth market sectors (e.g., the casino industry) remain at year 2000 levels. By evaluating these three scenarios, the trends analysis should effectively capture the full range of economic impacts resulting from potential future development.

The following subsections present the model results for each of the growth scenarios evaluated in the trends analysis. The model results are also compared with the most-likely growth (baseline) forecast to provide additional context to analysis.

[4] The growth scenarios of the economic trends analysis do not differentiate between workers directly associated with gaming activities (e.g., black jack dealers) and workers associated with ancillary activities (e.g., restaurant and hotel workers). The analysis recognizes that many, if not most, of the large casino operations also have hotel facilities physically attached to the casino. However, data were not available to differentiate employment by subsector (hotel versus casino) for each of the operations.

Low-Growth Scenario. The Low-Growth Scenario assumes that no further development or expansion would take place in key growth market sectors (such as gaming) from the year 2000 to 2020 and that the overall economy would continue to grow at a relatively slow pace. Table 5.1–3 shows the Low-Growth REMI model projections for employment, GRP, and population for each county and for the ROI. Table 5.1–4 shows projected differences between the Low-Growth Scenario and the Most-Likely (baseline) Scenario for population and employment.

Although total population, employment, and GRP are expected to increase during the study period in each county and for the ROI overall, under the Low-Growth Scenario (Table 5.1–3), the rate of economic and population expansion would be lower than that projected under the High-, Medium-, and Most-Likely Growth Scenarios. As shown in Table 5.1–4, by the year 2020 there would be almost 300 fewer jobs available than under the Most-Likely Growth Scenario, a 0.1 percent decrease from the baseline level. Population would drop from baseline levels by 0.3 percent, or by 1,337 people (Table 5.1–4). GRP for the ROI would be less than 1 percent below the Most-Likely Growth Scenario.

Table 5.1–3
Economic Projections for Low-Growth Scenario

	2000	2005	2010	2015	2020
Hancock County					
Total Employment (thousands)	19.719	21.217	22.148	23.074	23.849
GRP (billion fixed 92$)	0.856	0.966	1.071	1.195	1.314
Population (thousands)	42.352	46.004	49.001	51.444	53.335
Harrison County					
Total Employment (thousands)	130.900	136.857	139.367	141.947	144.244
GRP (billion fixed 92$)	5.277	5.868	6.406	7.046	7.671
Population (thousands)	189.327	194.696	199.513	204.064	208.275
Jackson County					
Total Employment (thousands)	71.825	77.368	78.896	81.543	83.889
GRP (billion fixed 92$)	3.723	4.203	4.537	5.020	5.503
Population (thousands)	135.497	147.532	155.601	162.559	168.485
ROI					
Total Employment (thousands)	222.444	235.442	240.410	246.565	251.982
GRP (billion fixed 92$)	9.856	11.037	12.013	13.261	14.489
Population (thousands)	367.176	388.232	404.115	418.067	430.096

Economic and population expansion under the Medium- and High-Growth Scenarios would range from about 15 to 30 percent above the Low-Growth Scenario. However, the difference between the Low-Growth Scenario and the Most-Likely Growth Scenario is almost negligible. Employment, population, and GRP would all be less than 1 percent below baseline projections. A reason for the small difference between the Most-Likely and Low-Growth Scenarios is that the REMI baseline forecast predicted only minor growth in gaming sector employment from 2000 to 2020. The REMI baseline forecast is based on the 30-year economic and demographic history of the region, with emphasis on the most recent years. Casino development has taken place in only 8 of those 30 years, and in the past several years (1997 to 1999) there has been a slowdown in casino development along the Mississippi coast. For these reasons, the REMI baseline model might underestimate future growth in the gaming sector.

Table 5.1–4
Low-Growth Rate Scenario Population and Employment Decreases From Baseline Conditions (*in thousands*)

	2000	2005	2010	2015	2020
Hancock County					
Decrease in Total Employment from Baseline	-0.008	-0.01	-0.024	-0.015	-0.007
Percentage Decrease	-0.039	-0.090	-0.108	-0.064	-0.029
Decrease in Population of Baseline	-0.004	-0.036	-0.069	-0.064	-0.041
Percentage Decrease	-0.009	-0.079	-0.142	-0.125	-0.077
Harrison County					
Decrease in Total Employment from Baseline	-0.321	-0.744	-0.932	-0.602	-0.274
Percentage Decrease	-0.245	-0.541	-0.664	-0.422	-0.190
Decrease in Population of Baseline	-0.069	-0.755	-1.549	-1.628	-1.240
Percentage Decrease	-0.037	-0.386	-0.770	-0.792	-0.592
Jackson County					
Decrease in Total Employment from Baseline	-0.010	-0.019	-0.020	-0.014	-0.012
Percentage Decrease	-0.014	-0.025	-0.026	-0.018	-0.014
Decrease in Population of Baseline	0.009	-0.0825	-0.144	-0.113	-0.055
Percentage Decrease	-0.007	-0.056	-0.093	-0.070	-0.033
ROI					
Decrease in Total Employment from Baseline	-0.339	-0.7833	-0.976	-0.631	-0.293
Percentage Decrease	-0.152	-0.332	-0.404	-0.255	-0.116
Decrease in Population of Baseline	-0.083	-0.8741	-1.763	-1.806	-1.337
Percentage Decrease	-0.023	-0.225	-0.434	-0.430	-0.310

Medium-Growth Scenario. The Medium-Growth Scenario also assumes that key growth market forces from the 1990s continue to occur during the course of the study period, but that this development proceeds at 50 percent of the growth rate of the 1990s.

Table 5.1–5 provides Medium-Growth model projections for regional employment, GRP, and population for each county and for the ROI. Table 5.1–6 shows projected differences between the Medium-Growth Scenario and the Most-Likely Growth Scenario for population and employment. As shown in Table 5.1–6, by the year 2020, under the Medium-Growth Scenario, the gaming industry would generate an additional 45,100 jobs in the ROI and population would increase by about 70,800 over the baseline projections. This equates to an 18 percent increase in employment and a 16 percent increase in population in the ROI over the Most-Likely Growth Scenario (Table 5.1–6). Regional annual population growth rate would reach 1.5 percent compared with 1 percent under baseline conditions. GRP would increase by 15.5 percent over the baseline forecast. The majority of these gains would occur in Harrison County, which would see a 28 percent increase in population and a 28 percent increase in employment from projected baseline levels. Although no casinos are assumed to be built in Jackson County, the "spillover" effect of large-scale gaming and resort development would lead to a 3 percent increase in population and a 1 percent increase in employment over baseline projections.

Table 5.1–5
Economic Projections for Medium-Growth Scenario

	2000	2005	2010	2015	2020
Hancock County					
Total Employment (thousands)	19.885	22.212	24.010	25.857	27.621
GRP (billion fixed 92$)	0.862	1.003	1.146	1.316	1.489
Population (thousands)	42.397	47.012	51.798	56.458	60.768
Harrison County					
Total Employment (thousands)	133.022	148.397	160.435	172.539	184.841
GRP (billion fixed 92$)	5.345	6.299	7.290	8.462	9.722
Population (thousands)	189.751	203.562	223.008	244.833	267.422
Jackson County					
Total Employment (thousands)	71.896	77.688	79.428	82.312	84.931
GRP (billion fixed 92$)	3.725	4.212	4.551	5.043	5.540
Population (thousands)	135.560	148.645	158.265	166.757	174.097
ROI					
Total Employment (thousands)	224.803	248.296	263.872	280.708	297.393
GRP (billion fixed 92$)	9.931	11.514	12.987	14.821	16.750
Population (thousands)	367.708	399.219	433.071	468.049	502.287

Table 5.1–6
Medium-Growth Rate Scenario Population and Employment Increases Over Baseline Conditions (in thousands)

	2000	2005	2010	2015	2020
Hancock County					
Increase in Total Employment from Baseline	0.158	0.975	1.838	2.768	3.766
Percentage Increase	0.803	4.594	8.291	11.990	15.787
Increase in Population of Baseline	0.041	0.972	2.728	4.950	7.392
Percentage Increase	0.096	2.111	5.560	9.609	13.848
Harrison County					
Increase in Total Employment from Baseline	1.801	10.800	20.140	29.990	40.320
Percentage Increase	1.372	7.845	14.352	21.038	27.901
Increase in Population of Baseline	0.355	8.111	21.950	39.140	57.910
Percentage Increase	0.187	4.150	10.915	19.029	27.639
Jackson County					
Increase in Total Employment from Baseline	0.060	0.299	0.512	0.755	1.030
Percentage Increase	0.084	0.387	0.648	0.925	1.228
Increase in Population of Baseline	0.053	1.030	2.520	4.085	5.556
Percentage Increase	0.039	0.698	1.618	2.511	3.297
ROI					
Increase in Total Employment from Baseline	2.020	12.070	22.490	33.510	45.120
Percentage Increase	0.907	5.110	9.315	13.557	17.885
Increase in Population of Baseline	0.448	10.110	27.190	48.180	70.850
Percentage Increase	0.122	2.599	6.700	11.474	16.423

Employment, population, and GRP under the Medium-Growth Scenario would increase about half the rate of the High-Growth Scenario. Under the Medium-Growth Scenario, employment, population, and GRP would increase by 17 percent, 16 percent, and 15 percent, respectively (compared with 33 percent, 31 percent, and 29 percent under High-Growth) over the Most-Likely Growth Scenario. Most of these effects would occur in Harrison and Hancock Counties, where casino development would take place. This development would generate growth in Jackson County as well, although at significantly lower rates.

High-Growth Scenario. The High-Growth Scenario assumes that the 1992 through 1999 average growth rate in key market sectors would continue through the end of the study period. As noted earlier, the model does not assume a specific distribution of employees among occupational categories, and it does not differentiate between gaming workers and workers associated with hotel, restaurant, or other related facilities co-located with the casino. Under the High-Growth Scenario, gaming sector employment would reach levels approximately 3.5 times the current level of gaming employment in the two counties. Table 5.1–7 presents model projections under the High-Growth Scenario for regional population, employment, and GRP for each of the constituent ROI counties. Table 5.1–8 shows projected differences between the High-Growth Scenario and Most-Likely Growth Scenario for population and employment. As shown in Table 5.1–8, by the year 2020 under the High-Growth Scenario, the gaming industry would generate an additional 84,000 jobs in the region and would stimulate population growth of about 134,000. These numerical increases represent a 33.5 percent increase in employment and a 31 percent increase in population over the Most-Likely Growth Scenario. The regional annual population growth rate would reach 2 percent compared with 1 percent under baseline conditions. GRP, a measure of the ROI's total output of goods and services, would increase by more than 29 percent over the baseline forecast. Most of these gains would occur in Harrison County, which would reach a population of 318,000, a greater than 50 percent increase from projected baseline levels. Although the analysis assumes that no casinos would be built in Jackson County, the "spillover" effect of large-scale gaming development would lead to a 6 percent increase in population over the baseline.

Table 5.1–7
Economic Projections for High-Growth Scenario

	2000	2005	2010	2015	2020
Hancock County					
Total Employment (thousands)	20.037	23.147	25.777	28.525	31.255
GRP (billion fixed 92$)	0.867	1.039	1.219	1.433	1.660
Population (thousands)	42.434	47.912	54.355	61.159	67.860
Harrison County					
Total Employment (thousands)	134.555	157.620	177.727	198.413	219.724
GRP (billion fixed 92$)	5.394	6.645	8.024	9.677	11.511
Population (thousands)	190.050	210.383	241.757	278.839	318.376
Jackson County					
Total Employment (thousands)	71.948	77.953	79.890	83.003	85.877
GRP (billion fixed 92$)	3.726	4.219	4.563	5.064	5.573
Population (thousands)	135.605	149.537	160.483	170.397	179.084
ROI					
Total Employment (thousands)	226.540	258.720	283.394	309.941	336.856
GRP (billion fixed 92$)	9.987	11.903	13.806	16.175	18.744
Population (thousands)	368.089	407.831	456.595	510.395	565.320

In summary, under the High-Growth Scenario, additional development would stimulate economic and population growth to levels significantly higher than those under the Most-Likely Growth Scenario. The population growth rate would increase from 1 percent annually to greater than 2 percent, resulting in more than a 50 percent increase in the population relative to levels in the year 2000. Economic indicators for employment and GRP would increase proportionately. Put into historical perspective, the ROI was able to achieve this rate of population growth only during the 1970s. The region has no recent history of maintaining a 2 percent population growth for a full two decades. As described in the affected environment section, after a decade of robust growth the regional economy then became quite stagnant throughout the 1980s and only began to rebound with the introduction of the gaming industry during the early 1990s. Economic and demographic data for the region and the state indicate that without the introduction of the gaming industry or the development of an alternative sector, the region would likely have continued to experience little or no growth throughout the past decade..

Sustained growth at the 1990s level is possible, but unlikely to occur. However, if such growth were to take place, the regional economy would experience significant demographic and economic changes. From a purely economic perspective, these changes would be positive, as manifested by robust job and income growth projected by REMI. Development in Hancock and Harrison Counties would also generate additional population and job growth in Jackson County, although economic changes in Jackson County would be far more modest than those in the other two counties. The ability of these counties to accommodate this economic and population growth would depend on many factors, including the degree to which local infrastructure, including roads, environmental management systems, and public services, is also enhanced to meet the demand of the additional population. These issues are addressed in applicable resource sections.

Table 5.1–8
High-Growth Rate Scenario Population and Employment Increases Over Baseline Conditions (in thousands)

	2000	2005	2010	2015	2020
Hancock County					
Increase in Total Employment from Baseline	0.310	1.911	3.605	5.436	7.400
Percentage Increase	1.572	8.999	16.261	23.545	31.018
Increase in Population of Baseline	0.078	1.871	5.285	9.650	14.480
Percentage Increase	0.184	4.064	10.770	18.735	27.135
Harrison County					
Increase in Total Employment from Baseline	3.334	20.020	37.430	55.860	75.210
Percentage Increase	2.541	14.549	26.678	39.189	52.039
Increase in Population of Baseline	0.653	14.930	40.690	73.150	108.900
Percentage Increase	0.345	7.639	20.240	35.562	51.958
Jackson County					
Increase in Total Employment from Baseline	0.112	0.564	0.974	1.445	1.976
Percentage Increase	0.157	0.729	1.234	1.772	2.355
Increase in Population of Baseline	0.098	1.923	4.738	7.725	10.540
Percentage Increase	0.072	1.302	3.042	4.749	6.256
ROI					
Increase in Total Employment from Baseline	3.756	22.490	42.010	62.740	84.580
Percentage Increase	1.686	9.522	17.403	25.383	33.527
Increase in Population of Baseline	0.830	18.720	50.720	90.520	133.900
Percentage Increase	0.226	4.812	12.496	21.560	31.033

5.1.1.3 Consequences on Socioeconomic Conditions

The following subsections describe the consequences of the no action alternative and proposed action alternative on the socioeconomic conditions of the ROI.

5.1.1.3.1 No Action Alternative

Under the no action alternative, socioeconomic conditions would be the same as those described above for the growth scenarios. The Corps would continue to review permits using the same procedures and analytical tools as used in the past. Any of the growth scenarios described in the trends analysis could occur. Therefore, conditions under the no action alternative would be the same as those reflected by the four growth scenarios described in the trends analysis section. The consequences on socioeconomics range from relatively slow economic and population growth under the Low-Growth Scenario to significant, robust population and economic growth under the High-Growth Scenario (in which the gaming industry expansion is assumed to continue at the same rate as in the 1990s throughout the study period) as compared with baseline conditions in 2000. The following summarizes the results of the modeling efforts performed for the trends analysis and provides additional information on the relative impacts of the evaluated scenarios.

As described earlier, the economic trends analysis projected how large-scale development would affect the size and makeup of the coastal Mississippi regional economy during the period 2000 to 2020. The REMI model was used to develop a baseline forecast that projected economic and demographic changes in the ROI based on past and current trends and conditions (i.e., the Most-Likely Growth Scenario), as well as three alternative forecasts: the High-Growth Scenario, the Medium-Growth Scenario, and the Low-Growth Scenario. The High-Growth Scenario assumed that the 1992 through 1999 growth rate seen in key market sectors would continue through 2020. The Medium-Growth Scenario assumed that development occurred at half the growth rate experienced between 1992 and 1999 in key market sectors. Finally, the Low-Growth Scenario assumed that there would be no increase in employment in key growth market sectors. The comparison of the results of the four REMI forecasts is presented in Table 5.1–9.

Table 5.1–9
Comparison of Economic and Demographic Projections in the Year 2020 for the ROI

Scenario	Total Employment (thousands)	GRP (billion fixed 92$)	Population (thousands)
Most-Likely Growth	252.275	14.503	431.432
Low-Growth	251.982	14.489	430.096
Medium-Growth	297.393	16.750	502.287
High-Growth	336.856	18.744	565.320

As shown in Table 5.1–9, the High-Growth Scenario would result in significantly higher economic and population growth than would occur under the Most-Likely Growth Scenario. Employment would increase by 33.5 percent over the Most-Likely Growth Scenario; GRP, by 29 percent, and population, by 31 percent. It follows that the Medium-Growth Scenario would generate increases in economic output and population growth at about 50 percent of what was estimated under High-Growth. The majority of these effects under both the High- and Medium-Growth models would be felt in Hancock and Harrison Counties, where casino development is permitted. However, there would be some expected spillover of growth into Jackson County as has previously occurred. It should be noted that the model might underestimate such spillover effects on Jackson County. The REMI model used commuting patterns based on 1990 Census

data.[5] Anecdotal evidence suggests commuting patterns have changed since the onset of casino development in the early 1990s. Specifically, it is believed that many of the Harrison County gaming workers reside in Jackson County and that the economic linkage between the counties is even stronger than that a decade ago. The main implication of this increase in development in Harrison County is that it would lead to larger economic population changes in Jackson County than would be predicted by the model.

The difference in the economic and demographic variables between the Most-Likely Growth Scenario and the Low-Growth Scenario is negligible. The Low-Growth model projected that employment, GRP, and population would fall only slightly below the estimations for the Most-Likely (baseline) model. A possible explanation for the similarity in the results of the two forecasts could be that the REMI baseline forecast, which puts a somewhat greater emphasis on the most recent years of existing data, predicted only minor growth. During the past several years (1997 to 1999), there has been a slowdown in casino development, which could result in an underestimate of future growth along the coast. If in fact the REMI model underestimates baseline expansion of certain key growth market sectors, the actual effects of the Low-Growth Scenario would be more "negative." Conversely, an underestimate of growth in the Most-Likely forecast would lead to an overestimate of the impacts in the High- and Medium-Growth Scenarios. The actual differences between the High- and Medium-Growth Scenarios and the baseline would be commensurately smaller than forecast by REMI. These limitations and uncertainties associated with the economic forecasts should be taken into account when using the model results for planning purposes. Nonetheless, the impact analysis should provide a reasonably accurate picture of economic conditions under the range of development scenarios evaluated.

Although the range of consequences varies significantly for the different growth scenarios, the High-Growth Scenario would result in the most robust increase in economic indicators. A high growth rate would be largely beneficial to the economy; however, short-term labor and housing shortages could result if gaming expansion occurred in a shorter time frame or if increases in infrastructure investment, including housing, lagged behind employment and population growth. These problems would be less likely to arise under the Low-Growth and Most-Likely Growth Scenarios and thus would require less detailed planning by regional or local governments.

5.1.1.3.2 Proposed Action

5.1.1.3.2.1 Regional Conservation Practices

RCPs might be used and implemented in two primary ways—development of site-specific permit conditions under the regulatory authority of the Corps and adoption of RCPs by non–Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast.

The Corps would Foster adoption of regional conservation measures that non-Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use to enhance ongoing programs, develop new requirements/regulations, initiate planning studies, or implement mitigation/control measures to reduce cumulative effects.

[5] 2000 Census data were not yet published at the time the model was generated and thus updated information could not be incorporated into model forecasts.

- *Implement the National Gambling Impact Study Commission Report to mitigate adverse impacts on public services and other socioeconomic issues under High- and Medium-Growth Scenarios.*

- *Prepare a comprehensive regional plan to address the safety of children, increased traffic, construction, septic tank failures, and social concerns from gaming.*

5.1.1.3.2.2 Effects of Implementing the Proposed Action on Socioeconomic Conditions

Minor beneficial effects would be expected. As noted earlier, because expansion of the industry base confers economic benefits on the region, the primary socioeconomic concerns would materialize mostly under the High-Growth Scenario, which could lead to labor and housing shortages if expansion occurs in a short time frame, or if other aspects of the economy also undergo a rapid expansion during the study period. By having the trends analysis in place, regional planners would be better able to isolate the impacts of the gaming sector expansion from other sector changes. Employment, housing, and other public service impacts could be assessed in the context of the overall economic status of the region. Because the socioeconomic factors generate impacts on other resource areas, including transportation and water resources, the trends analysis could provide information useful in developing long-term planning strategies for these other resources.

5.1.2 Public Services and Safety

5.1.2.1 Trends Analysis for Public Services and Safety

The level of future demand for public services would parallel economic and population growth in the ROI. Hence, demand for these services would increase the most under the High-Growth Scenario and increase the least under the Low-Growth Scenario. In all scenarios, the region would require some additional infrastructure investment to maintain the current level of public services, including teacher-student ratios, per capita hospital beds, and number of fire and police personnel per resident. Historically, public services such as schools, law enforcement, fire protection, and health care facilities have expanded to meet the needs of the region's growing population, although keeping up with growth has been a major challenge. Even during the high-growth years of the 1990s, however, public services were able to accommodate the needs of the rapidly growing region. School districts in the ROI have recently either constructed new facilities or expanded capacity at existing facilities. Police and fire departments have also expanded their programs and increased their personnel and their vehicle inventory to accommodate population growth. Gaming taxes have provided some funding for these public services (see Section 4.1.5). Gaming tax legislation in both Hancock and Harrison Counties requires a certain percentage of gaming tax revenues to be allocated to local schools and to fire and police agencies.

To accommodate future population levels forecast in the trends analysis, public services would have to expand to meet resulting demand. For example, to maintain the current ratio of police to civilians, one additional police officer would need to be hired for approximately every 330 new persons in the ROI.[6] Under the High-Growth Scenario, this would translate into 598 additional police officers by the end of the year 2020. Under the Medium-Growth Scenario, 408 additional police officers would be needed, and under the Low-Growth Scenario, 191 police officers would

[6] Based on a police force (full-time and part-time) of 1,112 and an ROI population of 363,988 (see Section 4.1.1, Population, and Section 4.1.5.2, Public Safety).

need to be added to maintain the current level of service. For fire services, one additional fire fighter would be needed for approximately every 390 new persons in the ROI to maintain current levels.[7] For the High-Growth Scenario, this would translate into 506 additional fire fighters by the end of the year 2020. Under the Medium-Growth Scenario, 345 additional fire-fighting personnel would be needed, and under the Low-Growth Scenario, 161 fire-fighting personnel would need to be added to maintain the current level of service. Under all scenarios, gaming taxes in Hancock and Harrison Counties would increase with revenue growth, thereby providing additional funding beyond federal, state, and local funding for schools, police, and fire-fighting services. To accommodate the sustained increase in demand that would occur under the High-Growth Scenario, proper planning would need to be implemented to ensure that public sector capacity is not exceeded.

With respect to public safety concerns, the potential for increased crime rates and other social problems resulting from further increases in the gaming industry were issues raised during scoping. Crime statistics for the coastal Mississippi region (in particular, for Harrison County) indicate increases in crime rates for both violent and non-violent crimes. Although there has not been a documented causal relationship between casinos and increasing crime rates, the *National Gambling Impact Study Commission Report* (1999) closely examined such a relationship and cited two prominent national studies that "suggested that a relationship might exist between gambling activity and the commission of crime," but concluded that insufficient data exist to quantify or define that relationship. Societal problems and impacts associated with problem gamblers identified as a concern in this national study included financial burdens, adverse family impacts (e.g., abuse and neglect), increased incidence of divorce, elevated suicide rates, increased homelessness rates, and disproportionate impacts on children (NGISC Report, 1999). Based on the available information, it is possible that such problems might significantly increase within the coastal communities under the various growth scenarios, particularly under Medium- and High-Growth conditions relative to current conditions. However, insufficient data exist to evaluate the cause of increases in crime rates.

5.1.2.2 Consequences for Public Services and Safety Under the No Action Alternative

Under the no action alternative, public services and safety conditions would be the same as those described in the trends analysis. The Corps would continue to review permits using the same procedures and analytical tools as used in the past. Because any of the growth scenarios described in the trends analysis could occur, conditions under the no action alternative would be the same as those reflected by any of the four growth scenarios described in the trends analysis section. Police, fire, and medical personnel would continue to be staffed as they have in the past in response to changes in population in the ROI as needed. Overall, only minor adverse effects would be expected on public services relative to conditions in 2000. With respect to public safety, significant adverse effects might occur relative to conditions in 2000 if the gaming industry continues to grow as predicted in the Medium- and High-Growth Scenarios.

5.1.2.3 Consequences for Public Services and Safety Under the Proposed Action

Long-term negligible to minor beneficial effects would be expected. The implementation of a trends analysis would allow for better planning with respect to public services. Forecasted population growth (or decline) would provide data for estimating the number of police and fire

[7] Based on a fire-fighting force (full-time and part-time) of 938 and an ROI population of 363,988 (see Section 4.1.1, Population, and Section 4.1.5.2, Public Safety).

personnel needed to maintain an acceptable response time to law enforcement and fire emergencies. With respect to public safety, adoption and implementation of research, education, and enforcement recommendations made in the *National Gambling Impact Study Commission Report* (1999) could provide some beneficial effects on the community relative to the no action alternative. However, public safety might continue to deteriorate relative to current conditions, even with implementation of these recommendations.

5.1.3 Environmental Justice

5.1.3.1 Trends Analysis for Environmental Justice

An environmental justice analysis must be included in every EIS to comply with Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*. The general purposes of the EO are as follows:

- To focus the attention of federal agencies on human health and environmental conditions in minority communities and low-income communities with the goal of achieving environmental justice.

- To foster nondiscrimination in federal programs that substantially affect human health or the environment.

- To give minority communities and low-income communities greater opportunities for public participation in, and access to, public information on matters relating to human health and the environment.

The purpose of the environmental justice trends analysis is to project how the different growth scenarios could affect minority or low-income people in the coastal Mississippi region during the period 2000 to 2020. Between 1990 and 2000, the absolute number of minority persons in the ROI increased by 8,255 (US DOC, Census, 2001a). Because of the overall population increase and the proportion of the increase that was non-minority, however, the percentage of minorities in the ROI decreased by 1 percent (US DOC, Census, 2001a). The number of persons living in poverty in the ROI decreased by 4,104 persons between 1990 and 2000, reflecting a 4 percent drop in the poverty rate (US DOC, Census, 2001a).

Examples of possible disproportionate adverse impacts resulting from development of large-scale gaming facilities and resorts include the following:

- Housing prices could rise. New development next to low-income areas could increase housing prices and property taxes in the area, decreasing the availability of affordable housing. Low-income people could be compelled to relocate to more distant housing markets where prices are lower.

- Displacement of low-income or minority populations could occur if significant areas of land are required to meet development needs (e.g., construction of new roads). As a result, the inventory of affordable housing would decrease, causing the affected residents to move to other housing markets.

- Encroachment of incompatible uses into minority or low-income residential neighborhoods could result from new large-scale development. For example, a high-

density urban land use could increase traffic flow through low-income or minority neighborhoods, raising safety issues and decreasing quality of life.

- New development could result in the displacement of businesses where low-income or minority populations work or receive services (e.g., grocery stores, laundromats, hair salons, and banks). Residents could be compelled to travel farther to get to work and to receive goods and services, or possibly to have to find new employment. However, depending on the type of new industry moving into these areas, and depending on the skill level of the person, low-income and minority populations might be able to find jobs in the new industry.

Census tract data show that there are neighborhoods with a significant percentage of minority populations in the Mississippi Coastal Study Area (CSA). A Census tract is considered to have a disproportionate percentage of low-income or minority populations under either of two conditions: (1) the percentage of persons in low-income or minority populations in the Census tracts exceeds the percentage in the county, or (2) the percentage of low-income or minority populations in the Census tract exceeds 50 percent. Table 5.1–10 lists the percentage of minority and low-income populations by county and for the ROI. Minority populations included in the Census are identified as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other. Poverty status, used to define low-income status, is reported as the number of persons with income below the poverty level.

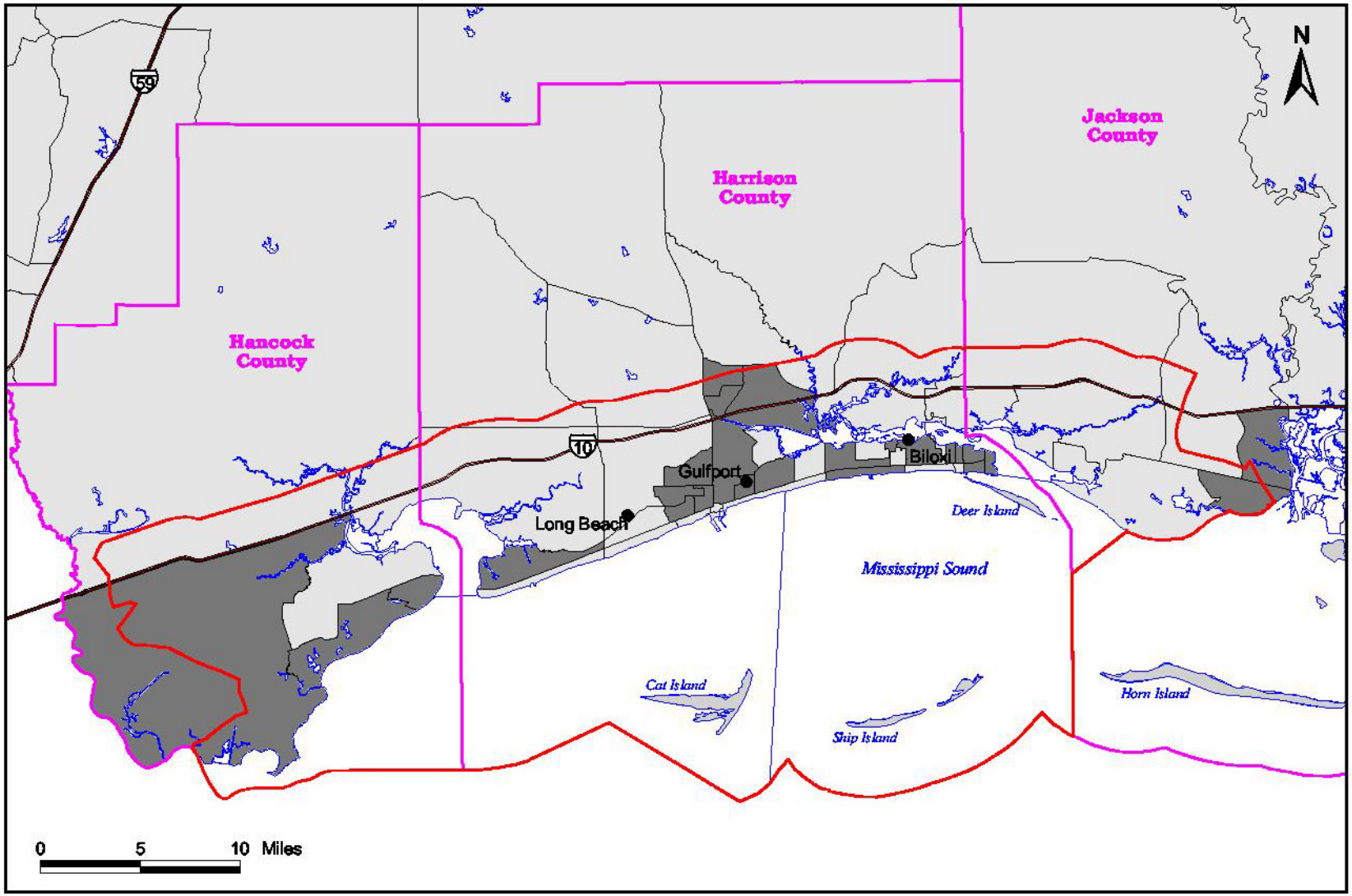
Table 5.1–10
Percentage of Minority and Low-Income Populations Per County and for the ROI

	Percent Minority	Percent Living in Poverty
Hancock County	9.7	15.3
Harrison County	26.9	14.9
Jackson County	24.6	13.6
ROI	20.4	14.6

Source: US DOC, Census, 2001a.

Figure 5.1–1 depicts the Census tracts (from the 2000 Census) where the minority or low-income populations of the tract exceeds the percentage of minority or low-income populations for the county, or where the percentage of low-income or minority populations in the tract exceeds 50 percent. Within the Mississippi CSA, there are 2 tracts in Jackson County, 3 in Hancock County, and 21 in Harrison County that meet these criteria. The majority of these tracts are along the coast and the bay in Biloxi and Gulfport, and along the coast in Long Beach, Bay Saint Louis, and Waveland. Therefore, there are neighborhoods with a disproportionate percentage of minority or low-income populations in medium- and high-density urban neighborhoods where large-scale gaming industry development has already occurred and is expected to continue to develop.

Most-Likely Growth Scenario. Under the Most-Likely Growth Scenario, economic development and casino growth would occur at a much more modest growth rate than was experienced during the 1990s, as described under the REMI baseline forecast. Further development could cause disproportionate adverse impacts on minority and low-income populations if residents were compelled to relocate, or because of short-term construction-related impacts, long-term traffic impacts, or visual impacts (see the Visual Resources, Land Use, and Transportation Sections). Predicting the extent of new development or expansion of existing casinos and exactly where this



LEGEND

- Census Tract with Minority Population Greater Than the County Average
- Coastal Study Area
- County Boundary

Source: State Data Center of Mississippi, 2001a.

Minority Populations

Figure 5.1-1

development would occur is speculative. The degree to which future growth of the gaming industry would affect the vulnerable communities depend on the nature and intensity of future land uses and cannot be accurately characterized at this time.

There could also be benefits from new casinos and resorts moving into the ROI. The development would create new jobs, and the increased number of tourists to the Mississippi coastal region would increase tax revenue, both of which could benefit minority and low-income populations.

Low-income and minority populations could be affected by acquisition of property by state or local land acquisition programs. These programs are publicly funded in whole or in part. This type of acquisition might be necessary for transportation improvement through the construction of new roads or widening of existing roads to relieve congestion from population and tourism growth, and for public safety (hurricane evacuation situations). Such transportation improvements could create disproportionate adverse impacts on minority and low-income populations if their homes or businesses were located on land required for such projects. However, the burden on minority and low-income populations would be mitigated by the Mississippi Public Welfare regulations. Title 43, Chapter 39 (Public Welfare: Relocation Assistance) of the Mississippi Code requires that financial assistance and advisory services be supplied to persons and businesses displaced as a result of land acquisition.

High-Growth Scenario and Medium-Growth Scenario. The same disproportionate adverse impacts on minority and low-income populations described under the Most-Likely Growth Scenario would be expected, but to a greater extent. The majority of the affected populations are already living in medium- and high-intensity use areas. The rate of expansion expected under the Medium and High-Growth Scenarios would increase the pressure of large-scale casino and associated development on the environmental justice neighborhoods. Such encroachment, however, is speculative and cannot be accurately characterized as to how it would change the demographics of the study area between 2000 and 2020. As under the Most-Likely Growth Scenario, there could also be positive benefits from new casinos and resort development, including the creation of new jobs and increased regional tax revenue, which could benefit minority and low-income populations.

5.1.3.2 Consequences of the No Action Alternative on Environmental Justice

Under the no action alternative, the conditions would be the same as those presented for the growth scenarios above. The Corps would continue to review permits using the same procedures and analytical tools as those used in the past and would continue to identify any disproportionately high or adverse impacts on minority and low-income populations due to federal actions. Any of the growth scenarios described in the trends analysis could occur. Therefore, conditions under the no action alternative would be the same as those reflected by the four growth scenarios described in the trends analysis section. Relative to conditions in 2000, minor adverse effects might occur as high-intensity growth continues throughout the CSA.

5.1.3.3 Consequences of the Proposed Action on Environmental Justice

Long-term minor beneficial effects would be expected. Implementation of the proposed action would allow for a better assessment of any direct, indirect, and cumulative impacts from proposed actions on minority and low-income populations. Populations that would be affected could be identified, and measures taken to avoid or mitigate any disproportionately high and adverse

impacts on the human health or environmental conditions in minority or low-income communities.

5.1.4 Protection of Children

5.1.4.1 Trends Analysis for the Protection of Children

Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, directs each federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks. Under all scenarios, if development occurred near a residential area, the construction activity associated with new development or expansion of existing facilities could be a safety risk to children. The risk would increase as the amount of development increases under each scenario. Safety measures, such as barriers to construction sites and "no trespassing" signs, would need to be used to prevent or deter children from playing in construction zones, and construction vehicles and equipment would need to be secured when not in use. Under all scenarios, tourism and population growth would increase traffic on roads in the study area. Although outside the purview of the Corps of Engineers, local transportation agencies might consider implementing a transportation plan to mitigate hazards due to increased traffic. Concern was expressed during the scoping process about the correlation between crime and casinos and how this would affect the safety of children residing in neighborhoods near casinos and of public safety in general. This concern has been raised as a national concern for the protection of children in the *National Gambling Impact Study Commission Report* (1999). Based on the available research, the document concludes: "Clearly, adolescents are a segment of the population who are at particular risk of developing problems with gambling" (NGISCR, 1999). Other possible adverse effects cited in the study included family disintegration, substance abuse, and increases in criminal activity. Crime as related to the population changes during the 1990s is discussed in Section 5.1.2.

5.1.4.2 Consequences of the No Action Alternative on the Protection of Children

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as used in the past and would continue to identify any adverse impacts that might affect the health or safety of children. Any of the growth scenarios described in the trends analysis could occur. Therefore, conditions under the no action alternative would be the same as those reflected by the four growth scenarios described in the Trends Analysis section. Relative to conditions in 2000, minor to significant adverse effects on children might occur under Medium- to High-Growth Scenarios as a result of increased casino development.

5.1.4.3 Consequences of the Proposed Action on the Protection of Children

Long-term minor beneficial effects would be expected relative to the no action alternative. A comprehensive regional plan to ensure the safety of children could be prepared to address a number of concerns such as increased traffic hazards, construction site safety, bacterial exposure (e.g., from septic tank failures), and social concerns that might be attributed to gaming in the area. Furthermore, adoption of specific recommendations for the protection of children made in the *National Gambling Impact Study Commission Report* (1999) might provide some beneficial effect relative to the no action alternative. In addition, these protection issues and mitigation measures should be addressed as part of "protection of children" NEPA analyses for future large-

scale permits. Implementation of a regional plan could allow for a better assessment of any direct, indirect, or cumulative impacts from proposed future actions that might adversely affect the health or safety of children. Potential risks to children could be identified and measures taken to avoid or mitigate risk to a child's health or safety.

5.2 LAND USE AND LAND COVER

This section presents projected changes in land use/land cover for the Mississippi coastal region for the period 2000–2020. The projected changes are best estimates and are based on the observed trends in land use/land cover change during the 1972–2000 period described in Section 3. Core assumptions in any forecasting methodology are more crucial than the sophistication of technique, and here the critical core assumption is that the 1972–2000 trends, particularly the 1992–2000 trends, would continue through 2020. The pace at which these trends would occur would vary, based on the rate of regional economic development as defined by the growth scenarios presented in the preceding economic impact assessment sections.

The remoteness of the 2020 target date is a potential problem in itself. Any forecast or projection must account for the characteristics of a trend from the date the forecast is made (2002) to the target date (2020). The longer the forecast period, the greater the chances that any of the conditions affecting the trend might change. As the length of the forecast period increases, uncertainty over the prevailing conditions also increases. The projected trends in land use/land cover in this study depend on the stability of trends in the coastal Mississippi economy as well as the wider state and national economies. These trends could change during the forecast period rendering the projections inaccurate. Other external factors, such as the price of energy, land, and individual agricultural products, as well as consumer tastes and preferences, play an important role in determining the level and nature of economic activities and resultant future land use/land cover changes. However, the long-term forecasts or projections provided below have the advantage of providing decision makers and the public more lead time (and hence more flexibility) in handling land use/land cover issues before they become problems or urgent crises.

With these caveats to be borne in mind, the following sections describe the projected changes in land use/land cover under each of the growth scenarios for (1) the coastal counties, (2) the Coastal Study Area (CSA), and (3) the watersheds. Information is provided for counties because these administrative units and the incorporated and unincorporated areas that they contain are responsible for land use regulations and controls. Many of the proposed mitigation measures for addressing the implications of land use/land cover change would also be initiated and administered by counties and incorporated areas. Projected changes in land use/land cover are also provided for the CSA, because this area is of prime concern, and for watersheds, because the analyses for other environmental resources addressed in this EIS are organized by natural watersheds and not by man-made administrative boundaries.

5.2.1 Trends Analysis

5.2.1.1 Technical Approach

Projected Land Use Calculations. To perform a trends analysis of land use patterns to the year 2020 a review was conducted of current and historical land use data sets, that would be representative of historical land use, pre-casino development land use, and current land use. GIS coverages of land use from the years 1972, 1992, and 2000 were selected. These data sets were available from MARIS (2000), MARIS (1992) the U.S. Geological Survey (USGS) (1972), and

USEPA (1992), respectively. Because each land use data set was originally developed with a different classification scheme, a consolidated classification was developed and applied to each data set for easier comparison among them. The consolidated categories are Medium Density Urban, High Density Urban, Transportation, Cropland/Pasture/Grassland, Deciduous/Mixed/ Bottomland Forest/Swamp, Upland Coniferous Forest, Wet Coniferous Forest/Savanna, Scrub-Shrub/Cutover/Barren, Emergent Wetland, and Surface Water/Other. In addition, because of other inconsistencies among the data sets, some manipulation was required to make them more comparable with each other, such as the following:

- Only the 1992 data set had a Transportation class. A similar class was added to the other data sets to reflect four-lane highways built at that time.

- There was a high degree of discrepancy between the deciduous forest acreage values in the 1992 MARIS data and the 1992 USGS data (National Land Cover Dataset [NLCD]) and 2000 MARIS data beyond what could be explained by deforestation. Upon further review it was determined that borderline deciduous forest stands were classified as scrub-shrub in the 1992 MARIS data. To correct for this, deciduous and mixed-forest areas in the 1992 NLCD data that were within the 1992 MARIS scrub/shrub areas were reclassified as deciduous/mixed forest in the 1992 MARIS data.

- Large discrepancies between the acreage for the upland coniferous forest and wet coniferous forest/savanna categories between the 2000 and the 1992 data sets were found, most likely the result of different methods of classifying the satellite imagery. A pine savanna category was not present in the 1972 data set. In addition, it is assumed that the older satellite imagery did not allow for upland coniferous forest to be distinguished from wet coniferous forest. To account for this, the upland coniferous forest and wet coniferous forest/savanna categories were combined to create a single coniferous forest/savanna category. However, wet coniferous forest/savanna areas were considered a separate category in calculating the potential future conversion of natural land cover types to developed areas. The percentage of all coniferous forest areas that were wet coniferous forest/savanna in 2000 was determined; then the total acreage converted from coniferous forest to developed areas was split between upland coniferous forest and wet coniferous forest/savanna using this percentage.

- The 1992 MARIS and 1972 USGS data sets were classified at a lower resolution than the 2000 MARIS data. As a result, it was evident there were several small natural areas in 2000 that were incorrectly classified as developed in 1992 and 1972. The urban areas appear to be more consolidated or generalized than they appear in aerial photographs. To correct for this error, land uses that were not expected to change from 1992 to 2000 and 1972 to 1992 were extracted from the 2000 and 1992 data sets respectively and applied to urban areas in the 1992 and 1972 data.

- The 2000 data set appeared to pick up isolated urban "pockets" (areas of fewer than 5 acres) in the less developed areas of the counties. These were not present in the 1992 or 1972 data sets. The earlier coverages appear to have overestimated urban areas in municipalities and along the coast; conversely, few urban pixels were found in rural areas even though Census data indicated significant population levels in these areas. This might have occurred as a result of different image classification and/or digitization techniques. A correction factor was applied to the 1972 and 1992 data sets based on Census data in order to more accurately reflect low-intensity development in 1972 and 1992.

- Comparison of wetland areas revealed that emergent wetland areas in 2000 were not classified as wetlands in 1992. Although wetland mitigation for development projects has occurred since 1992, it is unlikely that the 2000 image classification could have picked up mitigated wetlands in early stages of development. To account for this, wetlands present in the 2000 data set but not in the 1992 data were applied to the 1992 data set, and a similar enhancement was performed for the 1972 data using the reclassified 1992 data.

The primary focus of the land use analysis is to estimate the rate of growth of urban areas, and determine which land cover types would be converted to urban areas. To establish land use trends to 2020, the estimated increase in medium- and high-intensity urban land use acreages from 2000 to 2020 was determined using the following steps. The difference in per capita land consumption rates between 1992 and 2000 was calculated, and this result was multiplied by the expected population growth in 2020, generated by the REMI model (discussed in detail in Section 5.1) (REMI, 2001) for each of the growth scenarios on a subwatershed level. Subwatersheds were used because they cover the entire Mississippi coastal region and make for a more accurate level of analysis than the county or watershed level. Historical rates of change in acreages from other land use types to urban areas within each watershed were also calculated and applied, to account for the growth of urban areas. In addition, several assumptions were made in calculating 2020 projected land uses. The change in per capita land consumption was assumed to remain constant through 2020. Furthermore, only conversion to urban land use was considered, therefore conversion to/from other land use/land cover types was assumed to be negligible over the 20-year period. The land use analysis methodology is discussed in further detail in Appendix O.

Employment Sector Space Calculations. While projections of future demand for developed land are inherently uncertain, the employment change projections generated by the REMI model can be used to estimate the demand for square footage of commercial, office, retail, manufacturing, warehouse, and other kinds of industrial, commercial, and government sector space—and thus for the demand for land by employment sector. A full description of the approach used to generate these projections is provided in Appendix N. Tables listing the projected demand for square footage of space by location, type, and sector for the years 2000, 2005, 2010, 2015, and 2020 for the region of influence (ROI), as well as for Hancock, Harrison, and Jackson counties under the various growth scenarios are also provided in Appendix N.

Impervious Surface Calculations. Impervious surfaces are impenetrable surfaces such as pavement and rooftops through which water cannot flow. Such surfaces cause channeling and increased flow of water at collections points at down-gradient points on the surfaces. Arnold and Gibbons (1996) have argued that imperviousness is integrative and can be used to estimate or predict cumulative water resource impacts without regard to specific factors, helping to cut through much of the intimidating complexity surrounding nonpoint source pollution. Although impervious surfaces do not generate pollution, they (1) are a critical contributor to the hydrologic changes that degrade waterways; (2) are a major component of the intensive land uses that generate pollution; (3) prevent natural pollutant processing in the soil by preventing percolation; and (4) serve as an efficient conveyance system transporting pollutants into the waterways. The threshold value of imperviousness at which stream degradation first occurs is 10 percent impervious cover, which is indicative of an "impacted" stream or watershed (Arnold and Gibbons, 1996). To estimate the increase in the amount of impervious surfaces under the various growth scenarios in the study areas, the acreage of urban areas and the transportation class were used. The sum of impervious areas was calculated using 12 percent of the medium-intensity urban acreage, 85 percent of the high-intensity acreage, and the total acreage of the transportation class (USDA, NRCS, 1986).

5.2.1.2 Growth Scenarios

5.2.1.2.1 Most-Likely Growth Scenario

Coastal Counties. Under the Most-Likely Growth Scenario (Table 5.2–1), developed land acreage is projected to increase by about 12 percent and impervious land cover within the developed lands by 18.6 percent during the period 2000–2020. Although the medium-density urban land acreage is projected to increase by 3 percent, high-density urban land is projected to increase by 36.8 percent. The population of the three counties is projected to increase by 17 percent from 367,000 to 431,000. Most of the increase in developed land acreage (10,500 acres) is projected to come from conversion of emergent wetlands (2,900 acres), pine forest/savanna coverage (2,269 acres), and agricultural land (2,220 acres). The loss of emergent wetland would represent the largest percentage loss of existing coverage (5.2 percent) of any of the land use types identified.

Note that the State of Mississippi has a Coastal Preserves Program to preserve, conserve, restore, and manage Mississippi's coastal ecosystems, and in particular to enhance and perpetuate approximately 83,000 acres of important coastal Mississippi wetland resources. Nearly all of the emergent wetlands shown in Figure 4.2-1 are included in the program. The program, established in 2003, requires a permit for any regulated activity that occurs in a coastal wetland and that is not otherwise specifically excluded from the permit requirement under the Coastal Wetlands Protection Act (MS CODE §§ 49-27-1–49-27-71). This wetlands protection program, together with mitigation requirements under Corps permits for activities that impact wetlands, has the potential to substantially protect emergent wetlands in coastal Mississippi and the Coastal Study Area. Projections of emergent wetland losses in this EIS are based on a trends analysis projected into the future using data from 1970 through 2000. The effects of the Coastal Preserves Program on emergent wetland losses is still difficult to predict and has not been incorporated into the model projections. The program currently has title to nearly 28,000 acres of coastal wetlands. Explicit protection of those acres could have a variety of long-term effects on coastal Mississippi's emergent wetland resources, including increased development pressure on unprotected coastal wetlands, reduced impacts to coastal wetlands for non-water-dependent uses (e.g., residential and non-water-dependent commercial development), or reduced losses of functionally important coastal wetlands. For the purposes of this analysis, the reader is encouraged to keep in mind that losses of emergent wetlands do not take into account the protection bestowed on coastal wetlands by the Coastal Preserves Program or wetland impact offsets by mitigation activities.

By 2020 some 153 million square feet of office, retail, wholesale, and other kinds of space would be needed in the three coastal counties, an increase of 12 percent over estimated square footage in the year 2000. See Table 1 in Appendix N, which presents the projected demand for square footage of space by location and employment sector for the interim years of 2005, 2010, and 2015.

Hancock County. Under the Most-Likely Growth Scenario, developed land acreage in Hancock County is projected to increase by 11 percent and impervious land cover within the developed lands by 12 percent during the period 2000–2020 (Appendix O–Table 1). While medium-density urban land acreage is projected to increase by 9 percent, high-density urban land is projected to increase by 33 percent. The population of Hancock County is projected to increase from 42,000 to 53,000, or by 26 percent, during the same period. Most of the increase in developed land acreage (1,800 acres) is projected to come from losses in pine forest savanna coverage (704 acres), agricultural land (357 acres), and scrub-shrub/cutover/barren land (279 acres). Although

in terms of acreage, emergent wetland loss would be smaller (212 acres), the decrease in acreage would represent a 1 percent loss of the existing emergent wetland acreage in Hancock County, second only to agriculture in terms of percentage loss.

By 2020, some 14 million square feet of office, retail, wholesale, and other kinds of space would be needed in Hancock County, an increase of 20 percent over estimated square footage in the year 2000. See Table 2 in Appendix N, which presents the projected demand for square footage of space by location and employment sector for the interim years of 2005, 2010, and 2015.

Table 5.2–1
Coastal Counties Projected Land Use for the Year 2020—Most-Likely Growth Scenario

	Existing Land Use		Most-Likely Growth		
	2000 (acres)	Percentage of 2000 Total (%)	2020 (acres)	Percentage of 2020 Total (%)	Change 2000 to 2020 (%)
Land Use–General					
Developed	90,203	7.9	100,738	8.8	11.7
- Impervious	42,367		50,241		18.6
Natural	940,687	82.1	932,372	81.4	-0.9
Agricultural	101,724	8.9	99,504	8.7	-2.2
Inland Fresh Water	12,577	1.1	12,577	1.1	0.0
Subtotals	1,145,192	100.0	1,145,192	100.0	
Surface Water/Other	509,833		509,833		
Total Acres	1,655,024		1,655,024		
Land Use–Detailed					
Medium-Density Urban Land	50,170	4.4	51,651	4.5	3.0
High-Density Urban Land	24,572	2.1	33,626	2.9	36.8
Transportation	15,461	1.4	15,461	1.4	0.0
Cropland/Pasture/Grassland	101,725	8.9	99,504	8.7	-2.2
Deciduous/Mixed Bottomland Forest/Swamp	295,602	25.8	294,281	25.7	-0.4
Upland Coniferous Forest	172,415	15.1	171,181	15.0	-0.7
Wet Coniferous Forest/Savanna	180,095	15.7	179,060	15.6	-0.6
Scrub-Shrub/Cutover/ Barren	236,848	20.7	234,997	20.5	-0.8
Emergent Wetland	55,726	4.9	52,854	4.6	-5.2
Inland Fresh Water	12,577	1.1	12,577	1.1	0.0
Subtotals	1,145,192	100.0	1,145,192	100.0	
Surface Water/Other	509,833		509,833		
Total Acres	1,655,024		1,655,024		

Harrison County. Under the Most-Likely Growth Scenario, developed land acreage in Harrison County is projected to increase by 8 percent and impervious land cover within the developed lands by 10 percent (Appendix O–Table 2). Although medium-density urban land acreage is projected to increase by 6 percent, high-density urban land acreage is projected to increase by 18 percent. The population of Harrison County is projected to increase from 189,000 to 210,00, or

by 11 percent, during the same period. Most of the increase in developed land acreage (about 3,600 acres) is projected to result from conversion of scrub-shrub/cutover/barren land (1,022 acres), agricultural land (976 acres), and pine forest savanna (803 acres). Although the emergent wetland acreage loss would be relatively small in terms of acreage (113 acres), the decrease would represent an almost 2 percent loss of the existing emergent wetland acreage in Harrison County, second only to agricultural land loss in percentage terms.

By 2020 it is projected that some 88 million square feet of office, retail, wholesale and other kinds of space would be needed in Harrison County, an increase of 8 percent over the estimated square footage in the year 2000. Table 3 in Appendix N provides the projected demand for square footage of space by location and employment sector for the interim years of 2005, 2010, and 2015.

Jackson County. Under the Most-Likely Growth Scenario, developed land acreage in the county is projected to increase by 15 percent and impervious land cover within the developed lands is projected to increase by 31 percent during the period 2000–2020 (Appendix O–Table 3). Medium-density urban land acreage is projected to decrease by 4 percent, while high-density urban land acreage is projected to increase by 62 percent. The population of Jackson County is projected to increase from 135,000 to 168,000, or by 24 percent, during the same period. Most of the increase in developed land acreage (about 5,200 acres) is projected to come from conversion of emergent wetlands (2,500 acres), agricultural land (890 acres), and pine forest savanna (760 acres). Loss of emergent wetland acreage loss would translate into about a 9 percent reduction from existing acreage and would exceed acreage losses for all other land use/cover categories. Agricultural land acreage, for example, would decrease by almost 3 percent under this scenario.

By 2020, some 51 million square feet of office, retail, wholesale, and other kinds of space would be needed in Jackson County, an increase of 16 percent over the estimated square footage in the year 2000. Table 4 in Appendix N provides the projected demand for square footage of space by location and employment sector for the interim years of 2005, 2010, and 2015.

Coastal Study Area. Under the Most-Likely Growth Scenario, developed land acreage in the CSA would increase by about 9 percent and impervious land cover within the developed lands would increase by about 20 percent during the period 2000–2020 (see Table 5.2–2). Although the medium-density urban land acreage is projected to decrease by about 5 percent, high-density urban land acreage is projected to increase by 41 percent. Most of the increase in developed land acreage (about 4,300 acres) is projected to come from conversion of agricultural land and emergent wetlands (1,300 and 1,100 acres, respectively), and pine forest savanna (1,000 acres). Losses in agricultural land and emergent wetland acreage are projected to exceed other land cover losses both in terms of percentage (7 and 6 percent, respectively), as well as acreage.

Under the Most-Likely Growth Scenario the impervious cover area is projected to increase from approximately 24,000 acres in 2000 to 29,000 acres in 2020, resulting in a change from a 9 percent impervious cover to an 11 percent impervious cover for the entire CSA. Impervious cover was estimated at the subwatershed level because impervious cover is used for further analysis in the water resources section of this EIS, which must use watersheds as its geographic area to assess water quality impacts. There are 11 subwatersheds in the CSA. With the exception of the portion of the Turkey Creek–Old Fort Bayou subwatershed that lies within the CSA, all had impervious coverage of less than 10 percent in the year 2000 (Table 5.2–3 and Appendix O–Table 4). This is indicative of a "protected" status for stream health. The Turkey Creek–Old Fort Bayou subwatershed within the CSA had an estimated 12.5 percent impervious cover in

Table 5.2–2
Coastal Study Area Projected Land Use for the Year 2020—Most-Likely Growth Scenario

	Existing Land Use		Most-Likely Growth		
	2000 (acres)	Percentage of 2000 Total (%)	2020 (acres)	Percentage of 2020 Total (%)	Change 2000 to 2020 (%)
Land Use–General					
Developed	51,167	19.8	55,502	21.5	8.5
- Impervious	23,931		28,564		19.4
Natural	188,815	73.1	185,567	71.8	-1.7
Agricultural	16,386	6.3	15,299	5.9	-6.6
Inland Fresh Water	2,103	0.8	2,103	0.8	0.0
Subtotals	258,471	100.0	258,471	100.0	
Surface Water/Other	308,531		308,531		
Total Acres	567,002		567,002		
Land Use–Detailed					
Medium-Density Urban Land	28,622	11.1	27,323	10.6	-4.5
High-Density Urban Land	13,657	5.3	19,291	7.5	41.3
Transportation	8,888	3.4	8,888	3.4	0.0
Cropland/Pasture/Grassland	16,387	6.3	15,299	5.9	-6.6
Deciduous/Mixed/Bottomland Forest/Swamp	50,827	19.7	50,425	19.5	-0.8
Upland Coniferous Forest	22,293	8.6	21,699	8.4	-2.7
Wet Coniferous Forest/Savanna	45,899	17.8	45,516	17.6	-0.8
Scrub-Shrub/Cutover/Barren	46,933	18.2	46,349	17.9	-1.2
Emergent Wetland	22,863	8.8	21,577	8.3	-5.6
Inland Fresh Water	2,103	0.8	2,103	0.8	0.0
Subtotals	258,471	100.0	258,471	100.0	
Surface Water/Other	308,531		308,531		
Total Acres	567,002		567,002		

Table 5.2–3
Projected Percent Subwatershed Imperviousness for the Year 2020—Most Likely Growth Scenario

	Coastal Study Area		Watershed Study Area	
Subwatershed Name	**2000 Percent Impervious**	**2020 Percent Impervious**	**2000 Percent Impervious**	**2020 Percent Impervious**
Upper Wolf River	N/A	N/A	0.4	0.4
Upper Jourdan River	9.1	10.3	0.4	0.4
Lower Wolf River–Cane Creek	4.2	4.9	1.0	1.2
Rotten Bayou	4.1	6.0	1.4	1.9
DeLisle	5.1	5.8	5.1	5.8
Bayou La Croix	4.8	5.6	4.5	5.3
Biloxi River	6.8	8.1	1.4	1.5
Tuxachanie Creek	7.0	8.8	1.2	1.5
Turkey Creek–Old Fort Bayou	12.5	14.8	10.9	12.9
The Islands	0.0	0.0	0.0	0.0
Offshore Areas	0.0	0.0	0.0	0.0
Total	9.3	11.1	2.9	3.5

2000, above the 10 percent threshold value of imperviousness at which stream degradation first occurs and indicative of an "impacted" stream or watershed.

Under the Most-Likely Growth Scenario, by 2020, the extent of imperviousness in all of the subwatersheds in the CSA is projected to increase. With the exceptions of the Upper Jourdan River and Turkey Creek–Old Fort Bayou subwatersheds, however, all are projected to remain in the "protected" category with less than 10 percent impervious cover acreage. The Upper Jourdan River and Turkey Creek–Old Fort Bayou subwatersheds within the CSA are projected to have 10 and 14.8 percent impervious coverage, respectively, qualifying for the "impacted" category.

Watershed Study Area (Coastal Mississippi Watershed). Under the Most-Likely Growth Scenario, developed land acreage in the Watershed Study Area is projected to increase by 10 percent and impervious cover within the developed lands is projected to increase by 19 percent during the period 2000–2020 (see Table 5.2–4). Although medium-density urban land acreage is projected to increase by just 1 percent, high-density urban land acreage is projected to increase by 38 percent. Most of the increase in developed land acreage (about 6,700 acres) is projected to result from conversion of agricultural land (1,700 acres), pine forest/savanna (1,600 acres), and emergent wetlands (1,300 acres). Reductions in emergent wetlands in terms of percentage loss (6 percent) as well as acreage loss would be the largest for the various land use/land cover categories.

Table 5.2–4
Watershed Study Area Projected Land Use for the Year 2020—Most-Likely Growth Scenario

	Existing Land Use		Most-Likely Growth		
	2000 (acres)	Percentage of 2000 Total (%)	2020 (acres)	Percentage of 2020 Total (%)	Change 2000 to 2020 (%)
Land Use – General					
Developed	64,002	6.5	70,684	7.2	10.4
- Impervious	28,752		34,152		18.8
Natural	810,108	82.4	805,114	81.9	-0.6
Agricultural	105,117	10.7	103,429	10.5	-1.6
Inland Fresh Water	4,290	0.4	4,290	0.4	0.0
Subtotals	983,517	100.0	983,517	100.0	
Surface Water/Other	310,646		310,646		
TOTAL Acres	1,294,163		1,294,163		
Land Use – Detailed					
Medium Density Urban Land	37,235	3.8	37,620	3.8	1.0
High Density Urban Land	16,552	1.7	22,850	2.3	38.0
Transportation	10,215	1.0	10,215	1.0	0.0
Cropland/Pasture/Grassland	105,117	10.7	103,429	10.5	-1.6
Deciduous/Mixed Bottomland Forest/Swamp	235,461	23.9	234,587	23.9	-0.4
Upland Coniferous Forest	188,136	19.1	187,129	19.0	-0.5
Wet Coniferous Forest/Savanna	135,636	13.8	135,054	13.8	-0.4
Scrub-Shrub/Cutover/Barren	226,951	23.1	225,723	23.0	-0.5
Emergent Wetland	23,924	2.4	22,620	2.3	-5.5
Inland Fresh Water	4,290	0.4	4,290	0.4	0.0
Subtotals	983,517	100.0	983,517	100.0	
Surface Water/Other	310,646		310,646		
Total Acres	1,294,163		1,294,163		

The impervious cover for the Watershed Study Area is projected to increase from approximately 27,000 acres in 2000 to 34,000 acres in 2020, representing a change from a 3 percent impervious cover to a 3.5 percent impervious cover for the entire Watershed Study Area. The proper scale for assessing the significance of impervious cover, however, is the subwatershed, of which there are 11 in the Watershed Study Area. With the exception of the Turkey Creek–Old Fort Bayou subwatershed, all had impervious coverage of less than 10 percent in the year 2000 (Table 5.2–3), which is indicative of a "protected" status for stream health. The Turkey Creek–Old Fort Bayou subwatershed had an estimated 11 percent impervious cover in 2000, which is above the threshold value of imperviousness at which stream degradation first occurs and is indicative of an "impacted" stream or watershed.

Under the Most-Likely Growth Scenario, by the year 2020, the level of imperviousness in 7 of the 11 subwatersheds is projected to increase. With the exception of the Turkey Creek–Old Fort Bayou subwatershed, however, all are projected to remain in the "protected" category with less than 10 percent impervious cover acreage. The Turkey Creek–Old Fort Bayou subwatershed is projected to have a 12.9 percent impervious coverage, well into the "impacted" category.

Bay St. Louis Watershed. Under the Most-Likely Growth Scenario, developed land acreage in the Bay St. Louis watershed is projected to increase by 14 percent and impervious land cover within the developed land is projected to increase by 18 percent during the period 2000–2020 (Appendix O–Table 5). Although medium-density urban land acreage is projected to increase by 10 percent, high-density urban land acreage is projected to increase by 43 percent. Most of the increase in developed land acreage (about 3,100 acres) is projected to come from conversion of pine forest/savanna (1,000 acres), agricultural land (700 acres), and scrub-shrub/cutover/barren land (600 acres). Emergent wetland acreage loss (346 acres) is projected to be greater in terms of percentage loss than the other cover categories.

Biloxi Bay Watershed. Under the Most-Likely Growth Scenario, developed land acreage in the Biloxi Bay watershed is projected to increase by 9 percent and the impervious land cover within the developed lands by 19 percent during the period 2000–2020 (Appendix O–Table 6). Medium-density urban land acreage is projected to decrease by 5 percent, while high-density urban land acreage is projected to increase by 37 percent. Most of the increase in developed land acreage (about 3,700 acres) is projected to come from conversion of agricultural land (1,000 acres) and emergent wetlands (1,000 acres). The projected emergent wetland acreage losses is about the same as the projected acreage loss for agriculture, but would account for about 12 percent of the existing emergent wetlands acreage in the watershed.

5.2.1.2.2 Low-Growth Scenario

The land use/land cover projections under the Low-Growth Scenario would be essentially the same as those projected under the Most-Likely Growth Scenario. Land use/land cover changes seen under the Most-Likely Growth Scenario would also hold true for the Low-Growth Scenario, such as the projected loss of emergent wetlands and the increase in impervious cover for the Turkey Creek–Old Fort Bayou subwatershed, which is projected to see an increase in imperviousness that would, at 14 percent, be well above the threshold for an "impacted" stream or watershed.

Similarly, the projected demand for square footage of office, retail, wholesale, and other kinds of space in the three coastal counties is essentially the same, just slightly less than the demand under the Most-Likely Growth Scenario. See Appendix N–Tables 5 through 8.

5.2.1.2.3 Medium-Growth Scenario

Coastal Counties. Under the Medium-Growth Scenario, developed land acreage in the three coastal counties is projected to increase by about 26 percent and impervious land cover within the developed lands is projected to increase by about 36 percent (see Table 5.2–5) during the period 2000–2020. Although medium-density urban land acreage is projected to increase by 12 percent, high-density urban land is projected to increase by 69 percent as the population of the three counties is projected to increase from 367,000 to 502,000, or by 37 percent. Most of this increase in developed land acreage (23,000 acres) is projected to come from conversion of agricultural land (5,500 acres), pine forest/savanna (5,200 acres), scrub-shrub/cutover/barren land (5,100 acres), and emergent wetlands (3,700 acres) over the 2000–2020 period. The percentage decrease in emergent wetlands (7 percent) would exceed percentage losses for each of the other land cover categories.

Table 5.2–5
Coastal Counties Projected Land Use for the Year 2020—Medium-Growth Scenario

	Most-Likely Growth			Medium-Growth		
	2020 (acres)	**Percent Total 2020**	**Percent Change 2000–2020**	**2020 (acres)**	**Percent Total 2020**	**Percent Change 2000–2020**
Land Use – General						
Developed	100,738	8.8	11.7	113,212	9.9	25.5
- Impervious	50,241		18.6	57,532		35.8
Natural	932,372	81.4	-0.9	923,130	80.6	-1.9
Agricultural	99,504	8.7	-2.2	96,273	8.4	-5.4
Inland Fresh Water	12,577	1.1	0.0	12,577	1.1	0.0
Subtotals	1,145,192	100.0		1,145,192	100.0	
Surface Water/Other	509,833			509,833		
Total Acres	1,655,024			1,655,024		
Land Use – Detailed						
Medium-Density Urban Land	51,651	4.5	3.0	56,188	4.9	12.0
High-Density Urban Land	33,626	2.9	36.8	41,563	3.6	69.1
Transportation	15,461	1.4	0.0	15,461	1.4	0.0
Cropland/Pasture/Grassland	99,504	8.7	-2.2	96,273	8.4	-5.4
Deciduous/Mixed Bottomland Forest/Swamp	294,281	25.7	-0.4	292,122	25.5	-1.2
Upland Coniferous Forest	171,181	15.0	-0.7	169,572	14.8	-1.7
Wet Coniferous Forest/Savanna	179,060	15.6	-0.6	177,712	15.5	-1.3
Scrub-Shrub/Cutover/ Barren	234,997	20.5	-0.8	231,736	20.2	-2.2
Emergent Wetland	52,854	4.6	-5.2	51,988	4.5	-6.7
Inland Fresh Water	12,577	1.1	0.0	12,577	1.1	0.0
Subtotals	1,145,192	100.0		1,145,192	100.0	
Surface Water/Other	509,833			509,833		
Total Acres	1,655,024			1,655,024		

By 2020 some 178 million square feet of office, retail, wholesale, and other kinds of space would be needed in the three coastal counties under the Medium-Growth Scenario. The 178 million square feet represent an increase of 31 percent over the estimated square footage for the year 2000 (See Appendix N– Table 9).

Hancock County. Under the Medium-Growth Scenario developed land acreage in Hancock County is projected to increase by 18 percent and impervious land cover within the developed lands is projected to increase by 20 percent during the period 2000 to 2020 (Appendix O–Table 7). Although medium-density urban land acreage is projected to increase by 15 percent, high-density urban land is projected to increase by 56 percent as the population of the county is projected to increase from 42,000 to 61,000, or by 43 percent. Most of the increase in developed land acreage (3,000 acres) is projected to come from conversion of agricultural land (600 acres), pine forest/savanna coverage (1,200 acres), and scrub-shrub/cutover/barren (480 acres). The percentage decrease in agricultural lands (2 percent) would exceed percentage losses in each of the other land cover categories. Emergent wetlands are projected to lose 366 acres by 2020, or a little less than 2 percent of their 2000 coverage.

Although medium-density urban land acreage is projected to increase by 15 percent, high-density urban land is projected to increase by 56 percent. The population of Hancock County is projected to increase from 43,000 to 61,000, or by 43 percent. Most of the increase in developed land acreage (3,000 acres) is projected to come from conversion of pine forest/savanna coverage (1,200 acres), agricultural land (600 acres), and scrub-shrub/cutover/barren land (480 acres) over the 2000–2020 period. In terms of percentage, agricultural land would experience the largest loss of existing coverage (2 percent). Also, under the Medium-Growth Scenario, by 2020, 16 million square feet of office, retail, wholesale, and other kinds of space would be needed in Hancock County, which represents an increase of 38 percent over the estimated square footage in the year 2000 (See Appendix N–Table 10).

Harrison County. Under the Medium-Growth Scenario in Harrison County, developed land acreage is projected to increase by 26 percent and impervious land cover within the developed lands is projected to increase by 30 percent (Appendix O–Table 8). Although medium-density urban land acreage is projected to increase by 25 percent, high-density urban land is projected to increase by 71 percent. During the same period, the population of Harrison County is projected to increase from 190,000 to 267,000, or by 41 percent. Most of the increase in developed land acreage (14,000 acres) is projected to come from conversion of scrub-shrub/cutover/barren land (4,000 acres), agricultural land (3,800 acres), and pine forest/savanna coverage (3,100 acres) over the 2000–2020 period. Land devoted to agriculture would decrease by 10 percent, the largest percentage loss of the land cover categories identified. Emergent wetland loss is projected to be 441 acres, or a 6.5 percent loss.

It is projected that by 2020 some 110 million square feet of office, retail, wholesale, and other kinds of space would be needed in Harrison County under the Medium-Growth Scenario. The 110 million square feet represent an increase of 36 percent over the estimated square footage in the year 2000 (See Appendix N–Table 11).

Jackson County. Under the Medium-Growth Scenario developed land acreage in Jackson County is projected to increase by 18 percent and the impervious land cover within the developed land is projected to increase by 36 percent (Appendix O– Table 9). Although medium-density urban land acreage is projected to decrease by 5 percent, high-density urban land is projected to increase by 71 percent. During the same period (2000 to 2020), the population of Jackson County is projected to increase from 136,000 to 174,000, or by 28 percent. Most of this increase in

developed land acreage (6,000 acres) is projected to come from conversion of emergent wetlands (2,900 acres) and agricultural land (1,000 acres). The loss of emergent wetlands would represent the largest percentage loss of existing coverage (10 percent) of any of the land cover types identified.

It is projected that by 2020 almost 52 million square feet of office, retail, wholesale, and other kinds of space would be needed in Jackson County under the Medium-Growth Scenario. The 52 million square feet represent an increase of 17 percent over the estimated square footage in the year 2000 (See Appendix N–Table 12).

Coastal Study Area. Under the Medium-Growth Scenario, developed land acreage in the CSA is projected to increase by 21 percent, while the impervious land cover within the developed lands is projected to increase by 48 percent (see Table 5.2–6). Although medium-density urban land acreage is projected to decrease by 12 percent, high-density urban land is projected to increase by 102 percent under the Medium-Growth Scenario. Most of this increase in developed land acreage (almost 11,000 acres) is projected to come from losses in emergent wetlands (3,200 acres), agricultural land (2,600 acres), and pine forest/savanna (2,300 acres) over the 2000–2020 period. The loss of agricultural land and emergent wetlands would represent the largest percentage losses of existing coverage (16 and 14 percent, respectively) of any of the land cover types identified.

The impervious cover for the CSA as a whole under the Medium-Growth Scenario is projected to increase by 48 percent, from approximately 24,000 acres in 2000 to 35,000 acres in 2020. This represents a change from a 9 percent impervious cover to a 14 percent impervious cover for the entire CSA. With the exceptions of those portions of the Turkey Creek–Old Fort Bayou and the Upper Jourdan River subwatersheds that lie within the CSA, all the subwatersheds had impervious coverage of less than 10 percent in the year 2000 (Table 5.2–7 and Appendix O–Table 10), which is indicative of a "protected" status for stream health. The Turkey Creek–Old Fort Bayou subwatershed within the CSA had an estimated 13 percent impervious cover in 2000, which is above the threshold value of imperviousness at which stream degradation first occurs and is indicative of an "impacted" stream or watershed.

By 2020 under the Medium-Growth Scenario, the extent of imperviousness in all of the subwatersheds in the CSA is projected to increase. However, with the exceptions the Upper Jourdan River, Biloxi River, and Turkey Creek–Old Fort Bayou subwatersheds, all are projected to remain in the "protected" category with less than 10 percent impervious cover of acreage. The Upper Jourdan River, Biloxi River, and Turkey Creek–Old Fort Bayou subwatersheds are projected to have 12, 10, and 18 percent impervious coverage, respectively, indicating this would be considered "impacted."

Watershed Study Area. Under the Medium-Growth Scenario, developed land acreage in the Watershed Study Area is projected to increase by 26 percent, and the impervious acreage within the developed land is projected to increase by 46 percent during the period 2000 to 2020 (see Table 5.2–8). Medium-density urban land acreage is projected to increase by just 3 percent, while high-density urban land acreage is projected to increase by 94 percent. Most of the increase in developed land acreage (16,500 acres) is projected to come from losses in agricultural land (4,400 acres), pine forest/savanna (3,900 acres), and emergent wetlands (3,200 acres). Losses in emergent wetland acreage would exceed losses of other land uses, both in terms of actual acreage and percentage of existing acreage.

Table 5.2–6
Coastal Study Area Projected Land Use for the Year 2020—Medium-Growth Scenario

	Most-Likely Growth			Medium-Growth		
	2020 (acres)	Percentage of 2020 Total	Percent Change 2000–2020	2020 (acres)	Percentage of 2020 Total	Percent Change 2000–2020
Land Use – General						
Developed	55,502	21.5	8.5	61,712	23.9	20.6
- Impervious	28,564		19.4	35,380		47.8
Natural	185,567	71.8	-1.7	180,917	70.0	-4.2
Agricultural	15,299	5.9	-6.6	13,740	5.3	-16.1
Inland Fresh Water	2,103	0.8	0.0	2,103	0.8	0.0
Subtotals	258,471	100.0		258,471	100.0	
Surface Water/Other	308,531			308,531		
TOTAL Acres	567,002			567,002		
Land Use – Detailed						
Medium-Density Urban Land	27,323	10.6	-4.5	25,216	9.8	-11.9
High-Density Urban Land	19,291	7.5	41.3	27,607	10.7	102.1
Transportation	8,888	3.4	0.0	8,888	3.4	0.0
Cropland/Pasture/Grassland	15,299	5.9	-6.6	13,740	5.3	-16.1
Deciduous/Mixed Bottomland Forest/Swamp	50,425	19.5	-0.8	49,853	19.3	-1.9
Upland Coniferous Forest	21,699	8.4	-2.7	20,891	8.1	-6.7
Wet Coniferous Forest/Savanna	45,516	17.6	-0.8	44,984	17.4	-2.0
Scrub-Shrub/Cutover/Barren	46,349	17.9	-1.2	45,522	17.6	-3.0
Emergent Wetland	21,577	8.3	-5.6	19,667	7.6	-14.0
Inland Fresh Water	2,103	0.8	0.0	2,103	0.8	0.0
Subtotals	258,471	100.0		258,471	100.0	
Surface Water/Other	308,531			308,531		
Total Acres	567,002			567,002		

Table 5.2–7
Projected Percent Subwatershed Imperviousness for the Year 2020—Medium-Growth Scenario

	Coastal Study Area		Watershed Study Area	
Subwatershed Name	2000 Percent Impervious	2020 Percent Impervious	2000 Percent Impervious	2020 Percent Impervious
Upper Wolf River	N/A	N/A	0.4	0.4
Upper Jourdan River	9.1	11.8	0.4	0.5
Lower Wolf River-Cane Creek	4.2	5.8	1.0	1.4
Rotten Bayou	4.1	8.6	1.4	2.6
DeLisle	5.1	6.8	5.1	6.8
Bayou La Croix	4.8	6.7	4.5	6.3
Biloxi River	6.8	10.1	1.4	1.8
Tuxachanie Creek	7.0	11.5	1.2	2.0
Turkey Creek–Old Fort Bayou	12.5	18.4	10.9	16.1
The Islands	0.0	0.0	0.0	0.0
Offshore Areas	0.0	0.0	0.0	0.0
Total	9.3	13.7	2.9	4.3

Table 5.2–8
Watershed Study Area Projected Land Use for the Year 2020—Medium-Growth Scenario

	Most-Likely Growth			Medium-Growth		
	2020	Percentage of 2020 Total	Percent Change 2000–2020	2020	Percentage of 2020 Total	Percent Change 2000–2020
Land Use – General						
Developed	70,684	7.2	10.4	80,534	8.2	25.8
- Impervious	34,152		18.8	42,100		46.4
Natural	805,114	81.9	-0.6	797,821	81.1	-1.5
Agricultural	103,429	10.5	-1.6	100,872	10.3	-4.0
Inland Fresh Water	4,290	0.4	0.0	4,290	0.4	0.0
Subtotals	983,517	100.0		983,517	100.0	
Surface Water/Other	310,646			310,646		
Total Acres	1,294,163			1,294,163		
Land Use – Detailed						
Medium-Density Urban Land	37,620	3.8	1.0	38,200	3.9	2.6
High-Density Urban Land	22,850	2.3	38.0	32,119	3.3	94.0
Transportation	10,215	1.0	0.0	10,215	1.0	0.0
Cropland/Pasture/Grassland	103,430	10.5	-1.6	100,872	10.3	-4.0
Deciduous/Mixed Bottomland Forest/Swamp	234,587	23.9	-0.4	233,300	23.7	-0.9
Upland Coniferous Forest	187,129	19.0	-0.5	185,709	18.9	-1.3
Wet Coniferous Forest/Savanna	135,054	13.8	-0.4	134,207	13.6	-1.1
Scrub-Shrub/Cutover/Barren	225,723	23.0	-0.5	223,918	22.8	-1.3
Emergent Wetland	22,620	2.3	-5.5	20,687	2.1	-13.5
Inland Fresh Water	4,290	0.4	0.0	4,290	0.4	0.0
Subtotals	983,517	100.0		983,517	100.0	
Surface Water/Other	310,646			310,646		
Total Acres	1,294,163			1,294,163		

Impervious cover is projected to increase by 46 percent, from approximately 29,000 acres in 2000 to 42,000 acres in 2020. Total impervious cover would account for 4 percent of the WSA at the end of the study period. With the exception of the Turkey Creek–Old Fort Bayou subwatershed, all the subwatersheds had impervious coverage of less than 10 percent in the year 2000 (Table 5.2–7). This is indicative of a "protected" status for stream health. The Turkey Creek–Old Fort Bayou subwatershed had an estimated 10.9 percent impervious cover in 2000, which is above the threshold value of imperviousness at which stream degradation first occurs, and is indicative of an "impacted" stream or watershed.

By 2020 under the Medium-Growth Scenario, the extent of imperviousness in eight of the eleven subwatersheds is projected to increase, the one exception being the Upper Wolf River subwatershed, which is projected to have the same level of impervious cover in 2020 as it had in 2000, namely 0.4 percent. However, with the exception of the Turkey Creek–Old Fort Bayou subwatershed, all are projected to remain in the "protected" category with less than 10 percent impervious cover acreage. The Turkey Creek–Old Fort Bayou subwatershed is projected to have a 16 percent impervious coverage, well into the "impacted" category.

Bay St. Louis Watershed. Under the Medium-Growth Scenario, developed land acreage in the Bay St. Louis watershed, is projected to increase by 31 percent and the impervious cover within the developed land is projected to increase by 39 percent during the period 2000–2020 (Appendix O–Table 11). Medium-density urban land acreage is projected to increase by 23 percent, while high-density urban land acreage is projected to increase by 95 percent. Most of the increase in developed land acreage (about 7,000 acres) is projected to come from conversion of pine forest savanna (2,200 acres), agricultural land (1,500 acres), and scrub-shrub/ cutover/barren land (1,400 acres). The projected loss of emergent wetland acreage represents about 5 percent of the existing acreage.

Biloxi Bay Watershed. Under the Medium-Growth Scenario, developed land acreage in the Biloxi Bay watershed, is projected to increase by 23 percent, and impervious cover within the developed land is projected to increase by 50 percent during the period 2000–2020 (Appendix O–Table 12). Medium-density urban land acreage is projected to decrease by 10 percent, while high-density urban land acreage is projected to increase by 94 percent. Most of the increase in developed land acreage (about 9,600 acres) is projected to come from conversion of agricultural land (2,700 acres) and emergent wetlands (2,400 acres). The projected loss of emergent wetland acreage represents a 31 percent reduction from existing emergent wetland acreage in the Biloxi Bay watershed.

5.2.1.2.4 High-Growth Scenario

Coastal Counties. Under the High-Growth Scenario, developed land acreage in the three coastal counties is projected to increase by 38 percent and impervious cover in the developed land is projected to increase by 51 percent during the period 2000–2020 (see Table 5.2–9). Medium-density urban land acreage is projected to increase by 20 percent, while high-density urban land is projected to increase by 98 percent. The population of the three counties is projected to increase from 367,000 to 565,000, or by 54 percent, during the same period. Most of the increase in developed land acreage (34,000 acres) is projected to come from losses in agricultural land (8,300 acres), scrub-shrub/cutover/barren land (8,000 acres), pine forest/savanna coverage (7,900 acres), and deciduous/mixed/bottomland forest/swamp (5,400 acres) over the 2000–2020 period. The loss of emergent wetland (4,500 acres) would represent the largest percentage loss of existing coverage (8 percent) of any of the land use types identified.

By 2020 some 200 million square feet of office, retail, wholesale, and other kinds of space would be needed in the three coastal counties under the High-Growth Scenario. The 200 million square feet represent an increase of 47 percent over the estimated square footage in the year 2000 (See Appendix N–Table 13).

Hancock County. Under the High-Growth Scenario developed land acreage is projected to increase by 26 percent during the period 2000–2020, while impervious land cover within the developed lands is projected to increase by 28 percent (Appendix O–Table 13). Medium-density urban land acreage is projected to increase by 21 percent, and high-density urban land is projected to increase by 78 percent. During the same period, the population of Hancock County is projected to increase from 42,000 to 68,000, or by 60 percent. Most of the increase in developed land acreage (4,200 acres) is projected to come from conversion of pine forest/savanna (1,700 acres), agricultural land (860 acres), and scrub-shrub/cutover/barren land (670 acres). The percentage loss in agricultural land acreage (3 percent) would exceed that of any of the other land use types identified. Emergent wetland loss is projected to slightly exceed 500 acres, or 2.5 percent less than what existed in 2000.

Table 5.2–9
Coastal Counties Projected Land Use for the Year 2020—High-Growth Scenario

	Most-Likely Growth			High-Growth		
	2020 (acres)	Percentage of 2020 Total	Percent Change 2000–2020	2020 (acres)	Percentage of 2020 Total	Percent Change 2000–2020
Land Use – General						
Developed	100,778	8.8	11.7	124,287	10.9	37.8
- Impervious	50,241		18.6	64,001		51.1
Natural	932,372	81.4	-0.9	914,918	79.9	-2.7
Agricultural	99,504	8.7	-2.2	93,409	8.2	-8.2
Inland Fresh Water	12,577	1.1	0.0	12,577	1.1	0.0
Subtotals	1,145,192	100.0		1,145,192	100.0	
Surface Water/Other	509,833			509,833		
Total Acres	1,655,024			1,655,024		
Land Use – Detailed						
Medium-Density Urban Land	51,651	4.5	3.0	60,223	5.3	20.0
High-Density Urban Land	33,626	2.9	36.8	48,604	4.2	97.8
Transportation	15,461	1.4	0.0	15,461	1.4	0.0
Cropland/Pasture/Grassland	99,504	8.7	-2.2	93,409	8.2	-8.2
Deciduous/Mixed Bottomland Forest/Swamp	294,281	25.7	-0.4	290,212	25.3	-1.8
Upland Coniferous Forest	171,181	15.0	-0.7	168,135	14.7	-2.5
Wet Coniferous Forest/Savanna	179,060	15.6	-0.6	176,508	15.4	-2.0
Scrub-Shrub/Cutover/Barren	234,997	20.5	-0.8	228,852	20.0	-3.4
Emergent Wetland	52,854	4.6	-5.2	51,211	4.5	-8.1
Inland Fresh Water	12,577	1.1	0.0	12,577	1.1	0.0
Subtotals	1,145,192	100.0		1,145,192	100.0	
Surface Water/Other	509,833			509,833		
Total Acres	1,655,024			1,655,024		

By 2020, some 18 million square feet of office, retail, wholesale, and other kinds of space would be needed in Hancock County under the High-Growth Scenario. The 18 million square feet represent an increase of 55 percent over the estimated square footage in the year 2000 (See Appendix N–Table 14).

Harrison County. Under the High-Growth Scenario, developed land acreage in the county is projected to increase by 37 percent during the period 2000–2020, while impervious land cover within the developed lands is projected to increase by 41 percent (Appendix O–Table 14). Medium-density urban land acreage is projected to increase by 42 percent, and high-density urban land is projected to increase by 117 percent. During the same period, the population of Harrison County is projected to increase from 190,000 to 318,000, or by 67 percent. Most of the increase in developed land acreage (23,000 acres) is projected to result from conversion of scrub-shrub/cutover/barren land (6,600 acres), agricultural land (6,300 acres), and pine forest/savanna (5,200 acres) over the 2000–2020 period. The percentage loss in agricultural land acreage (20 percent) would exceed percentage losses of any of the other land use types identified. Emergent wetland loss is projected to slightly exceed 700 acres, a 12 percent loss in relation to 2000.

It is projected that by 2020 some 130 million square feet of office, retail, wholesale, and other kinds of space would be needed in Harrison County under the High-Growth Scenario. The 130 million square feet represent an increase of 60 percent over the estimated square footage in the year 2000 (See Appendix N–Table 15).

Jackson County. Under the High-Growth Scenario, developed land acreage in the county is projected to increase by 20 percent during the period 2000–2020, while the impervious land cover within the developed lands is projected to increase by 40 percent (Appendix O–Table 15). Medium-density urban land acreage is projected to decrease by 5 percent while high-density urban land is projected to increase by 79 percent. The population of Jackson County is projected to increase from 136,000 to 179,000, or by 32 percent, during the same period. Most of the increase in developed land acreage (6,700 acres) is projected to come from losses of emergent wetlands (3,300 acres) and agricultural land (1,100 acres) over the 2000–2020 period. The percentage loss of emergent wetlands (12 percent) would exceed percentage losses of any of the other land use types identified.

By 2020, about 52 million square feet of office, retail, wholesale, and other kinds of space would be needed in Jackson County under the High-Growth Scenario. The 52 million square feet represent an increase of 18 percent over the estimated square footage in the year 2000 (See Appendix N–Table 16).

Coastal Study Area. Under the High-Growth Scenario, developed land acreage in the CSA would increase by 31 percent during the period 2000–2020, while impervious land cover within the developed lands is projected to increase by 73 percent (see Table 5.2–10). Medium-density urban land acreage is projected to decrease by 18 percent, while high-density urban land is projected to increase by 156 percent. Most of the increase in developed land acreage (16,000 acres) is projected to come from conversion of emergent wetlands (4,900 acres), agricultural land (4,000 acres), and pine forest/savanna (3,500 acres). Agricultural land and emergent wetlands would have the largest percentage declines from existing acreage (25 and 21 percent, respectively) of any of the land use types identified.

During the study period 2000–2020, the impervious cover is projected to increase from approximately 24,000 to 41,000 acres, resulting in a total impervious cover of 16 percent for the entire CSA. During 2000, impervious land accounted for about 9 percent of the CSA land area. With the exception of those portions of the Turkey Creek–Old Fort Bayou and the Upper Jourdan River subwatersheds that lie within the CSA, all had impervious coverage of less than 10 percent in the year 2000 (Table 5.2–11 and Appendix O–Table 16). This is indicative of a "protected" status for stream health. The Turkey Creek–Old Fort Bayou subwatershed within the CSA had an estimated 15 percent impervious cover in 2000, which is above the threshold value of imperviousness at which stream degradation first occurs and is indicative of an "impacted" stream or watershed.

By 2020, under the High-Growth Scenario, the extent of imperviousness in all of the subwatersheds in the CSA is projected to increase. The Upper Jourdan River, Rotten Bayou, Biloxi River, Tuxachanie Creek, and Turkey Creek–Old Fort Bayou subwatersheds within the CSA are projected to have 13, 11, 12, 14, and 22 percent impervious coverage, respectively, qualifying for the "impacted" category. The others are projected to remain in the "protected" category with less than 10 percent impervious cover acreage.

Table 5.2–10
Coastal Study Area Projected Land Use for the Year 2020—High-Growth Scenario

	Most-Likely Growth			High-Growth		
	2020 (acres)	Percentage of 2020 Total (%)	Percent Change 2000–2020	2020 (acres)	Percentage of 2020 Total (%)	Change 2000–2020
Land Use – General						
Developed	55,502	21.5	8.5	67,249	26.0	31.4
- Impervious	28,564		19.4	41,425		73.1
Natural	185,567	71.8	-1.7	176,769	68.4	-6.4
Agricultural	15,299	5.9	-6.6	12,350	4.8	-24.6
Inland Fresh Water	2,103	0.8	0.0	2,103	0.8	0.0
Subtotals	258,471	100.0		258,471	100.0	
Surface Water/Other	308,531			308,531		
Total Acres	567,002			567,002		
Land Use – Detailed						
Medium-Density Urban Land	27,323	10.6	-4.5	23,384	9.0	-18.3
High-Density Urban Land	19,291	7.5	41.3	34,977	13.5	156.1
Transportation	8,888	3.4	0.0	8,888	3.4	0.0
Cropland/Pasture/Grassland	15,299	5.9	-6.6	12,350	4.8	-24.6
Deciduous/Mixed Bottomland Forest/Swamp	50,425	19.5	-0.8	49,342	19.1	-2.9
Upland Coniferous Forest	21,699	8.4	-2.7	20,163	7.8	-10.6
Wet Coniferous Forest/ Savanna	45,516	17.6	-0.8	44,506	17.2	-3.1
Scrub-Shrub/Cutover/Barren	46,349	17.9	-1.2	44,782	17.3	-4.6
Emergent Wetland	21,577	8.3	-5.6	17,976	7.0	-21.4
Inland Fresh Water	2,103	0.8	0.0	2,103	0.8	0.0
Subtotals	258,471	100.0		258,471	100.0	
Surface Water/Other	308,531			308,530.5		
Total Acres	567,001.7			567,001.7		

Watershed Study Area. Under the High-Growth Scenario, developed land acreage in the Watershed Study Area is projected to increase by 40 percent during the period 2000–2020, while impervious land cover within the developed lands is projected to increase by 71 percent (see Table 5.2–12). The medium-density urban land acreage is projected to increase by just 4 percent, while high-density urban land acreage is projected to increase by 144 percent during the same period. Most of the increase in developed land acreage (about 25,000 acres) is projected to result from the conversion of agricultural land (6,500 acres), pine forest/savanna (5,900 acres), and emergent wetlands (4,900 acres). Emergent wetland acreage is projected to decline by 21 percent, the largest percentage loss of a land cover type identified in the Watershed Study Area.

The impervious cover under the High-Growth Scenario is projected to increase from approximately 29,000 acres in 2000 to 49,000 in 2020. Impervious land cover would account for 5 percent of the entire Watershed Study Area in the year 2020 compared with the 3 percent impervious land cover in 2000. With the exception of the Turkey Creek–Old Fort Bayou subwatershed, all had impervious coverage of less than 10 percent in the year 2000, which is

Table 5.2–11
Projected Percent Subwatershed Imperviousness for the Year 2020—High-Growth Scenario

	Coastal Study Area		Watershed Study Area	
Subwatershed Name	**2000 Percent Impervious**	**2020 Percent Impervious**	**2000 Percent Impervious**	**2020 Percent Impervious**
Upper Wolf River	N/A	N/A	0.4	0.5
Upper Jourdan River	9.1	13.2	0.4	0.6
Lower Wolf River–Cane Creek	4.2	6.7	1.0	1.7
Rotten Bayou	4.1	10.8	1.4	3.3
DeLisle	5.1	7.7	5.1	7.7
Bayou La Croix	4.8	7.7	4.5	7.3
Biloxi River	6.8	11.8	1.4	2.1
Tuxachanie Creek	7.0	13.8	1.2	2.4
Turkey Creek–Old Fort Bayou	12.5	21.6	10.9	18.8
The Islands	0.0	0.0	0.0	0.0
Offshore Areas	0.0	0.1	0.0	0.1
Total	9.3	16.0	2.9	5.0

indicative of a "protected" status for stream health. The Turkey Creek–Old Fort Bayou subwatershed had an estimated 12 percent impervious cover in 2000, which is above the threshold value of imperviousness at which stream degradation first occurs and is indicative of an "impacted" stream or watershed.

By 2020 under the High-Growth Scenario, the level of imperviousness in all of the subwatersheds is projected to increase. With the exception of the Turkey Creek–Old Fort Bayou subwatershed, all are projected to remain in the "protected" category with less than 10 percent impervious cover acreage (although the De Lisle subwatershed, at a projected 8 percent impervious cover, would approach the threshold of an "impacted" stream or watershed). The Turkey Creek–Old Fort Bayou subwatershed is projected to have a 19 percent impervious coverage, well into the "impacted" category.

Bay St. Louis Watershed. Under the High-Growth Scenario, developed land acreage in the Bay St. Louis watershed would increase by 47 percent while the impervious land cover within the developed lands would increase by 59 percent (Appendix O–Table 17). Medium-density urban land acreage is projected to increase by 34 percent, while the high-density urban land acreage is projected to increase by 143 percent during the same period. Most of the increase in developed land acreage (about 10,400 acres) is projected to come from conversion of pine forest/savanna (3,300 acres), agricultural land (2,300 acres), and scrub-shrub/cutover/barren land (1,800 acres). Emergent wetland acreage is projected to decline by 8 percent, the largest percentage loss of existing land use/land cover (8 percent) in the Bay St. Louis watershed.

Table 5.2–12
Watershed Study Area Projected Land Use for the Year 2020—High-Growth Scenario

	Most-Likely Growth			High-Growth		
	2020 (acres)	Percentage of 2020 Total (%)	Percent Change 2000–2020	2020 (acres)	Percentage of 2020 Total (%)	Change 2000–2020
Land Use – General						
Developed	70,684	7.2	10.4	89,324	9.1	39.6
- Impervious	34,152		18.8	49,154		71.0
Natural	805,114	81.9	-0.6	791,310	80.5	-2.3
Agricultural	103,429	10.5	-1.6	98,593	10.0	-6.2
Inland Fresh Water	4,290	0.4	0.0	4,290	0.4	0.0
Subtotals	983,517	100.0		983,517	100.0	
Surface Water/Other	310,646			310,646		
Total Acres	1,294,163			1,294,163		
Land Use – Detailed						
Medium-Density Urban Land	37,620	3.8	1.0	38,772	3.9	4.1
High-Density Urban Land	22,850	2.3	38.0	40,338	4.1	143.7
Transportation	10,215	1.0	0.0	10,215	1.0	0.0
Cropland/Pasture/Grassland	103,429	10.5	-1.6	98,593	10.0	-6.2
Deciduous/Mixed Bottomland Forest/Swamp	234,587	23.9	-0.4	232,150	23.6	-1.4
Upland Coniferous Forest	187,129	19.0	-0.5	184,443	18.7	-2.0
Wet Coniferous Forest/ Savanna	135,054	13.8	-0.4	133,448	13.6	-1.6
Scrub-Shrub/Cutover/Barren	225,723	23.0	-0.5	222,304	22.6	-2.0
Emergent Wetland	22,620	2.3	-5.5	18,976	1.9	-20.7
Inland Fresh Water	4,290	0.4	0.0	4,290	0.4	0.0
Subtotals	983,517	100.0		983,517	100.0	
Surface Water/Other	310,646			310,646		
Total Acres	1,294,163			1,294,163		

Biloxi Bay Watershed. Under the High-Growth Scenario, developed land acreage in Biloxi Bay watershed, would increase by 36 percent during the period 2000 to 2020, while impervious land cover within the developed lands would increase by 76 percent (Appendix O–Table 18). Medium-density urban land acreage is projected to decrease by 15 percent, while high-density urban land acreage is projected to increase by 144 percent during the same period. Most of the increase in developed land acreage (about 15,000 acres) is projected to result from conversion of agricultural land (4,200 acres), emergent wetlands (3,700 acres—almost half the emergent wetlands that existed in the Biloxi Bay watershed in 2000), and scrub-shrub/cutover/barren land and pine forest/savanna (2,600 acres each). The projected loss of emergent wetland acreage (3,700 acres) represents by far the largest percentage loss of existing land use/land cover (47 percent) in the Biloxi Bay watershed.

5.2.2 No Action Alternative

Under the no action alternative, the land use conditions would be the same as those described under the growth scenarios presented above. The Corps would continue to review permits using

the same procedures and analytical tools used in the past, and would continue to identify any land use conflicts due to federal actions. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative would be the same as those reflected by the four growth scenarios described in the trends analysis section.

The most noticeable projected land use/land cover changes relative to current conditions in the coastal counties or Watershed Study Area under the no action alternative would be the emergent wetland loss and the projected increase in imperviousness in the Turkey Creek–Old Fort Bayou subwatershed discussed above. However, the overall change in land use/land cover is projected to be substantial within the CSA relative to current conditions. Nevertheless, all of the projected land use/land cover changes would be subject to relevant state, county, and community land use zoning, comprehensive plans, and subdivision regulations governing land use and development. Therefore, they would not conflict with applicable land use plans, policies, or controls. There might be indirect and secondary alterations to the environment as a result of the projected land use/land cover changes, and these are addressed in the appropriate resource sections that follow.

Although the extent of urban growth and the land uses that would be converted to urban areas have been estimated for the various scenarios, the precise direct and indirect alterations and impacts of such land conversion are difficult to assess. However, there is extensive literature on the generalized effects of land use/land cover changes that occur with development and urbanization (Dramstad et al., 1996; Goudie, 1994; Marsh, 1998; Strom and Nathan, 1998). These changes, identified in Table 5.2–13, are illustrative of the types and variety of effects that might or might not occur, depending on the individual circumstances of the land use/land cover changes, and the environmental sensitivities and/or vulnerabilities of the individual locations where the changes takes place. The table is meant to identify possible direct and indirect alterations. The potential effects of many of these are addressed in other sections of this document. The key environmental indicator of changes in impervious cover is addressed in more detail below.

5.2.2.1 Comparison of Changes in Urban Growth Under the Various Growth Scenarios

During the period 2000 to 2020, developed land area in the three coastal counties is projected to increase by 26 percent under the Medium-Growth Scenario and 38 percent under the High-Growth Scenario (compared with 12 percent under the Most-Likely Growth Scenario). Medium-density urban land acreage is projected to increase by 20 percent, while high-density urban land is projected to increase by 98 percent, almost doubling. The population of the three counties is projected to increase from 367,000 to 565,000, or by 54 percent, under the High-Growth Scenario during the same period. Medium-density and high-density urban land acreages are projected to increase 410 percent and 187 percent faster, respectively, under the Medium-Growth Scenario, and 680 percent and 270 percent faster, respectively, under the High-Growth Scenario than under the Most-Likely Growth Scenario. By the year 2020 under the High-Growth Scenario in Harrison County alone, both medium-density and high-density urban land acreages are projected to grow 650 percent faster than under the Most-Likely Growth Scenario.

Growth of developed areas between 2000 and 2020 in the CSA is projected to increase 21 percent under the Medium-Growth Scenario and 31 percent under the High-Growth Scenario (compared with 9 percent under the Most-Likely Growth Scenario). Overall, the CSA appears to be experiencing a decrease in medium-intensity urban areas because land is being converted from medium- to high-intensity urban areas faster than new medium-intensity urban areas are spreading.

Table 5.2–13
Potential Alterations from Land Use/Land Cover Change

Source or Issue	Direct Alterations	Indirect Alterations
Groundwater Contamination	• Runoff constituent variation due to alterations in the overlying land use can change the nature and amount of groundwater contamination. • Leachate from landfills, fertilizers and pesticides from agriculture, urban storm water, sewage effluent from drainfields, spills and leakages from above-ground activities are all sources of groundwater contamination.	• Groundwater contamination can adversely affect biological resources and human health.
Groundwater Flow	• Change in overlying land use can change groundwater flow by affecting recharge rates, particularly if the imperviousness of land cover in recharge zones is affected.	• Reduction in stream flow through reduction in groundwater discharge. • Change in riparian vegetation. • Change in wetland hydrologic regime through reduction of groundwater inflow.
Groundwater Withdrawal	• Groundwater withdrawal, particularly withdrawal that exceeds the safe aquifer yield, would eventually lower the water table and lead to an uneven upper surface (cones of depression) of the water table. With the development of cones of depression, hydraulic gradients increase, causing faster groundwater flow toward wells.	• Cones of depression can accelerate the migration of contaminated water by increasing hydraulic gradients and transmission velocities. • Loss of water to shallow wells might result from groundwater withdrawal. Drawdown of groundwater over a large area can also lead to loss of volume in the ground water-bearing substrata and might result in subsidence in the overlying ground. • In coastal areas, lower water quality could result from saltwater intrusion.
Habitat Loss	*See Vegetation Change and Loss*	
Hydrology	• Development and urbanization lead to changes in the shape and density of drainage networks. They replace ditches with storm sewers and small streams with underground pipes, introduce gutters and the channeling of tributaries. Road drains are grafted onto drainage networks. These changes increase runoff and reduce concentration times. • Alteration of drainage networks, destroying natural channels, creating artificial channels, and changing the size of drainage basins.	• Increase in the magnitude and frequency of peak discharges in receiving streams. Loss of aquatic habitats, reduced water supplies during low-flow periods, lower water quality.
Impervious Cover	• Land uses associated with impervious cover are sources of storm water pollution. • Note: while storm water loadings per acre increase with urban density, loadings per person decrease with higher residential densities.	• Reduction in water quality.
Light Pollution	• Light pollution, or the upward and outward distribution of light, either directly from fixtures or from reflection off the ground or other surfaces, increases with development and urban density. Light pollution can adversely affect astronomical research and the simple pleasure of viewing the night sky, by compromising observatories and competing with the light from stars. Light pollution can be intrusive and objectionable, affecting aesthetics.	• Among the ecological effects are adverse effects on wildlife behavior (disorientation, and avoidance or attraction to lights), and confusion and injury to migrating birds unable to see glass windows in lighted structures. Photoperiod response in plants, the process whereby certain frequencies and intensities of light regulate the development and flowering of plants, can be affected by light pollution.

Table 5.2–13
Potential Alterations from Land Use/Land Cover Change (continued)

Nonpoint Source Pollution	• Development and the increase in impervious surface cover multiply the sources of dispersed, nonspecific nonpoint source pollution. Sources include nutrients from agriculture, yards, and gardens; sediment; pathogens; petroleum hydrocarbons from cars and trucks on streets, highways, and parking lots; and atmospheric deposition.	• Reduction in water quality, loss of aesthetic and recreational values.
Overland Flow	• Changes in land use/land cover would alter or change precipitation interception by vegetation, infiltration by the soil, depression storage on the ground, and runoff. Developed land has higher coefficients of runoff than undeveloped or rural land. Increases in runoff coefficients produce a corresponding decrease in concentration times. *See Storm Water Discharge*.	• Increases in overland flow produce larger and more frequent peak flows in streams, leading to increased flooding and flood hazard, and damage to aquatic environments. *See Storm Water Discharge*.
Point Source Pollution	• Development frequently entails the addition of point source pollution sources that release pollutants from known discharge points or outfalls (usually pipes or ditches). Sources include oxygen-demanding wastes, toxic minerals and inorganic compounds, synthetic organic compounds, radioactive wastes, and thermal discharges.	• Reduction in water quality, adverse effects on aquatic habitats and human health. • Thermal discharges cause changes in species and increased growth rates in many aquatic organisms. • Nutrient loading, particularly of nitrogen and phosphorous, can induce accelerated rates of biological activity and the eutrophication of water bodies.
Septic Tanks and Drainfields	• Introduction of contaminants into the soil and eventually groundwater, particularly pathogens and nutrients such as nitrogen and phosphorus.	• Acceleration of algae growth in aquatic systems.
Shoreline (Coastal) Alteration	• Development frequently brings the construction of seawalls, breakwaters, and groins in an attempt to protect coastal real estate. Seawalls often increase the scouring effects of waves, resulting in deeper water immediately near shore. Increased erosion on adjacent unprotected properties results as waves converge on the projecting seawall and refract to the right and left. • Groins, jetties, and breakwaters commonly deprive downshore areas of their sediment supply by interrupting longshore drift, thus leading to beach erosion and shoreline retreat.	• Damage to shore and near-shore habitats, and loss of aesthetic and recreational values.
Soil Compression	• Decomposition of soils, particularly organic soils, and compression caused by the weight of overlying buildings and structures, and/or drainage, can lead to subsidence.	• Release of confining pressure on inflowing water might result from excavation and fill activities.
Soil Erosion	• Land clearing for development breaks reduced the protective vegetative cover and, if the cover not replaced by a permanent substitute cover, exposes the topsoil to rapid wind and water erosion.	• Sedimentation of local and downstream water bodies within the local watershed, reduction in the quality of the aquatic environment, particularly on wetlands. Sediment clogging of channels can increase flooding and reduce water quality.

Table 5.2–13
Potential Alterations from Land Use/Land Cover Change (continued)

Storm Water Discharge	• Change in land use can affect the rate and amount of runoff reaching streams and rivers. Increases in surface imperviousness decrease infiltration and increase overland flow, or storm water discharge resulting in greater magnitudes and frequencies of peak flows on streams due to an increase in the coefficient of runoff and a decrease in concentration time. • Other changes include reduction of natural depression storage with grading and leveling of land, and linking of road drains on drainage networks.	• Increased flooding, reduction in water quality, acceleration of channel erosion, and habitat degradation.
Stream Alteration	• Stream channel changes include aggradation from increased sediment loadings, and degradation as storm water discharges increase. Channel degradation can lead to severely eroded channels.	• Destruction of riparian and channel habitats. Reduction in water quality and degradation of the aquatic environment. Reduction in aesthetic and recreational values.
Topography/ Slope Alteration	• Disturbance of slope environments (such as deforestation or vegetation removal, mechanical cut and fill operations, and drainage alteration) can mean a loss of equilibrium (i.e., increased instability) associated with natural conditions, and increased erosion and runoff. • Drainage changes around roads, utilities, and infrastructure can cause increased seepage, and redirected stream flows can weaken slopes and cause slope failures.	• Increased runoff rates resulting in increased soil erosion, greater flooding, and decreased water quality downslope might result, depending on the upslope contribution to runoff and actual runoff patterns (concentrated or diffuse).
Vegetation Change and Loss	• Development typically results in the wholesale destruction and loss of most existing vegetation. New developments would typically introduce new vegetation, but the species diversity of the new plant cover remains far below that of the pre-development cover that it replaces. • Note: new development frequently results in the deterioration of the existing managed urban and suburban landscape with urban decay. Weed species and noxious plants often take over as vacated houses and streets decay.	• Habitat loss and isolation, and habitat fragmentation. Loss of wildlife, reduced mixing among isolated wildlife populations. Reductions in species diversity. Increase in opportunistic species in marginal habitats. • Loss of vegetation can also mean the loss of vegetation's noise absorbing and diverting characteristics, thus increasing ambient noise levels and the distances over which noise travels. • Loss of vegetation's aesthetic values.
Water Quality Reduction	• Development increases point and nonpoint sources of water pollutants. Sources include oxygen-demanding wastes, plant nutrients, sediments, pathogens, toxic minerals and inorganic compounds, synthetic organic compounds, and thermal discharges. *See Point Source Pollution and Nonpoint Source Pollution*.	• Nutrient loading, changes in the balance of dissolved oxygen, carbon dioxide, and micro-organisms, and an increase in the production of total organic matter. These frequently lead to further alteration in the aquatic environment and eutrophication, including increased rate of basin in-filling by organic matter, decreased water clarity, change in fish species diversity to pollution-tolerant types, decline in aesthetic quality because of unpleasant odors, decline in recreational value, and increased cost of water treatment.
Wetland Loss	• Development frequently results in the incremental loss of wetlands, and puts pressure on the hydrological regimes important for supporting wetlands.	• Loss of the aquatic and terrestrial species associated with wetlands. • Loss of flood control functions of wetlands. • Loss of aesthetic and recreational values. • Loss of wetlands as a water quality treatment mechanism.

Sources: Dramstad, et. al., 1996; Goudie, 1994; Marsh, 1998; Strom and Nathan, 1998.

5.2.2.2 Loss of Land Cover Types to Urban Areas Under the Various Growth Scenarios

The projected losses of land cover types such as emergent wetlands and agriculture to urban areas are as high as 25 percent under the various growth scenarios for the study areas. Table 5.2–14 presents a matrix of the projected losses of these land cover types to urban areas for each scenario and study area, which are summarized as follows:

- Agricultural lands and emergent wetlands represent the largest percentage losses among all land use types to urban areas under all the scenarios and study areas.

- The greatest percentage of agricultural land in the coastal counties under the Medium-Growth Scenario—20 percent—would occur in Harrison County. Emergent wetland loss is projected to be just over 700 acres, 12 percent less than what existed in 2000.

- Much of the loss of emergent wetlands in the Watershed Study Area would occur in the Biloxi Bay watershed. Under the Medium-Growth Scenario, 31 percent of wetlands would be lost, compared with 12 percent under the Most-Likely Growth Scenario. Under the High-Growth Scenario, 47 percent would be lost.

The large loss of wetlands to urban areas would be a considerable alteration under the no action alternative. The implications of wetland loss are addressed in Section 5.7.2.

Table 5.2–14
Projected Loss of Selected Land Cover Types to Urban Areas

	Agricultural Loss		Wetland Loss	
Scenario and Study Area	**Acreage**	**Percent**	**Acreage**	**Percent**
Most-Likely Growth Scenario				
Coastal Counties	2,221	2.2	2,872	5.2
Coastal Study Area	1,088	6.6	1,286	5.6
Watershed Study Area	1,688	1.6	1,304	5.5
Medium-Growth Scenario				
Coastal Counties	5,452	5.4	3,738	6.7
Coastal Study Area	2,647	16.1	3,196	14.0
Watershed Study Area	4,245	4.0	3,237	13.5
High-Growth Scenario				
Coastal Counties	8,316	8.2	4,515	8.1
Coastal Study Area	4,037	24.6	4,887	21.4
Watershed Study Area	6.524	6.2	4,948	20.7

5.2.2.3 Comparison of Changes in Impervious Surfaces Under the Various Growth Scenarios

The threshold value of imperviousness at which stream degradation first occurs is 10 percent impervious cover, which is indicative of an "impacted" stream or watershed. Under the no action alternative, impervious cover under the various growth scenarios is projected to exceed this threshold in the following areas:

- Impervious cover as a percentage of the CSA land cover is projected to increase from 9 percent in 2000 to 11 percent in 2020 under the Most-Likely Growth Scenario, and to 16 percent under the High-Growth Scenario, for an increase of 19 and 72 percent respectively. Under all scenarios, the CSA would exceed the 10 percent impervious cover threshold by 2020, thus qualifying for the "impacted" category.

- At the subwatershed level in the CSA, the number of subwatersheds that would exceed the 10 percent impervious cover threshold would range from two under the Most-Likely Growth Scenario to five under the High-Growth Scenario. One subwatershed, Turkey Creek–Old Fort Bayou, exceeded the threshold in 2000.

- Impervious cover as a percentage of the Watershed Study Area is projected to increase from 3 percent in 2000 to 3.5 percent in 2020 under the Most-Likely Growth Scenario, and to 5 percent under the High-Growth Scenario, for an increase of 21 and 72 percent respectively.

- At the subwatershed level in the Watershed Study Area, only the Turkey Creek–Old Fort Bayou subwatershed would exceed the "impacted" category threshold for imperviousness. This subwatershed, however, already exceeded the threshold in 2000 and therefore is already experiencing considerable alteration through stream degradation.

Overall, the CSA is projected to experience the largest increases in impervious surfaces. Most of the development growth is expected to occur there, as opposed to the more rural northern parts of the counties and Watershed Study Area.

The areas that exceed the threshold value of 10 percent imperviousness (at which stream degradation first occurs), thus qualifying for the "impacted" category, would experience considerable alteration under the no action alternative. The implications of this are discussed in the Water Resources section (Section 5.4).

5.2.2.4 Comparison of Changes in Employment Sector Space under the Various Growth Scenarios

Demand for office, retail, wholesale, and other kinds of space in the three coastal counties is projected to grow by 31 percent by 2020 over the estimated square footage in the year 2000 under the Medium-Growth Scenario, which is a 17 percent increase over the Most-Likely Growth Scenario demand. Much of the increase would take place in Harrison County. Under the High-Growth Scenario, space requirements would grow by 47 percent over the estimated square footage in the year 2000, a 31 percent increase over the Most-Likely Growth Scenario.

5.2.3 Proposed Action

5.2.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. RCPs may be used and implemented through adoption by non–Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast. Suggestions for various RCPs that should be considered for implementation are presented below. These RCPs are general land use recommendations that pertain only to fostering adoption of BMPs. RCPs for other resource areas that might be affected by land use changes (as indicated previously in Table 5.2–13) are discussed in the appropriate resource section below. Some of the site-specific RCPs discussed in other sections might be adopted as permit conditions.

- Encourage minimal uses of land with high contaminant production potential, particularly in recharge zones, in order to protect groundwater.

- Encourage the use of pervious surface materials for driveways, parking lots, etc., to reduce creation of impervious cover and favor cluster development over large lot development in suburban and exurban areas.

- Encourage adoption of land use ordinances that protect topography and sloped areas and limit maximum allowable density based on average slop inclination based on the presence of unstable soils or higher average slope inclinations, require set percentages of ground to be left undisturbed.

- Encourage conservation programs and landscape ecology principles that minimize habitat loss and fragmentation. Maintain habitat corridors, small core habitat patches, and clusters of core habitat patches to foster wildlife movement.

- Encourage management of existing land uses to control storm water runoff, soil erosion, sedimentation, and building encroachment. Various land-protection actions, such as deed restrictions and environmental easements, might be appropriate.

5.2.3.2 Effects of Implementing the Proposed Action

Minor long-term benefits to land use would be expected from implementing the proposed action relative to no action alternative. There is ample opportunity for planning tools to be implemented and for low-impact development to occur, through Corps action and state, county, and community land use zoning, comprehensive plans, and subdivision regulations governing land use and development. Because land management responsibility falls on many different federal, state, and local agencies, and on private landowners, the implementation and effectiveness of regional conservation practices are difficult to forecast. The cumulative effects of past and current development can also reduce the effectiveness of RCPs, and their effectiveness in urban areas is limited. RCPs that are retrofitted into existing urban and suburban areas would not be expected to be as effective as the RCPs that are implemented in new developments in the future.

5.3 WATER RESOURCES

5.3.1 Surface Water

5.3.1.1 Trends Analysis for Surface Water Resources

5.3.1.1.1 Technical Approach for Surface Water Resources

Four groups of water quality parameters—pathogens, sediment, nutrients, and metals—were selected to estimate future cumulative impacts for coastal Mississippi. These parameters are key indicators of water quality impacts resulting from changing land uses. Fecal coliform was selected as a pathogen indicator because of public health risks associated with exposure by contact and shellfish consumption. Sediment was selected because it is directly associated with earth-disturbing activities. BOD_5, total nitrogen, and total phosphorus were selected as indicators for nutrient enrichment and associated low dissolved oxygen. Copper and zinc were selected because these are the common metals associated with land use changes.

Changes in impervious surface area within each watershed were also evaluated as a key indicator of the health of the watershed. Studies have shown that after a watershed reaches 10 percent imperviousness, its hydrologic function and ecological health are altered and might become impaired (Arnold, 1996; Goudie, 1994). Public comments received during the scoping phase of this EIS indicated that these water quality parameters were the most important concerns of regulatory agencies and the general public.

A spreadsheet watershed-loading model developed by Tetra Tech, Inc., described in section 4.8.2.1, was used to estimate potential contribution of pathogens, sediment, nutrients, and metals for different land uses in all of the subwatersheds of the coastal Mississippi watershed. For each subwatershed, land uses were predicted for the year 2020 using socioeconomic forecast modeling. REMI and GIS-based growth simulation modeling were used for four different land growth scenarios: Low-Growth/Most-Likely Growth (presented together because the growth projections under the two scenarios are virtually identical, as discussed in Section 5.1); Medium-Growth; and High-Growth. Using the estimates of pathogen, sediment, nutrient, and metal contributions per land use type, as listed in Tables 4.8–14 through 4.8–31, potential contributions were calculated to predict water quality concerns. Estimates by land use for each subwatershed are as follows:

- Percent yield of pathogens—Figure 5.3–1 and Appendix P, Table 1.
- Percent yield of sediment—Figure 5.3–2 and Appendix P, Table 2.
- Percent yield of BOD_5—Figure 5.3–3 and Appendix P, Table 3.
- Percent yield of total nitrogen—Figure 5.3–4 and Appendix P, Table 4.
- Percent yield of total phosphorus—Figure 5.3–5 and Appendix P, Table 5.
- Percent yield of copper—Figure 5.3–6 and Appendix P, Table 6.
- Percent yield of zinc by land use for each subwatershed—Figure 5.3–7 and Appendix P, Table 7.

Cadmium and chromium were also investigated, but changes in the predicted load contributions were negligible.

5.3.1.1.2 Growth Scenarios

Low-Growth/Most-Likely Growth Scenarios. As noted earlier, after a watershed reaches 10 percent imperviousness, its hydrologic function and ecological health are altered and might become impaired. Additional imperviousness associated with roadways, parking lots, and new construction negatively affects water quality. For example, as storm water runoff increases—carrying sediment, metals, and nutrients—water bodies become over-stressed and are unable to maintain an ecosystem balance.

The Turkey Creek–Old Fort Bayou subwatershed is 10.9 percent impervious at present. Turkey Creek currently has impaired water bodies on the state list of impaired waters for the following parameters of concern: nutrients, pathogens, pH, priority organics, nonpriority organics, metals, total toxics, organic enrichment/low dissolved oxygen, habitat alterations, siltation, turbidity, arsenic, and toxics. Under the Low-Growth/Most-Likely Growth Scenarios, Turkey Creek–Old Fort Bayou is expected to reach 13 percent imperviousness by the year 2020. This slight increase in imperviousness is expected to exacerbate existing water quality problems. Future pollutant load contributions were calculated for the Low-Growth/Most-Likely Growth Scenarios for the year 2020. Pollutant loadings projections indicated a slight increase for all water quality parameters in Turkey Creek–Old Fort Bayou. A discussion of these projections follows.

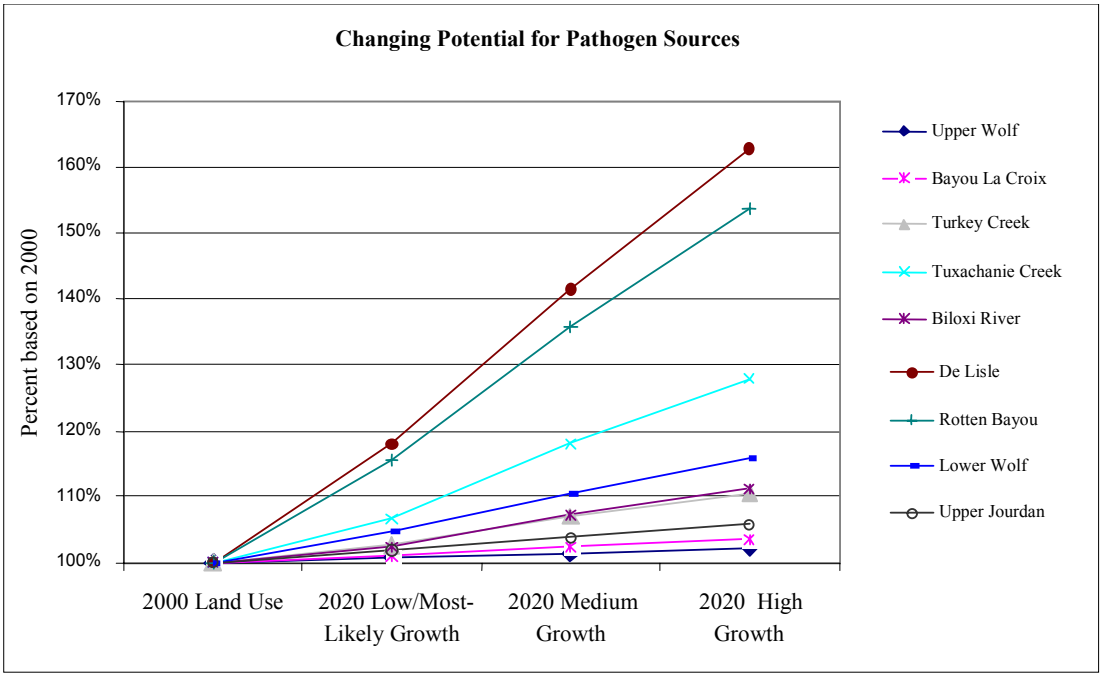


Figure 5.3–1. Increased Pathogen Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

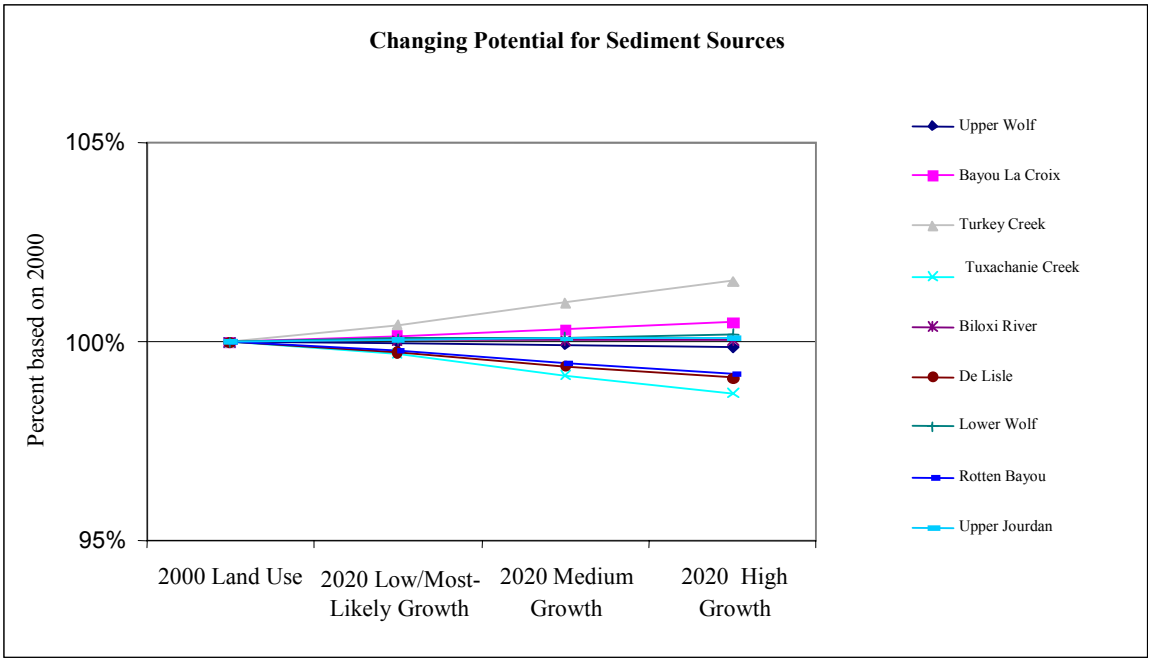


Figure 5.3–2. Changing Sediment Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

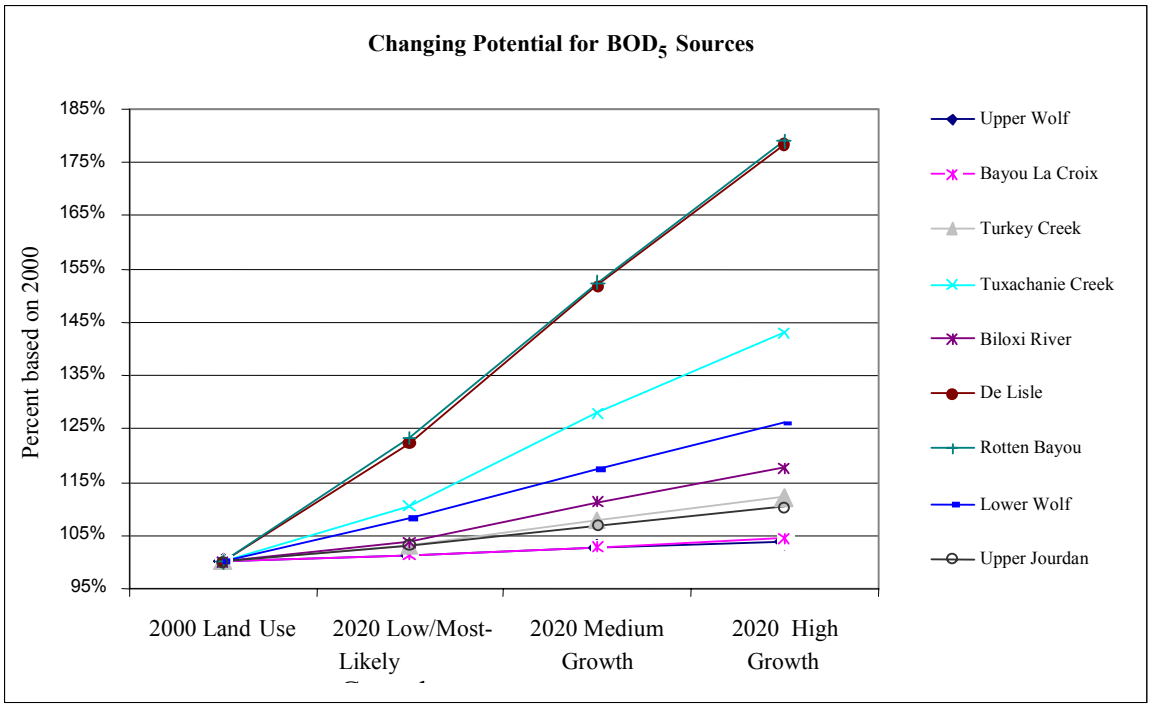


Figure 5.3–3. Changing BOD_5 Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

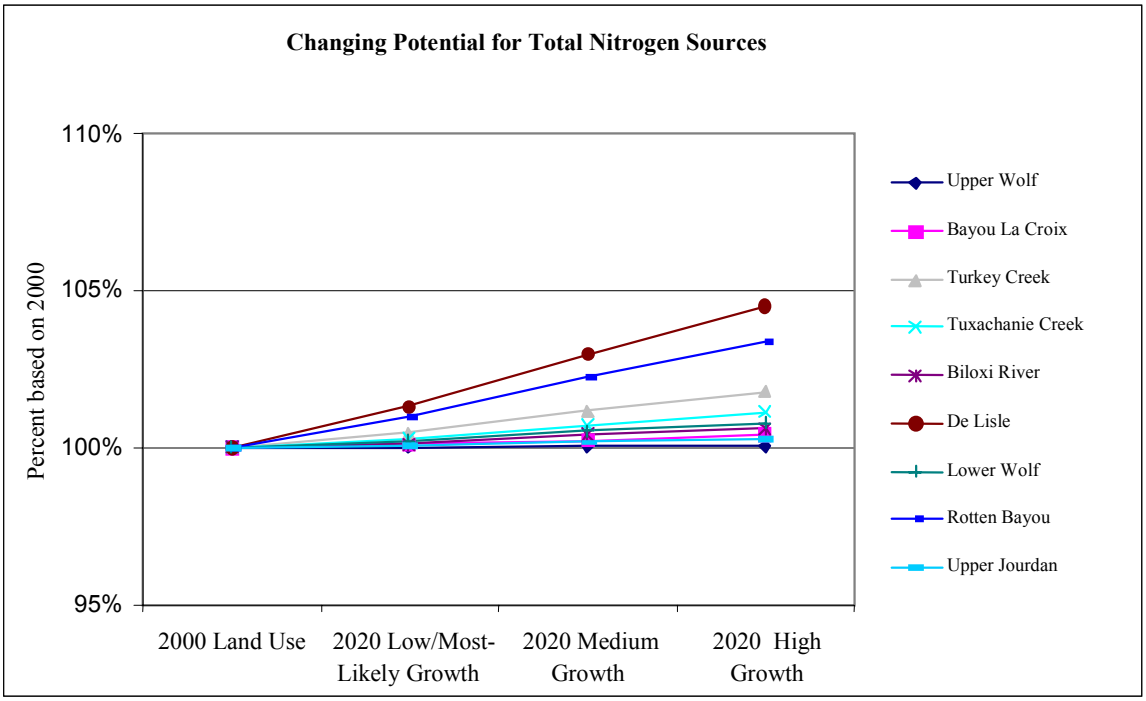


Figure 5.3–4. Changing Total Nitrogen Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

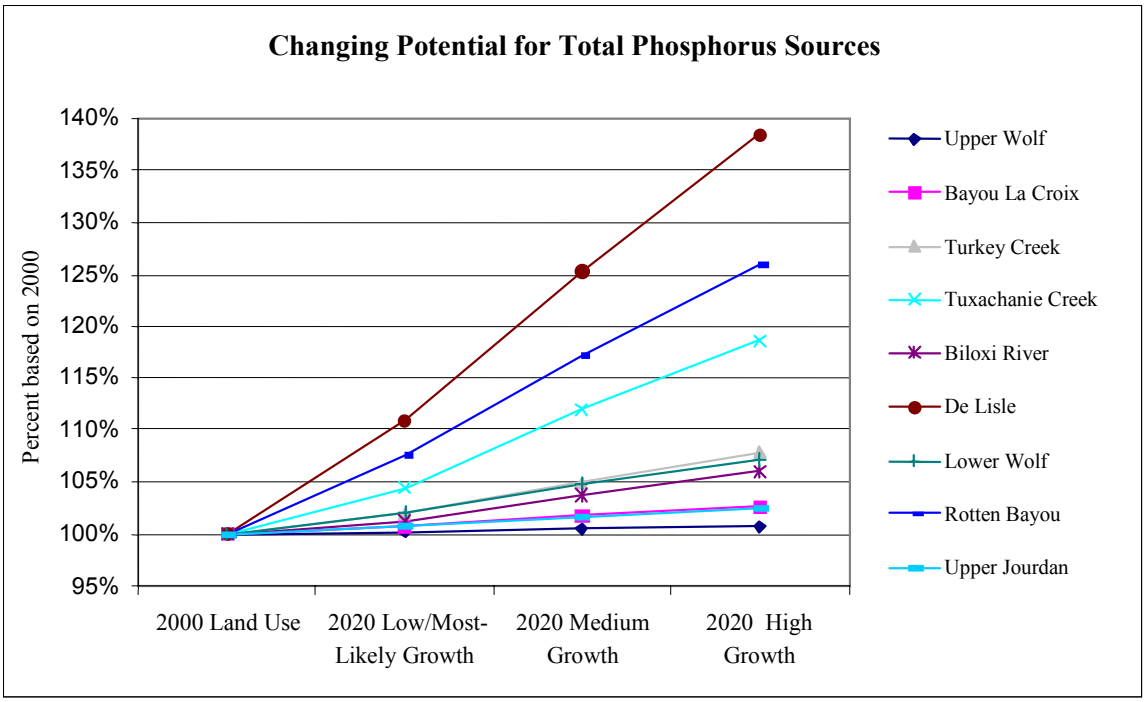


Figure 5.3–5. Changing Total Phosphorus Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

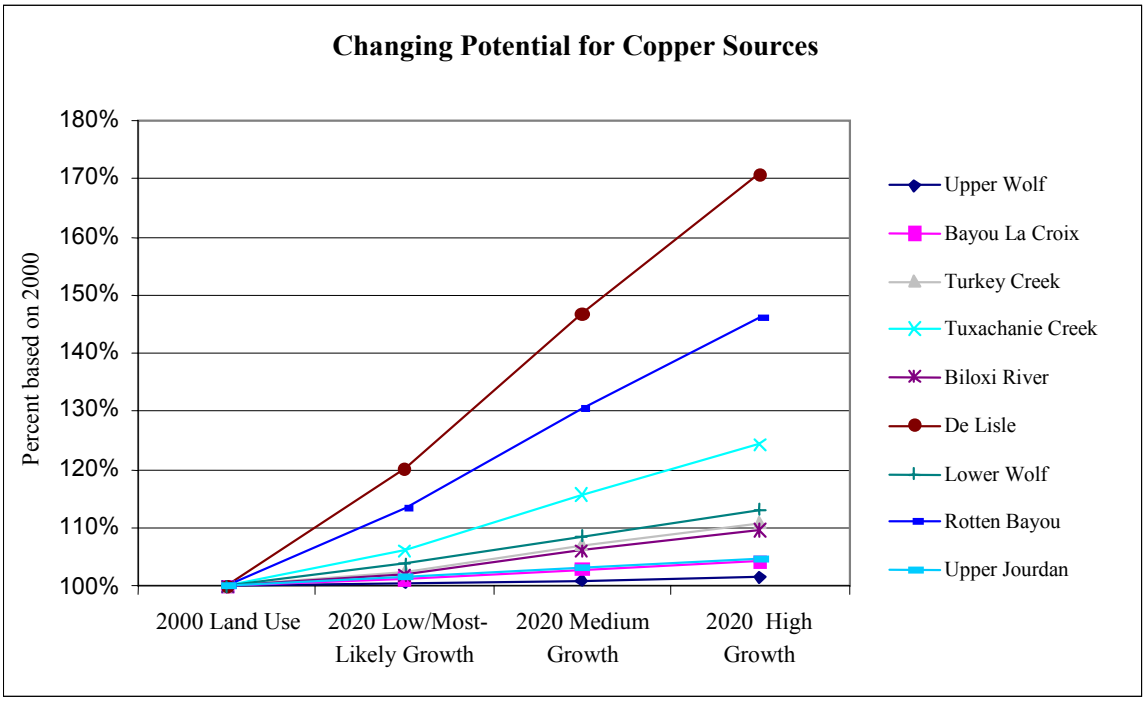


Figure 5.3–6. Changing Copper Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

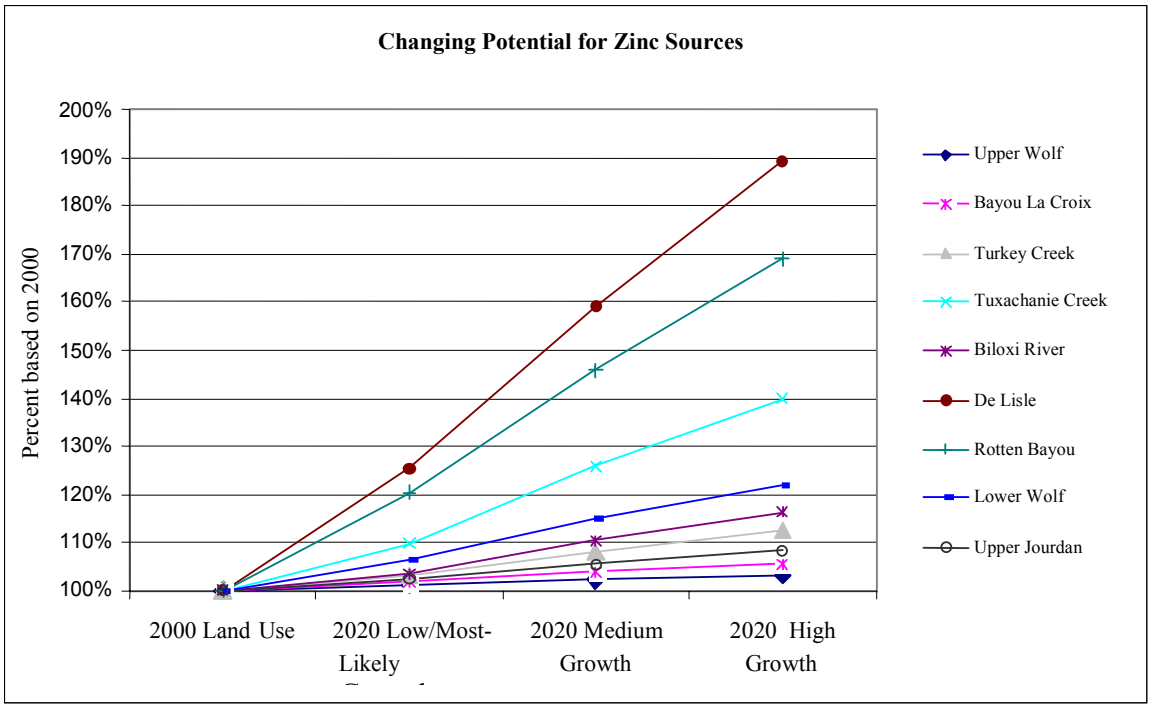


Figure 5.3–7. Changing Zinc Loadings Available for Transport to Surface Waters Due to Predicted Changes in Land Use.

Three other watersheds—De Lisle, Rotten Bayou, and Tuxachanie Creek—are expected to have slightly increased pollutant loadings of all indicators evaluated, except sediment, which is not expected to change. Segments of these watersheds are listed on the state list of impaired waters for impairments due to pathogens. De Lisle subwatershed is also listed for biological impairments, while Rotten Bayou is listed for nutrients, organic enrichment, and low dissolved oxygen. Based on forecasts described below, these impairments can be expected to worsen as land uses change and the areas become more urbanized.

Projected changes for selected water quality indicator pollutants under the Low-Growth/Most-Likely Growth Scenarios are as follows:

Pathogens. Pathogen loadings in four of the coastal Mississippi subwatersheds could increase. Each of the watersheds contain water bodies listed on the list of impaired waters for pathogens. Pathogen loadings in De Lisle and Rotten Bayou could increase to 18 and 16 percent, respectively. Pathogen loadings in Lower Wolf and Tuxachanie Creek are projected to increase by approximately 5 percent. In contrast, Upper Jourdan, Upper Wolf, Turkey Creek–Old Fort Bayou, Biloxi River, and Bayou La Croix are projected to have a negligible percentage increase in pathogen loadings (see Appendix P). Overall, the increase in pathogen loads might increase beach and shellfish-bed closures associated with storm events.

Sediment. None of the watersheds are projected to experience a change in sediment contributions. This analysis excludes any sediment contribution associated with increased flows in small tributaries and drainage ditches due to an increase in impervious surfaces (see Appendix P).

Nutrients. BOD_5 loadings in four watersheds are projected to increase. A 22 percent increase in BOD_5 loadings is projected for De Lisle and Rotten Bayou while increased loadings would reach approximately 10 percent for Lower Wolf and Tuxachanie Creek. Upper Jourdan, Upper Wolf, Turkey Creek–Old Fort Bayou, Biloxi River, and Bayou La Croix would have a negligible percentage increase in BOD_5 loadings (see Appendix P).

Total nitrogen loadings would increase only negligibly in all of the watersheds under the Low-Growth/Most-Likely Growth Scenarios (see Appendix P). Phosphorus loadings would increase in three of the watersheds: by 10 percent in De Lisle and Rotten Bayou and by 5 percent in Tuxachanie Creek. Upper Jourdan, Upper Wolf, Lower Wolf, Turkey Creek–Old Fort Bayou, Biloxi River, and Bayou La Croix are projected to experience only a negligible percentage increase in total phosphorus loadings (see Appendix P).

Metals. Three watersheds are projected to have increased copper loadings. A 10 percent increase in copper loadings is projected for De Lisle and Rotten Bayou and a 5 percent increase is projected for Tuxachanie Creek. Upper Jourdan, Upper Wolf, Lower Wolf, Turkey Creek–Old Fort Bayou, Biloxi River, and Bayou La Croix are projected to have only a negligible percentage increase in copper loadings (see Appendix P).

Zinc loadings are projected to increase in four watersheds. A 20 percent increase is projected for De Lisle and Rotten Bayou, while zinc loadings into Lower Wolf and Tuxachanie Creek are projected to increase by approximately 10 percent. Upper Jourdan, Upper Wolf, Turkey Creek–Old Fort Bayou, Biloxi River, and Bayou La Croix are projected to have a negligible percentage increase in zinc loadings (see Appendix P).

Medium-Growth Scenario. Impaired water bodies in the Turkey Creek–Old Fort Bayou watershed are on the state list of impaired waters for the following parameters of concern: nutrients, pathogens, pH, priority organics, non-priority organics, metals, total toxics, organic enrichment/low dissolved oxygen, habitat alterations, siltation, turbidity, arsenic, and toxics. Under the Medium-Growth Scenario, Turkey Creek–Old Fort Bayou is expected to reach 16 percent imperviousness by the year 2020. This increase is expected to exacerbate the existing water quality problems. Future pollutant load contributions were calculated for the Medium-Growth Scenario for the year 2020. Pollutant load contribution predictions showed increases for all water quality parameters in Turkey Creek–Old Fort Bayou.

The De Lisle subwatershed is 5 percent impervious and is expected to reach 7 percent under the Medium-Growth Scenario by the year 2020. The De Lisle subwatershed is on the state list of impaired waters for pathogens and biological impairments. As the percentage of imperviousness approaches 10 percent, it is possible that existing impairments would be exacerbated and new impairments will develop. Based on the predicted land use changes, pollutant increases are forecasted to range from 1 percent to 59 percent, except for sediment, which is not expected to change.

Two other watersheds, Rotten Bayou and Tuxachanie Creek, are expected to have slightly increased pollutant loadings for all indicators evaluated except sediment. Segments of these watersheds are listed on the state list of impaired waters for impairments due to pathogens. Rotten Bayou is also listed for nutrients, organic enrichment, and low dissolved oxygen. Based on the predictions described below, these impairments can be expected to worsen as land uses change and the areas become more urbanized.

Under the Medium-Growth Scenario, Lower Wolf and Biloxi River are expected to have minor increases in pollutant loadings. Lower Wolf is on the state list of impaired waters for pesticides, siltation, nutrients, and pathogens. Biloxi River is listed for pathogens. These problems would be expected to worsen under the Medium-Growth Scenario.

Projected changes under the Medium-Growth Scenario for specific indicators are as follows:

Pathogens. Pathogen loadings are projected to increase for seven of the Coastal Mississippi subwatersheds, all of which contain water bodies on the impaired waters list for pathogens. A 35 to 40 percent increase in pathogen loadings is projected for De Lisle and Rotten Bayou, while pathogen loadings to Tuxachanie Creek are projected rise by 18 percent. Increased pathogen loadings to Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River are estimated to range from 5 to 7 percent. Loadings to Upper Jourdan, Upper Wolf, and Bayou La Croix would increase only marginally under this scenario (see Appendix P). The predicted increase in pathogen loads might lead to an increase in beach closures associated with storm events.

Sediment. Sediment loadings are projected to increase in one watershed, Turkey Creek–Old Fort Bayou, but only by a negligible percentage. Sediment loadings to Turkey Creek–Old Fort Bayou are projected to increase by a negligible percentage under this growth scenario. This projection excludes any sediment contribution associated with increased flows within small tributaries and drainage ditches due to increases in impervious surfaces (see Appendix P).

Nutrients. BOD_5 loadings are expected to increase in seven watersheds. Up to a 50 percent increase in BOD_5 loadings is projected for De Lisle and Rotten Bayou, while

loadings to Lower Wolf and Tuxachanie Creek are projected to increase between 18 and 28 percent. A 10 percent increase is projected for Upper Jourdan, Turkey Creek–Old Fort Bayou, and Biloxi River. Only a negligible increase is forecasted for Upper Wolf and Bayou La Croix (see Appendix P). Total nitrogen loadings are projected to increase by a negligible amount in all of the watersheds (see Appendix P).

Phosphorus loadings are forecast to increase in six watersheds. The largest increase is projected for De Lisle, where phosphorus loading could increase by 25 percent by the year 2020. Phosphorus loadings to Rotten Bayou and Tuxachanie Creek are projected to increase by approximately 15 percent, while Turkey Creek–Old Fort Bayou, Lower Wolf, and Biloxi River could receive approximately a 5 percent increase. Increased loadings to Upper Jourdan, Upper Wolf, and Bayou La Croix are projected to be negligible (see Appendix P).

Metals. Copper loadings are projected to increase in six watersheds. Loadings to De Lisle and Rotten Bayou are projected to increase by 30 to 45 percent by 2020. A 15 percent increase in copper loadings is forecast for Tuxachanie Creek, while Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River would experience approximately 5 percent increases. A negligible increase in copper loadings is projected for Upper Jourdan, Upper Wolf, and Bayou La Croix under this growth scenario (see Appendix P).

Zinc loadings are projected to increase in eight watersheds. Increases of between 45 and 60 percent are projected for De Lisle and Rotten Bayou, while loadings to Tuxachanie are projected to rise by 25 percent. A 10 to 15 percent increase in zinc loadings is projected for Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River, but only a 5 percent increase is forecast for Upper Jourdan and Bayou La Croix. A negligible increase is projected for Upper Wolf (see Appendix P). An increase of metals in submerged sediment is expected in subwatersheds with increased metal loadings.

High-Growth Scenario. Six of the watersheds—De Lisle, Rotten Bayou, Tuxachanie Creek, Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River—are expected to have major increased loads of all indicators evaluated under the High-Growth Scenario. Pollutant loadings to the Upper Wolf subwatershed, however, are not projected to change substantially.

Impervious surface, which accounted for 5 percent of the De Lisle subwatershed land area in 2000, would increase to 8 percent under the High-Growth Scenario by the year 2020. De Lisle subwatershed is on the state impaired waters list for pathogens and biological impairments. As the percentage of imperviousness nears 10 percent, it is possible that existing impairments would be exacerbated and new impairments would develop. Based on the predicted land use changes, pollutant increases are predicted to range from 5 percent to 89 percent, except for sediment, which is not expected to change.

The Rotten Bayou subwatershed is expected to experience increased pollutant loadings for all indicators evaluated except sediment. Segments of this subwatershed are listed on the state impaired waters list for impairments due to pathogens, nutrients, organic enrichment, and low dissolved oxygen. Based on the predictions described below, these impairments can be expected to worsen as land uses change and the areas become more urbanized. Pollutant loading increases are predicted to range from 4 percent to 77 percent, except for sediment.

The Tuxachanie Creek watershed is expected to experience slightly increased pollutant loadings of all indicators evaluated, except sediment. Segments of this watershed are listed on the state

impaired waters list for impairments due to pathogens. Pathogen loadings are projected to increase by approximately 28 percent. Other pollutant loading increases are predicted to range from 1 percent to 43 percent, except for sediment.

The Lower Wolf subwatershed is expected to have increased pollutant loadings of all indicator pollutants in 2020. Lower Wolf is on the state list of impaired waters for pesticides, siltation, nutrients, and pathogens. Pollutant loading increases are predicted to range from 1 percent to 26 percent, except for sediment.

Under the High-Growth Scenario, Turkey Creek–Old Fort Bayou is expected to reach 19 percent imperviousness by the year 2020. This increase in imperviousness is expected to exacerbate the existing water quality problems. Future pollutant loads were calculated for the High-Growth Scenario for the year 2020. The predictions showed increases for all water quality parameters in Turkey Creek–Old Fort Bayou. Although the percentage of increase is not as great as those predicted for the De Lisle, Rotten Bayou, Tuxachanie Creek, Lower Wolf, and Biloxi River subwatersheds, it does not translate into a lesser impact on the Turkey Creek–Old Fort Bayou watershed. Many streams in the Turkey Creek watershed are impaired because of the amount of imperviousness in the subwatershed. In the water bodies that already have elevated in-stream concentrations of pollutants, additional loadings can result in further damage, regardless of the percentage of increase.

The Biloxi River subwatershed is expected to have increased pollutant loadings for all indicators. Biloxi River is on the state impaired waters list for pathogens. Pollutant increases are predicted to range from 1 percent to 17 percent, except for sediment.

Projected changes under the High-Growth Scenario for specific indicators are described below:

Pathogens. Pathogen loadings are projected to increase in eight subwatersheds, all of which have water bodies on the impaired waters list for pathogens. A 50 to 60 percent increase in pathogen loadings is projected for De Lisle and Rotten Bayou, while pathogen loadings to Tuxachanie Creek are projected to increase by 28 percent. Lower Wolf is forecast to receive a 16 percent increase in pathogen loadings and Turkey Creek–Old Fort Bayou and Biloxi River a 10 percent increase in pathogen loadings. Upper Jourdan and Bayou La Croix are projected to experience a 5 percent increase in pathogen loadings by the year 2020, while in the Upper Wolf subwatershed, pathogen loading increases would be negligible (see Appendix P). The predicted increase in pathogen loads might increase beach and shellfish-bed closures associated with storm events.

Sediment. Only the Turkey Creek–Old Fort Bayou watershed is expected to experience an increase in sediment contributions, although the change is projected to be negligible. The projections exclude potential sediment loadings associated with increased flows within small tributaries and drainage ditches due to increased impervious surface area (see Appendix P).

Submerged sediment quality declines when metals and other pollutants are adsorbed to suspended sediments. The trend predictions are only for sediment and not for metals or other pollutants attached to submerged sediment.

Nutrients. Increased BOD_5 loadings are projected for nine subwatersheds. The largest increases are projected for De Lisle and Rotten Bayou, where BOD_5 loadings could rise by as much as 78 percent. BOD_5 loadings to Tuxachanie Creek are forecast to increase by 40

percent, while a 26 percent increase is projected for Lower Wolf. Loadings to Upper Jourdan, Turkey Creek–Old Fort Bayou, and Biloxi River would increase by about 10 percent under the High-Growth Scenario. Small increases in BOD_5 loadings are projected for Upper Wolf and Bayou La Croix (see Appendix P).

Under the High-Growth Scenario, by the year 2020, total nitrogen loadings are forecast to increase by 5 percent in De Lisle and Rotten Bayou. Only negligible increases are projected for the other watersheds evaluated in this study (see Appendix P).

Phosphorus loadings are projected to increase in six watersheds, with increases of 38 percent in De Lisle and 26 percent in Rotten Bayou. Loadings to Tuxachanie Creek are forecast to grow by 20 percent, while Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River are expected to experience a 7 percent increase in total phosphorus loadings. Only negligible increases are predicted for Upper Jourdan, Upper Wolf, and Bayou La Croix under the High-Growth Scenario (see Appendix P).

Metals. Increased copper loadings are projected for nine subwatersheds. The largest increases are forecast for De Lisle, where copper loadings are projected to increase by as much as 70 percent during the period 2000–2020. During the same period, copper loadings are projected to increase by 46 percent in Rotten Bayou; 24 percent in Tuxachanie Creek; and 10 percent in Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River. Copper loadings to Upper Jourdan and Bayou La Croix are projected to increase by 5 percent, while only a negligible increase is forecast for Upper Wolf (see Appendix P).

In addition, increased zinc loadings are forecasted for nine subwatersheds. The largest increases are forecast for De Lisle, where zinc loadings are projected to increase by as much as 90 percent during the period 2000–2020. During the same period, zinc loadings are projected to increase by 70 percent in Rotten Bayou, 40 percent in Tuxachanie Creek, 20 percent in Lower Wolf, 15 percent in Biloxi River, 10 percent in Upper Jourdan and Turkey Creek–Old Fort Bayou, and 5 percent in Bayou La Croix, while only a negligible increase is forecast for Upper Wolf (see Appendix P).

Metals are found in both the water column and attached to sediments which are then transported by storm water to nearby water bodies. Projections relate to metals; they are not differentiated for metals absorbed to sediments. An increase in metals in the sediment is expected, but difficult to quantify.

5.3.1.2 No Action Alternative

Under the no action alternative, conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as used in the past, and would continue to identify and implement mitigation measures to address, some adverse impacts associated with increased pollutant load contributions. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative could be the same as those reflected by any of the four growth scenarios described in Section 5.3.1 above.

Relative to conditions in 2000, minor impacts to significant adverse impacts on water quality are expected under the growth scenarios. Minor to moderate impacts might occur under the Most-Likely and Low-Growth Scenarios, while minor to significant adverse effects might occur under the Medium and High-Growth Scenarios. De Lisle, Rotten Bayou, and Tuxachanie Creek are

expected to experience changes in water quality regardless of which of the growth scenarios occurs. Lower Wolf, Turkey Creek–Old Fort Bayou, and Biloxi River would be the more vulnerable water bodies under the pollutant loading increases projected under the Medium- and High-Growth Scenarios.

A comparison between growth scenarios shows that changing from a Low-Growth/Most-Likely Scenario to a Medium-Growth Scenario increases the number of watersheds with elevated pollutant loadings. This trend is also seen when comparing the Medium-Growth Scenario to the High-Growth Scenario; more watersheds are impacted and to a greater degree. Pathogens, BOD_5, total phosphorus, copper, and zinc are expected to increase under all of the growth scenarios, but most dramatically under the High-Growth Scenario.

A summary of the findings for each of the subwatersheds is presented below:

Bayou La Croix. The three growth scenarios were evaluated and found to have minimal impact on any of the parameters when compared with 2000 levels, even though the watershed has many segments on the state impaired waters list for the parameters of concern (including nutrients, pathogens, organic enrichment/low dissolved oxygen, siltation, and unknown toxicity). Although these impairments are likely to be exacerbated under any of the growth scenarios, no significant change in water quality would be expected.

De Lisle. The De Lisle subwatershed is on the state impaired waters list for pathogens and biological impairments. The range of increases in pollutant loadings estimated for the growth scenarios is as follows:

- Pathogens—18 to 60 percent
- Sediment—no change
- BOD_5—22 to 78 percent
- Total Nitrogen—1 to 5 percent
- Total Phosphorus—10 to 38 percent
- Copper—20 to 70 percent
- Zinc—25 to 90 percent

High growth in this subwatershed would be expected to dramatically affect water quality under the no action alternative. Water quality changes in the ranges predicted would likely cause additional water bodies to become impaired and existing impairments would worsen.

Lower Wolf River. The Lower Wolf River subwatershed is on the state impaired waters list for pathogens, pesticides, siltation, and nutrients. The range of increases in pollutant loadings estimated for the growth scenarios is presented below:

- Pathogens—5 to 16 percent
- Sediment—no change
- BOD_5—10 to 26 percent
- Total Nitrogen—negligible
- Total Phosphorus—1 to 7 percent

- Copper—1 to 10 percent
- Zinc—10 to 20 percent

Overall, only minor changes in water quality are expected under the Low-Growth/Most-Likely and Medium-Growth Scenarios within this subwatershed.

Rotten Bayou. The one water body in the Rotten Bayou subwatershed is on the state list of impaired waters for pathogens, nutrients, and organic enrichment/low dissolved oxygen. The range of increases in pollutant loadings estimated for the growth scenarios is as follows:

- Pathogens—16 to 60 percent
- Sediment—no change
- BOD_5—22 to 78 percent
- Total Nitrogen—1 to 5 percent
- Total Phosphorus—10 to 26 percent
- Copper—10 to 46 percent
- Zinc—20 to 70 percent

High growth in this subwatershed would be expected to dramatically affect water quality in the overall watershed. Water quality changes in the ranges predicted would likely cause additional water bodies to become impaired and existing impairments to become worse under all of the growth scenarios (but particularly for Medium- and High-Growth).

Upper Jourdan River. Three water bodies in the Upper Jourdan River subwatershed are on the state list of impaired waters for pathogens, siltation, pH, nutrients, biological impairments, and organic enrichment/low dissolved oxygen. The range of increases in pollutant loadings estimated for the growth scenarios is presented below:

- Pathogens—negligible to 5 percent
- BOD_5— negligible to 10 percent
- Copper—negligible to 5 percent

Only minor changes are expected in water quality in this subwatershed.

Upper Wolf River. Two water bodies in the Upper Wolf River subwatershed are on the state list of impaired waters for pesticides, siltation, nutrients, and organic enrichment/low dissolved oxygen. Projections indicate that pollutant loadings would increase only negligibly from 2000 levels under all growth scenarios evaluated in this study. The projected small increases might be explained by the fact that the subwatershed is in the headwaters of the coastal Mississippi watershed, beyond areas where significant growth is projected.

Biloxi River. Three water bodies on the state list of impaired waters for pathogens are in the Biloxi River subwatershed. The range of increases in pollutant loadings estimated for the growth scenarios is as follows:

- Pathogens—2 to 10 percent

- Sediment—no change
- BOD_5—5 to 17 percent
- Total Nitrogen—negligible to 5 percent
- Total Phosphorus—1 to 6 percent
- Copper—2 to 10 percent
- Zinc—3 to 18 percent

Overall, only minor changes in water quality are expected under the Low-Growth/Most-Likely and Medium-Growth Scenarios within this subwatershed.

Turkey Creek–Old Fort Bayou. There are 26 water bodies in the Turkey Creek–Old Fort Bayou subwatershed on the state list of impaired waters for pathogens, nutrients, pH, priority organics, non-priority organics, metals, total toxics, habitat alterations, siltation, turbidity, arsenic, toxics, and organic enrichment/low dissolved oxygen. The range of increases in pollutant loadings estimated for the growth scenarios is presented below:

- Pathogens—2 to 10 percent
- Sediment—1 to 2 percent
- BOD_5—3 to 13 percent
- Total Nitrogen—negligible to 2 percent
- Total Phosphorus—1 to 8 percent
- Copper—1 to 10 percent
- Zinc—2 to 12 percent

Significant past growth in this subwatershed has already affected water quality, as evidenced by the number of impaired water bodies. Although the projected increases are not as great as those predicted for some of the other subwatersheds, it is expected that already impaired streams would become worse with additional development. In those water bodies that already have elevated in-stream concentrations of pollutants, additional loadings, regardless of the increase, would cause additional damage to the biological integrity of the affected water body. Furthermore, this subwatershed is estimated to have the highest percentage of impervious surface—well above 10 percent for all growth scenarios. Therefore, water quality and geomorphological adverse impacts would be expected to increase within this subwatershed.

Tuxachanie Creek. The Tuxachanie subwatershed has two water bodies on the state list of impaired waters for pathogens. The range of increases in pollutant loadings estimated for the growth scenarios is as follows:

- Pathogens—5 to 28 percent
- Sediment—no change
- BOD_5—10 to 40 percent
- Total Nitrogen—negligible
- Total Phosphorus—5 to 20 percent

- Copper—5 to 24 percent
- Zinc—10 to 40 percent

Increased growth and increased imperviousness in this subwatershed could impair water quality, particularly under the Medium- and High-Growth Scenarios. Water quality changes might cause other water bodies to become impaired and existing impairments to become worse.

5.3.1.3 Proposed Action

5.3.1.3.1 Regional Conservation Practices

The RCPs presented below were developed to reduce specific cumulative effects on water resources from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented in the following ways:

1. RCPs to be used for formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development on a case-by-case basis.

- *Implement riparian buffer requirements as appropriate to protect stream corridors and wetlands from disturbance within project footprint. In areas with large amounts of impervious surfaces, volume and velocity of storm water runoff increase. Riparian buffers help to protect streambanks from erosion and filter pollutants in the runoff.*

- *Implement Low-Impact Development (LID) measures and create wetlands, detention ponds, or bioretention cells to reduce peak storm water flows and maximize groundwater infiltration.*

2. Through this EIS process, foster adoption of RCP measures that non-Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, development of new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects

- *Encourage adoption of requirements for developments to hook up to centralized wastewater treatment systems rather than installing new on-site sewage disposal systems (OSDS).* Centralized wastewater treatment systems can treat wastewater more effectively and reduce the opportunities for surface water and groundwater contamination associated with OSDS failures.

- *Encourage OSDS BMPs in areas without public sewer service to help maintain optimum operating efficiency and appropriate technology application*. BMPs for regular OSDS maintenance and proper OSDS operation can reduce pathogen and nutrient loadings attributable to system failures.

- *Encourage zoning ordinances that restrict the number of new septic systems permitted on hydric soils or other soils not suitable for septic systems*. Installing new septic systems in areas with improper soil conditions or in areas that are already at capacity with existing septic systems can lead to both groundwater and surface water contamination. Restricting new septic systems can reduce pathogen and nutrient loadings to water bodies

in the area. Requiring advanced alternative septic systems in areas with improper soils can enhance water quality and reduce the potential for septic tank failure.

- *Promote strict policies for septic system maintenance in order to reduce pathogen and nutrient loadings attributable to system failure*.

- *Encourage owners, through public education efforts, to improve the operation and maintenance of their septic systems*. Public education is an effective tool for controlling nonpoint source pollution. Many people are willing to implement BMPs for nonpoint source control once they understand the benefits associated with them.

- *Promote storm water control regulations (e.g., illicit discharge detection and elimination, construction site storm water runoff control, post-construction storm water management practices) for rural areas not covered under the new NPDES MS4 program requirements (i.e., less than 1,000 people per square mile).*

- *Foster initiation of ecological restoration projects to restore degraded streams*.

- *Encourage implementation of BMP options that can reliably achieve water quality goals (e.g., multiple pond systems, porous pavement, infiltration basins, and extended detention ponds) by reducing storm water runoff and allowing pollutants in storm water to settle out before the runoff enters nearby water bodies.* Not all BMPs have the same level of effectiveness. The BMPs mentioned above are known to reduce storm water runoff attributable to impervious surfaces and to allow pollutants contained in storm water to settle out before the runoff enters nearby water bodies. This can help reduce water body impairments.

- *Encourage storm water management plans for large development projects to control runoff during construction and during operation of a new facility*.

- *Encourage implementation regional storm water planning initiatives to encourage the use of LID landscape design approaches (i.e., on-site structural controls rather than regional controls) at development projects to reduce peak flows during storm events*. Implementing such techniques would reduce pathogen, nutrient, and sediment loadings, as well as reduce flood events. LID is a landscape design approach that uses on-site structural controls to the extent practicable rather than regional controls. The controls used can include the following:

    - Disconnection of impervious surfaces. Divert storm water runoff to grassed swales, rain barrels, and overland flow rather than designing impervious systems to whisk runoff quickly to streams.

    - Reduce impervious surfaces. Design with less pavement to reduce the volume of runoff. Smaller parking lots, sidewalks on one side of the road, and narrower residential streets provide the desired quality of life and reduce total imperviousness.

    - On-site controls to treat storm water. Build bioretention cells, sand filters, rain barrels, pocket wetlands and other features into the landscape. Several of these systems can be aesthetically designed to enhance landscape appeal.

These concepts work best when they are used to design new developments. They are equally adaptable to providing storm water management to previously developed areas that have little or no storm water management, and are therefore a good approach to storm water management in older neighborhoods and infill development. LID provides opportunities for developed areas to incorporate (retrofit) storm water management structures into small open spaces (e.g., linear grassed medians of roads and parking lots, grassed or paved areas within parking lots, industrial and business complexes).

- *Encourage adoption of an updated storm water design manual for development projects within the coastal Mississippi region*. The *2000 Maryland Stormwater Design Manual* initiated a new approach to designing storm water management that focused on controlling impacts on the receiving waters rather than just at the outfall of the storm drain from the new development. Numerous other state storm water programs are now using the manual. Beyond incorporating design indices such as peak flow and nutrient management contained in previous guides, the manual recommends measures that protect receiving streams from accelerated erosion, preserve the volume of precipitation infiltrating the ground rather than running off as surface flow, and promote the use of LID features.

- *Encourage adoption of on-site storm water management control measures such as bioretention cells (key storm water management structures for the on-site management of precipitation that fit into small open space to treat runoff from impervious surfaces).* These structures provide the ability to retrofit existing sites to control smaller storms (which include the bulk of precipitation events) and thereby compensate for sites not developed with attention to current storm water management objectives. These measures can also retain and infiltrate soil to groundwater or, after treatment through soil/vegetation filters, to underdrains that discharge to storm sewers.

- *Encourage creation of wetland systems for storm water management to reduce sediment, nutrient, and metal loads as well as hydrologic changes.* Created wetland systems can also reduce peak storm flows and increase fish and wildlife habitat.

- *Encourage the use of BMPs at construction sites of new development projects and during forestry operations to control runoff.* BMPs could target construction sites that disturb more than one acre and reduce pollutant loads to nearby water bodies by trapping sediment, nutrients, and metals. Controls could include installation of sediment fence/straw bale barriers, temporary gravel construction access, vegetated filter strips, or hydroseeding. Other management tools for controlling pollutant loads from construction areas include training local construction operators and establishing procedures for inspection and enforcement. Examples of BMPs for forestry operations include installation of brush barriers, grade stabilization, responsible fertilizer and pesticide applications, and revegetation of roads and harvested areas. Implementation of these BMPs would reduce sediment, nutrient, and metal loads as well as hydrologic changes.

- *Promote restriction of land application of manure near water bodies*. Storm water runoff from areas with manure applications can contain high levels of pathogens and nutrients, and transport them directly into nearby water bodies.

5.3.1.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor to significant beneficial effects with respect to water quality and geomorphology of streams, compared with impacts under the no action alternative. Such steps would therefore likely decrease the regional cumulative effects of development under all growth scenarios. Relative to current conditions, implementing the proposed action might actually improve water quality conditions even with additional growth. The benefits of implementing the RCPs described above include reduced pathogen, sediment, nutrient, and metal loads to water bodies; reduced storm water volume and velocity; and improved habitat.

Land use planning, zoning, and development restrictions are a primary means of preventing environmental degradation. Under the umbrella of these considerations, BMPs, alternative maintenance procedures, and education of management and technical personnel can provide on-the-ground improvements. Many BMPs and other management options reduce the amount of impervious surface on a site, thus reducing the velocity and volume of storm water runoff. Most BMPs are cost-effective approaches to managing storm water runoff, require no additional land area, involve no construction, and can be implemented with minimal effort.

Storm water BMPs are management tools for enabling sustainable growth. Historical water quality data indicate that growth occurred in a few areas where water quality conditions remained the same or improved slightly. Such results might be attributable to the implementation of BMPs. By implementing BMPs, water quality impairments can be reduced even when development leads to an increase in impervious areas. Depending upon the effectiveness of the BMPs implemented, water quality improvements can be substantial.

5.3.2 Coastal Processes

Predicting the impact of development on a coastal system's water quality processes with greater accuracy would require in-depth study, including development of a site- and scenario-specific hydrodynamic model, which is beyond the scope of this EIS. Future proposed developments would need to be individually evaluated for their impact on the Mississippi coastline. Perturbations within a water body associated with the placement of floating establishments, as well as changes in the land associated with ancillary development, might be negligible when viewed individually, but taken together can be additive. In addition, future mitigation practices need to be developed on a site-specific basis. For example, site-specific hydrodynamic modeling could evaluate beach erosion due to changes in wave action, changes in sedimentation patterns in estuary areas, navigation management, and changes in aquatic habitat.

5.4 GEOLOGY, SOILS, AND GROUNDWATER

5.4.1 Trends Analysis for Geology, Soils, and Groundwater

The primary issues of concern identified for the geological, soil, and groundwater resources are erosion potential, presence of unsuitable soils leading to septic tank failures, and use of groundwater as a public water supply. The trends analysis for these issues are also discussed in Sections 5.3 (Water Resources) and 5.9 (Utilities).

Erosion. Soil erosion is a key issue of concern in the coastal area. Erosion is a natural process caused by rainfall and runoff as well as by wind and wave action, which break down overlying soil and rock. Soil erosion leads to high sedimentation rates in water bodies, resulting in a reduction of overall water quality reduction in a watershed. Sediment can also help soil-adhering pollutants to migrate into the surface water system. Areas with large areas of bare soil, such as construction sites, can produce large amounts of sediment unless construction BMPs are carefully adhered to.

To assess trends in erosion potential, a watershed-based loadings model was developed to quantify soil loss for each subwatershed in the coastal Mississippi watershed for all the growth scenarios. The model evaluated how changes in land use and new construction activities would affect potential soil loss across the region. See Section 5.3, Water Resources, for the technical approach and trends analysis for soil loss and sedimentation effects.

Hydric Soils and Septic Tanks. Pollution from malfunctioning septic tanks has been a growing concern for the coastal Mississippi region. If an effluent plume from septic tank failure reaches an aquifer or surface water system, it can adversely affect the quality of water and cause health concerns. Septic tank effluent entering a water body can result in low dissolved oxygen and high pathogen levels, leading to beach and shellfish bed closures due to the health effects of pathogens, as well as decreased fishing productivity. For septic tanks to function properly, they must be installed in proper soil, hydrologic, and topographic conditions. The soil must be able to drain and filter the effluent to allow for microbial degradation of organic material. Over a third of the soils in the study area are classified as hydric (soils that remain saturated for most of the year). Hydric soils by definition produce conditions that are inappropriate for septic tank installation. Because of limited access to the municipal sewer system in the study area and the increase in development, there are increasing conflicts associated with the installation of septic tanks in areas of hydric soils (Holloman, 1998).

Septic tank use trends were assessed using water quality data (MDEQ, 2000; MOLWR, n.d.), soil suitability information, and maps of areas with available municipal sewer system access. The water quality effects from septic tank failures are presented in Section 5.3, Water Resources. Septic tank failure rates and solutions are presented in Section 5.9, Utilities.

Groundwater. Groundwater is the exclusive source of municipal water supply in the CSA. Municipal water supplies and private wells are all sourced from a large network of subsurface aquifers. Groundwater is replenished through precipitation and subsequent infiltration through the subsurface into the aquifer. Urban development can draw down the level of the water table and affect the amount of groundwater in deeper aquifers through excessive groundwater consumption, and result in increasing impervious surfaces such as parking lots, concrete sidewalks and driveways, and building roofs.

In coastal aquifers where there is a large source of saltwater, a subsurface mixing area of saltwater and freshwater, or interface, occurs below the water table. When the amount of freshwater infiltrating into the aquifer decreases or aquifer drawdown is greater than aquifer recharge, the interface moves inland, resulting in saltwater intrusion.

To quantify impacts on groundwater resources, future changes in impervious surfaces were estimated for each of the growth scenarios to assess potential decreases in recharge rates. Studies that evaluated groundwater drawdown in the region and predicted increases in water consumption were assessed in the trends analysis. The trends analysis for groundwater usage is presented in Section 5.9, Utilities.

5.4.2 No Action Alternative

Under the no action alternative, the Corps would continue to review permits using the same procedures and analytical tools used in the past and would continue to identify and potentially mitigate some adverse effects associated with increased sedimentation. Effects from the no action alternative would be the same under any of the growth scenarios, but the relative magnitude of the effects would increase with growth of developed areas. Summaries of the projected conditions under the growth scenarios are presented below.

Soil Loss and Sedimentation. Long-term minor adverse effects on soils would be expected. As described in Section 5.3.1, only one subwatershed would be expected to experience an increase in soil loss and potential sediment loadings from an increase in development. Sediment loadings under the Medium- and High-Growth Scenarios would increase by a negligible amount in the Turkey Creek–Old Fort Bayou subwatershed.

Hydric Soils/Septic Tanks. Septic tank systems serve 24 percent of the population of Hancock County, 10 percent of the population of Harrison County, and 31 percent of the population of Jackson County. If septic tanks are properly designed, installed, operated, and maintained in appropriate soil and groundwater conditions, they can be a very economical and efficient means of treating wastewater. However, because over a third of the soils in coastal Mississippi are considered hydric, the wastewater from the septic tanks might not be properly absorbed or cleansed in these areas and might contaminate ground or surface water (GRPC 2001a; 2001b). The proportion of soils unsuitable for septic tanks in Hancock County is 50 percent; in Harrison County, 32 percent; and in Jackson County, 58 percent (Table 4.3–4). Failing septic tanks in the CSA have contributed significantly to the impaired water quality along the Gulf Coast (EcoSystems, 2000). Water quality assessments conducted by the MDEQ have determined that failing and substandard individual on-site treatment systems are a leading cause of degraded or polluted water sources in the coastal area of Mississippi (Holloman, 1998). Given the population growth rate projected for these areas under each of the growth scenarios, it is likely that septic tanks would continue to be installed in unsuitable areas and that additional failures could occur. At the same time, expansion of the current wastewater treatment system network is expected to continue, which could reduce the number of failing septic tanks in the future. As discussed in Section 5.3, minor to significant adverse effects on water quality would be expected with respect to changes in pathogen loadings.

Groundwater Resources. Currently, MDEQ/OLWR is addressing the issue of groundwater depletion and the closely related issue of saltwater intrusion. Available data suggest that regional groundwater levels and quality have been fairly stable to date. Water supply infrastructure capacities appear sufficient for the projected population growth.

5.4.3 Proposed Action

5.4.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. The following RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented in two primary ways: through the development of site-specific permit conditions under the regulatory authority of the Corps and the adoption of

RCPs by non–Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast.

RCPs to be used for formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects on a case-by-case basis:

- *Implement Low Impact Development measures and create wetlands, detention ponds, or bioretention cells to reduce peak storm water flows and maximize groundwater infiltration.*

Through this EIS process, foster adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, development of new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects.

- *Encourage adoption of requirements for developments to hook up to centralized wastewater treatment systems rather than installing new OSDS.* Sanitary systems can treat wastewater more effectively and reduce the opportunities for surface water and groundwater contamination associated with OSDS failures.

- *Encourage expansion of wastewater treatment plant service coverage to reduce regional reliance on OSDS.*

- *Foster required use of BMPs for OSDS and alternative treatment systems (e.g., aerobic systems, sand filtration, drip systems) in areas without public sewer service or areas having unsuitable soils*. BMPs can help maintain optimum operating efficiency by requiring regular OSDS maintenance and proper OSDS operation. Following such operation and maintenance recommendations can reduce pathogen and nutrient loadings attributable to system failures.

- *Encourage enactment of zoning ordinances that restrict the number of new septic systems permitted on hydric soils or other soils not suitable for septic systems*. Installing new septic systems in areas with improper soil conditions or in areas that are already at capacity with existing septic systems can lead to both groundwater and surface water contamination. Restricting the installation of new septic systems can reduce pathogen and nutrient loadings to water bodies in the area.

- *Encourage implementation of strict policies for septic system maintenance in order to reduce pathogen and nutrient loadings attributable to system failures*.

- *Encourage owners, through public education efforts, to improve the operation and maintenance of their septic systems*. Public education is an effective tool for controlling nonpoint source pollution. Many people are willing to implement BMPs for nonpoint source control once they understand the benefits associated with them.

- *Favor storm water collection infrastructure designed to use bioretention ponds or similar structures that allow storm water to infiltrate through the subsurface and into the aquifer while removing nonpoint source pollutants*.

- *Encourage continued update of regional planning studies and monitoring efforts for tracking groundwater aquifer quality, levels, and alternative sources*.

5.4.3.2 Effects of Implementing the Proposed Action

Long-term minor beneficial effects would be expected under the proposed action alternative. Significant efforts to reduce septic tank failures and expand wastewater treatment plant coverage would provide a substantial benefit to quality of life, water quality, human health, and aquatic habitat. Relative to current conditions, implementation of the proposed action could actually improve the quality of the environment and public service beyond current levels while still accommodating even High-Growth projections. To achieve this end, cooperative planning efforts among agencies and private institutions, along with significant capital investment, would be required.

5.5 BIOLOGICAL RESOURCES

This section presents the results of the trends and environmental consequences analysis for biological resources, including terrestrial life (Section 5.5.1), wetlands (Section 5.5.2), aquatic life (Section 5.5.3), and federally listed threatened and endangered species (Section 5.5.4).

5.5.1 Terrestrial Life

Section 5.5.1 presents the results of the trends and environmental consequences analysis for terrestrial life, which includes vegetation and wildlife. Given the scale of this regional cumulative effects study and the lack of population data for wildlife, the wildlife assessment focuses on changes to terrestrial habitat that would likely result in proportional impacts on wildlife populations in the region.

5.5.1.1 Trends Analysis for Terrestrial Life

5.5.1.1.1 Technical Approach for Terrestrial Life

Coastal Mississippi is home to a diverse assemblage of terrestrial wildlife species: mammals, birds, fish, reptiles, amphibians, and invertebrates are well represented in the three coastal counties. Habitat requirements for these species vary widely, and the same can be said for the large number of plant species that are found in the region. For the purposes of this analysis, plant species have been grouped into vegetative cover types that represent a coarse estimate of where assemblages of common plant species are most likely to occur. In the trends analysis model, economic data were correlated to changes in vegetative cover types. The model was not designed to identify the exact geographic location of specific land use changes, but rather the overall increase or decrease of a particular cover type over time. Because of the sheer number of common terrestrial wildlife and plant species in southern Mississippi, it would be a large undertaking beyond the scope of this EIS to examine trends for each species individually. However, it is possible to make some broad interpretations of the predicted changes in vegetation cover and the associated impacts on wildlife based on future development scenarios. The trends analysis pays special attention to regionally important vegetative community types such as bottomland hardwood forest, emergent wetlands, wet pine savanna, and upland longleaf pine forest. Regionally important wildlife species in need of resource management measures are for the most part classified as rare, threatened, and endangered species, which are covered in Section 5.5.4.

5.5.1.1.2 Growth Scenarios

Most-Likely Growth Scenario. Under all growth projections for the Bay St. Louis and Biloxi Bay watersheds, the CSA, and the three counties, natural and agricultural acreage is expected to decline and urban acreage is expected to increase (see Tables 5.5–1, 5.5–2, and 5.5–3). Because most terrestrial wildlife species are in some way dependent on natural lands and some thrive in agricultural settings, losses of natural vegetation and agricultural acreage predicted by the model are assumed to translate into loss and fragmentation of wildlife habitat. Under the Most-Likely Growth Scenario, about 8,000 acres of natural land, and about 2,000 acres of agricultural land would be converted to urban land use out of the 1.1 million acres that make up the three-county study area. Just under half of this urban land conversion would be expected to take place in the quarter-million acres of the CSA.

Table 5.5–1
Bay St. Louis Watershed, Trends in Vegetation and Wildlife Habitat Coverages

			1972	1992	Existing (2000)	Most-Likely Growth (Low) 2020	Medium-Growth 2020	High-Growth 2020
Deciduous/ Mixed Bottomland Forest/ Swamp	Total Acres		165,729	138,525	137,917	137,477	136,959	136,485
	Loss from Previous		-	-27,204	-608	-440	-958	-1,432
	Percent Change from Previous		-	-16.41%	-0.44%	-0.32%	-0.69%	-1.04%
	Cumulative Loss Since 1972		-	-27,204	-27,812	-28,252	-28,770	-29,244
	Cumulative Percent Loss Since 1972		-	-16.41%	-16.78%	-17.05%	-17.36%	-17.65%
Pine Forest	Total Acres		222,452	205,261	141,355	140,360	139,143	138,032
	Loss from Previous		-	-17,191	-63,906	-995	-2,212	-3,323
	Percent Change from Previous		-	-7.73%	-31.13%	-0.70%	-1.56%	-2.35%
	Cumulative Loss Since 1972		-	-17,191	-81,097	-82,092	-84,304	-87,627
	Cumulative Percent Loss Since 1972		-	-7.73%	-36.46%	-36.90%	-37.90%	-39.39%
	Upland Pine Forest	Total Acres			82,362	81,713	80,933	80,220
		Loss from Previous			-	-649	-780	-713
		Percent Change from Previous			-	-0.79%	-0.95%	-0.88%
		Cumulative Loss Since 2000			-	-649	-1,429	-2,142
		Cumulative Percent Loss Since 2000			-	-0.79%	-1.74%	-2.60%
	Wet Pine Forest/ Savanna	Total Acres			58,993	58,647	58,210	57,812
		Loss from Previous			-	-346	-437	-398
		Percent Change from Previous			-	-0.59%	-0.75%	-0.68%
		Cumulative Loss Since 2000			-	-346	-738	-1,181
		Cumulative Percent Loss Since 2000			-	-0.59%	-1.33%	-2.00%

Table 5.5–2
Biloxi Bay Watershed, Trends in Vegetation and Wildlife Habitat Coverages

			1972	1992	Existing (2000)	Most-Likely Growth (Low) 2020	Medium-Growth 2020	High-Growth 2020
Deciduous/ Mixed Bottomland Forest/ Swamp	Total Acres		67,441	102,999	97,544	97,110	96,341	95,665
	Gain or Loss from Previous		-	35,558	-5,455	-434	-1,203	-1,879
	Percent Change from Previous		-	52.72%	-5.30%	-0.44%	-1.23%	-1.93%
	Cumulative Gain Since 1972		-	35,558	30,103	29,669	28,900	28,224
	Cumulative Percent Gain Since 1972		-	52.72%	44.64%	43.99%	42.85%	41.85%
Pine Forest	Total Acres		300,618	191,070	182,417	181,824	180,773	179,849
	Loss from Previous		-	-109,548	-8,653	-593	-1,644	-2,568
	Percent Change from Previous		-	-36.44%	-4.53%	-0.33%	-0.90%	-1.41%
	Cumulative Loss Since 1972		-	-109,548	-118,201	-118,794	-119,845	-120,769
	Cumulative Percent Loss Since 1972		-	-36.44%	-39.32%	-39.52%	-39.87%	-40.17%
	Upland Pine Forest	Total Acres			105,774	105,416	104,776	104,213
		Loss from Previous			-	-358	-640	-563
		Percent Change from Previous			-	-0.34%	-0.61%	-0.54%
		Cumulative Loss Since 2000			-	-358	-998	-1,561
		Cumulative Percent Loss Since 2000			-	-0.34%	-0.94%	-1.48%
	Wet Pine Forest/ Savanna	Total Acres			76,643	76,407	75,997	75,636
		Loss from Previous			-	-236	-410	-361
		Percent Change from Previous			-	-0.31%	-0.54%	-0.48%
		Cumulative Loss Since 2000			-	-236	-646	-1,007
		Cumulative Percent Loss Since 2000			-	-0.31%	-0.84%	-1.31%

In the three counties combined, losses of more than 1 percent each of the existing acreages of pine forest, deciduous forest, and shrub-scrub/cutover land would be expected as a result of an increase in recreation-induced growth. Any future change in the proportion of cutover land to pine forest would be expected to be determined more by the economics of the timber industry than by the economics of the recreation industry. It is also expected that natural succession would alter the composition of natural vegetation from one category to another over time. For example, replanted cutover land grows into pine forest, and pine forest can become deciduous forest in the absence of periodic burning.

Losses of emergent wetland acreage in the three-county area are expected to total about 2,800 acres under the Most-Likely Growth Scenario, slightly more than 5 percent of existing wetlands. Most of these losses are predicted to occur in Jackson County. Slightly less than half would be lost in the quarter-million acres of the CSA. Losses of emergent wetlands would be expected to occur near the coast because that is where the largest percentage of emergent wetlands naturally occur. Wetland and seagrass beds serve as nursery grounds for fish and invertebrates that are prey for many coastal and migratory birds. Wetland losses would be expected to adversely affect many rare resident and migratory species because of losses of food and cover.

Table 5.5–3
Coastal Study Area, Trends in Vegetation and Wildlife Habitat Coverages

			1972	1992	Existing (2000)	Most-Likely Growth (Low) 2020	Medium-Growth 2020	High-Growth 2020
Deciduous/ Mixed Bottomland Forest/ Swamp	Total Acres		47,697	53,332	50,827	50,426	49,853	49,342
	Gain or Loss from Previous		-	5,635	-2,505	-401	-974	-1,485
	Percent Change from Previous		-	11.81%	-4.70%	-0.79%	-1.92%	-2.92%
	Cumulative Gain Since 1972		-	5,635	3,130	2,729	2,156	1,645
	Cumulative Percent Gain Since 1972		-	11.81%	6.56%	5.72%	4.52%	3.45%
Pine Forest	Total Acres		103,635	69,616	68,192	67,216	65,875	64,669
	Loss from Previous		-	-34,019	-1,424	-976	-2,317	-3,523
	Percent Change from Previous		-	-32.83%	-2.05%	-1.43%	-3.40%	-5.17%
	Cumulative Loss Since 1972		-	-34,019	-35,443	-36,419	-37,760	-38,966
	Cumulative Percent Loss Since 1972		-	-32.83%	-34.20%	-35.14%	-36.44%	-37.60%
	Upland Pine Forest	Total Acres			22,293	21,699	20,891	20,163
		Loss from Previous			-	-594	-808	-728
		Percent Change from Previous			-	-2.66%	-3.72%	-3.48
		Cumulative Loss Since 2000			-	-594	-1,402	-2,130
		Cumulative Percent Loss Since 2000			-	-2.66%	-6.29%	-9.56%
	Wet Pine Forest/Savanna	Total Acres			45,899	45,516	44,984	44,506
		Loss from Previous			-	-383	-532	-478
		Percent Change from Previous			-	-0.83%	-1.17%	-1.06%
		Cumulative Loss Since 2000			-	-383	-915	-1,393
		Cumulative Percent Loss Since 2000			-	- 0.83%	-2.00%	-3.03 %

Other land management activities that are not reflected in the model would be expected to have both adverse and beneficial impacts on vegetation and wildlife under the Most-Likely Growth Scenario. Conversion of mature pine forest (especially longleaf pine) to short-rotation pine plantation, residential and commercial development, or agriculture would all be expected to have adverse impacts on forest interior-dwelling birds and other species that require large tracts of unfragmented habitat for survival. In addition, residential development adjacent to existing mature longleaf pine forests would be expected to complicate the use of prescribed burning as a management tool because of smoke and safety issues. Recovery efforts for species dependent on the longleaf pine ecosystem would not succeed without protection of existing pine forests and the use of prescribed burning to maintain the herbaceous layer and kill invading hardwood trees.

Adverse impacts would also be expected from the construction of logging roads for timber harvest. Roads that penetrate wildlands have the potential of bringing humans in closer contact with wildlife and increasing the likelihood of direct and indirect adverse impacts from roadkill and introduction of exotic plant species. Timber harvest would be expected to have adverse impacts on some mature forests, and contribute to erosion and sedimentation in small headwater streams. Long-term benefits would, however, be expected if timber harvest is used as a management tool as the first step in a clearcut or thinning operation to restore longleaf pine forest. Sand and gravel mining would be expected to have adverse impacts on benthic aquatic species by altering stream channels and introducing silt into streams. Likewise, development

activities that disrupt natural drainage patterns by ditching, draining, damming, or filling aquatic and adjacent upland habitats would be expected to have similar negative impacts.

Adverse cumulative impacts on birds would be expected as a result of human activity in coastal areas in the form of chemical and oil spills, entanglement in fishing gear, and disturbance of nesting areas. Long-term adverse impacts to water quality and wetlands could reduce the abundance of fish prey species for pelicans. Water pollution would also be expected to have adverse effects on aquatic species.

Low-Growth Scenario. Effects on wildlife and vegetation under the Low-Growth Scenario would be expected to be virtually the same as effects under the Most-Likely Growth Scenario.

Medium-Growth Scenario. Urban land in the 1.1 million acres of the three-county study area would be expected to increase at the expense of natural and agricultural areas under the Medium-Growth Scenario (see Tables 5.5–1, 5.5–2, and 5.5–3). Developed land would be expected to increase by about 23,000 acres, while natural acreage would decline by roughly 17,500 acres, and agricultural land by 5,500 acres. This represents a loss of almost 2 percent of existing natural land, and just over 5 percent of agricultural land. Losses of agricultural land to reforestation or development could have adverse effects on wildlife species, particularly grassland songbirds and bobwhite quail (*Colinus virginianus*), which thrive in field edges and pastures. Roughly half of the change from natural to urban land would take place in the quarter-million acres of the CSA. Harrison County could see a drop of about a 10 percent in its agricultural land base and a 6.5 percent drop in its existing emergent wetlands. That 6.5 percent represents about 440 acres of Harrison County emergent wetlands. Losses of forested wetlands are also likely if 2,600 acres of the deciduous forest/mixed/bottomland forest category in Harrison County are converted by development. Under the Medium-Growth Scenario, Jackson County could also lose about 10 percent of its emergent wetlands, mostly the southwest corner of the county. Jackson County has about four times the emergent wetland acreage as Harrison County, thus Jackson County emergent wetlands losses could have significant adverse effects on estuarine species.

Harrison County could also lose about 3,000 acres of pine forest/savanna under the Medium-Growth Scenario. Although this represents a loss of only about 2 percent of the most abundant cover type in the county (roughly 125,000 acres), losses of pine forest represent a potential loss of habitat for species dependent on pineland habitat. Losses of wet pine savanna could decrease the amount of suitable habitat for the diverse herbaceous vegetation found in that vegetative community. Wet pine savannas are thought to have among the highest species richness (species per acre) of any vegetative community in North America (Brewer, 1998).

High-Growth Scenario. Developed land is predicted to increase by up to 34,000 acres in the 1.1 million acres of the three counties combined, under the High-Growth Scenario. Just over 23,000 acres of predicted newly developed land would be in Harrison County, and about two-thirds of that would be within the CSA. A concurrent loss of 25,700 acres of natural areas in the three-county area would accompany this high level of economic growth. About half of the natural land converted to other uses in the three-county area would be expected to come from within the roughly quarter-million acres of the CSA. Approximately 8,300 acres of agricultural land could be lost in the three-county area by 2020 under the High-Growth Scenario. Hancock and Jackson Counties could lose about 3 percent of their agricultural lands, but Harrison County could see a reduction of almost 20 percent. Effects on wildlife that use agricultural areas under the High-Growth Scenario would be similar to effects under the Medium-Growth Scenario. Losses in emergent wetlands acreage in the three-county area are expected to reach about 4,500 acres (a 21 percent loss) under the High-Growth Scenario. Like the Moderate Growth Scenario, the majority

of these losses are predicted to occur in the Jackson County portion of the CSA. Adverse effects on rare species dependent upon wetland habitat would be expected, but would occur primarily in the most intensely developed areas.

In forest and shrub-scrub habitats, losses under the High-Growth Scenario would be expected to be about 5 percent or less when examined at the level of the three-county area or the CSA. Harrison County would be expected to lose a greater percentage of its upland natural area than the other two counties. About 7,000 acres of the 21,000 acres of forested and shrub-scrub habitat lost in the three-county area would be from inside the CSA. Given the distribution of predicted land use change, only minor adverse impacts to forest habitats in Hancock and Jackson Counties north of I-10 would be expected. However, even with minimal loss of acreage, forest fragmentation and development-related prohibitions on prescribed burning could make habitat less suitable for species dependent on the longleaf pine ecosystem.

5.5.1.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as used in the past, and would continue to identify and mitigate adverse impacts on terrestrial life. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative would be the same as those reflected by any of the four growth scenarios described in Section 5.5.1 above.

Relative to conditions in 2000, minor adverse impacts on terrestrial wildlife and vegetation would be expected, particularly for areas south of I-10. Given the diversity of wildlife and vegetation on the Mississippi coast, some wildlife species would be expected to benefit from changes in land cover predicted by the model while others would decline. Over the next 20 years, losses of wetland vegetative communities such as wet pine savanna and bottomland hardwood forest would be expected. Likewise, adverse impacts on freshwater aquatic wildlife and waterfowl would be expected, because these species are largely dependent on rivers, streams, and wetlands that are regulated by the Corps. For areas north of I-10, relative negligible adverse impacts would occur on vegetation and terrestrial wildlife given that little development has occurred or is likely to occur in these areas. Timbering operations are the main driver for regional changes north of I-10.

5.5.1.3 Proposed Action

5.5.1.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. The RCPs below were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. RCPs might be used and implemented in the following two ways:

1. RCPs to be used for formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects on a case-by-case basis.

- *Implement riparian buffer requirements as appropriate to protect stream corridors and wetlands from disturbance within project footprint.* Riparian corridors are a focus for wildlife habitat conservation in coastal Mississippi (Ramseur, 2002). Not only are bottomland hardwood forests and other vegetation near watercourses important for

wildlife, they also function as buffers to maintain water quality and stabilize hydrologic conditions in streams and rivers. Intact riparian vegetation also moderates runoff to streams and rivers, reducing adverse impacts of runoff on water bodies. This buffering function is particularly important near urban areas; impervious surface in urban areas can deliver freshwater rapidly to estuaries. Delivering large quantities of freshwater to brackish estuaries at elevated rates can result in adverse effects on estuarine wildlife.

- *Maintain habitat corridors and conserve high-quality wildlife habitat with adequate buffers, as appropriate*. To the extent possible, minimize development footprints and configure them to conserve wildlife habitat and maintain corridors.

2. RCPs developed through this EIS process to foster adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, development of new requirements/ regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects.

- *Encourage the use of prescribed burning in upland and wet pine savanna for forest and wildlife management*. Fire suppression is the single biggest threat to wildlife habitat in wet and upland pinelands (Ramseur, 2002). Fire suppression leads to dense overstory and shrub layer growth that shades out the herbaceous layer and degrades plant diversity. A loss of plant diversity degrades wildlife habitat for many species, including federally listed species like the gopher tortoise and red-cockaded woodpecker. At the urban-wildland interface, prescribed burning is very important for control of forest fuel loads for public safety. Wildfires fed by high fuel loads can damage life and property. Recent research efforts have also discovered that fire suppression and associated vegetation effects have a greater influence on the hydrology of wet pine savannahs than ditches or roads (Ramseur, 2002).

- *Encourage master planning of residential and commercial development to avoid or reduce fragmentation of existing forest habitat*. Fragmented habitats are harder to manage with prescribed fire than large tracts under single ownership with no development. Forest-interior bird species suffer population declines when contiguous forests are replaced with edge habitats created by forest fragmentation (Burdick et al., 1989). Available wildlife and wetland habitat estimation methodologies (i.e., HEP, WET, EPW) can be used to quantify habitat lost to development and estimate appropriate mitigation measures.

- *Encourage development planning and actions that reduce point and nonpoint source water pollution*. Most rare species would be expected to benefit from a reduction in point and nonpoint source water pollution in the Pascagoula, Biloxi Bay, and Bay St. Louis watersheds. Sediment, fertilizers, herbicides, sewage, petroleum products, and toxic chemicals all have the potential to adversely impact rare species directly or impact the prey organisms on which rare species feed (USFWS, 2001e).

- *Encourage initiation of surveys of high-quality wildlife habitat and natural vegetative communities on a county or watershed scale*. Natural resource inventory through remote sensing as well as field surveys can provide planning agencies with information needed to identify potential future environmental impacts on areas with high resource values. Easements, acquisitions, and voluntary land donations can be used to protect and restore high-quality natural vegetative communities on private land.

- *Encourage identification of environmentally degraded areas suitable for restoration of regionally important vegetative communities and establish mitigation banks for important cover types*. Bottomland hardwoods, wet pine savanna, upland longleaf pine forest, and emergent wetlands are examples of regionally important vegetative communities that would be reduced under future growth scenarios. Wetlands mitigation banking is an environmental management concept that has been put into practice in recent years to replace lost wetlands with created wetlands. Mitigation banks could be established for other cover types such as upland longleaf pine forest. Because restored areas can take years to mature, initiating restoration activities in mitigation areas before future development impacts occur would increase the availability of suitable habitat by the time it was needed to compensate for impacts.

5.5.1.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor beneficial effects on terrestrial vegetation and wildlife species relative to the no action alternative for all growth scenarios. Furthermore, implementation of the proposed action might result in minor improvements to terrestrial habitat above current conditions, even with additional growth as projected for the Low-Growth and Most-Likely Growth Scenarios, assuming that the RCPs are implemented. However, minor adverse effects might still occur (relative to current conditions) for the Medium- and High-Growth Scenarios, even with the implementation of RCPs, although implementation of RCPs should mitigate these impacts.

There are ample opportunities for protection and restoration of regionally significant habitats in the three coastal counties. Because land management responsibility falls on many different federal, state, and local agencies, as well as private landowners, the implementation and effectiveness of RCPs are difficult to forecast. Cumulative effects of development, infrastructure, long-lived toxic pollutants, unsustainable harvesting, sedimentation, fire suppression, and forestry practices that have adversely impacted wildlife and the vegetative communities that support them on the Mississippi coast would not be expected to be reversed or mitigated in the short term. Urban and suburban areas would not be expected to return to wildlife habitat except at enormous cost. Consumer preferences for waterfront property and water-oriented recreation would be expected to drive development in sensitive wetland and riparian areas. Mitigation and restoration efforts to replace regionally significant vegetative communities such as wet pine savanna would not be expected to fully replace lost habitat. Wildlife species that are neither game species nor threatened or endangered generally have few protections from indirect take, such as habitat destruction. At this time, wetlands are the only vegetative community with significant legal protections against loss, but remote sensing data show that protections have not prevented a net loss of wetlands on the Mississippi coast.

5.5.2 Wetlands

This section presents the results of the trends and environmental consequences analysis for wetlands, with a focus on historical and predicted losses of emergent wetlands in the region. It should be noted that deciduous hardwoods and pine savanna habitat also contain wetlands; however, data were insufficient to distinguish wetland from non-wetland areas in these habitat communities. Therefore, impacts on these forested areas were evaluated collectively in Section 5.5.1 under the Terrestrial Life section.

5.5.2.1 Trends Analysis for Wetlands

5.5.2.1.1 Technical Approach for Wetlands

Impacts on wetlands were evaluated primarily through an analysis of both historical losses of wetlands and land use modeling efforts (based on remote sensing data and GIS-based land use projections, Appendix O), as described in Section 5.2.1.1. It should be noted that there is a fair degree of uncertainty associated with these projections of estimated loss, because of the variability in the historical remote sensing results. To further support this analysis, an exhaustive search of available wetlands permits was conducted and the findings analyzed in order to assess potential loss of wetlands from development. Overall, the methodology provides an indication of the magnitude of wetlands loss over the past three decades and the likely loss over the next 20 years, as well as a method by which to adopt regional resource management measures for the protection of this valuable resource. The results of this analysis are presented below.

When reviewing the losses in emergent wetlands in the region it is important to note that these losses have not occurred solely from direct development impacts. Rather, wetland losses have occurred from a variety of natural and anthropogenic causes, including sea level rise and erosion, lack of sediment replenishment, severe weather, flood events (which might be due in part to increases in development), natural succession, and direct loss during development activities (Dahl, 2000). Available wetland permit data suggests that less than 10 percent of the recent emergent wetland losses in the region were due to direct filling of wetlands from building activities (USACE, 2001). Other anthropogenic factors (cumulative effects of development), loss of sediment replenishment, and erosion/sea level rise appear to be the primary cause of emergent wetland loss.

5.5.2.1.2 Growth Scenarios

Most-Likely Growth Scenario

Bay St. Louis Watershed. According to the projected land use model used by Tetra Tech (Table 5.5–4 and Appendix O), the Bay St. Louis watershed is estimated to lose more than 300 acres of emergent wetlands (2 percent) in the watershed by 2020. The watershed was estimated to have 21,603 acres of emergent wetlands in 1972, 20,249 acres in 1992, and 16,059 acres in 2000, which indicates an accelerating loss of emergent wetlands in the watershed since 1972. While the 20-year loss of emergent wetlands in the Bay St. Louis watershed under this scenario is small in total acres, the cumulative loss in the watershed from 1972 to 2020 would amount to nearly 6,000 acres, or 27 percent, of the emergent wetlands that were in the watershed in 1972.

Table 5.5–4
Bay St. Louis Watershed, Trends in Acres of Emergent Wetlands

	1972	1992	Existing (2000)	Most-Likely Growth (Low) 2020	Medium-Growth 2020	High-Growth 2020
Total Acres	21,603	20,249	16,059	15,712	15,237	14,810
Loss from Previous	-	-1,354	-4,190	-347	-822	-1,249
Percent Change from Previous	-	-6.27%	-21%	-2.16%	-5.12%	-7.78%
Cumulative Loss Since 1972	-	-1,354	-5,544	-5,891	-6,366	-6,793
Cumulative Percent Loss Since 1972	-	-6%	-26%	-27%	-31%	-37%

Source: See Appendix O.

Biloxi Bay Watershed. The Biloxi Bay watershed had less than one-half of the acreage of emergent wetlands in 2000 as the Bay St. Louis watershed, and it would lose almost three times as much of this community type under the Most-Likely Growth Scenario from 2000 to 2020 (Table 5.5–5) (Appendix O). Beginning with 7,866 acres in 2000, emergent wetlands in the watershed are estimated to decline by 958 acres (12 percent), to 6,908 acres in 2020. This is a reversal of the trend of losses of emergent wetlands in the watershed from 1972 to 2000. From 1972 to 1992, the watershed lost 1,920 acres (15 percent) of its emergent wetlands. Cumulatively, however, the 958-acre loss from 2000 to 2020 under this scenario pushes total losses of emergent wetlands in the watershed since 1972 to near 50 percent.

Table 5.5–5
Biloxi Bay Watershed, Trends in Acres of Emergent Wetlands

	1972	1992	Existing (2000)	Most-Likely Growth (Low) 2020	Medium-Growth 2020	High-Growth 2020
Total Acres	12,881	10,961	7,866	6,908	5,451	4,166
Loss from Previous	-	-1,920	-3,095	-958	-2,415	-3,700
Percent Change from Previous	-	-15%	-28%	-12%	-31%	-47%
Cumulative Loss Since 1972	-	-1,920	-5,015	-5,973	-7,430	-8,715
Cumulative Percent Loss Since 1972	-	-15%	-39%	-46%	-58%	-68%

Source: See Appendix O.

Coastal Study Area. The CSA had 22,863 acres of emergent wetlands in 2000, which was 96 percent of all emergent wetlands in the two watersheds in 2000 (Table 5.5–6) (Appendix O). Under the Most-Likely Growth Scenario, the CSA would lose 1,286 acres, or 6 percent, of its emergent wetlands by 2020, bringing the total extent of this community type in the area to 21,577 acres. The loss rate is well below the levels lost between 1972 to 1992, when the CSA lost 11 percent (3,709 acres) of its emergent wetlands. The 1,286-acre loss of emergent wetlands in the CSA from 2000 to 2020 under this scenario would bring the total cumulative loss in the area since 1972 to 34 percent (11,079 acres).

Low-Growth Scenario

Estimates for the extent of wetland community types under the Low-Growth Scenario are the same as for the Most-Likely Growth Scenario.

Table 5.5–6
Coastal Study Area, Trends in Acres of Emergent Wetlands

	1972	1992	Existing (2000)	Most-Likely Growth (Low) 2020	Medium-Growth 2020	High-Growth 2020
Total Acres	32,656	28,947	22,863	21,577	19,666	17,976
Loss from Previous	-	-3,709	-6,084	-1,286	-3,197	-4,887
Percent Change from Previous	-	-11%	-21%	-6%	-14%	-21%
Cumulative Loss Since 1972	-	-3,709	-9,793	-11,079	-12,990	-14,680
Cumulative Percent Loss Since 1972	-	-11%	-30%	-34%	-40%	-45%

Source: See Appendix O.

Medium-Growth Scenario

Bay St. Louis Watershed. Under the Medium-Growth Scenario, the loss of emergent wetlands in the Bay St. Louis watershed from 2000 to 2020 would be more than twice the loss under the Most-Likely Growth Scenario (Appendix O). A total of 822 acres are projected to be lost, which would represent a 5 percent reduction in emergent wetlands in the watershed from the 16,059 acres in the watershed in 2000. Cumulatively, under the Medium-Growth Scenario, emergent wetlands acreage in the watershed would continue to decrease from 1972 levels, when emergent wetland acreage totaled 21,603 acres. By 2020 this acreage would diminish by 6,713 acres.

Biloxi Bay Watershed. Losses of wetland communities in the Biloxi Bay watershed under the Medium-Growth Scenario are slightly more severe than those in the Bay St. Louis watershed (Appendix O). Emergent wetland losses are more than double than those under the Most-Likely Growth Scenario. A total of 2,415 acres of emergent wetlands are projected to be lost in the watershed under the Medium-Growth Scenario, compared with a loss of 958 acres under the Most-Likely Growth Scenario. This reduces the extent of the wetland community type in the watershed to 5,451 acres. The watershed had 12,881 acres of emergent wetlands in 1972, and the additional loss under the Medium-Growth Scenario increases the cumulative loss from 1972 to 2020 to 7,430 acres, or 58 percent of the 1972 acreage.

Coastal Study Area. Under the Medium-Growth Scenario, the loss of emergent wetlands in the CSA increases from 1,286 acres under the Most-Likely Growth Scenario to 3,197 acres (Appendix O). This is a 14 percent loss from 2000 to 2020, which reduces the remaining extent of emergent wetlands in the CSA to 19,666 acres. From the 32,656 acres of emergent wetlands in 1972, the cumulative loss in the CSA amounts to 12,990 acres (40 percent).

High-Growth Scenario

Bay St. Louis Watershed. Emergent wetlands in the Bay St. Louis watershed would be reduced under the High-Growth Scenario by 1,249 acres to 14,810 total acres in 2020 (Appendix O). This is nearly four times the loss under the Most-Likely Growth Scenario and one and a half times the loss under the Medium-Growth Scenario. The projected loss from 2000 to 2020 under this scenario brings the cumulative loss in the watershed since 1972 to 7,962 acres, a 37 percent loss.

Biloxi Bay Watershed. Emergent wetlands are projected to suffer a 3,700-acre loss in the Biloxi Bay watershed from 2000 to 2020 under the High-Growth Scenario (Appendix O). This is a 47 percent loss of the 7,866 acres the watershed had in 2000, and it leaves the watershed with only 4,166 acres of emergent wetlands, 466 acres more than are projected to be lost in the 20-year period. Under the High-Growth Scenario, the cumulative loss of emergent wetlands in the watershed since 1972 totals 8,715 acres, a 68 percent reduction.

Coastal Study Area. Under the High-Growth Scenario, emergent wetlands in the CSA would be reduced by 4,887 acres (21 percent) to 17,976 acres (Appendix O). This is one and half times the loss under the Medium-Growth Scenario and nearly four times the loss under the Most-Likely Growth Scenario. The remaining acres of emergent wetlands in the area in 2020 would be just over one-half what the area had in 1972. The cumulative loss over the 48 years is projected to be 14,680 acres (45 percent).

5.5.2.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as in the past, and would continue to identify and mitigate adverse impacts on wetlands. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative would be the same as those reflected by any of the four growth scenarios described in Section 5.5.2.1 above.

Relative to conditions in 2000, long-term direct and indirect minor adverse effects would result from the Most-Likely and Low-Growth Scenarios, while significant adverse might occur under the Medium- and High-Growth Scenarios due to cumulative loss of wetlands. Losses of specific wetland community types in the two coastal Mississippi watersheds considered in this EIS and across the CSA include emergent wetlands, as well as wetlands found within forested communities (e.g., bottomland hardwood swamps and pine savanna forests). Emergent wetlands would be lost in the Biloxi Bay watershed at about three times the rate as in the Bay St. Louis watershed, and more than 98 percent of all of emergent wetland losses would occur in the CSA. Overall, 6 to 21 percent of the existing emergent wetlands might be lost in the CSA, depending on the future growth that might occur. Cumulative loss of wetlands since 1972 would range from 34 percent to nearly 50 percent total loss.

The no action alternative would have impacts on wetland communities that go beyond losses of specific acreages or percentages of the wetlands existing in 2000 or that existed in 1972. In some instances, mitigation and compensation would continue to occur far from the site of wetland disturbance; compensation and mitigation might only superficially consider the functional value of wetlands that are disturbed; and the success of wetland mitigation would continue to remain largely undetermined and lag considerably behind wetland disturbance as it occurs. The true impact of wetland losses under the No Action Alternative could remain unknown for some time after 2020. Impacts on flooding, water supply, fish populations, threatened and endangered species, and wildlife in general could take years to manifest themselves completely.

5.5.2.3 Proposed Action

Consideration of the effects of implementing the proposed action with respect to wetlands implies that some of the issues raised over the last decade as coastal Mississippi saw enormous growth and discussed in this EIS will be addressed differently than they have been in the past—or, in some cases, might be factored into the decision-making process for the first time. The issues and concerns relevant to wetlands are the balance among wetland disturbance, mitigation, compensation, and creation; losses of functional values of wetlands; the success of wetland mitigation, compensation, and creation in offsetting spatial and functional losses of wetlands; and the location of mitigation, compensation, and creation with respect to the wetlands disturbed.

Conclusions drawn from analysis of the effects of implementing the proposed action, however, inevitably are qualitative. Wetland restoration and creation are not exact sciences; their success depends at least partially on forces over which people do not have control, such as climate and geology. The degree of success, furthermore, is often not clear for 20 years or more after a project is undertaken. The functional values of Mississippi wetlands have not been thoroughly researched; therefore, further diminishment of functional values due to near-term wetland losses would not be completely understood. Historic wetlands were lost largely before the concept of functional wetland value was understood, and, at least, future attempts to regain those lost functional values would be based on best professional judgment.

5.5.2.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, related actions for the conservation of coastal resources, and reduction of environmental and socioeconomic effects associated with development. RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented in three primary ways: development of site-specific permit conditions under the regulatory authority of the Corps, preparation of regional studies for the conservation of coastal resources through interagency efforts (pending availability of funds), and adoption of RCPs by non-Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast.

1. RCPs to be used in formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects on a case-by-case basis.

- *Implement wetland buffer requirements to protect on-site wetland habitat from disturbance*.

- *Use created wetlands for storm water control when site conditions allow*. See the Water Resources section for further details on the benefits of this measure.

- *Require wetlands mitigation using a watershed-based decision process (e.g., assess on-site mitigation options, mitigation within the same watershed, functional value considerations, and potential for mitigation success within current area)*. The decision to compensate for wetland disturbance on-site or off-site would be based on a single or multiple watershed-level analysis of the costs and benefits of the two options, taking into consideration the suitability of the disturbance site to support created or restored wetlands and the functional values that could be gained at the disturbance site versus an off-site location. If wetlands must be disturbed, the decision to require mitigation, compensation, restoration, or creation would be made based on an evaluation of the location and functional value of the wetlands being disturbed. In general, more valuable wetlands require more on-site mitigation than less valuable wetlands.

2. Regional studies and management approaches to be implemented through an interagency cooperative effort for the conservation of coastal resources. These would be implemented as funds become available).

- *Institute a robust mitigation tracking system to monitor mitigation implementation and effectiveness*. The success of mitigation and compensation would be tracked more closely. Stricter requirements for successful mitigation and compensation would be imposed. The revised requirements would be based increasingly on long-term ecological success of the mitigation or compensation effort and less on meeting short-term engineering goals.

- *Through an interagency cooperative effort, institute a GIS-based functional value assessment study and tracking system on the remaining wetlands in the region*. As knowledge of the functional value of wetlands in Mississippi grows, it should be incorporated into permitting decisions to minimize loss of functional value and requirements for mitigation, restoration, and creation. Such mitigation decisions would be based less and less on compensating acreage alone.

- *Through an interagency cooperative effort, study regional wetland stressors*. Wetland loss can be caused by a wide range of stressors including direct loss, excessive sedimentation, lack of sediment loads, sea level rise, hydrology/hydrodynamic modifications, flooding, and severe climatic events. Improving wetland habitat and minimizing wetland stressors can be an extremely complex task that requires cooperation of many stakeholders. A better understanding of these stressors and solutions through cooperative efforts is needed to ensure long-term success. By using a watershed approach, restoration projects can be prioritized, and wetland management measures for reducing stressors can be identified and implemented.

3. Foster adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, development of new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects. These efforts could include the following:

- *Encourage initiation of ecosystem restoration and other types of projects under authority of the Water Resources Development Act of 2000 involving a cooperative effort among state, local, and federal agencies and private watershed/river corridor associations*.

- *Encourage the use of storm water management structures consisting of artificial wetland detention ponds, where practical, at commercial and residential development sites*. Wetland detention ponds would reduce pollutant and nutrient loadings to surface waters, provide aesthetically pleasing surroundings, and provide wetland habitat for some wildlife. Reduction in nutrient and pathogen loading from developed land is critical to meeting water quality standards and maintaining the health of the lower Mississippi's surface waters.

5.5.2.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor beneficial effects on wetlands as compared with the no action alternative. Implementing the proposed action would affect the future of wetlands in coastal Mississippi in numerous beneficial ways. Wetlands of higher functional value would be disturbed less as the understanding of wetland function increases. Wetland mitigation and compensation would increasingly be strategically situated to replace lost functional values and to ensure that mitigation projects are executed successfully. Wetland restoration, mitigation, compensation, and creation would become more successful as long-term requirements are imposed. More successful mitigation and compensation would further offset the loss of functional wetland values. Implementing the proposed action would result in decreased wetland destruction, increased wetlands with vital functional values, and some replacement of wetlands in the coastal Mississippi region where they existed historically. Benefits of these results would be realized by people and by ecological systems; these benefits are considered in other sections of the EIS.

5.5.3 Marine Aquatic Life

5.5.3.1 Trends Analysis for Marine Aquatic Life

5.5.3.1.1 Technical Approach for Marine Aquatic Life

Estimates of future cumulative impacts on the aquatic resources of coastal Mississippi are difficult to project because interactions between environmental parameters and biological systems are complex. These estimations are additionally difficult in open systems, such as estuarine and marine environments, where many species have migratory life histories. Even under optimal environmental conditions, populations of species can experience wide fluctuations. The health and integrity of the habitat was determined to be the most appropriate approach for estimating future cumulative impacts for aquatic resources of coastal Mississippi. In most instances, estimations of water quality and changes in wetlands were used as an indicator of the potential cumulative impacts on aquatic life.

5.5.3.1.2 Growth Scenarios

Most-Likely Growth Scenario

Aquatic Plants. The acreage of submerged aquatic vegetation (SAV) in the Mississippi Sound was reduced from 20,000 acres to 11,767 acres as a result of Hurricane Camille in 1969. Eleuterius (1973) determined that 68 percent of potential seagrass habitat was vegetated in 1973, compared with 13 percent as of 1992. Subsequent surveys indicated that the SAV coverage continued to decline to approximately 2,000 acres in 1992 (Moncrieff et al., 1998). Overall, the Mississippi Sound has suffered a 90 percent decline in seagrass vegetation since 1968.

Moncrieff and others (1998) suggest that loss of vegetated areas corresponds with potential loss in water clarity over time as a result of anthropogenic influences; cyclic shifts in precipitation patterns, which would affect both salinity and turbidity; or a combination of these factors.

The cumulative effects of declining water quality, extended periods of depressed salinities, and physical disturbances such as tropical storms and hurricanes are the primary threat to the seagrasses in the Mississippi Sound. Although significant losses of seagrasses in the Mississippi Sound have sometimes occurred over short periods of time, the data provided above indicate an average annual loss from 1968 to 1992 of approximately 750 acres per year. At the baseline level, the existing degradation in water quality and unpredictable natural events place the remaining seagrass populations at precariously low levels.

Shrimp. The larvae of brown and white shrimp are estuarine-dependent, and positive correlations between estuarine vegetation and shrimp productivity have been demonstrated (Turner, 2000). Under baseline growth conditions, emergent wetland losses would result in a 5 percent decline in habitat. Continued declines in wetlands habitat can adversely affect shrimp populations.

Oysters. Oyster landings in coastal Mississippi waters have experienced high variability in the years since 1972. The primary threats to the oyster populations in Mississippi are fluctuations in environmental parameters, particularly salinity (Gordon, S. personal comm., MSDMR, March 2002). Approximately 97 percent of Mississippi's oyster landings come

from oyster beds that lie west of Cat Island in areas that have restricted freshwater inflows. The lack of sufficient freshwater inflows results in salinities below 14 to 15 parts per thousand, which is considered optimal for healthy oyster populations. In addition, the occasional opening of the Bonnett Carre Spillway in Louisiana can reduce the salinity in the Mississippi Sound to the point that it is essentially freshwater for prolonged periods of time, resulting in catastrophic mortalities of oysters (Coblentz, 2000b). As long as the freshwater inflows to Mississippi Sound remain unchanged, oyster populations would continue to follow historical trends.

Improvements in wastewater treatment and the change in many high-growth areas from septic systems to sewer systems have increased the possibility for higher harvest ratings. For example, the oyster beds in the vicinity of Biloxi Bay could be reclassified at a higher level as a result of improved water quality from wastewater treatment improvements (Gordon, S. personal comm., MSDMR, March 2002).

Blue Crabs. Blue crabs are estuarine-dependent and positive correlations have been observed between estuarine vegetation and blue crab production (Orth and van Montfrans, 1990; Turner, 2000). Projections of emergent wetlands under Most-Likely Growth conditions indicate a 6 percent decline in habitat. Continued declines in wetlands habitat have the potential to adversely affect blue crab populations.

Essential Fish Habitat (EFH). The High-Growth rates in southeast coastal areas require the expansion of facilities and infrastructure to meet increasing demands. This expansion threatens the wetlands, shoreline, and adjacent contiguous lands, and has the potential to adversely affect the aquatic resources. The most significant threat facing fisheries is from the loss of habitat by natural and human-related causes. Table 5.5–7 lists specific threats to EFH from growth in the coastal counties.

Low-Growth Scenario. The effects on aquatic resources under the Low-Growth Scenario would be expected to be virtually the same as effects under the Most-Likely Growth Scenario. Refer to the discussion above.

Medium-Growth Scenario

Aquatic Plants. Water quality analysis of future conditions in the Mississippi Sound under the Medium-Growth Scenario indicates that there could be a slight reduction in sediment loading. Reductions in sediment loading have the potential to result in improved water quality conditions, which might have a positive effect on seagrass populations in the sound. However, these positive effects could be offset by depressed salinities and physical disturbances from weather.

Shrimp. The larvae of brown and white shrimp are estuarine-dependent, and positive correlations between estuarine vegetation and shrimp productivity have been demonstrated (Turner, 2000). Under Medium-Growth conditions, emergent wetland losses indicate a 7 percent decline in habitat. Continued declines in wetlands habitat have the potential to adversely affect shrimp populations.

Table 5.5–7
Threats to Essential Fish Habitat

Category	Threat
Physical Alterations	Navigation projects, ports, marinas, and maintenance dredging
	Canals, ditches, levees, and embankments
	Tidal water control structures
	Pipeline crossings and rights-of-way
	Impoundments and alteration of freshwater inflow
	Industrial/commercial operations
	Housing developments
	Oil and gas operations in the Gulf of Mexico
	Agriculture and silviculture practices
Water Quality Issues	Point source discharges
	Hydromodifications
	Nonpoint source runoff
	Hypoxia "dead zones"
	Entrainment, impingement, and thermal-cooling water discharges
	Hazardous waste management
	Petroleum products and operations
	Chemical contaminant spills
	Atmospheric deposition
	Ocean dumping
Biologic Alterations	Blooms (toxic and nontoxic)
	Introduction of exotic species:
	Viruses and other disease organisms
	Zebra mussels
	Edible brown mussels
	Mammals
	Fishes
	Other vertebrates
	Wetland and aquatic plants

Source: GMFMC, 1998.

Oysters. Oyster populations are primarily affected by the quantity of freshwater flowing into the Mississippi Sound; therefore, it is unlikely that conditions under the Medium-Growth Scenario would have a significant effect on oyster populations.

Blue Crabs. Blue crabs are estuarine-dependent and positive correlations have been observed between estuarine vegetation and blue crab production (Orth and van Montfrans, 1990; Turner, 2000). Projections of emergent wetlands under Medium-Growth conditions indicate a 14 percent decline in habitat. Continued declines in wetlands habitat have the potential to adversely affect blue crab populations.

Essential Fish Habitat. Growth and development under the Medium-Growth Scenario would result in the continued loss of habitat, which has the potential to adversely affect EFH in the coastal Mississippi area.

High-Growth Scenario

Aquatic Plants. Water quality analysis of future conditions for the Mississippi Sound under the High-Growth Scenario predicts a slight reduction in sediment loading. Reductions in sediment loading have the potential to result in improved water quality conditions, which might have a positive effect on seagrass populations in the sound. However, these positive effects could be offset by depressed salinities and physical disturbances from weather.

Shrimp. The larvae of brown and white shrimp are estuarine-dependent, and positive correlations between estuarine vegetation and shrimp productivity have been demonstrated (Turner, 2000). Projections of emergent wetlands under High-Growth conditions indicate an 8 percent decline in habitat. Continued declines in wetlands habitat have the potential to adversely affect shrimp populations.

Oysters. Oyster populations are primarily affected by the quantity of freshwater flowing into the Mississippi Sound; therefore, it is unlikely that conditions under the High-Growth Scenario would have a significant effect on oyster populations.

Blue Crabs. Blue crabs are estuarine-dependent and positive correlations have been observed between estuarine vegetation and blue crab production (Orth and van Montfrans, 1990; Turner, 2000). Projections of emergent wetlands under High-Growth conditions indicate an 21 percent decline in habitat. Continued declines in wetlands habitat have the potential to adversely affect blue crab populations.

Essential Fish Habitat. Growth and development under the High-Growth Scenario would result in the continued loss of habitat, which has the potential to adversely affect EFH in the coastal Mississippi area.

5.5.3.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools used in the past, and would continue to identify and mitigate adverse impacts on aquatic life. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative could be the same as those reflected by any of the four growth scenarios described in Section 5.5.3.1 above.

As a result of significant development pressure and natural causes, Mississippi's coastline had lost more than 50 percent of its wetlands by 2000 (see Section 5.5.2). The loss of Mississippi's wetlands not only adversely affects Mississippi's fisheries, but also the fisheries of all the Gulf of Mexico states, from Florida to Texas. Ninety-eight percent of commercial fisheries' landings from the Gulf of Mexico are dependent on the health of the coastal habitats. Mississippi's coastal wetlands provide critical nursery areas for many species of fish and shellfish, and the relationship between estuarine wetlands and productivity of the fisheries has been clearly established for a number of economically valuable species (e.g., shrimp and menhaden). The loss of coastal wetlands represents one of the principal threats to these fisheries, and therefore to the communities that depend on the fishing industry.

A summary of resource-specific impacts and stressors follows. Overall, the condition of these resources would continue to worsen.

Aquatic Plants. The seagrass beds in the Mississippi Sound are threatened by the cumulative effects of natural events and anthropogenic activities in the coastal marine environment. The primary causes for this decline are most likely water quality, extended periods of depressed salinities, and physical disturbances such as tropical storms and hurricanes. As discussed above, 58 percent of the SAVs in the Mississippi Sound were lost as a direct result of the erosion and sedimentation caused by Hurricane Camille in 1969, and by the persistent low-salinity water resulting from discharged flood waters. By 1975, vascular seagrasses had been reduced by 33 percent and algal cover had been reduced by 41 percent. Additional losses of seagrass beds from 1971 to 1975 occurred as a result of the prolonged exposure to low-salinity water during the spring and winter in those years. By 1992, only 13 percent of the potential seagrass habitat was vegetated.

Fish. Estuaries provide food, habitat, and refuge from predation, serving as essential nursery grounds for a wide variety of economically important fishes and invertebrates (USEPA, 1999). The decline of fisheries can result from habitat degradation or from overfishing. As the carrying capacity of an estuary declines, the fish stocks that inhabit it can no longer support fishing levels that were previously sustainable. Therefore, the status of fishery resources can be used as an indicator to assess the suitability of estuarine habitat for sustaining those fisheries (USEPA, 1999).

Coastal development has altered the appearance of the coastline dramatically. Many waterfront-dependent industries have been dislocated as development along the coast has occurred. Support structures for fishing operations such as ice and fuel docks, in addition to unloading and berthing facilities, were either lost outright or moved to less accessible locations.

Coastal Mississippi's fleet of commercial fishing vessels has declined by 30 percent from about 2,000 operating units in 1989 to approximately 1,400 units in 1998 (Posadas, 2000). As one would expect, there has also been a subsequent decline in the number of commercial fishermen over the last 10 years as well. A reduction in shoreside infrastructure facilities is responsible for the decline in the commercial fishing fleet, and the continued increase in fuel costs has had, and would continue to have, serious deleterious effects on the size and composition of the commercial fishing fleet.

Shrimp. Long-term yields of commercial shrimp are directly related to the quantity and quality of intertidal habitat. Although there has been a 20 percent loss of wetlands over the past 65 years, the fisheries of the northern Gulf of Mexico have not declined as predicted from this loss of habitat. In fact, the average annual landings for shrimp have increased by more than 2 million pounds since 1992. The primary reason has been attributed to advances that have been made in shrimp harvesting (Turner, 2000). Today's shrimping fleets consist of more and larger vessels with bigger engines, make use of sophisticated electronics, and have four trawling nets instead of just one net. In addition, the climatic influences on fishing effort and on shrimp growth and survival cause large annual variations in shrimp populations. These variations confound conclusions linking wetland loss with shrimp productivity.

Oysters. Annual oyster production is highly variable from year to year due primarily to natural environmental fluctuations. Many of Mississippi's most productive areas have been closed to harvest because of increased pollution associated with coastal development. Decreased oyster production resulting from closed beds is more a reflection on the human health conditions related to oyster consumption than it is on the overall health of the oyster

populations themselves. The state water quality standard for shellfish growing areas is the strictest state water quality standard, even higher than for swimming.

Blue Crab. Blue crabs are highly dependent on estuaries and the destruction of wetlands by development of waterfront properties results directly in loss of productive habitat acreage. There is a quantitative relationship between blue crab production and habitat, and Turner and Boesch (1988) found evidence of decreased fishery production following wetland losses and increased fishery production following gains. Estuarine tidal creeks, salt marshes, and grass beds are the most sensitive habitats occupied by blue crabs (Guillory et al., 2001). The quality of marsh habitat has deteriorated due to increased bulkheading, channelization, and changes in upland drainage patterns as well as increased buffering/filtering capacities linked to commercial and residential development. Additional impacts on estuarine habitat include declining water quality and accelerated dredge and fill activities for shoreline development.

Essential Fish Habitat. Given the broad definition of EFH, the extensive estuarine distribution of the managed species and NMFS guidance to be risk averse in the face of uncertainty, all of the estuarine systems of the Gulf of Mexico are considered habitat for fish managed by the Gulf of Mexico Fishery Management Council (NMFS, 1998). Thus, EFH consists of all waters and substrates (mud, sand, shell, rock and associated biological communities) within these estuarine boundaries, as well as the subtidal vegetation (seagrasses and algae) and adjacent tidal vegetation (marshes and mangroves).

Marshland is being lost through subsidence, erosion, sediment and freshwater deficits, channelization, and rising mean sea level. Aggravating factors contributing to marshland losses include management for agriculture, flood control, and wildlife habitat. Pollution from agricultural, municipal, and industrial activities (including widespread oil and gas production) produces additional habitat degradation.

5.5.3.3 Proposed Action

5.5.3.3.1 Regional Conservation Practices

The policy of the Gulf of Mexico Fishery Management Council is to conserve, protect, restore, and develop habitats upon which fisheries depend; to increase the extent of their distribution and abundance; and to improve their productive capacity for the benefit of present and future generations (GMFMC, 1998). The Council has developed a list of guidelines and recommendations that support this policy. These guidelines are not meant to replace or modify any state regulation or guideline. The guidelines were adopted as RCPs in this document, and can prevent or minimize adverse effects on coastal aquatic resources from future development. These RCPs might be used and implemented in the following ways.

1. RCPs to be used for formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development on a case-by-case basis.

- *Plan construction and maintenance of channels, canals (boat access and drainage), dredge material sites, bulkheads, seawalls, transportation infrastructure, buildings, and ditches to minimize harm to aquatic habitat consistent with Gulf of Mexico Fishery Management Council recommendations (see below).*

- *Avoid sensitive aquatic habitat and incorporate adequate buffers and controls to minimize indirect effects.*

2. Regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities), may elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects include the following.

- *Foster development of navigation channels and boat access canals that provide for (1) alignments of channels and access canals that use existing channels, canals, and other deepwater areas to minimize initial and maintenance dredging requirements (where feasible), (2) alignments that avoid sensitive habitats such as oyster reefs and areas of submerged or emergent vegetation (where possible), and (3) locating canals and channels so that they do not cut through barrier beaches, barrier islands, or other Gulf of Mexico shoreline protection features*.

- *Encourage construction techniques for navigation channels and boat access canals that minimize turbidity and dispersal of dredged materials into sensitive wetland areas (i.e., submerged grasses and shellfish beds)*.

- *Foster development of navigation channels and boat access canals to (1) promote adequate water circulation, (2) avoid confined and dead-end canals, (3) minimize depths and maximize width of waterways, (4) orient canals toward prevailing summer winds to enhance water exchange, (5) use locks that connect more saline areas to fresher areas, and (6) ensure that navigation channel maintenance would be confined to seasons when impacts on larval and juvenile fishes would be minimal*.

- *Encourage the use of confining levees for disposal of dredged material when disposal sites are located near wetlands, and encourage the use of vegetation, native hay mulch, or other means to eliminate possible wind or water erosion or encroachment onto wetlands*.

- *Encourage the placement and movement of pipes used in hydraulic dredging processes to avoid damaging or destroying sensitive habitats (e.g., emergent marshes, endangered species habitats) where feasible*.

- *Favor the use of vegetation plantings, sloping (3:1) riprap, or gabions over the use of vertical seawalls as shoreline stabilization methods because the preferred methods provide better shoreline protection and good-quality fish and wildlife habitat*.

- *Discourage the use of vertical structures when bulkheads or seawalls are required in areas where marsh exists along the shoreline*.

- *Encourage the use of vertical structures such as bulkheads and seawalls when they are to be (1) aligned at or landward of the mean high tide line, (2) placed above wetland vegetation, and (3) constructed so that reflective wave energy does not scour or otherwise adversely affect adjacent essential fish habitat or adjacent shorelines*.

- *Encourage bulkhead and seawall construction in which submerged riprap material is placed at the toe of the structure to protect its integrity, reduce reflective wave energy, and provide hard substrate for aquatic organisms*.

- *Encourage the use of bulkhead and seawall breakwaters with openings that allow for fish ingress and egress and for water circulation*.

- *Favor bulkhead and seawall breakwaters constructed of riprap material with a minimum of 3:1 slope in most cases over those constructed of vertical wall structures.*

- *Encourage construction of roadways, railways, and airports that avoids wetlands; when avoidance cannot be achieved, encourage (1) selection of routes resulting in the least environmental damage, preferably along cleared, existing rights-of-way and road beds, (2) use of bridges instead of filling, (3) use of suitable erosion control and vegetation-restoration methods on bridge approaches, and (4) use of span bridges that do not disrupt flow, instead of culverts.*

- *Foster the use of transportation-related structures whose design and maintenance would prevent shoaling and alteration of natural water circulation.*

- *Discourage construction of drainage canals and ditches having the potential to drain wetlands, affect special aquatic sites, or cause other adverse impacts.*

- *Encourage the construction of upland retention ponds and other water management features such as sheet-flow diffusers to intercept materials that are toxic to marsh vegetation or aquatic life.*

- *Encourage the use of natural vegetation to line drainage canals and ditches because it slows floodwaters, binds sediments, prevents erosion, and provides fish and wildlife habitats; discourage construction of ditches and canals lined with concrete.*

- *Foster the development of drainage canal and ditch projects that avoid excessive clearing of brush, trees, and riparian vegetation for equipment access and/or project design.*

- *Avoid siting mosquito ditching in wetlands or in areas that drain coastal wetlands, create encroachment of saltwater into lower-salinity wetlands, and cause water stagnation. Encourage designs that provide for access for aquatic organisms that feed on mosquito larvae.*

- *Avoid configuring structures that would significantly alter the quality of aquatic habitat in terms of lighting, water quality, sedimentation, water depth, water temperature, and water clarity.*

- *Encourage siting of sewage treatment and disposal facilities in upland areas, and not in wetlands or other fragile coastal habitats.*

- *Encourage sewage treatment and disposal facilities that (1) use vegetated wetlands as natural filters and (2) that, for large-scale wastewater discharges, limit the use of pollutant assimilators to wetlands that have been specifically created for such purpose, and overall environmental and ecological suitability has been demonstrated.*

- *Favor planning for sewage treatment and disposal facilities that (1) provides for discharging into open ocean waters instead of into estuarine waters, since discharging into estuarine waters has a higher potential to result in contamination of living marine resources and nutrient overloading and (2) that provides for the siting of discharge points in coastal waters away from critical habitats such as oyster reefs, marshes, sand*

and mud flats, seagrass beds, endangered species habitats, and other environmentally sensitive habitats.

- *Foster conservation and restoration of seagrass beds in the Mississippi Sound. Encourage control of salinity levels and restoration of habitat for recovery of coastal fisheries.*

5.5.3.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor beneficial effects on aquatic life as compared with the no action alternative. However, the cumulative effects of coastal development, sedimentation, water quality degradation, restricted freshwater inflows, and the destruction of estuarine wetlands that have adversely affected the estuarine environments on which these species depend would not be reversed in the short-term. The complexity of the relationship between estuarine-dependent species, the fluctuating biological, chemical, and physical attributes of estuarine and nearshore marine environments, and the often-complex life histories of many of these species make it difficult to link cause and effect. In addition, many estuarine-dependent species migrate, do not spend the entire life cycle in the estuary, and have the ability to relocate to more favorable locales should habitat conditions warrant. The high mobility of the species involved makes it difficult to show direct cause and effect of coastal development on marine populations in such a relatively limited geographic area.

One could expect, however, that any actions that result in a decline of habitat and water quality degradation, as well as continued improvements to existing habitats would result in fewer stressors affecting the biological communities. Over time, mitigation and restoration efforts to protect, conserve, and enhance coastal wetlands and associated habitats and to limit coastal development, restore freshwater inflow patterns, and improve water quality, would result in beneficial effects on the species inhabiting the coastal waters of Mississippi.

5.5.4 Rare, Threatened, and Endangered Species

5.5.4.1 Trends Analysis for Rare, Threatened, and Endangered Species

5.5.4.1.1 Technical Approach for Rare, Threatened, and Endangered Species

Past and potential natural resource impacts on rare, threatened, and endangered (RTE) species were derived from information in scientific literature and USFWS/NMFS recovery plans. RTE species have been a subject of scientific inquiry since the establishment of the Endangered Species Act; literature pertaining to RTE species in coastal Mississippi habitats was used when available. If Mississippi studies were not available, the best available life history and habitat information from studies conducted in the southeastern United States or Gulf of Mexico were considered. Projected changes in land cover derived from the trends analysis model were then correlated to potential impacts on RTE species. Direct impacts due to habitat loss and fragmentation were the least difficult to correlate to the model. Some RTE species are habitat specialists that are known from only one cover type and rarely persist when deprived of that habitat. Marine RTE species observed in the coastal waters of Mississippi are primarily migratory and do not inhabit these waters year-round. Most of these species, such as the sea turtles, spend the majority of the year in the open ocean and are subject to a variety of threats far removed from Mississippi. Therefore, localized events occurring on the coast of Mississippi cannot be directly linked to the health and condition of the population of these species.

Indirect impacts on RTE species due to predicted changes in water quality, recreation, human disturbance, or fire suppression were more difficult to estimate. Indirect impacts are included in the analysis because literature sources provide evidence that cumulative indirect impacts could have a role in the decline of some RTE species.

5.5.4.1.2 Growth Scenarios

Most-Likely Growth Scenario. Under all growth projections in the coastal, county, and watershed study areas, natural and agricultural acreage is expected to decline and urban acreage is expected to increase. Because most rare terrestrial species occupy natural lands and some occasionally use agricultural areas, losses of natural vegetation and agricultural acreage predicted by the model are assumed to translate into loss and fragmentation of rare species habitat. Under the baseline growth scenario, about 8,000 acres of natural land, and about 2,000 acres of agricultural land would be converted to urban land use in the 1.1 million acres of the three-county study area. This represents a loss of 1 percent of available wildlife habitat. Just under half of the urban land conversion would be expected to take place in the quarter million acres of the CSA.

Threatened and endangered species, virtually by definition, are not abundant and their habitat needs tend to be specific. Therefore, direct and indirect impacts on threatened and endangered species would be expected to occur in specific locations throughout the study area. The model upon which this analysis was based was not designed to identify exactly where specific land use changes would occur in the distant future. However, many species are in decline because of development-related impacts that have been documented in the threatened and endangered species recovery plans developed by the U.S. Fish and Wildlife Service (USFWS). Assuming that these impacts would continue to some extent under all the growth scenarios, generalizations can be made about how land use change might affect threatened and endangered species as the region's economy and human population grows.

In the three counties combined, losses of more than 1 percent each of the existing acreages of pine forest, deciduous forest, and shrub-scrub/cutover land would be expected to result from an increase in recreation-induced growth. Any future change in the proportion of cutover land to pine forest would be expected to be determined more by the economics of the timber industry than by the economics of the recreation industry. It is also expected that natural succession would alter the composition of natural vegetation from one category to another over time. For example, replanted cutover land could grow into pine forest, and pine forest could become deciduous forest in the absence of periodic burning.

Losses of emergent wetlands acreage in the three-county area are expected to be about 2,800 acres under the Most-Likely Growth Scenario. This represents a loss of just over 5 percent of existing wetlands; most of those losses are predicted to occur in Jackson County. Slightly less than half would be lost in the quarter-million acres of the CSA. Losses of emergent wetlands would be expected to occur near the coast because that is where the largest percentage of emergent wetlands naturally occurs. Wetlands and seagrass beds are important habitat for some species such as manatees and Alabama red-bellied turtles, and they also serve as nursery grounds for fish and invertebrates that are prey for many estuarine species such as aquatic turtles, marine mammals, and coastal birds, (e.g., piping plover). Wetland losses would be expected to have adverse effects on many resident and migratory rare species because of losses of food and cover.

Development of multistory hotels and other tall structures could impact bald eagle flight in areas adjacent to water (USFWS, 1987). New roads, large housing developments, and commercial development near water all have the potential to disturb existing eagle nests. Removal of

potential nest trees—usually tall, live or dead trees with open crowns—would be expected to deprive eagles of nesting habitat. Beachside construction of homes and businesses could impact sea turtles during the nesting and hatching seasons. Adult female sea turtles leaving the surf to nest are easily disturbed by the presence of white light (e.g., from automobiles, buildings, street lights), which often causes them to return to the sea without nesting. Young turtles, which hatch primarily at night, can become disoriented by artificial lighting from houses, hotels, street lamps, and automobiles. Disorientation of the young hatchlings could result in their being misdirected toward roads and buildings rather than the surf. Direct adverse impacts on sea turtles could occur from construction of buildings in or on the dunes (USFWS, 1998b).

Conversion of mature pine forest (especially longleaf pine) to short-rotation pine plantation, residential and commercial development, or agriculture would be expected to have adverse impacts on as many as six different federally listed species in coastal Mississippi (USFWS 1990a; Natureserve 2000; Puckett and Franz, 2001). Residential development adjacent to existing mature longleaf pine forests would be expected to limit prescribed burning as a management tool because of habitat fragmentation, smoke, and safety issues. However, there is some residual cultural acceptance of prescribed fire in coastal Mississippi. Some homeowners in the urban-wildland interface are aware of the positive effects of prescribed fire for reduction of forest fuel loads and the protection of private property from catastrophic fire (Ramseur, 2002). Recovery efforts for species dependent on the longleaf pine ecosystem would not succeed without protection of existing pine forests and the use of prescribed burning to maintain the herbaceous layer and kill invading hardwood trees. Preservation and appropriate management of mature pine forest present the opportunity to protect a suite of rare animals: red-cockaded woodpecker, gopher tortoise, Mississippi gopher frog, eastern indigo snake, Mississippi sandhill crane, and black pine snake. Likewise, destruction of mature pine forest would have adverse impacts on the preservation and recovery of all these rare animals.

Declines in gopher tortoise populations would be expected to have adverse effects on many other species. Active and abandoned gopher tortoise burrows provide shelter for more than 360 species of animals, including the threatened eastern indigo snake and soon-to-be-listed Mississippi gopher frog (Puckett and Franz, 2001). Seven species of rare insects known only from gopher tortoise burrows were observed in burrows in southern Mississippi (Lago, 1991).

Roads that penetrate wildlands also have the potential to bring humans in closer contact with Louisiana black bear, a species that has generally suffered from human contact. Road construction through black pine snake habitat increases the likelihood of direct and indirect adverse impacts on black pine snake as a result of roadkill. Roads that facilitate access to Mississippi sandhill crane habitat have reportedly contributed to population decline (Natureserve, 2001d; USFWS, 2001b). Chemical spraying on roadsides has also had reported adverse impacts on the Mississippi sandhill crane.

Timber harvest would be expected to have adverse impacts on the Louisiana quillwort, because timber harvest in the watershed could alter surface runoff and contribute to erosion and sedimentation in small headwater streams. Louisiana quillwort grows best in filtered light beneath a relatively closed tree canopy. Removing the forest canopy at Louisiana quillwort sites could result in alteration of temperature regimes on the forest floor and increased growth of competing herbaceous species (USFWS, 1996). Changing the patterns of light and temperature in quillwort habitat would be expected to have adverse effects on the survival of the species.

Sand and gravel mining would be expected to have adverse impacts on Louisiana quillwort populations by removing substrate where quillworts grow, altering stream channels, and

introducing silt into streams. Likewise, development activities that disrupt natural drainage patterns by ditching, draining, damming, or filling aquatic and adjacent upland habitats would be expected to have similar negative impacts on quillwort habitat (USFWS, 1996). Sand and gravel mining would also be expected to have adverse impacts on the pearl darter because of habitat alteration (USFWS, 2001e).

The activities of native and feral animals can have adverse impacts on Louisiana quillwort. Beaver dams on small streams can damage small, isolated populations of this plant if long-term inundation overwhelms the plants' ability to survive. Feral hogs are reported to pose a threat to quillwort populations in Mississippi (USFWS, 1996). Hogs disturb habitat as they root for food in wetlands. Illegal plant specimen collection by botanists and collectors is also a potential threat.

Planned wetlands dredging and filling for new infrastructure and housing would be expected to have adverse indirect impacts on the hydrology of the last Mississippi gopher frog breeding pond. Development would also be expected to further isolate current Mississippi gopher frogs from other undiscovered or restored populations elsewhere in the state. Research indicates that these frogs are best suited to open woodlands with a well-developed herbaceous layer. Periodic low-intensity wildfire is the primary means to maintain this habitat. Nearby development would be expected to complicate the use of prescribed fire as a management tool because of safety and smoke concerns near residences.

The last known Mississippi gopher frog population, like other rare species, is in peril of extinction because of its small size. The Mississippi gopher frog, Mississippi sandhill crane, and Louisiana black bear populations are each down to levels of between 100 and 200 individuals. Their very small population size alone makes them vulnerable to extinction. Recovery plans written for the species would be expected to include propagation of the species and reintroduction to former habitat. Recovery for the Mississippi gopher frog and other regional endemics would not be expected to succeed unless there is suitable undeveloped habitat nearby to support additional individuals. Development-related destruction and fragmentation of wet pinelands and bottomland hardwood forests would be expected to further deprive rare species of land needed to expand their populations. These effects could be particularly significant for species such as the Louisiana black bear that need large territories for successful reproduction.

Adverse cumulative impacts on brown pelicans, gulf sturgeon, and sea turtles would be expected as a result of human activity in coastal areas in the form of chemical and oil spills, entanglement in fishing gear, and disturbance of nesting areas. Long-term adverse impacts on water quality and wetlands could reduce the abundance of fish prey species for pelicans. Water pollution would also be expected to have adverse effects on the pearl darter, the yellow-blotched map turtle, the gulf sturgeon, and piping plover. Direct and indirect adverse impacts on the yellow-blotched map turtle would be expected from removal of snags and river obstructions for navigation, as well as channel modifications that result in the elimination sandbars used for turtle nesting (USFWS, 1993). Increased human activity in yellow-blotched map turtle habitat could result in increased illegal collecting and destruction of basking turtles.

Increased recreation on islands and beaches that serve as turtle nesting sites would be expected to hurt Alabama red-bellied turtle reproduction. The USFWS (1989) recommends prohibiting human use in prime nesting areas when turtles are nesting and hatchlings are emerging. New construction (bridges, breakwaters, jetties) that destroys or alters beds of submerged aquatic vegetation would be expected to have adverse impacts on adult Alabama red-bellied turtle habitat (Mann, 2001). The construction of physical barriers (e.g., locks, weirs, and dams) to spawning grounds has the potential to result in adverse effects on the gulf sturgeon. Although manatees are

migratory transients in Mississippi, increases in recreational boating can adversely affect those few individuals.

Low-Growth Scenario. Effects on wildlife habitat and RTE species under the Low-Growth Scenario would be expected to be virtually the same as the Most-Likely Growth Scenario above.

Medium-Growth Scenario. The impacts on RTE species under the Medium-Growth Scenario would be of the same nature as those previously described for the Most-Likely Growth Scenario; however, they would be more severe, given the increase in development. Developed land would be expected to increase by about 23,000 acres while natural acreage would decline by roughly 17,500 acres, and agricultural land by 5,500 acres. This represents a loss of almost 2 percent of existing natural land and just over 5 percent of agricultural land. Roughly half the change from natural to urban land would take place in the quarter-million acres of the CSA. Harrison County could see about a 10 percent drop in its agricultural land base, and a 6.5 percent drop in its existing emergent wetlands (about 440 acres of Harrison County emergent wetlands). Losses of forested wetlands are also likely if 2,600 acres of the deciduous forest/mixed/bottomland forest category in Harrison County are converted by development. Jackson County could also lose about 10 percent of its emergent wetlands under the Medium-Growth Scenario, mostly from the southwest corner of the county. Jackson County has about four times the emergent wetlands acreage as Harrison County, thus Jackson County emergent wetlands losses could have significant adverse effects on estuarine species. Wetlands are especially important to many rare, threatened, and endangered species for reasons discussed under the Most-Likely Growth Scenario above.

Harrison County could also lose about 3,000 acres of pine forest/savanna under the Medium-Growth Scenario. Although this represents a loss of only about 2 percent of the most abundant cover type in the county (roughly 125,000 acres), losses of pine forest represent a potential loss of habitat for the six rare species dependent on pineland habitat. Impacts on threatened and endangered species like the gopher tortoise and eastern indigo snake would depend on whether recreation-related development fragmented existing pine forest habitat or otherwise made it unsuitable. Losses of wet pine savanna could decrease the amount of suitable habitat for the Mississippi sandhill crane. Fluctuations in pine acreage in existing commercial pine plantations due to timber management activities would not be expected to affect threatened and endangered species because rare species generally do not use these areas.

High-Growth Scenario. The impacts on RTE species under the High-Growth Scenario would be of the same nature as those previously described for the Most-Likely Growth Scenario; however, they would be more severe, given the increase in development. Developed land is predicted to increase by up to roughly 34,000 acres in the 1.1 million acres of the three counties combined, under the High-Growth Scenario. Just over 23,000 acres of predicted newly developed land would be located in Harrison County, and about two-thirds of that would be within the CSA. A concurrent loss of 25,700 acres of natural areas in the three-county area would accompany this high level of economic growth. This represents a loss of just under 3 percent of existing wildlife habitat. About half the natural land converted to other uses in the three-county area would be expected to come from within the roughly quarter-million acres of the CSA. Losses of emergent wetland acreage in the three-county area would be expected to reach about 4,500 acres (a 21 percent loss) under the High-Growth Scenario. Like the Medium-Growth Scenario, the majority of these losses are predicted to occur in the Jackson County portion of the CSA. Adverse effects on rare species dependent upon wetland habitat would be expected to be significant relative to the Most-Likely Growth Scenario, but largely restricted to the most intensely developed areas.

In forest and shrub-scrub habitats, losses under the High-Growth Scenario would be expected to be about 5 percent or less when examined at the level of the three-county area or the CSA. Harrison County would be expected to lose a greater percentage of its upland natural area than the other two counties. About 7,000 acres of the 21,000 acres of forested and shrub-scrub habitat lost in the three-county area would be from inside the CSA. Given the distribution of predicted land use change, only minor adverse impacts on threatened and endangered species' forested habitats in Hancock and Jackson Counties north of I-10 would be expected. However, even with minimal loss of acreage, forest fragmentation could make habitat less suitable for rare species dependent on the longleaf pine ecosystem.

5.5.4.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as used in the past, and would continue to identify and mitigate adverse impacts on RTE species. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative could be the same as those reflected by any of the four growth scenarios described in Section 5.5.4.1 above.

Relative to current conditions, minor to significant adverse impacts on RTE species could occur as a result of cumulative effects from development in the region. Of particular note, is the possible extinction of the Mississippi gopher frog in the absence of significant intervention. Most populations of federally listed species would not be expected to meet recovery goals in Mississippi if historical growth patterns and management approaches continue. The no action alternative would be expected to have fewer adverse effects on migratory RTE species that spend only part of their life cycle in Mississippi because widely ranging species are less vulnerable to extinction from local impacts than species with very small population size and limited range. Development has, however, been implicated in the loss of wetland and aquatic habitats used by endemic RTE species found only in Mississippi and small portions of adjacent states.

5.5.4.3 Proposed Action

5.5.4.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. The following RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented in two primary ways: development of site-specific permit conditions under the regulatory authority of the Corps and adoption of RCPs by non–Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast. These RCPs are derived primarily from recommendations presented in USFWS recovery plans for species listed in the coastal Mississippi area.

1. RCPs to be used for formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development on a case-by-case basis.

- *Encourage maintenance of protective buffers for RTE species (e.g., minimize human disturbance within 1,500 feet of bald eagle reproduction sites (USFWS, 1987), provide for zones of undisturbed vegetation between development and wildlife habitat, comply*

with Louisiana quillwort recovery plan recommendations for 50-meter streamside buffers when timbering harvests approach areas known to support quillwort (USFWS, 1996)).

- *Prohibit dredging in areas supported by the Alabama red-bellied turtle.*

- *In consultation with USFWS, conduct necessary monitoring and habitat conservation planning as required to avoid adverse impacts on RTE species*

2. Regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, develop new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects could include the following:

- *Encourage research, monitoring, and mapping of coastal Mississippi RTE species (e.g., Alabama red-bellied turtle) to obtain information on species' life history, habitat requirements, and reproduction in order to develop effective conservation measures*. All the RTE species from coastal Mississippi would be expected to benefit from more research into species' life history, habitat requirements, and reproduction (USFWS, 1989; 1993; 1996). Life history information is a prerequisite to developing effective conservation measures (USFWS, 1989). Some species such as the Mississippi sandhill crane and red-cockaded woodpecker have been subject to years of study and much is known about their life cycles. For other species, such as the Alabama red-bellied turtle, life history is mostly unknown.

- *Foster implementation of a comprehensive Habitat Conservation Plan under regulations of the Endangered Species Act to identify and protect habitat for RTE species within the region, such as the Mississippi gopher frog, which is in danger of extinction unless significant intervention occurs*.

- *Improve water quality through fostering a reduction in point and nonpoint source water pollutants*. (See the Water Resources section for specific RCPs.) Most rare species would be expected to benefit from a reduction in point and nonpoint source water pollution in the Pascagoula, Biloxi Bay, and Bay St. Louis watersheds. Sediment, fertilizers, herbicides, sewage, petroleum products, and toxic chemicals all have the potential to impact rare species directly or impact the prey organisms on which rare species feed (USFWS, 2001e).

- *Foster control of invasive species (e.g., feral pigs) and native predators (e.g., crows, beavers) that are hindering recovery efforts for some RTE species*. Control feral pigs, which are invasive, nonnative species that have been observed destroying Alabama red-bellied turtle nests and Louisiana quillwort populations, and feeding on sea turtle eggs (USFWS, 1989, 1996). Native predators can also hinder recovery efforts for some rare species. Crows (*Corvus* spp.) have been reported to feed on Alabama red-bellied turtle nests, and beaver (*Castor canadensis*) dams are a potential threat to some Louisiana quillwort populations. Under very specific circumstances, control of these native species during critical portions of endangered species' life cycles might be necessary to boost chances of recovery.

- *Encourage management of forests using prescribed burning, where practical*. Manage public forest land to restore open-canopy longleaf pine stands preferred by red-cockaded woodpecker, gopher tortoise, and other rare species known from longleaf pine habitats

(USFWS, 1990a). Use easements, acquisitions, and land donations on a voluntary basis to protect and restore longleaf pine forests on private land. Pine forests can be managed with prescribed fire; fire suppression is the single biggest threat to the biological integrity of pineland habitats (Ramseur, 2002). Whenever possible, development and new roads should be designed to avoid fragmenting existing mature pineland habitat. Easements and land acquisition can also be used as a tool to protect riparian and wetland species such as the Louisiana quillwort and Alabama red-bellied turtle (USFWS, 1989; 1996).

- *Foster public outreach and involvement initiatives*. Educate citizens and law enforcement officials about rare, threatened, and endangered species in coastal Mississippi (USFWS, 1989). Roadkill, wanton shooting, accidental take by commercial fishermen, and illegal collection for the pet trade have had adverse effects on endangered reptile species in Mississippi. Educating law enforcement officials about federally listed species would be expected to help officials apprehend people who kill or who traffic in rare species (USFWS, 1993).

- *Encourage restrictions/control of mining impacts near RTE habitat*. The USFWS recommends that "surface mining for sand and gravel should be prohibited near known [Louisiana] quillwort habitat" (USFWS, 1996). A prohibition on sand and gravel mining would also be expected to benefit the pearl darter (USFWS, 2001e). Mining activities degrade Louisiana quillwort habitats downstream with sediment deposition, and deep holes left in stream channels create slow water habitats unsuitable for the pearl darter. The USFWS also identifies future impoundments in tributaries of the Pascagoula River known to support pearl darter as a threat to this species (USFWS, 2001e). Dams fragment pearl darter populations and create unsuitable lacustrine habitat (USFWS, 2001e).

- *Foster conservation of riverine habitat*. The USFWS recommends prohibiting snagging (removing) obstructions from river channels known to support Alabama red-bellied turtle and yellow-blotched map turtle (USFWS, 1989; 1993). Snagging has adverse impacts on turtles by removing logs that turtles use for basking structure. Logs and snags often serve as habitat for invertebrate prey species of the yellow-blotched map turtle. The USFWS also recommends prohibiting dredging that removes aquatic vegetation in areas known to support Alabama red-bellied turtles (USFWS, 1989). Alabama red-bellied turtles use aquatic vegetation for both food and cover.

- *Favor project plans that protect dune areas above the mean high water line, which are used for nesting by many species of sea turtles*.

- *Encourage limiting artificial lighting at beachfront locations*. Artificial lighting can cause disorientation and misorientation of sea turtle adults and hatchlings. Turtle hatchlings are attracted to light, and come out of the ocean to go toward a light source, increasing their chances of death or injury. In addition, as nesting females avoid areas with intense lighting, highly developed areas might cause problems for turtles trying to lay eggs (USFWS, 1998b).

- *Encourage restricting recreational activities on area beaches near RTE habitat (1) when necessary to protect nesting by federally listed birds and turtles (USFWS, 1989), (2) when the use of all-terrain vehicles would conflict with incubation of bird and turtle eggs (USFWS, 1989), and (3) when heavy use of nesting beaches might reduce hatchling success due to sand compaction (NMFS, 2001).*

- *Encourage limiting mechanical raking on beaches to (1) reduce compaction of sand and creation of tire ruts that might hinder or trap hatchlings, (2) reduce surface penetration and disturbance or exposure of nests, and (3) reduce disposal of debris on the high beach (which covers nests and alters nest temperatures) (NMFS, 2001).*

5.5.4.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs (particularly through USFWS leadership) by federal, state, and/or local authorities would result in minor to potentially significant beneficial effects to RTE, as compared to the No Action Alternative. These long-term benefits to RTE species would be expected from implementing RCPs, implementing HCPs, and enhanced consideration of cumulative effects as part of Corps permitting actions. Species protected under the ESA are rare or declining because of a combination of life history characteristics, and past anthropogenic impacts, some dating back to the early 20th century. Cumulative effects of development, infrastructure, long-lived toxic pollutants, unsustainable harvest, sedimentation, fire suppression, and forestry practices that have imperiled RTE wildlife species on the Mississippi coast would not be expected to be reversed or mitigated in the short term. Urban and suburban areas would not be expected to return to wildlife habitat except at considerable cost. Consumer preferences for waterfront property and water-oriented recreation would be expected to confound efforts to protect and recover RTE aquatic species.

5.6 CULTURAL RESOURCES

5.6.1 Trends Analysis, Mississippi Coastal EIS Cultural Resources

5.6.1.1 Technical Approach

This analysis examines the effects of urbanization and infrastructure growth on cultural, historic, and Native American resources by focusing on identifying areas of high, moderate, and low potential for archaeological sites, using a qualitative predictive model and identifying existing historic standing structures. For archaeological sites, the study focuses on areas on bluffs and near freshwater sources. Concerns regarding the shift in the historical culture of the coast from a rural fishing community to a more urbanized region with an economy based on tourism are considered to a degree in the land use and socioeconomic impacts sections of the EIS. The loss of the "coastal way of life," however, is a social issue associated with local values and cannot be evaluated in an objective, consistent manner. It should be also be noted that the study area has a history of supporting tourism and gambling, as discussed in Section 4.11 of this EIS. Tourism was encouraged beginning in the post–Civil War era and has continued into the present. Gambling, along with "bootlegging" and illegal alcohol production, began during the 1920s and grew during the Depression and Prohibition.

Potential Locations of Archaeological Sites. The Coastal Study Area south of I-10 consists primarily of "flatwoods" (almost 45 percent of Hancock County), terraces and floodplains of the Pearl River, and Coastal Plain uplands. In Harrison County most of the soil in the cultural resources study area is loamy with loamy subsoil, on uplands, except for a strip of sandy soils along the Mississippi Gulf (USDA 1975, 1981, 1983). Archaeological sites are most likely to be found near sources of freshwater and on bluffs, in part to avoid flooding. Areas near wetlands also have a high potential for prehistoric occupations because wetlands provide an environment for a rich mix of waterfowl, mammals such as deer, fish and shellfish, and edible plants, all of

which can be caught or collected for food and other uses. Archaeological sites within and close to the study area have been found along the rivers, especially the river mouths, and on islands. High-probability areas include areas behind saltwater with freshwater streams nearby. The farther the distance from freshwater, the lower the potential for the presence of archaeological sites. Areas back in the pine forests would have a moderate to low probability for the presence of archaeological sites. In addition to these terrestrial sites, historic shipwrecks can be located along the floor of the Mississippi Sound and along river bottoms (Mississippi SHPO, 2001). Overall, the three counties had more development and construction than anywhere else in the state of Mississippi, and the entire area is critical in terms of potential degradation of historic resources (McGahey, personal communication, 2001).

Standing Structures. Historic districts that are listed on the National Register of Historic Places are present in most of the towns in the cultural resources study area, including Biloxi, Gulfport, Bay St. Louis, Pascagoula, and Ocean Springs (Mississippi SHPO, 2001). A historic district consists of standing structures that are at least 50 years old and that retain their historic integrity as a group, including the relationships between the buildings and the streetscape. Usually the buildings have been minimally altered or not altered at all, although buildings that are considered "noncontributing" do exist within historic districts. Individual buildings that are considered significant or potentially significant (are at least 50 years old and have been altered very little in appearance since they were built) might also be present in the rural parts of the study area.

5.6.1.2 Growth Scenarios

Most-Likely Growth Scenario. Under this scenario, the population of the CSA is projected to increase by about 17.5 percent during the period 2000 to 2020. It is not possible to predict where construction would take place; however, archaeological sites are usually in areas that are favored for modern-day occupation as well, such as on bluffs and near freshwater sources. Planned construction could include a new commercial development north of Gulfport; new casinos in Bay St. Louis; a new community to be built 6 miles north of I-10 north of Gulfport; and a new casino in the Back Bay of Biloxi, to be located in D'Iberville. Historic districts listed on the National Register of Historic Places exist in Bay St. Louis, Gulfport, and Biloxi. This type of construction can put pressure on historic districts and individual standing structures, including efforts to modify or demolish existing significant structures or to construct new buildings that are out of character with the existing historic buildings, thus changing the feel of the district. For example, construction of multistory hotels cut off the viewshed of existing historic structures. Furthermore, loss of undeveloped land (10,000 acres of additional natural and agricultural land are estimated to be developed by 2020 [see land use projections, Section 5.2]) would disturb archaeological sites present beneath the surface and would put pressure on rural historic structures, which might be subject to demolition. Construction in the Back Bay, for example, could disturb existing archaeological sites.

Low-Growth Scenario. Under this scenario, few large-scale developments would be built in the CSA during the period 2000 to 2020. Without these developments and associated growth in residences, infrastructure, and commercial buildings, population changes would be similar to those under the Most-Likely Growth Scenario. Predicted changes in land use under this scenario would also be similar to those in the Most-Likely Growth Scenario.

Medium-Growth Scenario. Under this scenario, large-scale development would occur at a moderate rate (about half the rate of development that occurred during the 1990s). Impacts would be similar to those under the Most-Likely Growth Scenario, but more undeveloped land would be disturbed by construction so there would be an increase in soil disturbance caused by the

increased construction. Under this scenario, the population would be predicted to grow 36 percent in the CSA, with increases by county ranging from 28 percent in Jackson County to 41 percent in Harrison County and 43 percent in Hancock County (each) (REMI model, Appendix L).

More than 20,000 acres of land would be developed, and a loss of natural areas and agricultural areas would occur within the three-county area (see land use projections, Section 5.2). Soil disturbances on this unbuilt land would disturb archaeological sites and could greatly increase pressure for demolition of historic rural standing structures. At the same time, high-density urban land use is predicted to increase by 51 percent, put pressure on existing urban historic districts and individual historic structures.

High-Growth Scenario. This scenario assumes a higher level of urban development based in part on a higher number of future large-scale projects. This scenario includes projects that have been permitted but not constructed, and planned projects that might be permitted in the future. As with the Medium-Growth Scenario, adverse impacts on known and potential archaeological sites, and on existing standing structures, would be increased as construction and soil disturbance increase.

Under this scenario, the population is projected to increase by 54 percent between 2000 and 2020. Population increases would range from 36 percent in Jackson County to 68 percent in Harrison County. Development under this scenario would almost certainly threaten archaeological sites in the study area, and pressure by developers to modify or demolish traditional historic communities would be great.

Under the High-Growth Scenario, approximately 34,000 acres of land would be developed, and a loss of natural areas and agricultural areas would occur in the three-county area (see land use projections, Section 5.2). Soil disturbances on this unbuilt land could disturb archaeological sites and could greatly increase pressure for demolition of historic rural standing structures. High-density urban growth is predicted to increase by 61 percent, putting pressure on existing historic districts and historic individual structures.

5.6.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools used in the past and would continue to identify and mitigate adverse impacts on cultural resources. Any of the growth scenarios described in the trends analysis could occur. Therefore, conditions under the no action alternative would be the same as those reflected by the four growth scenarios described in Section 5.6.1.

Relative to conditions in 2000, adverse impacts on yet-undiscovered archaeological sites could occur. Furthermore, increases in high-density development, particularly under Medium- and High-Growth Scenarios, would likely cause additional pressure on existing historic districts and historic individual structures in certain locations. Intensive economic growth over the past decade has generated intensive commercial development to date, which has put intense pressure on existing historic buildings and archaeological sites. Archaeological sites could be damaged by soil disturbance caused by new construction. Increase in population could increase the risk to archaeological sites and submerged shipwrecks posed by vandalism or an increase in treasure hunting. Existing historic structures and historic districts could be adversely affected by construction of new buildings in historic districts or within their viewshed, or within the viewshed

of individual structures. The historic character of the district, as well as the setting of individual structures, could be adversely affected.

5.6.3 Proposed Action Alternative

5.6.3.1 Regional Conservation Practices

Mississippi has a Comprehensive Historic Preservation Plan that was revised in 2000 (MDAH, 2000). In addition to federal laws protecting cultural resources, such as the National Historic Preservation Act, the Mississippi Antiquities Law is also in place. This law covers historic structures, archaeological sites, shipwrecks, and other cultural resources. It establishes the ability of counties or municipalities to create historic district commissions. Among their powers, these commissions have the authority to recommend the adoption of ordinances designating historic districts, landmarks, or landmark sites. The commissions also "review applications proposing construction, alteration, demolition, or relocation of any resource or tax parcels designated as landmarks or landmark sites contained within a historic district." (Mississippi Code § 39-13-5). The law also puts in place the Certified Local Government (CLG) program of the National Park Service for the state of Mississippi. The Mississippi Department of Archives and History administers the program. This program allows CLGs to receive funding to inventory and protect historic resources. CLG communities in the study area are Biloxi, Ocean Springs, and Pascagoula. These CLGs have preservation programs, including historic preservation ordinances. The law also discusses designation and protection of Mississippi landmarks.

In addition, private organizations also work to protect cultural resources. These organizations include the Mississippi Heritage Trust, the Mississippi Archaeological Association, the Mississippi Association of Professional Archaeologists, the Mississippi Band of Choctaw Indians, the Mississippi African American Historic Preservation Council, the Mississippi Main Street Association, and locally, the Friends of Beauvoir.

Local government and private associations can protect historic districts, buildings, archaeological sites, and other historic resources through these government mechanisms by requiring review of new construction and adherence to federal and state laws protecting historic resources. Stricter requirements for conducting phased archaeological investigations in areas having high probability for cultural resources could help to protect these resources from future development. In addition, enhanced regional planning to reduce aesthetic/visual impacts in historic districts could further reduce adverse impacts on cultural resources.

5.6.3.2 Effects of Implementing the Proposed Action

Minor long-term beneficial effects could result from implementation of the proposed action. Effects on historic districts and buildings and on archaeological sites would be evaluated as part of a larger cumulative impact rather than on an individual permit request basis. Under the proposed action, a wider geographic area could be considered rather than the limited footprint of an individual proposed casino, for example. Examining impacts on a wider geographic area would allow for an assessment of effects on a greater proportion of historic districts, or an assessment of effects on the larger landscape, where archaeological sites could occur. Furthermore, review of new construction sites by local and private associations with respect to cultural resource conservation could ensure further protection of cultural resources.

5.7 AIR QUALITY

Under the Clean Air Act (CAA) of 1970 (42 U.S.C. 7401) and subsequent amendments, USEPA has established the National Ambient Air Quality Standards (NAAQS) for several criteria pollutants to protect human health and welfare. These criteria pollutants are particulate matter (PM-10), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), lead (Pb) particles, and ozone (O_3). Also addressed by the CAA is the emission of air toxics, referred to as hazardous air pollutants (HAPs). HAPs consist of 188 compounds regulated by USEPA under the CAA. All HAPs are pollutants that are known or suspected to cause cancer and other health-related problems.

All of the contaminants addressed by the CAA affect the ambient quality of the air around us. A large variety of natural and man-made sources emit these pollutants. Anthropogenic sources, including mobile sources (such as cars, trucks, and trains) and stationary sources (such as factories, gas stations, and dry cleaners), all contribute to air pollution. Several natural sources, including what are called biogenic sources (e.g., natural oil and gas seeps, and vegetation), also emit pollutants.

Sources of air pollution are not the only factors that must be considered when analyzing air quality. Some pollutants are not directly emitted but form in the atmosphere when chemical reactions take place between two or more compounds. Ozone is an example of this process. Ozone, one of the six criteria pollutants, is not directly emitted but forms at ground level when a chemical reaction between NO_x, and VOCs (ozone precursors) takes place in the presence of sunlight. The need for sunlight in this reaction makes ozone formation difficult to accurately predict. Seasonal temperature changes are also a controlling factor causing the summer months to be the typical "ozone season."

Weather patterns also strongly control how emitted pollutants affect the ambient air quality of a certain area. Wind speed, height, and direction have a direct effect on how much air pollution there is in any certain area and where it occurs. There are cases where an entire region has been affected by the air pollution coming from sources outside that region. Therefore, summarizing air pollutant emissions from a specific region would not always accurately describe the ambient air quality of that area.

Ambient ozone levels and low-level ozone formation are key air quality issues in the coastal Mississippi region. The area is currently in attainment for all criteria pollutants, including ozone, but the current standard has been exceeded on occasion. The few exceedances of the current standard have not caused the area to be determined a nonattainment area for ozone. They are, however, a signal that in this region, at times and in certain places, the ozone levels can become higher than what USEPA considers healthy (USEPA, OAR, 2001a).

An air quality analysis that takes into account regional emissions, trends, and weather patterns is extremely complex. The Gulf Coast Ozone Study (GCOS) is a computer-generated model that has been employed to predict ozone levels in the Mississippi coastal counties, Pensacola, Mobile, New Orleans, and Baton Rouge. This three-phase study has involved research over several years. The first two phases have been completed, and they provided general guidance regarding the importance of NO_X and VOC emissions. The phase III modeling effort is expected to resume after more is known about USEPA's scheduling regarding implementation of the 8-hour standard (USEPA, OAR, 2001a).

The coastal Mississippi region is not the only area of the country that is concerned about ambient concentrations of low-level ozone. Concern has risen enough that USEPA has proposed a new, tougher standard for ozone, changing from the 1-hour average of 0.12 ppm to an 8-hour average of 0.08 ppm. This proposed standard has not been implemented because of uncertainties involving attainment/nonattainment designations. The final designations are expected by 2004 or 2005. There is potential for Hancock, Harrison, and Jackson Counties to be designated as nonattainment areas for ozone due to stricter standards (USEPA, OAR, 2001a).

USEPA issued rules that require large reductions in NO_x emissions in 22 eastern states, including Mississippi. Along with the requirement to prepare state reduction plans, state governors were asked to offer recommendations for designation of attainment/nonattainment areas in their states. The Governor of Mississippi responded to this request in July 2000 by declining to recommend any attainment/nonattainment designations and requesting that no counties or MSAs be designated as being in nonattainment (USEPA, 2003).

5.7.1 Trends Analysis

5.7.1.1 Technical Approach

To analyze the air quality conditions of the study area, past trends in air quality and emissions data were analyzed along with key indicator variables for mobile source emissions. Past available monitoring data from the USEPA AIRData Web site were analyzed for trends for the 5-year period from 1996 to 2001 for Hancock and Jackson Counties and the 3-year period from 1999 to 2001 (USEPA, OAR, 2001b). In addition, mobile source emission trends were evaluated using indicator variables for mobile source emissions, including Annual Average Daily Traffic (AADT) numbers from Interstate 10, shipping port cargo in annual tons, airport flight operations, and future economic growth projections.

Point source trends in the study area were analyzed by assessing pollutant emission loads, which are listed on Title V permits. The major emitters of criteria pollutants are the Mississippi Power Company and DuPont de Nemours company, both in Harrison County, and Tennessee Gas Pipeline Company in Hancock County. The main concern in the region is ozone precursor emissions, which are largely controlled by mobile source emissions.

5.7.1.2 Growth Scenarios

Most-Likely and Low-Growth Scenarios. The most recent monitoring information for ozone provides an indicator for baseline trends (USEPA, OAR, 2001b). The annual highest recorded concentration values were lower than the current standard of 0.12 ppm for all three counties (except for three exceedances), yet still slightly above the proposed standard of 0.08 ppm. Although this is a short-term period, the monitoring data seem to show a small-scale decreasing trend.

Several indicator variables were used to surmise the most likely growth rate for mobile sources. Changes in the level of mobile sources might directly affect ozone levels in the region. A summary of the trends for key mobile sources in the area is presented below:

- ***Vehicular Traffic.*** The AADT showed an average increase of 17 percent over the three counties in a 7-year period (Fagan, personal communication, 2002).

- ***Cargo Shipments.*** Annual tons of cargo handled by the Port of Gulfport increased 12.5 percent from 1994 to 2001 (Hudson, 2002).

- ***Air Passengers.*** The total number of passengers flown in and out of the Gulfport-Biloxi Regional Airport increased four fold from 1992 to 2000 (GBRA, 2002).

Each of these three indicators shows an increasing trend of mobile source emissions. Despite these increases, ozone levels have not increased, but rather have declined slightly. This might be due in part to weather conditions and advancements in technology for reducing mobile source emissions. Under the Low-Growth/Most-Likely Growth Scenarios, projected population growth (17 percent) would increase the level of mobile sources by 2020 (see Section 5.10). The degree to which this increase would translate into proportional increases in mobile emissions is unclear, however, particularly when considering the potential for increased use of technology for reducing emissions (e.g., hybrid vehicles, cleaner fuels, higher fuel efficiencies). Considering historical trends and the moderate growth projected, it is likely that ambient air quality could remain the same or actually improve with ever-increasing use of technologies and alternative fuels that reduce mobile source emissions. Thus, the three counties might remain in attainment for all criteria pollutants under the current standard. With respect to the criteria modification for ozone, it is unclear whether the area might be classified as being in nonattainment with adoption of the lower standard, given the historical data. This change in designation might actually further improve air quality through statewide and multistate efforts to reduce ozone precursor emissions.

Medium and High-Growth Scenarios. In the Medium- and High-Growth Scenarios, there would be an increase in population of 36 percent and 54 percent, respectively, and therefore an increase in mobile source emissions would be expected. Under both the Medium- and High-Growth Scenarios, an increase in ozone precursor emissions would have the potential to cause minor to significant adverse effects on the ambient air quality of the region. Under both of these scenarios, ambient ozone levels would be expected to rise. That increase coupled with the implementation of the newer, stricter standard would likely cause the area to be designated a nonattainment area for ozone.

5.7.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools used in the past and would continue to identify and mitigate adverse impacts on air quality. Any of the growth scenarios described in the trends analysis could occur. Therefore, conditions under the no action alternative could be the same as those reflected by the four growth scenarios described in Section 5.7.1.

Relative to conditions in 2000, the continued increase in the growth of industry and population has the potential to increase mobile sources that might decrease ambient air quality of the study area. It is unclear, however, whether the increases in mobile sources would actually translate into proportional increases in emissions given the use of technology to further reduce emissions over the next two decades. In any event, the results of the trends analysis indicate that under the Low-Growth and Most-Likely Growth Scenarios, air quality would likely remain the same with some potential for improvement while minor to significant adverse effects (relative to current conditions) might occur under the Medium- and High-Growth Scenarios. Under the Medium- and High-Growth Scenarios, it is possible that the area may be designated in nonattainment for ozone.

5.7.3 Proposed Action

5.7.3.1 Regional Conservation Practices

The formation of ozone is the major air quality concern for the study area. Point and mobile source emissions contribute ozone precursors, which need to be reduced to enhance air quality. RCPs might be used to reduce these emissions and the formation of ozone. RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. The RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented by adoption of RCPs by non–Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast, as presented below.

- *Encourage increasing the amount and spatial distribution of ozone monitors, to help quantify formation trends in the study area. Such data could assist in managing and controlling ozone emissions.*

- *Encourage application of the results of the Gulf Coast Ozone Study to determine ozone formation and behavior, and consider creating a similar model that specifically analyzes stationary and mobile sources in the study area.*

- *Encourage the inclusion of public transportation options in current and future urban development plans to reduce traffic levels on area roads and resultant mobile source emissions.*

- *Encourage measures that increase traffic flow, encourage carpooling, and increase public outreach measures to encourage the use of alternative public transportation, especially during high-ozone conditions.*

- *Encourage making changes to the SIP to reflect the need to decrease ozone precursor emissions if the coastal area is designated nonattainment for ozone, and consider further reductions of ozone precursor emissions in specific areas through measures such as the use of alternative fuels, stricter point source controls, incentives for public transportation, and use of hybrid vehicles.*

5.7.3.2 Effects of Implementing Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor beneficial effects with respect to air quality when compared with the no action alternative. Implementing the RCPs and enhanced comprehensive planning would likely result in increased air quality, as well as reduce the potential for the area to be designated as being nonattainment for ozone. Such actions would therefore likely decrease the regional cumulative effects of development. Relative to current air quality conditions, implementing the proposed action might further improve air quality under the Low-Growth and Most-Likely Growth Scenarios or might mitigate adverse impacts and eliminate significant effects under the Medium- and High-Growth Scenarios.

5.8 NOISE

5.8.1 Trends Analysis for Noise

5.8.1.1 Technical Approach for Noise

As discussed in Section 4.6, there are several noise sources within the study area, including air traffic (military, private, and commercial), vehicular traffic, rocket testing operations at Stennis Space Center, and other anthropogenic activities associated with medium- and high-density urban development (e.g., lawn mowers, construction equipment, emergency equipment, and boats). The trends analysis for noise included an evaluation of existing noise studies prepared for Stennis Space Center, Kessler Air Force Base, and Gulfport-Biloxi International Airport, as well as an evaluation of key indicators that might correlate with changes in noise levels. These indicators included transportation measures, such as Annual Average Daily Traffic (AADT) and airport passenger levels, and changes in urban development (e.g., increases in high-density development).

5.8.1.2 Growth Scenarios

Most-Likely Growth Scenario. Overall, minor increases in noise levels are expected under the Most-Likely Growth Scenario relative to current conditions. Significant changes in noise levels might occur, however, relative to current levels in isolated locations where land use conflicts might occur (e.g., increased traffic near schools or hospitals). Increased noise levels are expected in areas where land use becomes more urban. Under this growth scenario, there would be an estimated increase of more than 10,000 acres of high-density urban development within the coastal counties (a 37 percent increase relative to current conditions), with half of this increase occurring within the CSA (a 41 percent increase relative to current conditions). Noise sources include mobile line sources along transportation corridors and continuous, non-primary sources such as pedestrian traffic, machinery, lawn mowers, and other urban sources. Under the Most-Likely Growth Scenario, noise levels might increase by as much as 10 to 20 dB compared with current conditions in certain areas, as a result of increased traffic, construction activities, and other urban sources. Representative noise levels of urban areas are presented in Table 5.8–1. Outside the urbanized areas, changes in noise levels are expected to be minimal.

With respect to the large stationary sources in the region such as the Gulfport-Biloxi International Airport, the Stennis Space Center, and the Kessler Air Force Base, noise levels are expected to remain similar to current conditions. The affected region for each of these sources is expected to remain within the current footprint based on available studies. In fact, previous increased operations at the Gulfport-Biloxi International Airport have not changed the noise zone footprint because of airport regulations and quieter aircraft technologies. Although the noise contours for these areas are not expected to change significantly, the frequency of aircraft use of Gulfport-Biloxi International Airport is expected to rise with projected increases in passenger levels.

Low-Growth Scenario. As discussed in Section 5.2, estimated population and economic growth for the Low-Growth Scenario and the Most-Likely Growth Scenario are virtually the same. Therefore, noise levels under the Low-Growth Scenario would essentially be the same as those described above for the Most-Likely Growth Scenario.

Table 5.8–1
Examples of Noise Levels at Various Locations

Outdoor Location	Decibels
Apartment next to freeway	88
3/4 mile from major airport	86
Downtown urban with construction	79
Urban high density apartment	78
Urban housing on major avenue	68
Old urban residential areas	59
Wooded residential	51
Agricultural crop land	44
Rural residential	39
Ambient wilderness levels	35

Source: NPC, 2002.

Medium-Growth Scenario. Under the Medium-Growth Scenario, noise levels would be similar to those described under the Most-Likely Growth Scenario. However, additional areas would experience increases in noise levels as a result of land conversions to high-density development. Under the Medium-Growth Scenario, 17,000 acres of land would be converted into high-density development within the three coastal counties, with 14,000 of these located in the CSA. This increase in high-density development, along with increased traffic levels, would increase the potential for unacceptable noise levels in a few areas.

High-Growth Scenario. Under the High-Growth Scenario, noise levels would be similar to those described under the Most-Likely Growth Scenario. However, additional areas would experience increases in noise levels as a result of land conversions to high-density development. Under the High-Growth Scenario, 24,000 acres of land would be converted into high-density development within the three coastal counties, with 21,000 of these located in the CSA. This increase in high-density development, along with increased traffic levels, would increase the potential for unacceptable noise levels in isolated areas.

5.8.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as used in the past, and would continue to identify and mitigate adverse impacts associated with increased noise levels. Any of the growth scenarios described in the trends analysis could occur. Therefore, conditions under the no action alternative could be the same as those reflected by the four growth scenarios described in Section 5.8.1, above.

Relative to conditions in 2000, overall minor increases in noise levels are expected for each of the growth scenarios, along with the potential for significant adverse impacts on noise levels in scattered locations where sensitive land use occurs (e.g., increased traffic that might occur near schools or hospitals). Increased noise levels are anticipated in areas where land use becomes more urban. Overall, high-density development is expected to increase by 10,000–24,000 acres within the coastal counties; the majority of this growth would occur within the CSA. Noise sources include mobile line sources along transportation corridors and continuous, non-primary sources such as pedestrian traffic, machinery, lawn mowers, and other urban sources. With the land-use change to high-density, noise levels might increase in certain areas by as much as 10 to

20 dB compared with current conditions, as a result of increased traffic, construction activities, and other urban sources. Beyond urbanized areas, however, changes in noise levels are expected to be minimal.

With respect to large stationary sources in the region such as the Gulfport-Biloxi International Airport, the Stennis Space Center, and Kessler Air Force Base, noise levels are expected to remain similar to current conditions under all of the growth scenarios.

5.8.3 Proposed Action

5.8.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. These RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented in the following ways.

1. Require adoption of site-specific permit conditions for individual permits for large-scale developments under the regulatory authority of the Corps on a case-by-case basis.

- *Require noise abatement and BMPs to reduce noise levels during construction and operation particularly when land use conflicts arise near sensitive areas such as hospitals, churches, schools, nursing homes, and residential communities*.

2. Foster adoption of RCPs by non–Corps entities to reduce cumulative effects from development along the coast. RCPs beyond the regulatory control of the Corps that could reduce regional cumulative effects associated with development are presented below. Certain RCPs mentioned below are already being implemented or plans are under way to institute such measures. In such cases, these RCPs are presented to indicate the importance of their implementation and enforcement to reduce cumulative effects and to advocate enhancements as appropriate.

- *Encourage construction of noise barriers along major roadways to control automotive noise effects on surrounding areas*.

- *Encourage BMPs to limit noise from construction sites by controlling vehicle access and equipment use, and hours of operation*.

- *Foster institution of land use planning tools to reduce the potential for land use conflicts near sensitive areas such as hospitals, churches, schools, nursing homes, and residential communities*. As necessary, require noise monitoring and noise abatement measures in order to ensure that construction activities and/or proposed projects comply with noise regulations.

- *Encourage project planning that includes advanced technology for reducing sound levels emitted from machinery, automobiles, and aircraft*.

5.8.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor beneficial effects with respect to noise issues when compared with noise levels under the no action alternative. Implementing the RCPs and enhanced comprehensive planning would likely result in decreased noise levels, as well as reduce the potential for unacceptable noise conflicts near sensitive land use areas. Such actions would therefore likely decrease the regional cumulative effects of development. Relative to current noise levels, implementing the proposed action might further reduce noise levels in certain areas (even with additional growth), and/or might mitigate noise increases and eliminate significant noise conflicts.

5.9 UTILITIES

5.9.1 Trends Analysis for Utilities

5.9.1.1 Technical Approach

The trends analysis for utilities relies on recent historical records regarding usage and capacity, along with consideration of future population growth. An overview of the approach is presented below:

Water Usage: Available historical records on water usage, well capacity, and the population projections were used to analyze the impacts on water supply and quality, as supplied by the incorporated areas of the coastal Mississippi area.

Wastewater Treatment: Wastewater treatment plant capacity, unincorporated population, projected population, treatment methods, and soil characteristics were analyzed for impacts on wastewater for Hancock, Harrison, and Jackson counties.

Storm Water: Storm water system stresses were evaluated by considering changes in storm water flows due to increases in impervious surfaces for each of the growth scenarios. The historical extent of imperviousness from 1972–2000 would serve as a baseline, and the projected imperviousness from 2000 to 2020 (Tables 5.2–3, 5.2–7, and 5.2–11) for the various growth scenarios were compared on a subwatershed basis. Watersheds with an imperviousness of less than 10 percent are considered "protected" while those with an imperviousness above this threshold are indicative of an "impacted" watershed (Arnold and Gibbons, 1996). The baseline data show only one impacted watershed, the Turkey Creek–Old Fort Bayou watershed, with an imperviousness of 11 percent in 2000. Gulfport, which is within this watershed, has experienced street and house flooding during the past several years.

Solid and Hazardous Waste: A 76-acre municipal landfill was opened in 1988, but reached capacity by the end of 2000 (USACE, Mobile District, 2002). A 100-acre expansion of this landfill began in 2000 and is expected to last 15 years. This serves as the benchmark for the solid waste analysis for future development. Since there is only one municipal landfill in the ROI, population trends would be used as the basis of comparison for the growth scenarios.

Hazardous wastes are controlled from "cradle to grave," and regulatory programs are already in place to regulate hazardous materials and wastes. There is no hazardous waste disposal

facility located within the ROI. No impacts due to population growth are expected except increased regulation by the appropriate state agencies over the increasing number of users. Thus, hazardous waste issues were not evaluated further.

Telecommunications and Energy: Telecommunications, electricity, and natural gas are provided by commercial for-profit entities. Part of these entities' corporate strategy is to provide service to an expanding customer base, regardless of the rate of population growth. Therefore, no impacts are expected in this resource area with respect to the growth scenarios or alternatives. Thus, telecommunication and energy issues were not evaluated further.

5.9.1.2 Growth Scenarios

Most-Likely Growth Scenario. Under the Most-Likely Growth Scenario, population in the three-county area would increase by about 17.5 percent (0.8 percent annual growth), with more than 60,000 new residents. In general, infrastructure build-out should be able to keep pace with an annual growth rate that is less than 1 percent. Available information on current and projected future infrastructure capacity, with a focus on high-growth areas, is presented below:

Water Usage: Both Gulfport and Biloxi are in Harrison County, and each serves approximately 50,000 people. Under the Most-Likely Growth Scenario, demand for services might increase by as much as 70,000. For Gulfport, Table 5.9–1 shows the current and future water demand. The current water well capacity for Gulfport is 10,070 gallons per minute (gpm), which can serve a population of more than 95,000 people. Therefore, if all the increase in population in Harrison County were within the city of Gulfport water system, it could provide service without any difficulty.

Table 5.9–1
Projected Water Demand, City of Gulfport

	Average Daily Water Demand (gallons per minute)		
Service Area	***Year 2000***	***10-Year Projection***	***20-Year Projection***
North of I-10	2,004	3,327	4,321
South of I-10	4,439	5,112	5,749
Total	**6,443**	**8,439**	**10,070**

Source: GWSTF, 2001.

Even with casino growth that began in 1992 (Gulfport has two casinos), there has been no "crisis of service." Gulfport has responded to deficiencies in its water supply and distribution system by completing a master plan and has budgeted funds for Water Master Plan improvements (A. Garner Russell and Associates, Inc., 2000). Gulfport is planning for the future and should be able to serve future demands, either with the existing system or with the planned improvements, when they become necessary.

The current maximum capacity of the Biloxi water system is 26.1 million gallons per day (MGD), which is capable of serving a population of more than 150,000 people (Furr, personal communication, 2002). If all the projected population growth of Harrison County were within the Biloxi water system, it could provide service without any difficulty.

In the smaller cities of Gautier, Ocean Springs, and D'Iberville, providing water service that meets municipal standards would take years to plan and finance. Any population growth would adversely affect the time and financial resources necessary to accomplish this.

The unincorporated areas of the three coastal counties are the least able to provide water service to accommodate new growth. Any population growth would adversely affect the ability to provide water service, and might force developers to rely on individual wells for water service.

Wastewater Treatment: Wastewater treatment plants serve 76 percent of the population in Hancock County, 89 percent of the population in Harrison County, and 69 percent of the population in Jackson County (Peterson, 1999). The projected most-likely population growth for Hancock County is 26 percent, for Harrison County, 11 percent and for Jackson County, 24 percent. Thus the need for increased wastewater treatment plant services is likely to range between 10 and 25 percent. The current unused treatment capacity for plants in the three-county area should accommodate this projected increase in service rate (unused capacities are as follows: Hancock County, 40 percent to 56 percent; Harrison County, 6 percent to 56 percent; and Jackson County, 20 percent to 46 percent) (McGraw and Glover, personal communication, 2002; USACE, Mobile District, 2000; USEPA and MDEQ, 2002).

Inflow and infiltration into the collection systems that feed into the wastewater treatment plants have been problems in some areas, which indicates that the current infrastructure needs repair. Peak flows during storm events can prevent proper treatment of the wastewater, causing partially treated or untreated wastewater to be discharged. A. Garner Russell and Associates, Inc., an engineering firm, developed a 20-year master plan for the Gulfport wastewater system in September 2000. From the master plan, the collection system was experiencing average daily flows (ADF) of 6.035 MGD south of I-10 and 2.103 MGD north of I-10. Wet-weather flows, calculated at three times the ADF plus inflow and infiltration, were 40.419 MGD (28,069 gpm) south of I-10 and 14.594 MGD (10,135 gpm) north of I-10. The 20-year flow projections estimate the ADF to be 8.297 MGD south of I-10 and 5.871 MGD north of I-10, with wet-weather flows of 43.618 MGD (30,290 gpm) south of I-10 and 33.348 MGD (23,158 gpm) north of I-10. To accommodate the 20-year projected flows, an estimated $74,106,800 would be needed to rehabilitate or upgrade the wastewater collection system.

Septic tank systems serve 24 percent of the population of Hancock County, 10 percent of the population of Harrison County, and 31 percent of the population of Jackson County (Peterson, 1999). If septic tanks are properly designed, installed, operated, and maintained in appropriate soil and groundwater conditions, they can be very economical and efficient in treating wastewater. However, failing septic tanks in coastal Mississippi have contributed significantly to the impaired water quality along the Gulf Coast (EcoSystems, 2000). Since the soils in coastal Mississippi typically are hydric (soils that remain saturated for most of the year), the wastewater from the septic tanks cannot be absorbed or cleansed and contaminates ground or surface water. The proportion of soils unsuitable for septic tanks in Hancock County is 50 percent; for Harrison County, 32 percent; and for Jackson County, 58 percent (See Table 4.3–4). Given the population growth projected for these areas, it is likely that septic tanks would continue to be installed in unsuitable areas and that additional failures could occur. Water quality assessments conducted by the MDEQ have determined that failing and substandard individual on-site treatment systems are the primary cause of degraded or polluted water sources in coastal Mississippi (see Sections 4.7.3.3 and 5.3 for further details regarding septic tanks).

Storm Water: Under the Most-Likely Growth Scenario, Turkey Creek–Old Fort Bayou is the only watershed estimated to have imperviousness exceeding the 10 percent threshold. The imperviousness of the Turkey Creek–Old Fort Bayou watershed is projected to increase to 13 percent by 2020, adversely affecting the existing storm water flooding problems.

Solid and Hazardous Waste: During the period 1990–2000, the population increased by 16.5 percent and the 76-acre landfill reached capacity within 12 years. The projected population growth rate would likely fill the new 100-acre landfill expansion landfill within its projected 15-year life expectancy—additional landfill capacity would then be required or materials would have to be trucked out of the area. With current planning efforts, however, no significant impacts on solid waste capacity or costs would be expected over the next 20 years.

Low-Growth Scenario. This scenario would yield similar infrastructure conditions as those described above for the Most-Likely Growth Scenario.

Medium-Growth Scenario. Under the Medium-Growth Scenario, the population in the three-county area would increase by 36 percent (1.5 percent annual growth), with more than 134,000 new residents. In general, infrastructure build-out should be able to keep pace with a 1.5 percent annual growth rate. Available information on current and projected future infrastructure capacity, with a focus on high-growth areas, is presented below:

Water Usage. Under the Medium-Growth Scenario, the projected population of Harrison County would reach 267,422 in the year 2020 (See Table 5.2–6), an increase of more than 78,000 people from the year 2000. Even if all the increase in population in Harrison County occurred within the City of Gulfport's water system, demands would just approach the limits of the system under the current expansion plans. Therefore, the City of Gulfport should be able to provide water service without any difficulty. Furthermore, if all the projected population growth in Harrison County were within the Biloxi water system, it too could provide service without any difficulty. Therefore, in areas with the highest growth potential there does not appear to be a projected water supply shortfall.

In the smaller cities of Gautier, Ocean Springs, and D'Iberville, providing water service that meets municipal fire protection needs to annexation or expansion areas might take years to plan and finance. Population growth could adversely impact the time and financial resources necessary to accomplish this, although the smaller cities have demonstrated a willingness to annex growth areas and implement upgrades in their utility systems to accommodate growth.

Although many unincorporated areas have existing water systems and plan to expand them, the unincorporated areas of the three coastal counties would be the least able to provide water service to accommodate new growth. Rural water systems generally do not provide the same level of fire protection as the municipal systems. Population growth could adversely affect the ability to provide water service and might force developers to rely on individual wells for water service.

Wastewater Treatment: Under this scenario, the projected population growth for Hancock County is 43 percent; for Harrison County, 41 percent; and for Jackson County, 28 percent. Based on the availability capacities discussed under the Most-Likely Growth Scenario, there is enough remaining treatment capacity in the wastewater treatment plants in the three counties to meet the projected population growth.

The inflow and infiltration and septic tank system impacts are the same as those expected under the Most-Likely Growth Scenario.

Storm Water: Under this scenario, Turkey Creek–Old Fort Bayou is the only watershed estimated to have a level of imperviousness exceeding the 10 percent threshold. The imperviousness of the Turkey Creek–Old Fort Bayou watershed is projected to increase to 16 percent by 2020, adversely affecting the existing storm water flooding problems.

Solid and Hazardous Waste: The projected population growth rate would likely fill the new 100-acre expansion of the landfill within the projected 15-year life expectancy. Additional landfill capacity would be required or materials would have to be trucked out of the area. With current planning efforts, however, no significant impacts on solid waste capacity or costs would be expected over the next 20 years.

High-Growth Scenario. Under the High-Growth Scenario, population in the three-county area would increase by more than 50 percent (at a rate of 2 percent annual growth), with nearly 200,000 new residents. In general, infrastructure build-out should be able to keep pace with a 2 percent annual growth rate. However, short-term stresses to the system might be encountered if additional resources are not applied to keep pace with growth. Available information on current and projected-future infrastructure capacity, with a focus on high-growth areas, is presented below:

Water Usage: Under the High-Growth Scenario, the projected population of Harrison County would reach 318,376 in the year 2020 (see Table 5.2–4), an increase of approximately 129,000 people from the year 2000. Given the current capacities of the Gulfport and Biloxi water supply systems, it is unclear whether they would be able to adequately supply water under this growth scenario. However, it should be noted that these systems were able to keep pace with high growth rates in the past decade. Therefore, it is unlikely that there would be a water supply crisis; rather, adequate investments would likely be made to keep pace with demand. There may, however, be increased incidences of shortfalls during stress periods, for example, under drought conditions.

In the smaller cities of Gautier, Ocean Springs, and D'Iberville, providing water service that meets municipal fire protection needs to annexation or expansion areas might take years to plan and finance. Population growth could adversely impact the time and financial resources necessary to accomplish this, although the smaller cities have demonstrated a willingness to annex growth areas and implement upgrades in their utility systems to accommodate growth.

Although many unincorporated areas have existing water systems and plan to expand them, the unincorporated areas of the three coastal counties would be the least able to provide water service to accommodate new growth. Rural water systems generally do not provide the same level of fire protection as the municipal systems. Population growth could adversely impact the ability to provide water service and might force developers to rely on individual wells for water service.

Wastewater Treatment: Under the High-Growth Scenario, the projected population growth for Hancock County would approach 60 percent; for Harrison County, 68 percent; and for Jackson County, 32 percent. Given the available capacities discussed above and projected upgrades (see the Most-Likely Growth Scenario), there might not be enough remaining treatment capacity in the wastewater treatment plants in the three counties to meet the

projected population growth. Further expansion and upgrading of the wastewater treatment systems might be necessary to meet demand estimated under the High-Growth Scenario.

The inflow and infiltration and septic tank system impacts are the same as under the Most-Likely Growth Scenario.

Storm Water: Under this scenario, Turkey Creek–Old Fort Bayou is the only watershed estimated to have a level of imperviousness exceeding the 10 percent threshold. The imperviousness of the Turkey Creek–Old Fort Bayou watershed is projected to increase to 19 percent by 2020, adversely affecting the existing storm water flooding problems. Two other watersheds of concern, DeLisle and Bayou La Croix, are also projected to have relatively high levels of imperviousness—figures exceeding 7 percent. Within the Coastal Study Area boundary, five watersheds would have levels of imperviousness exceeding 10 percent; including Upper Jourdan River (13 percent), Rotten Bayou (11 percent), Biloxi River (12 percent), Tuxachanie Creek (14 percent), and Turkey Creek–Old Fort Bayou (22 percent). Thus, localized storm water problems might occur in these areas under the High-Growth Scenario.

Solid and Hazardous Waste: During the period 1988–2000, the counties' 76-acre landfill was completely filled up, as population expanded by 16.5 percent. With a population growth rate of more than 50 percent, the new 100-acre expansion would reach capacity considerably before the expected 15-year lifecycle. This would require finding a new landfill site or sending solid waste to existing landfills more than 50 miles away. In general, this might cause only short-term minor adverse effects with respect to solid waste disposal capacity and costs.

5.9.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools as in the past, and would continue to identify any adverse impacts that might affect infrastructure. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative could be the same as those reflected in any of the four growth scenarios described in Section 5.9.1 above. Relative to conditions in 2000, minor to moderate adverse effects on infrastructure might occur, including those below:

- Increased imperviousness in watersheds in the Coastal Study Area, particularly under the High-Growth Scenario.
- Degradation of storm water control measures due to increased flows, resulting in impaired streams and increased incidence of flooding in certain areas.
- Additional septic tank failures.

5.9.3 Proposed Action

5.9.3.1 Regional Conservation Practices

RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with

development. These RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used and implemented in two primary ways: development of site-specific permit conditions under the regulatory authority of the Corps and adoption of RCPs by non–Corps entities (e.g., federal, state, and local agencies, and private entities) to reduce cumulative effects from development along the coast.

1. RCPs to be used for formulating site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects. The Corps might consider adoption of the following permit conditions to reduce cumulative effects on a case-by-case basis.

- *Require, where feasible, that developments hook up to centralized wastewater treatment systems rather than installing new OSDS.*

- *Require low impact development (LID) measures and create wetlands, detention ponds, or bioretention cells to reduce peak storm water flows and maximize groundwater infiltration.*

2. Regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, development of new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects could include the following:

- *Conduct storm water studies to identify the sources within the watershed of pathogen loadings into the bays during storm events*. Initiate corrective actions for the worst areas.

- *Study health department permit criteria for private septic tank installation and recommend use of alternative technologies for septic systems in hydric soils*. Other economically feasible options that are best suited for the rural areas of the Mississippi coastal region include aerobic treatment plants for primary and secondary wastewater treatment, constructed wetlands, and sand filter systems (EcoSystems, 2000).

- *Conduct a regional water supply study to assess the adequacy of groundwater as the principal water supply and evaluate the utility of alternative sources such as upland reservoirs.*

- *Initiate aggressive inflow and infiltration corrective action programs to reduce the load on the wastewater treatment systems during storm events.*

- *Expand and/or upgrade water service systems so that, as municipalities annex unincorporated areas, developers in those areas can obtain water services from centralized networks rather than from individual wells.*

- *Develop cost-sharing mechanisms to have developers of major projects assist in providing funds for piping infrastructure to deliver water to smaller cities and unincorporated areas.*

- *Expand or upgrade wastewater treatment systems so that unincorporated areas, when annexed, can be connected to a centralized wastewater treatment system.*

- *Develop cost-sharing mechanisms to have developers of major projects assist in wastewater collection systems upgrades, extensions, inflow and infiltration programs, or special water quality studies*.

- *Require developers to increase drainage capacity in subdivisions, and possibly require specific quality control measures*. The creation of wetlands as a means to control storm water runoff should be considered.

- *Implement LID approaches to reduce storm water peak flows and improve water quality*.

- *Continue to enhance recycling programs that can reduce the volume of materials going to the municipal landfills, as well as to the construction debris landfills*.

5.9.3.2 Consequences of the Proposed Action

Long-term minor to moderate beneficial effects would be expected relative to the no action alternative. Significant efforts to improve storm water management measures and expand wastewater treatment plant coverage could, however, provide a substantial benefit to quality of life, water quality, human health, flood control, and aquatic habitat. Furthermore, additional efforts to curtail septic tank failures could further improve water quality and public health. Relative to current conditions, implementation of the proposed action could actually improve the quality of the environment and public service beyond current levels, while still accommodating even High-Growth projections. To achieve this end, cooperative planning efforts between agencies and private institutions, along with significant capital investment, would be required.

5.10 TRANSPORTATION

5.10.1 Trends Analysis

5.10.1.1 Technical Approach for Transportation

Coastal Mississippi uses a wide range of transportation resources including air, rail, roadway, and water infrastructure. These resources provide access to various functional locations such as industrial, residential, and recreational areas, and connect residents with businesses on the local, national, and international levels. Over the past 20 years, increasing numbers of passengers and volumes of freight have resulted in enormous changes in the transportation system. A steady increase in population, coupled with strong economic growth, is largely responsible for current demand for transportation services in the Coastal Mississippi study area. A goal of this trends analysis is to use past information to create a transportation planning and decision framework that would guide development of the future transportation infrastructure under various growth scenarios.

To project future transportation conditions in the coastal Mississippi study area, several different factors were analyzed to determine overall increases in a particular transportation resource over time. Specific transportation resources were examined as a sample of the transportation system in the study area, and then general interpretations of the particular changes were applied to the entire transportation infrastructure. Population increases under the various growth scenarios were determined using the REMI model; effects of growth and population increase were then used as indicator variables to observed transportation trends.

- *Air transportation* trends were analyzed using data from previous aircraft operations and scheduled seats. In addition, capabilities and plans for expansion were considered to identify areas where future capacity shortfalls might exist.

- *Public transportation* trends were analyzed using ridership data from the Coastal Transit Authority's public bus service. Areas of service were also considered to determine the extent and accessibility of the route system.

- *Road transportation* trends were analyzed using Level-of-Service determinations along US 90, one of the most heavily used roads in Biloxi. Areas experiencing congestion were also analyzed in an attempt to predict future problem areas. In addition, plans for construction, expansion, and improvement were considered to identify areas where future capacity shortfalls might exist.

- *Water transportation* trends were analyzed using data on port vessel calls and tonnage. Access to rail and road infrastructure was considered to identify possible increases in these resources. In addition, capabilities and plans for expansion were considered to identify areas where future capacity shortfalls might exist.

5.10.1.2 Growth Scenarios

Air Transportation. During the advent of gaming activities in coastal Mississippi in the 1990s, passenger boardings at the Gulfport-Biloxi International Airport (GBIA) grew by 434 percent. GBIA handled approximately 950,000 passengers during 2000 (GBIA, 2002). The airport master plan forecast projects 2.1 million total passengers by 2020, which is a 121 percent increase over 2000. Major improvements to the Gulfport-Biloxi International Airport were completed in the 1990s to accommodate expanded commercial and military development. These improvements were made as a result of an anticipated steady growth in the resort business and its allied businesses; continued stability in the federal and defense sectors; and above-average growth in population (similar to levels predicted for the High-Growth Scenario). The airport has plans to expand the existing terminal, baggage claim, and security screening areas by 30 percent in the short term, as well as to build a new scheduled-passenger terminal adjacent to the existing terminal when total passenger movements approach 1.3 million. The existing terminal would then be converted to international and charter operations, which would permit growth of up to 12 million annual passengers (Frallic and Crawford, personal communication, 2002).

Most-Likely Growth Scenario. Projections indicate a 17 percent increase in population under the Most-Likely Growth Scenario. Under this scenario, the expected number of passengers handled at GBIA would be slightly more than 1 million, which is well within the planned capacity of the airport. Under this scenario no effects on air transportation would be expected.

Low-Growth Scenario. Effects on transportation under the Low-Growth Scenario would be expected to be the same as effects under the Most-Likely Growth Scenario.

Medium-Growth Scenario. Projections indicate a 36 percent increase in population under the Medium-Growth Scenario. Using this growth rate, the expected number of passengers handled at GBIA would be more than 1 million. Minor short-term effects on air transportation might be anticipated until GBIA implements currently planned expansion projects. Expansion of existing facilities as passenger movements approach 1.3 million would be expected to cause delays and add congestion at the airport.

High-Growth Scenario. Projections indicate a 54 percent increase in population under the High-Growth Scenario. Using this growth rate, the expected number of passengers handled at GBIA would reach about 1.5 million. Minor short-term impacts on air transportation might be anticipated until GBIA completes currently planned expansion projects. Expansion of existing facilities as passenger movements approach 1.3 million would be expected to cause delays and add congestion at the airport.

Public Transportation. The CTA operates a fleet of 45 buses providing fixed route and demand-response services to Harrison County, with extensions to Jackson County. From 1992 to 2001, ridership increased by 52 percent, to 709,389 passengers. Funding is in place to implement a Multimodal Transportation Plan for Harrison County, designed to improve mass transit and air quality, decrease traffic congestion, and stimulate economic development (GPRC, 1998).

Most-Likely Growth Scenario. Projections indicate a 17 percent increase in population under the Most-Likely Growth Scenario. Using this growth rate, the expected number of riders on CTA buses would exceed 830,000. Since ridership in 2000 was slightly over 800,000, it is expected that current infrastructure would be able to handle this increase, and no effects would be anticipated.

Low-Growth Scenario. Effects on public transportation under the Low-Growth Scenario would be expected to be virtually the same as effects under the Most-Likely Growth Scenario.

Medium-Growth Scenario. Projections indicate a 36 percent increase in population under the Medium-Growth Scenario. Using this growth rate, the expected number of riders on CTA buses could approach or exceed 1 million. Given the potential for new development in areas not currently served by existing bus routes, it would be expected that additional vehicles and routes would be needed to accommodate the increased population. Minor effects would be expected as infrastructure supply lags behind ridership demand.

High-Growth Scenario. Socioeconomic forecasting predicts a 54 percent population growth rate under the High-Growth Scenario. Using this growth rate, the expected number of riders on CTA buses would be approximately 1.1 million. Additional riders would also be expected due to urbanization. Deficiencies in both routes and vehicles would be expected to have moderate effects on public transportation.

Rail Transportation. The CSX Railroad currently passes approximately 22 trains through the region each day. These operations have resulted in 67 collisions from 1993 to 1997. The KCS Railroad operates 6 days a week, with business activity averaging approximately 48 cars per day. At graded crossings, 17 collisions have occurred from 1993 to 1997 (Federal Railroad Administration, Office of Safety Analysis, n.d.). Thus, rail traffic as it is currently configured within the coastal Mississippi study area can present a serious public safety risk. Although it is difficult to predict the future number of collisions that could occur, it is likely that increased traffic accidents, including fatalities, could occur as a result of increased rail and automobile traffic under each of the growth scenarios. This risk might be in proportion to the growth estimated for each of the scenarios (ranging from 17 percent for the Most-Likely Growth Scenario to over 50 percent growth for the High-Growth Scenario).

Road Transportation. US 90 is one of the main thoroughfares in the ROI and is experiencing severe congestion in Biloxi. A 1998 analysis of signalized intersections along a stretch of US 90 shows capacity adequate at five of the seven intersections studied (USACE, 2000). However, US

90 intersections at Veterans Avenue and Porter Avenue were heavily congested in the afternoon peak. Table 5.10–1 shows the LOS for signalized intersections and freeway sections in the ROI based on year 2025 traffic projections (PBS&J, 2001).

In addition, I-10 within the ROI has shown an increase of 5 to 7 percent in traffic volumes per year for the past 1 decades. Table 5.10–2 shows increases in volume at selected locations and the projected year 2025 based on traffic counts and projections provided by the GRPC volumes (Taylor and Yarrow, personal communication, 2002).

Table 5.10–1
Year 2025 Projected Conditions—A.M. Peak Hour Conditions

Analysis Type	Location	LOS
Signalized Intersection	Cowan Loraine Road at Pass Road	D
	Cowan Loraine Road at US 90	B
	Popps Ferry Road at Pass Road	F
	Beauvoir Avenue at US 90	F
	Veterans Avenue at Pass Road	F
	Veterans Avenue at US 90	F
	Rodenberg Avenue at Pass Road	F
Freeway Section	Eastbound I-10 between Cedar Lake Road and I-110	C
	Southbound I-110 between Rodriguez Street and Bay View Drive	F
	Eastbound I-10 between Woolmarket Road and Cedar Lake Road	C
	Corridor Route between Popps Ferry Road and Pass Road	NA

Table 5.10–2
Traffic Volumes

Location	Actual 1990	Actual 2000	Increase Per Year (percent)	Projected 2025
I-10 Biloxi	26,000	47,000	6.1	62,500
I-10 Gulfport	35,000	56,000	4.8	82,900
I-110 South of I-10	16,000	33,000	7.5	43,200
I-110 Biloxi Bay Bridge	24,000	55,000	8.6	61,200
US 49 North of I-10	31,800	52,000	5.0	56,700
US 49 South of I-10	29,600	52,000	5.8	60,000
US 90 Ocean Springs	27,000	40,000	4.0	47,000
US 90 Biloxi	25,000	43,000	5.6	45,600
US 90 Gulfport	27,000	36,000	2.9	38,000
Pass Road – Biloxi	16–22,000	22–33,000	4.1	39,200
Pass Road – Gulfport	17–19,000	18–30,000	4.7	22,200
SR 609 – South of I-10	9–15,000	25–31,000	7.5	23,500
Three Rivers Road	10,300	17,000	5.1	N/A

Most-Likely Growth Scenario. Although certain areas are currently experiencing capacity deficiencies, LOS determinations are expected to be lower than those predicted for the year 2025 based on projected growth estimates for this scenario. Minor impacts would be expected as LOS begins to deteriorate at heavily used sections of freeway and signalized intersections. In addition, projected traffic volumes on the major transportation arteries in the ROI are, in general, expected to be less than the projected 2025 volumes. Minor impacts would be expected. As traffic volumes increase drivers begin to experience an increase in unstable and forced flow traffic conditions.

Low-Growth Scenario. Effects on transportation under the Low-Growth Scenario would be expected to be virtually the same as effects under the Most-Likely Growth Scenario.

Medium-Growth Scenario. Conditions under this scenario are expected to be similar to the 2025 projections for LOS and traffic volumes based on projected growth estimates for this scenario. Moderate to significant adverse impacts would be expected as LOS determinations on major thoroughfares become increasingly unacceptable and traffic volumes reach design capacity.

High-Growth Scenario. Conditions under this scenario are expected to be worse than the 2025 projections for LOS and traffic volumes based on projected growth estimates for this scenario. Significant adverse impacts would be expected as a majority of thoroughfares begin to experience LOS F, creating unacceptable delays, increased accident frequencies, and increased pollution emissions.

Water Transportation. Since 1998, the Port of Bienville has seen the number of vessel calls increase from one per week to one per day in the last decade and yearly tonnage increase by 75 percent, from 400,000 tons to 700,000 tons. From 1997 to 2000, the Port of Gulfport experienced a 28 percent increase in tonnage to 3,131 thousand tons and forecasts for the year 2025 predict an increase to 4,826 tons. Based on the forecast, a capacity shortfall would begin in 2002; by 2005, Gulfport would have to improve its throughput by 17 percent to keep up with demand. The great majority of growth for Gulfport is expected to occur in pulp, paper, lime, cement, glass, iron, and steel—the increase is not related to large-scale development in the area (Parsons, Brinkerhoff, Quade, Douglas, Inc., 2000). Since these shipping increases are not directly linked to potential large-scale development in the region (the commodities are sent nationwide), water transportation and port capacity issues were not given further consideration in the analysis.

5.10.2 No Action Alternative

Under the no action alternative, conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools used in the past, and would continue to identify and mitigate adverse impacts on transportation infrastructure. Since any of the growth scenarios described in the trends analysis could occur, the conditions under the no action alternative could be the same those reflected by the four growth scenarios described in Section 5.10.1, above.

Relative to conditions in 2000, negligible to minor adverse impacts were identified for all transportation issues, with the exception of automobile traffic congestion and rail crossing hazards. Compared with current conditions, significant adverse impacts would be expected on automobile traffic, particularly along major transportation corridors (e.g., US 90, I-10, Popps Ferry Road, Pass Road, and other corridors and interchanges), for all of the growth scenarios—but particularly for the Medium- and High-Growth Scenarios. In addition, significant public

safety risks would continue at railroad crossings at major road intersections. This would be particularly true under the Medium- and High-Growth Scenarios.

5.10.3 Proposed Action

5.10.3.1 Regional Conservation Practices

Any inadequate allocation of resources and implementation of plans to respond to regional growth has the potential to cause substantial congestion and capacity deficiencies in the various transportation resources. However, implementation of good management practices (i.e., RCPs) in the coastal Mississippi area could mitigate such potential impacts. RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. These RCPs might be used to foster adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects. These RCPs are presented below.

- *Encourage development of a comprehensive transportation study to clearly identify capacity-deficient areas that experience unacceptable congestion.*

- *Foster development of plans to evaluate ways to enhance Coastal Transit Authority coverage and ridership, with consideration given to light-rail commuter service.*

- *Encourage use of Intelligent Transportation Systems to increase the safety and efficiency of the surface transportation system and to achieve benefits that include time savings, improved throughput, reduced crashes and fatalities, cost avoidance, increased customer satisfaction, reduced emissions, and decreased energy requirements.*

- *Encourage restricted travel on heavily used roads (i.e., dedicate roads or lanes for vehicles carrying a minimum number of passengers, where appropriate).*

- *Encourage development of multimodal systems to reduce reliance on vehicular transportation and accommodate bicycles, pedestrians, rail, and transit.*

- *Encourage relocation of the CSX mainline tracks north of I-10 to eliminate the numerous at-grade rail/roadway crossings, reduce injuries and deaths resulting from frequent train-vehicle collisions, reduce traffic congestion associated with roadway closings, and end trains running directly through the area's most populated corridors.*

- *Encourage development of an east/west transit corridor along the existing CSX railroad right-of-way, extending from Pass Christian to Biloxi, to alleviate congestion on US 90 and Pass Road.*

- *Encourage development of additional north/south routes to alleviate congestion on US 49 and Cowan/Lorraine Road.*

- *Encourage development of an East Harrison County Connector, a controlled access freeway connecting I-10 to US 90, to reduce congestion on I-10, I-110, and US 90.*

- *Encourage development of a Gulfport Connector, a controlled access freeway in the vicinity of the Port of Gulfport connecting I-10 to US 90, to reduce congestion on I-10, I-110, and US 90, to provide better access for truck traffic from I-10 to the Port of Gulfport and to relieve congestion on US 49.*

5.10.3.2 Effects of Implementing the Proposed Action

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor to significant beneficial effects with respect to transportation issues when compared with conditions described under the no action alternative. Depending on the state and federal resources allocated for road construction projects, implementing the RCPs and enhanced comprehensive planning would likely alleviate congestion problems projected for all of the growth scenarios. Such actions would reduce the potential for future significant cumulative adverse effects associated with large-scale development projects and permitting actions under the different growth scenarios.

5.11 VISUAL AND AESTHETIC RESOURCES

5.11.1 Trends Analysis for Visual and Aesthetic Resources

5.11.1.1 Technical Approach

Visual and aesthetic resources are natural resources, landforms, vegetation, and man-made structures that generate one or more pleasurable sensory reactions and evaluations by the observer. These sensory reactions are traditionally categorized as visual, auditory, and olfactory responses—in other words, sight, sound, and smell. The visual sense is the focus of this section. The other sensory stimulants, sound and smell, are addressed (to the extent their presence is perceivable), in the Noise, Air Quality, and Water Quality sections. In terms of visual resources, many places in coastal Mississippi have been recognized for their beauty and designated as such by federal or state agencies. Recognition of aesthetic resources also occurs at local levels through zoning, planning, or other public means.

For conducting the trends analysis, very limited data are available on the aesthetic resources of coastal Mississippi. (An overview of some of these resources was presented in Section 4.12.) Impacts on visual and aesthetic resources have occurred through the construction of large, brightly lit casinos, with development encroaching on areas with particular aesthetic appeal. To identify future impacts on visual and aesthetic resources, historical trends were evaluated, including an evaluation of the change in high-density development.

5.11.1.2 Growth Scenarios

Most-Likely Growth Scenario. Over the past decade, Biloxi has added nine casino developments to its shoreline and Gulfport has added two. The casinos in Biloxi are concentrated on the east point of the city at the mouth of Biloxi Bay, with others along the Back Bay—areas that had an urban character before the casinos arrived. The character of the Biloxi area where the casinos are located has nevertheless changed since the casinos arrived, from a waterfront primarily characterized by the fishing and the seafood industry to one dominated by large, modern, well-lit

buildings that lack a sense of connection to the maritime past. The Gulfport casinos are located along the coast in a less-developed area (although Gulfport has seen enormous residential and retail growth since the casinos came to Mississippi). Even with the growth brought by the gaming industry, the historical and aesthetic character of much of the Mississippi coastline beyond the direct influence of the casino developments has been retained—although secondary growth has altered this character somewhat and continues to do so.

By the year 2020 the population of the three coastal Mississippi counties is projected to increase by 17 percent, from 367,000 in 2000 to 431,000. Developed land is projected to increase from 90,000 acres in 2000 to 101,000 acres in 2020, or by 12 percent. While medium-density urban land is projected to grow by 3 percent between 2000 and 2020, high-density urban land is projected to grow by 37 percent under the Most-Likely Growth Scenario. This projected growth in population and developed land can be expected to have both short- and long-term negligible to minor adverse effects on visual and aesthetic resources.

Visual and aesthetic resource impacts would be those that cause a diminishment of the public enjoyment and appreciation of a resource, or one that impairs the character or quality of such a place, particularly those resources identified in Section 4.11. The following are among the potential visual and aesthetic resource impacts that can be expected with the growth of population, developed land, and land use/land cover changes:

- ***Alteration and degradation of scenic integrity (views, viewsheds, vistas).*** Additional construction along the coast, residential developments, and additional services developed to support a growing population would be typical alterations that could alter the visual environment.

- ***Blockage or decrease in views.*** Some residents could expect deterioration of views from their homes as additional residential areas are developed, and views from more developed areas could be altered as more land is consumed by buildings, parking lots, and roads.

- ***Decrease in visibility due to air pollution, particularly particulates.*** Traffic has increased in coastal Mississippi with the additional 50,000 visitors to casinos a day and 20,000 new residents. Additional growth and immigration would add to traffic and air pollution.

- ***Alteration and degradation of architectural integrity or style.*** While historic structures would be maintained with their historic character, new construction can be expected to use modern architectural materials and styles, diluting the historic architectural character of the coastal area.

- ***Degradation of aesthetic qualities (beauty, peace, and quiet).*** Alterations to scenic views, blockages of views, decreased visibility, and alterations in architectural style would cumulatively result in a degradation of the aesthetic qualities of the coastal area.

- ***Degradation of emotional, spiritual, and restorative values of an area (lake, shoreline).*** While such values are personal, to the extent that relatively undeveloped areas that retain much of their natural character have emotional and restorative value, development along the coast would likely reduce such values in these areas.

Without knowing exactly where the projected development and land use/land cover changes would take place, it is, of course, impossible to know where or to what extent the above potential

impacts on visual and aesthetic resources would occur. Individual community development codes typically address visual and aesthetic requirements for local developments. They vary tremendously in their scope, content, detail, and strictness or leniency. Some have a comprehensive set of codes, governing such things as open space, building siting and architectural design, landscape design, screening and buffering, as well as signs, lighting, setbacks, and building height requirements—all of which have to be satisfied before a building or development permit is granted. Other community development codes are lax, with virtually no requirements. Most communities have something in between these two code requirement extremes.

Among the key factors to be considered in assessing the potential for visual and aesthetic resource impacts are (1) the spatial relationship of the projected developments with neighboring land uses; (2) the mass, scale, and height of the projected developments, and the degree of vegetation modification and their visibility from the surrounding area; (3) the degree to which the projected development would visually contrast with the surroundings in design and materials; and (4) the degree to which the projected developments would result in glare, shadows, or night lighting requirements. Criteria for assessing the significance of visual and aesthetic changes as a result of projected development include the introduction of new structures or alteration of vegetation that (1) substantially detracts from the scenic attractiveness and scenic integrity of the area; (2) substantially blocks views of scenic vistas; and (3) produces substantial light or glare that poses a nuisance.

One additional visual and aesthetic resource impact that can be expected as a result of the land use/land cover changes associated with the projected population growth and development is light pollution. Light pollution, or the upward and outward distribution of light (either directly from fixtures or from reflection off the ground or other surfaces) has aesthetic, ecological, and health risks. Among the ecological impacts are adverse effects on wildlife behavior (disorientation and avoidance or attraction to lights), and confusion and injury to migrating birds unable to see glass windows in lighted structures. Plants also can be affected by light pollution. The potential for ecological impacts are addressed in the Biological Resources section. Light pollution, or skyglow, can adversely affect the simple pleasure of viewing the night sky by competing with the light from stars. Thus light pollution can affect aesthetics.

Low-Growth Scenario. For visual and aesthetic resources, the projected impacts of the Low-Growth Scenario would be essentially the same as those projected for the Most-Likely Growth Scenario discussed above.

Medium-Growth Scenario. The Medium-Growth Scenario would have both short- and long-term minor to moderate adverse effects on visual and aesthetic resources, relative to current conditions. By the year 2020 the population of the three coastal Mississippi counties is projected to increase by 36 percent, to 502,000 from 367,000 in 2000, or double the rate under the Most-Likely Growth Scenario. Developed land is projected to increase from 90,000 acres in 2000 to 113,000 acres in 2020, or by 26 percent, more than twice the rate under the Most-Likely Growth Scenario. While medium-density urban land is projected to grow by 12 percent between 2000–2020, high-density urban land is projected to grow by 69 percent under the Medium-Growth Scenario, compared with 3 and 37 percent growth, respectively, under the Most-Likely Growth Scenario.

While the types of impacts on visual and aesthetic resources would be similar to those identified for the Most-Likely Growth Scenario, the potential would be commensurately larger, given the

greater projected population growth and accompanying increase in developed land under the Medium-Growth Scenario.

High-Growth Scenario. The High-Growth Scenario would have both short- and long-term minor to potentially significant adverse effects on visual and aesthetic resources. By the year 2020 the combined population of the three coastal Mississippi counties is projected to increase by 54 percent to 565,000 from 367,000 in 2000, or about three times the rate under the Most-Likely Growth Scenario. Developed land is projected to increase from 90,000 acres in 2000 to 124,000 acres in 2020, or by 38 percent, more than three times the rate under the Most-Likely Growth Scenario. While medium-density urban land is projected to grow by 20 percent between 2000 and 2020, high-density urban land is projected to grow by 98 percent under the High-Growth Scenario, compared with 3 and 37 percent growth, respectively, under the Most-Likely Growth Scenario. This projected growth in population and developed land can be expected to have both short- and long-term minor to potentially significant adverse effects on visual and aesthetic resources, compared to current conditions.

The types of impacts on visual and aesthetic resources would be similar to those identified for the Most-Likely Growth Scenario, only the potential would be commensurately larger, given the larger projected population growth and increase in developed land.

5.11.2 No Action Alternative

Under the no action alternative, the conditions would be the same as those presented in the trends analysis above. The Corps would continue to review permits using the same procedures and analytical tools used in the past, and would continue to identify and mitigate adverse impacts on visual and aesthetic resources. Any of the growth scenarios described in the trends analysis could occur. Therefore conditions under the no action alternative could be the same those reflected in any of the four growth scenarios described in Section 5.11.1, above. Relative to conditions in 2000, minor to potentially significant adverse effects on visual and aesthetic resources might occur. By the year 2020, high-density development is expected to grow within a range of 30 to nearly 100 percent. This increase in high-density development could result in additional adverse effects on visual and aesthetic resources, including vistas in and around historic districts and property. In addition, additional light pollution caused by large-scale developments in the coastal area could further impair wildlife.

5.11.3 Preferred Alternative

5.11.3.1 Regional Conservation Practices

Studies have shown that both residents of and visitors to urban areas prefer areas that tend to have the following attributes: naturalness, upkeep/civilities, openness, historical significance, and order. They tend to dislike areas with opposite attributes: obtrusive, human-made uses; dilapidation; restriction; lack of historical significance; and disorder (Nasar, 1998). Through the NEPA process, the Corps might handle visual and aesthetics on a site-specific basis, which could lead to the adoption of site-specific permit conditions.

RCPs might be implemented to reduce visual and aesthetic impacts. RCPs consist of a wide range of BMPs, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. RCPs might be used to foster adoption of regional conservation measures that non–Corps entities (e.g.,

federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects. These RCPs are presented below.

- *Encourage planning that (1) provides for landscaping, preserves a sense of countryside, and preserves and enhances scenic views of rivers, lakes, water, and other aesthetically pleasing natural attributes; (2) promotes cleanliness and maintenance of places, structures, and buildings; (3) supports the presence of and preserves open spaces and scenery; and (4) promotes visual order, cohesiveness, and compatibility.*

- *Encourage development planning and actions that preserve places and buildings of cultural and historical significance.*

- *Encourage redevelopment planning and actions that address visual and aesthetic shortcomings such as built areas of high contrast (e.g., adjacent or mixed-use commercial and industrial areas having excessive poles, wires, and signs); places with crowding, congestion, narrow roads, and similar restrictions; and areas with disorder, chaos, and the lack of a uniform style.*

- *Encourage development planning and actions that minimize light pollution through measures such as (1) avoiding or minimizing outdoor lighting, (2) employing automatic controls to extinguish lighting whenever it is not needed, (3) using motion detectors to turn lights on when needed (e.g., security applications), (4) focusing lighting downward, (5) avoiding uplighting of trees and architectural details, and (6) avoiding the use of mercury vapor lamps. While some light pollution is an inevitable by-product of the land use/land cover change that accompanies population growth and development, implementing these RCPs can minimize light pollution levels (Wilson, 1998).*

- *Encourage adoption or enforcement of local zoning ordinances to limit areas where neon lights and flashing signs are allowed.*

5.11.3.2 Effects of Implementing the Preferred Alternative

Under the proposed action, enhanced comprehensive planning and implementation of RCPs by federal, state, and/or local authorities would result in minor beneficial effects with respect to visual and aesthetic resources. Such actions would therefore be likely to somewhat decrease the regional cumulative effects of development. Relative to current conditions, implementing the proposed action might mitigate some additional visual and aesthetic impacts to less-than-significant levels; however, overall conditions would likely continue to decline with respect to visual and aesthetic quality under each of the development scenarios.

5.12 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

The no action alternative and the proposed action would result in some unavoidable adverse environmental effects, as detailed in the previous sections. Many of these effects would be reduced through mitigation; however, certain impacts would be unavoidable. The principal unavoidable adverse effects on the environment are summarized below.

- ***Water Resources.*** Issuance of additional permits for large-scale developments under the no action alternative would have direct and indirect minor to significant adverse effects

on water quality, as discussed in Section 5.3, depending on the extent of future growth in the region. Under the proposed action, these impacts would be reduced. However, unavoidable adverse effects would occur under both alternatives, because increases in impervious surface under each growth scenario would likely continue to stress stream geomorphology and aquatic habitat. Implementation of RCPs to reduce these impacts under the proposed action might result in only minor adverse impacts on water quality and geomorphology even under high-growth conditions. In particular, enhanced application of RCPs for controlling storm water peak flows, particularly the use of created wetlands and bioretention units, might improve conditions even beyond current conditions.

- ***Biological Habitat/Wildlife.*** Induced growth, particularly under the High-Growth Scenario, would result in unavoidable loss of terrestrial habitat in the region. This loss of habitat would in turn result in adverse effects on wildlife and sensitive species. Of particular concern is the significant cumulative loss of wetlands in the CSA due to anthropogenic and natural causes. Implementation of RCPs to enhance wetland function, create wetlands, and closely manage and track wetland loss and mitigation efforts would reduce and could reverse these negative trends.

- ***Visual and Aesthetic Resources.*** Some loss of scenic attractiveness and loss of scenic integrity would be associated with implementing either of the alternatives. Implementing the no action alternative, however, would have greater visual and aesthetic impacts than implementing the proposed action.

- ***Groundwater Resources.*** Projected population growth would continue to place increased demands and unavoidable adverse impacts on aquifers of the region under both the no action and proposed action alternatives. In the long term, additional growth might ultimately lead to a need to ensure alternative sources of water using reservoirs.

5.13 IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that use of these resources would have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of a proposed action (e.g., extinction of a threatened or endangered species).

No significant irreversible commitments of resources would be expected from implementation of the alternatives considered in this EIS. However, minor and potentially significant irretrievable commitments of resources could occur under either alternative. Several federally listed species in the area might experience minor to significant adverse impacts. Of particular note is the Mississippi gopher frog, which is on the verge of extinction. This species is represented by only one remaining small population found in an isolated location along the Mississippi coast. The impact of development could limit the potential recovery of this species if significant intervention is not applied. Implementing RCPs under the proposed action could mitigate this impact. In addition, minor irreversible impacts on aesthetic resources might occur from implementing either alternative.

5.14 SHORT-TERM USES OF MAN'S ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Minor to significant conflicts between short-term use and long-term sustainability of coastal Mississippi are foreseen under both alternatives, but particularly for the no action alternative under high-growth conditions. Significant development activities in the watershed under the no action alternative could result in significant increases in nutrient and pathogen loadings for parameters that have exceeded water quality parameters in the past. Therefore, long-term significant impacts on water quality might result in a system that appears to be beyond its carrying capacity for pathogens and nutrient loadings. Furthermore, significant increases in impervious surface, particularly in the Turkey Creek–Old Fort Bayou subwatershed, could continue to result in geomorphologic impairments of streams, loss of wetland and riparian habitat, degradation of water quality, and increased potential for flooding. These impacts could result in long-term adverse effects on the aquatic ecological productivity of the coastal area.

In the long term, loss of natural areas due to development also might result in minor adverse effects on the biological productivity of terrestrial systems under each alternative. Clearing vegetation cover would reduce foraging and breeding habitat for wildlife and sensitive species in the area. For sensitive and federally listed species, continued high-growth development in the absence of significant intervention and mitigation could result in significant impacts, considering long-term cumulative effects.

5.15 SUMMARY OF ENVIRONMENTAL AND SOCIOECONOMIC CONSEQUENCES

Table 5.15–1 presents a summary of the environmental and socioeconomic consequences of the alternatives analyzed in this EIS for each resource area. The primary focus of this analysis is on the long-term (20-year) regional cumulative effects of Corps permitting actions in the coastal Mississippi area under various development scenarios and regulatory frameworks. Under the no action alternative, the Corps would continue to perform cumulative effects analysis for permits on an ad hoc basis and regional growth would continue to be managed as in the past. Essentially, the no action alternative represents the status quo and serves as a benchmark against which the proposed action can be evaluated. Preparation of a comprehensive trends analysis and development and implementation of a special-purpose permit evaluation methodology constitute the proposed action described in Section 2.0. This is the Corps's preferred alternative for considering cumulative effects associated with the permitting of large-scale development projects in coastal Mississippi.

Table 5.15–1
Summary of Environmental and Socioeconomic Effects

No Action Alternative (Baseline)	Proposed Action
Socioeconomics: Economics	
• Minor to significant beneficial effects on economics might occur relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. • Population Growth (2020): 431,000–565,000 (368,000 in 2000). • Population % Growth (2020): 17–54 percent. • GRP (2020): $14.5–$18.5 billion ($10 billion in 2000). • Employment (2020): 252,000–336,000 (227,000 in 2000). • Under the Low-Growth Scenario (zero growth in casino sector), Hancock and Jackson Counties projected to still have robust growth (about 25 percent growth by 2020) from other sectors, while only 10 percent growth is projected for Harrison by 2020. • Under High-Growth Scenario, Harrison and Hancock would grow by more than 60 percent; 85 percent of this growth would be directly associated with casino development. • About 8 percent of casino growth would spill into Jackson, accounting for 25 percent of Jackson's overall growth under the High-Growth Scenario.	• Similar to no action alternative.
Socioeconomics: Public Services and Safety	
• Minor adverse effects on public services might occur relative to current (2000) conditions. • Significant adverse effects on public safety might occur relative to current conditions under the Medium- and High-Growth Scenarios, assuming that casino development would drive future growth. • Growth scenarios reflect future conditions under the no action alternative. Adverse effects include potential increases in crime and social problems, as cited in the *National Gambling Impact Study Commission Report (1999)*.	• Long-term minor beneficial effects on public services might occur from implementing RCPs relative to the no action alternative. RCPs include enhanced regional planning and implementation of action items in the *National Gambling Impact Study Commission Report*. • No effect to minor adverse effects on public services might occur relative to current conditions (2000). • Public safety might continue to deteriorate relative to current (2000) conditions even with implementation of RCPs.
Socioeconomics: Environmental Justice	
• Minor adverse effects on environmental justice might occur relative to current (2000) conditions under the High-Growth Scenario. • Growth scenarios reflect future conditions under the no action alternative. Adverse effects include increased potential for encroachment and displacement of environmental justice neighborhoods.	• Long-term minor beneficial effects on environmental justice neighborhoods might occur from implementing RCPs (e.g., enhanced regional planning and consideration of environmental justice issues) relative to the no action alternative. • No effect to minor adverse effects might occur relative to current (2000) conditions.
Socioeconomics: Protection of Children	
• Minor to significant adverse effects on children might occur under the Medium- and High-Growth Scenarios relative to current (2000) conditions assuming casino development would drive future growth. • Growth scenarios reflect future conditions under the no action alternative. Potential adverse effects associated with gambling activities cited in the *National Gambling Impact Study Commission Report* include family disintegration, substance abuse, and increased criminal activity.	• Long-term minor beneficial effects on children might occur relative to the no action alternative from implementing RCPs (e.g., implementing action items in the *National Gambling Impact Study Commission Report*). • However, risks to children might continue to increase relative to current (2000) conditions even with the implementation of RCPs, assuming casino development would continue to drive future growth.

Table 5.15–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Land Use/Land Cover	
• No conflict effects relative to current (2000) conditions would occur because all development would be subject to relevant state, county, and community land use zoning, comprehensive plans, and subdivision regulations. • Growth scenarios reflect future conditions under the no action alternative. Substantial land cover changes are projected for the entire area relative to current (2000) conditions. Specific impacts are addressed in other resource sections. • Development in the Coastal Study Area would increase by 8 percent to 31 percent and impervious surface would increase by 19 percent to 73 percent relative to 2000. High-density growth is projected to double under the High-Growth Scenario. • Loss of natural area cover in the three counties would range from 9,000 to 27,000 acres, or 1 percent to 3 percent of available natural habitat. • Demands for office, retail, and wholesale space in the three coastal counties are projected to grow 31 percent to 47 percent relative to current conditions (2000) under the Medium- and High-Growth Scenarios.	• Long-term minor beneficial effects (on other resources) might occur relative to the no action alternative from implementing RCPs that advocate low-impact development methods, habitat conservation, and enhanced regional planning. Land cover changes, however, would still be similar to those under the no action alternative.
Water Resources	
• Minor to moderate adverse effects on water quality might occur under the Most-Likely and Low-Growth Scenarios. • Minor to significant adverse effects on water quality might occur under the Medium- and High-Growth Scenarios. Primary impacts due to increased pathogen, nutrient, and BOD_5 loadings, particularly during storm events. Sedimentation would not be a significant adverse impact on water quality, relative to other stressors. Inadequate storm water controls (due to serious wetland loss and increased impervious surface) and septic tank failures would continue to be the major cause of water quality impairments along the coast. • Growth scenarios reflect future conditions under the no action alternative. Many water bodies in the region are included on the state's list of impaired waters, primarily as a result of pathogens, nutrients, and BOD_5 loadings. Subwatersheds that would likely experience the most significant decline in water quality relative to current conditions due to increased loadings of these parameters include De Lisle, Lower Wolf River, Rotten Bayou, Tuxachanie Creek, and (to a lesser extent) Biloxi River. Subwatersheds that would change little relative to current conditions include: Bayou La Croix, Upper Jourdan River, and Upper Wolf River. Turkey Creek–Old Fort Bayou is already significantly impaired and would not experience dramatic changes in loadings. However, significant increases in impervious surface under the High-Growth Scenario, along with minor increases in loadings, would result in additional impairments in Turkey Creek–Old Fort Bayou.	• Long-term minor to significant beneficial effects on water quality might occur relative to the no action alternative from implementing RCPs. RCPs focus on controlling storm water peak flows containing nutrients and pathogens, and reducing sources (septic tank failures). RCPs are summarized below: – Require latest technology and BMPs for new septic tank installations – Enact inspection and maintenance requirements, as well as public outreach initiatives, to enhance existing septic tanks – Expand sewer systems in areas with septic tank failures – Implement MS4 program requirements – Implement BMPs for nonpoint source controls (agriculture) and construction (including riparian buffers) – Implement low-impact development landscape design approaches for storm water control – Create wetlands and bioretention facilities for storm water control • Minor adverse to significant beneficial effects might occur relative to current (2000) conditions depending on the location and extent of RCP implementation.

Table 5.15–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Geology, Soils, and Groundwater	
• Negligible to minor adverse effects on soils might occur under all growth scenarios. Soil loss might be reduced in some subwatersheds due to loss of agricultural land cover, whereas soil loss might increase to a minor extent in other subwatersheds. • Improper installation or maintenance of septic tanks located in hydric soils has caused septic tank failures, which have resulted in significant adverse impacts on water quality. • There are insufficient data to quantify the carrying capacity of groundwater aquifers in the region. Lowering of the groundwater table and saltwater intrusion might occur in the future. It is unclear, however, whether the carrying capacity of these aquifers would be reached in 20 years. Data suggest infrastructure is sufficient to address future needs.	• Long-term minor beneficial effects on soils and groundwater might occur relative to the no action alternative from enhanced regional planning and implementation of RCPs. • Minor adverse effects on soils and groundwater might occur relative to current (2000) conditions.
Biological Resources: Terrestrial Life (Vegetation and Wildlife)	
• Minor adverse effects on vegetation cover and wildlife populations might occur south of I-10; only negligible adverse effects are likely to occur north of I-10 relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. Loss of natural area cover within the three counties might range from 9,000 acres (Most-Likely Growth Scenario) to 27,000 acres (High-Growth Scenario), or 1 percent to 3 percent of available natural habitat. Loss of wet pine savanna and bottomland hardwood forests would be expected.	• Long-term minor beneficial effects might occur from implementing RCPs that advocate prescribed burning (where practical), clustered development, wildlife corridors, riparian habitat conservation, monitoring, and enhanced management of sensitive habitat. • Minor adverse effects would still likely occur relative to current (2000) conditions under both the Medium- and High-Growth Scenarios.
Biological Resources: Wetlands	
• Minor adverse effects on wetlands might occur relative to current (2000) conditions under the Most-Likely and Low-Growth Scenarios. • Significant adverse effects on wetlands might occur relative to current (2000) conditions under the Medium- and High-Growth Scenarios. • Growth scenarios reflect future conditions under the no action alternative. Loss of emergent wetlands in the Coastal Study Area would range from 1,000 acres (Most-Likely Growth Scenario) to 5,000 acres (High-Growth Scenario), or 5 percent to 21 percent of available emergent wetland habitat. Cumulative losses over a 50-year period would range from one-third to nearly one-half of emergent wetlands in the Coastal Study Area. Loss of wetlands in bottomland hardwood and pine savanna forests would also occur. However, data are insufficient to quantify potential losses.	• Long-term minor to significant beneficial effects might occur from implementing RCPs relative to the no action alternative. RCPs include instituting a functional value assessment study and tracking system, implementing watershed-based mitigation decision-making, conducting detailed study of wetland stressors, implementing ecosystem restoration/creation projects, implementing a robust mitigation tracking system, and requiring wetland creation for storm water management (where practical). • Minor adverse to minor beneficial effects might occur relative to current (2000) conditions depending on the extent of RCP implementation.
Biological Resources: Aquatic Life	
• Minor adverse effects on aquatic life might occur relative to current (2000) conditions as a result of increased development. However, significant cumulative adverse effects on aquatic life from human activities and natural causes have occurred, particularly to sea grass beds, over the past several decades. • Growth scenarios reflect future conditions under the no action alternative. Significant deterioration of aquatic life habitat has occurred, including adverse fluctuations in salinity levels, erosion due to severe weather events, nutrient loadings, and direct loss due to development and shoreline protection measures.	• Long-term minor beneficial effects from implementing RCPs would occur relative to the no action alternative. RCPs include bulkhead and seawall design modifications, wetland mitigation, modification to navigation channel maintenance procedures, ecological restoration and monitoring (sea grass beds), salinity monitoring, and storm water management. • Minor adverse to minor beneficial effects might occur relative to current (2000) conditions depending on the extent of RCP implementation.

Table 5.15–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Biological Resources: Rare, Threatened and Endangered (RTE) Species	
• Minor to significant adverse effects on RTE might occur relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. Federally listed species would not be expected to reach recovery goals with continuation of historical growth and current management approaches. Of particular note is the possible extinction of the Mississippi gopher frog in the absence of significant intervention.	• Long-term minor to potentially significant beneficial effects from implementing RCPs might occur relative to the no action alternative. RCPs include RTE species research, monitoring, and mapping; implement water quality RCPs; control of invasive species and natural predators; use of prescribed burning for forest management (where practical); initiation of habitat conservation plan and intervention efforts to protect the Mississippi gopher frog, as appropriate; public outreach and involvement initiatives; restriction and control of mining activities that impact RTE species; conservation of riverine habitat; protective buffers for RTE species; and restrictions on recreational activities as appropriate to protect beach RTE species' habitat. • Minor adverse to significant beneficial effects might occur relative to current (2000) conditions depending on the extent of RCP implementation.
Cultural Resources	
• Minor adverse effects on cultural resources might occur relative to current (2000) conditions, particularly under the Medium- and High-Growth Scenarios. • Growth scenarios reflect future conditions under the no action alternative. Increased potential for high-intensity development to encroach upon historic structures. Increased potential to disturb yet-undiscovered archaeological sites. •	• Long-term minor beneficial effects on cultural resources might occur relative to the no action alternative from enhanced regional planning. • However, unavoidable minor adverse effects might occur relative to current (2000) conditions even with the implementation of RCPs.
Air Quality	
• Negligible to minor adverse effects on air quality might occur relative to current (2000) conditions under the Low- and Most-Likely Growth Scenarios, while minor to significant adverse effects might occur under the Medium- and High-Growth Scenarios. • Growth scenarios reflect future conditions under the no action alternative. Increases in mobile sources might result in increased ozone precursor emissions that might in turn result in increased ozone levels. Limited historical trends suggest that increases in mobile sources have not directly resulted in increases in ozone levels; in fact, ozone levels have decreased slightly. Significant growth, however, might ultimately result in the area's being designated nonattainment for ozone, particularly under the Medium- and High-Growth Scenarios.	• Long-term minor beneficial effects on air quality might occur relative to the no action alternative from enhanced regional planning and control of ozone precursor emissions. • Minor adverse effects on air quality might occur relative to current (2000) conditions even with the implementation of RCPs.

Table 5.15–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
Noise	
• Overall, minor adverse effects on noise levels might occur under all growth scenarios relative to current (2000) conditions. Significant adverse effects might occur if high-intensity development and unacceptable noise levels encroach upon sensitive land uses (e.g., hospitals, schools, nursing homes, churches). • Growth scenarios reflect future conditions under the no action alternative. Increases in high-density development might result in increased levels of noise, particularly along transportation corridors and from construction activities. High-density development is expected to increase by 10,000 to 24,000 acres in the coastal counties. This increase is expected to occur primarily in medium-density areas, where average noise levels might increase by 10 to 20 dB compared with current conditions.	• Long-term minor beneficial effects on noise levels might occur relative to the no action alternative from enhanced regional planning (that minimizes noise near sensitive areas) and implementation of noise abatement measures (e.g., noise barriers along highway corridors, use of noise-reducing technology for construction machinery and aircraft). • Minor beneficial to minor adverse effects on noise levels might occur relative to current (2000) conditions depending on the extent of RCP implementation and location. Significant adverse effects should be avoided.
Utilities	
• Minor to moderate adverse effects on infrastructure might occur relative to current (2000) conditions. • Growth scenarios reflect future conditions under the no action alternative. Overall, levels of service should be maintained through adaptive management. Adverse effects that are likely to occur include increased potential for flooding due to inadequate storm water control measures and increases in impervious surface, and septic tank failures.	• Long-term minor to moderate beneficial effects on infrastructure and the environment might occur relative to the no action alternative from implementing RCPs. Infrastructure RCPs include upgrading storm water control measures (inflow and infiltration corrective action, wetland creation, bioretention facilities); applying LID planning methods; expanding wastewater treatment system coverage; expanding water supply systems; evaluating alternative water supply approaches; implementing septic tank BMPs (implementing maintenance, stricter permitting regulations, use of alternative treatment technology); and expanding recycling programs. • Minor beneficial to minor adverse effects on infrastructure might occur relative to current (2000) conditions depending on the extent of RCP implementation.
Transportation	
• Negligible to minor adverse effects might occur on all transportation modes, with the exception of auto traffic. Significant adverse impacts on auto traffic would be expected under all growth scenarios, but particularly under the Medium- and High-Growth Scenarios and along major transportation corridors (e.g., US 90, I-10, Popps Ferry Road, Pass Road, and other corridors and interchanges). Also, significant public safety risks would continue to increase at railroad crossings, particularly under the Medium- and High-Growth Scenarios. • Growth scenarios reflect future conditions under the no action alternative. Overall, levels of service (LOS) during peak hours would reach severe congestion levels with LOS values ranging from D to F.	• Long-term minor to significant beneficial effects on transportation might occur relative to the no action alternative from implementing RCPs. Transportation RCPs include updating regional comprehensive transportation plans as appropriate, developing east/west and north/south connectors, relocating CSX mainline tracks north of I-10, enhancing Coastal Transit Authority coverage, and evaluating and implementing transportation management strategies (e.g., regional synchronized traffic signals, Intelligent Transportation System, carpooling, multimodal systems). • Minor beneficial to minor adverse effects on infrastructure might occur relative to current (2000) conditions depending on the extent of RCP implementation and location.

Table 5.15–1
Summary of Environmental and Socioeconomic Effects (continued)

No Action Alternative (Baseline)	Proposed Action
• Minor to potentially significant adverse effects on visual and aesthetic resources might occur relative to current (2000) conditions depending on the nature of future projects and the intensity of growth. • Growth scenarios reflect future conditions under the no action alternative. High-density development is expected to increase by 30 to nearly 100 percent by 2020, depending on the growth scenarios. High-density development might encroach on historic structures and natural areas, which could adversely affect visual and aesthetic vistas in the region.	• Long-term minor beneficial effects on visual and aesthetic resources might occur relative to the no action alternative from enhanced regional planning and application of landscape planning measures that minimize adverse visual and aesthetic impacts associated with large-scale development projects. • However, unavoidable adverse effects might occur relative to current (2000) conditions even with the implementation of RCPs.

As part of the proposed action, RCPs have been developed to enhance regional conservation efforts, principally undertaken by local and state agencies for the reduction of adverse effects associated with development. RCPs consist of a wide range of best management practices, planning studies, and related actions for the conservation of coastal resources and reduction of environmental and socioeconomic effects associated with development. These RCPs were developed to reduce specific cumulative effects from development as identified through this EIS process, particularly through the trends analysis. As part of the special-purpose methodology, these RCPs might be used and implemented in two primary ways:

1. ***Formulate site-specific permit conditions under the regulatory authority of the Corps for large-scale development projects***. Upon the review of proposed large-scale development projects, the Corps of Engineers might formulate site-specific permit conditions based in part on these RCPs (identified in Table 5.15–2 under this first heading) for the reduction of environmental and/or socioeconomic effects.

2. ***By conducting the trends analysis and providing the results of this EIS, foster adoption of regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects***.

    - State and local regulatory authorities might elect to formulate new regulations based in part on these RCPs to conserve coastal resources and reduce environmental and/or socioeconomic effects from development.

    - Federal, state, and local regulatory authorities, as well as nongovernmental organizations might elect to conduct studies based in part on these RCPs to provide a better understanding of the effects of development on coastal resources.

    - Federal, state, and local regulatory authorities, as well as nongovernmental organizations might elect to incorporate, in whole or in part, RCPs as part of ongoing and/or new coastal planning initiatives for the conservation of coastal resources.

    - Private entities might elect to formulate mitigation measures and BMPs based in part on these RCPs in order to reduce environmental and/or socioeconomic effects associated with specific development projects.

In the case of wetlands, a third type of RCP has been identified. Regional studies and management approaches could be implemented through an interagency cooperative effort for the conservation of coastal resources (pending the availability of funds)

A summary of the resource-specific RCPs previously discussed in this section is presented in Table 5.15–2.

It is estimated that approximately half the growth in the CSA since 1992 has been induced by casino gaming establishments that received Corps permits. Thus, measures to reduce cumulative effects associated with Corps permitting actions can be accomplished only through cooperative efforts between or among federal, state, and local agencies, as well as private industry and developers.

Given the uncertainty associated with predicting the condition of natural resources and socioeconomic conditions over the next 20 years, a comprehensive trends analysis was conducted to evaluate changes that could occur under different growth scenarios. Growth scenarios evaluated in this assessment included most-likely growth (based on a sophisticated forecast model, similar to a 30-year average annual growth), High-Growth (continuation of 1992 to 2000 annual growth rate), Medium-Growth (half the annual growth from 1992 to 2000), and Low-Growth (zero growth in the casino sector, with Low-Growth overall). Overall, economic development under the Low-Growth Scenario was only 1 percent below the growth predicted for the Most-Likely Growth Scenario. By evaluating these growth scenarios, the trends analysis effectively captures the full range of economic impacts and cumulative effects of Corps permitting actions under reasonable maximum economic activity, as well as relatively stagnant economic conditions.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs)

1. RCPs for the development of site-specific permit conditions under the regulatory authority of the Corps.
Water Resources • Implement riparian buffer requirements (e.g., 100 foot) as appropriate to protect stream corridors and wetlands from disturbance within project footprint. • Implement Low-Impact Development (LID) measures and create wetlands, detention ponds, or bioretention cells to reduce peak storm water flows and maximize groundwater infiltration.
Geology, Soils, and Groundwater • Implement LID measures and create wetlands, detention ponds, or bioretention cells to reduce peak storm water flows and maximize groundwater infiltration.
Biological Resources–Terrestrial Life • Implement riparian buffer requirements as appropriate to protect stream corridors and wetlands from disturbance within project footprint. • Maintain habitat corridors and conserve high-quality wildlife habitat with adequate buffers, as appropriate. To the extent possible, minimize development footprints and configure them to conserve wildlife habitat and maintain corridors.
Biological Resource–Wetlands • Implement wetland buffer requirements to protect on-site wetland habitats from disturbance. • Create wetlands for storm water control when site conditions allow. • Require wetlands mitigation using a watershed-based decision process (e.g., assess on-site mitigation options, mitigation within the same watershed, functional value considerations, potential for mitigation success within current area).

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

Biological Resources–Aquatic Life • Plan construction and maintenance of channels, canals (boat access and drainage), dredge material sites, bulkheads, seawalls, transportation infrastructure, and ditches to minimize harm to aquatic habitat consistent with the Gulf of Mexico Fishery Management Council recommendations on Essential Fish Habitat. • Avoid sensitive aquatic habitat and incorporate adequate buffers and controls to minimize indirect effects.
Biological Resources–Rare, Threatened, and Endangered (RTE) Species • Encourage maintenance of protective buffers for RTE species (e.g., minimize human disturbance within 1,500 feet of bald eagle reproduction sites, provide for zones of undisturbed vegetation between development and wildlife habitat, comply with Louisiana quillwort recovery plan recommendations for 50-meter streamside buffers when timbering harvests approach areas known to support quillwort). • Regulate dredging in areas supported by the Alabama red-bellied turtle.
Noise • Require noise abatement and BMPs to reduce noise levels during construction and operation, particularly when land use conflicts arise near sensitive areas such as hospitals, churches, schools, nursing homes, and residential communities.
Utilities • Require LID measures and create wetlands, detention ponds, or bioretention cells to reduce peak storm water flows and maximize groundwater infiltration.
2. Regional studies and management approaches to be implemented through an interagency cooperative effort for the conservation of coastal resources (implemented pending availability of funds).
Biological Resources–Wetlands • Institute a robust mitigation tracking system to monitor mitigation implementation and effectiveness. • Through an interagency cooperative effort, institute a GIS-based functional value assessment study and tracking system on wetlands within the region and incorporate knowledge gained into permitting decisions. • Through an interagency cooperative effort, study regional wetland stressors.
3. Regional conservation measures that non–Corps entities (e.g., federal, state, and local agencies, and private entities) might elect to use for enhancing ongoing programs, developing new requirements/regulations, initiating planning studies, or implementing mitigation/control measures to reduce cumulative effects.
Socioeconomics • Implement the *National Gambling Impact Study Commission Report* to mitigate adverse impacts on public services and other socioeconomic issues under High- and Medium-Growth Scenarios. • Prepare a comprehensive regional plan to address the safety of children, increased traffic, construction, septic tank failures, and social concerns caused by gaming.
Land Use • Encourage minimal uses of land with high contaminant production potential, particularly in recharge zones, in order to protect groundwater. • Encourage the use of pervious surface materials for driveways, parking lots, etc., to reduce creation of impervious cover, and favor cluster development over large lot development in suburban and exurban areas. • Encourage adoption of land use ordinances that protect topography and sloped areas and limit maximum allowable density based on average slop inclination based on the presence of unstable soils or higher average slope inclinations, require set percentages of ground to be left undisturbed. • Encourage conservation programs and landscape ecology principles that minimize habitat loss and fragmentation. Maintain habitat corridors, small core habitat patches, and clusters of core habitat patches to foster wildlife movement. • Encourage management of existing land uses to control storm water runoff, soil erosion, sedimentation, and building encroachment. Various land-protection actions, such as deed restrictions and environmental easements, might be appropriate.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

Water Resources • Encourage adoption of requirements for developments to hook up to centralized wastewater treatment systems rather than installing new OSDS. • Encourage OSDS BMPs in areas without public sewer service to help maintain optimum operating efficiency and appropriate technology application. BMPs for regular OSDS maintenance and proper OSDS operation can reduce pathogen and nutrient loadings attributable to system failures. • Encourage zoning ordinances that restrict the number of new septic systems permitted on hydric soils or other soils not suitable for septic systems. • Promote strict policies for septic system maintenance in order to reduce pathogen and nutrient loadings attributable to system failures. • Encourage owners, through public education efforts, to improve the operation and maintenance of their septic systems. • Promote storm water control regulations (e.g., illicit discharge detection and elimination, construction site storm water runoff control, post-construction storm water management practices) for rural areas not covered under the new NPDES MS4 program requirements (i.e., fewer than 1,000 people per square mile). • Foster initiation of ecological restoration projects to restore degraded streams. • Encourage implementation of BMP options that can reliably achieve water quality goals (e.g., multiple pond systems, porous pavement, infiltration basins, and extended detention ponds) by reducing storm water runoff and allowing pollutants in storm water to settle before the runoff enters nearby water bodies. • Encourage storm water management plans for large development projects to control runoff during construction and during operation of a new facility. • Encourage implementation of regional storm water planning initiatives to encourage the use of LID landscape design approaches (i.e., on-site structural controls rather than regional controls) at development projects to reduce peak flows during storm events. The controls can include disconnection of impervious surfaces, reduction of impervious surfaces, and use of on-site storm water treatment methods. • Encourage adoption of an updated storm water design manual for development projects within the coastal Mississippi region. • Encourage adoption of on-site storm water management control measures such as bioretention cells (key storm water management structures for the on-site management of precipitation that fit into small open space to treat runoff from impervious surfaces). • Encourage creation of wetland systems for storm water management to reduce sediment, nutrient, and metal loads as well as hydrologic changes. • Encourage the use of BMPs at construction sites of new development projects and during forestry operations to control runoff. • Promote restriction of land application of manure near water bodies.
Geology, Soils, and Groundwater • Encourage adoption of requirements for developments to hook up to centralized wastewater treatment systems rather than installing new OSDS. Sanitary systems can treat wastewater more effectively and reduce the opportunities for surface water and groundwater contamination associated with OSDS failures. • Encourage expansion of wastewater treatment plant service coverage to reduce regional reliance on OSDS. • Foster required use of BMPs for OSDS and alternative treatment systems (e.g., aerobic systems, sand filtration, drip systems) in areas without public sewer service or areas having unsuitable soils. BMPs can help maintain optimum operating efficiency by requiring regular OSDS maintenance and proper OSDS operation. Following such operation and maintenance recommendations can reduce pathogen and nutrient loadings attributable to system failures. • Encourage enactment of zoning ordinances that restrict the number of new septic systems permitted on hydric soils or other soils not suitable for septic systems. Installing new septic systems in areas with improper soil conditions or in areas that are already at capacity with existing septic systems can lead to both groundwater and surface water contamination. Restricting the installation of new septic systems can reduce pathogen and nutrient loadings to water bodies in the area. • Encourage implementation of strict policies for septic system maintenance in order to reduce pathogen and nutrient loadings attributable to system failures. • Encourage owners, through public education efforts, to improve the operation and maintenance of their septic systems. Public education is an effective tool for controlling nonpoint source pollution. Many people are willing to implement BMPs for nonpoint source control once they understand the benefits associated with them. • Favor storm water collection infrastructure designed to use bioretention ponds or similar structures that allow storm water to infiltrate through the subsurface and into the aquifer while removing nonpoint source pollutants. • Encourage continued update of regional planning studies and monitoring efforts for tracking groundwater aquifer quality, levels, and alternative sources.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

Biological Resources–Terrestrial Life • Encourage the use of prescribed burning in upland and wet pine savanna for forest and wildlife management. • Encourage master planning of residential and commercial development to avoid or reduce fragmentation of existing forest habitat. • Encourage development planning and actions that reduce point and nonpoint source water pollution. • Encourage initiation of surveys of high-quality wildlife habitat and natural vegetative communities on a county or watershed scale. • Encourage identification of environmentally degraded areas suitable for restoration of regionally important vegetative communities (e.g., bottomland hardwoods, wet pine savanna, upland longleaf pine forest, emergent wetlands) and establish mitigation banks for important cover types.
Biological Resources–Wetlands • Encourage initiation of ecosystem restoration and other types of projects under authority of the Water Resources Development Act of 2000 involving cooperative efforts among state, local, and federal agencies and private watershed/river corridor associations. • Encourage the use of storm water management structures consisting of artificial wetland detention ponds, where practicable, at commercial and residential development sites.
Biological Resources–Aquatic Life • Foster development of navigation channels and boat access canals that provide for (1) alignments of channels and access canals that use existing channels, canals, and other deepwater areas to minimize initial and maintenance dredging requirements (where feasible), (2) alignments that avoid sensitive habitats such as oyster reefs and areas of submerged or emergent vegetation (where possible), and (3) locating canals and channels so that they do not cut through barrier beaches, barrier islands, or other Gulf shoreline protection features. • Encourage construction techniques for navigation channels and boat access canals that minimize turbidity and dispersal of dredged materials into sensitive wetland areas (i.e., submerged grasses and shellfish beds). • Foster development of navigation channels and boat access canals to (1) promote adequate water circulation, (2) avoid confined and dead-end canals, (3) minimize depths and maximize width of waterways, (4) orient canals toward prevailing summer winds to enhance water exchange, (5) use locks that connect more saline areas to fresher areas, and (6) provide that navigation channel maintenance would be confined to seasons when impacts to larvae and juvenile fishes would be minimal. • Encourage the use of confining levees for disposal of dredged material when disposal sites are located near wetlands and the use of vegetation, native hay mulch, or other means to eliminate possible wind or water erosion or encroachment onto the wetlands. • Encourage the placement and movement of pipes used in hydraulic dredging processes to avoid damaging or destroying sensitive habitats (e.g., emergent marshes and endangered species habitats) where feasible. • Favor the use vegetation plantings, sloping (3:1) riprap, or gabions over the use of vertical seawalls as shoreline stabilization methods because the preferred methods provide better shoreline protection and good-quality fish and wildlife habitat. • Discourage the use of vertical structures when bulkheads or seawalls are required in areas where marsh exists along the shoreline. • Encourage the use of vertical structures as bulkheads and seawalls when they are to be (1) aligned at or landward of the mean high tide line, (2) placed above wetland vegetation, and (3) constructed so that reflective wave energy does not scour or otherwise adversely affect adjacent essential fish habitat or adjacent shorelines. • Encourage bulkhead and seawall construction in which submerged riprap material is placed at the toe of the structure to protect its integrity, reduce reflective wave energy, and provide hard substrate for aquatic organisms. • Encourage the use of bulkhead and seawall breakwaters with openings that allow for fish ingress and egress and for water circulation. • Favor bulkhead and seawall breakwaters constructed of riprap material with a minimum of 3:1 slope in most cases over those constructed of vertical wall structures. • Encourage construction of roadways, railways, and airports that avoids wetlands; when avoidance cannot be achieved, encourage (1) selection of routes resulting in the least environment damage, preferably along cleared, existing rights-of-way and road beds, (2) use of bridges instead of filling, (3) use of suitable erosion control and vegetation-restoration methods on bridge approaches, and (4) use of span bridges that do not disrupt flow, instead of culverts.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

• Foster the use of transportation-related structures whose design and maintenance would prevent shoaling and alteration of natural water circulation. • Discourage construction of drainage canals and ditches having the potential to drain wetlands, affect special aquatic sites, or cause other adverse impacts. • Encourage the construction of upland retention ponds and other water management features such as sheet-flow diffusers to intercept materials that are toxic to marsh vegetation or aquatic life. • Encourage the use of natural vegetation to line drainage canals and ditches because it slows floodwaters, binds sediments, prevents erosion, and provides fish and wildlife habitats; discourage construction of ditches and canals lined with concrete. • Foster the development of drainage canal and ditch projects that avoid excessive clearing of brush, trees, and riparian vegetation for equipment access and/or project design. • Avoid siting mosquito ditching in wetlands or in areas that drain coastal wetlands, create encroachment of saltwater into lower-salinity wetlands, and cause water stagnation. Encourage designs that provide for access for aquatic organisms that feed on mosquito larvae. • Avoid configuring structures that would significantly alter the quality of aquatic habitat in terms of lighting, water quality, sedimentation, water depth, water temperature, and water clarity. • Encourage siting of sewage treatment and disposal facilities in upland areas, and not in wetlands or other fragile coastal habitats. • Encourage sewage treatment and disposal facilities that (1) use vegetated wetlands as natural filters and (2) that, for large-scale wastewater discharges, limit the use of pollutant assimilators to wetlands that have been specifically created for such purpose, and overall environmental and ecological suitability has been demonstrated. • Favor planning of sewage treatment and disposal facilities that (1) provides for discharging into open ocean waters instead of into estuarine waters, since discharging into estuarine waters has a higher potential to cause contamination in living marine resources and nutrient overloading, and (2) provides for the siting of discharge points in coastal waters away from critical habitats such as oyster reefs, marshes, sand and mud flats, seagrass beds, endangered species habitats, and other environmentally sensitive habitats. • Foster conservation and restoration of seagrass beds in the Mississippi Sound. Encourage control of salinity levels and restoration of habitat for recovery of coastal fisheries.
Biological Resources–Rare, Threatened, and Endangered (RTE) Species • Encourage research, monitoring, and mapping of coastal Mississippi RTE species (e.g., Alabama red-bellied turtle) to obtain information on species' life history, habitat requirements, and reproduction in order to develop effective conservation measures. All the RTE species from coastal Mississippi would be expected to benefit from more research into species life history, habitat requirements, and reproduction (USFWS, 1989; 1993; 1996). Life history information is a prerequisite to developing effective conservation measures (USFWS, 1989). Some species such as the Mississippi sandhill crane and red-cockaded woodpecker have been subject to years of study and much is known about their life cycles. For other species, such as the Alabama red-bellied turtle, life history is mostly unknown. • Foster implementation of a comprehensive Habitat Conservation Plan under regulations of the Endangered Species Act to identify and protect habitat for RTE species within the region, such as the Mississippi gopher frog, which is in danger of extinction unless significant intervention occurs. • Improve water quality through fostering a reduction in point and nonpoint source water pollutants. (See water resources section for specific RCPs.) Most rare species would be expected to benefit from a reduction in point and nonpoint source water pollution in the Pascagoula, Biloxi Bay, and Bay St. Louis watersheds. Sediment, fertilizers, herbicides, sewage, petroleum products, and toxic chemicals all have the potential to impact rare species directly or impact the prey organisms on which rare species feed (USFWS, 2001e). • Foster control of invasive species (e.g., feral pigs) and native predators (e.g., crows, beavers) that are hindering recovery efforts for some RTE species. Control feral pigs, which are invasive, nonnative species that have been observed destroying Alabama red-bellied turtle nests and Louisiana quillwort populations, and feeding on sea turtle eggs (USFWS, 1989; 1996). Native predators can also hinder recovery efforts for some rare species. Crows (*Corvus* spp.) have been reported to feed on Alabama red-bellied turtle nests, and beaver (*Castor canadensis*) dams are a potential threat to some Louisiana quillwort populations. Under very specific circumstances, control of these native species during critical portions of endangered species' life cycles might be necessary to boost chances of recovery.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

• Encourage management of forests using prescribed burning, where practical. Manage public forest land to restore open-canopy longleaf pine stands preferred by red-cockaded woodpecker, gopher tortoise, and other rare species known from longleaf pine habitats (USFWS, 1990a). Use easements, acquisitions, and land donations on a voluntary basis to protect and restore longleaf pine forests on private land. Manage pine forests with prescribed fire; fire suppression is the single biggest threat to the biological integrity of pineland habitats (Ramseur, 2002). Whenever possible, plan development and new roads to avoid fragmenting existing mature pineland habitat. Easements and land acquisition can also be used as a tool to protect riparian and wetland species such as the Louisiana quillwort and Alabama red-bellied turtle (USFWS, 1989; 1996). • Foster public outreach and involvement initiatives. Educate citizens and law enforcement officials about rare, threatened, and endangered species in coastal Mississippi (USFWS, 1989). Roadkill, wanton shooting, accidental take by commercial fishermen, and illegal collection for the pet trade have had adverse effects on endangered reptile species in Mississippi. Educating law enforcement officials about federally listed species would be expected to help officials apprehend people who kill or who traffic in rare species (USFWS, 1993). • Encourage restrictions/control of mining impacts near RTE habitat. The USFWS recommends that "surface mining for sand and gravel should be prohibited near known [Louisiana] quillwort habitat" (USFWS, 1996). A prohibition on sand and gravel mining would also be expected to benefit the pearl darter (USFWS, 2001e). Mining activities degrade Louisiana quillwort habitats downstream with sediment deposition, and deep holes left in stream channels create slow water habitats unsuitable for the pearl darter. The USFWS also identifies future impoundments in tributaries of the Pascagoula River known to support pearl darter as a threat to this species (USFWS, 2001e). Dams fragment pearl darter populations and create unsuitable lacustrine habitat (USFWS, 2001e). • Foster conservation of riverine habitat. The USFWS recommends prohibiting snagging (removing) obstructions from river channels known to support Alabama red-bellied turtle and yellow-blotched map turtle (USFWS, 1989; 1993). Snagging has adverse impacts on turtles by removing logs that turtles use for basking structure. Logs and snags often serve as habitat for invertebrate prey species of the yellow-blotched map turtle. The USFWS also recommends prohibiting dredging that removes aquatic vegetation in areas known to support Alabama red-bellied turtles (USFWS, 1989). Alabama red-bellied turtles use aquatic vegetation for both food and cover. • Favor project plans for development project plans that protect dune areas above the mean high water line that are used for nesting by many species of sea turtles. • Encourage limiting artificial lighting at beachfront locations. Artificial lighting can cause disorientation and misorientation in sea turtle adults and hatchlings. Turtle hatchlings are attracted to light and come out of the ocean to go toward a light source, increasing their chances of death or injury. In addition, as nesting females avoid areas with intense lighting, highly developed areas may cause problems for turtles trying to lay eggs (USFWS, 1998b). • Encourage restricting recreational activities on area beaches near RTE habitat (1) when necessary to protect nesting by federally listed birds and turtles (USFWS, 1989), (2) when use of all-terrain vehicles would conflict with incubation of bird and turtle eggs (USFWS, 1989), and (3) when heavy use of nesting beaches might reduce hatchling success due to sand compaction (NMFS, 2001). • Encourage limiting mechanical raking on beaches to (1) reduce compaction of sand and creation of tire ruts that might hinder or trap hatchlings, (2) reduce surface penetration and disturbance or exposure of nests, and (3) reduce disposal of debris on the high beach (which covers nests and alters nest temperatures) (NMFS, 2001).
Cultural Resources • Protect historic districts, buildings, archaeological sites, and other historic resources through reviews of new construction and adherence to federal and state laws protecting historic resources. Regulatory requirements to conduct phased archaeological investigations and viewshed studies in historic districts might be used to plan proper mitigation.
Air Quality • Encourage increasing the number and spatial distribution of ozone monitors to help quantify formation trends and to provide data that could assist in managing and controlling ozone emissions. • Encourage application of the results of the Gulf Coast Ozone Study to determine ozone formation and behavior, and consider creating a similar model that specifically analyzes stationary and mobile sources in the study area. • Encourage including public transportation options in current and future urban development plans to reduce traffic levels on area roads and resultant mobile source emissions. • Encourage measures that increase traffic flow, encourage carpooling, and increase public outreach measures to encourage the use of alternative public transportation, especially during high-ozone conditions. • Encourage changes to the SIP to reflect the need to decrease ozone precursor emissions if the coastal area is designated as being in nonattainment for ozone, and consider further reductions of ozone precursor emissions in specific areas through measures such as the use of alternative fuels, stricter point source controls, incentives for public transportation, and use of hybrid vehicles.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

Noise

- Encourage construction of noise barriers along major roadways to control automotive noise effects on surrounding areas.
- Encourage BMPs to limit noise from construction sites by controlling vehicle access and equipment use, and hours of operation.
- Foster institution of land use planning tools to reduce the potential for land use conflicts near sensitive areas such as hospitals, churches, schools, nursing homes, and residential communities. As necessary, require noise monitoring and noise abatement measures in order to ensure that construction activities and/or proposed projects comply with noise regulations.
- Encourage project planning that includes advanced technology for reducing sound levels emitted by machinery, automobiles, and aircraft.

Utilities

- Encourage adoption of requirements for developments to hook up to centralized wastewater treatment systems rather than installing new OSDS.
- Conduct storm water studies to identify the sources within the watershed of pathogen loadings into the bays during storm events, and seek corrective actions to reduce such loadings where feasible.
- Conduct studies to evaluate health department criteria for private septic tank installation and recommend use of alternative technologies for septic systems in hydric soils (e.g., aerobic treatment plants, constructed wetlands, sand filter systems).
- Conduct regional water supply study to assess adequacy of groundwater as the principal water supply and evaluate the utility of alternative sources such as upland reservoirs.
- Initiate aggressive inflow and infiltration corrective action programs to reduce the load on wastewater treatment systems during storm events.
- Expand or upgrade water service systems so that, as municipalities annex unincorporated areas, developers in those areas can obtain water services from centralized networks rather than from individual wells.
- Develop cost-sharing mechanisms to have developers of major projects assist in providing funds for piping infrastructure to deliver water to smaller cities and unincorporated areas.
- Expand or upgrade wastewater treatment systems so that unincorporated areas, when annexed, can be connected to a centralized wastewater treatment system.
- Develop cost-sharing mechanisms to have developers of major projects assist in wastewater collection systems upgrades, extensions, inflow and infiltration programs, or special water quality studies.
- Require developers to increase drainage capacity in subdivisions, and possibly require specific quality control measures (e.g., created wetlands).
- Implement LID approaches to reduce storm water peak flows and improve water quality.
- Continue to promote recycling programs to reduce the volume of materials going to municipal and construction debris landfills.

Transportation

- Encourage development of a comprehensive transportation study to clearly identify capacity-deficient areas that experience unacceptable congestion.
- Foster development of plans to evaluate ways to enhance Coastal Transit Authority coverage and ridership, with consideration given to light-rail commuter service.
- Encourage use of Intelligent Transportation Systems to increase the safety and efficiency of the surface transportation system and to achieve benefits that include time savings, improved throughput, reduced crashes and fatalities, cost avoidance, increased customer satisfaction, reduced emissions, and decreased energy requirements.
- Encourage restricted travel on heavily used roads (i.e., dedicate roads or lanes for carpooling, where appropriate).
- Encourage development of multimodal systems to reduce reliance on vehicular transportation and accommodate bicycles, pedestrians, rail, and transit.
- Encourage relocation of the CSX mainline tracks north of I-10 to eliminate the numerous at-grade rail/roadway crossings, reduce injuries and deaths resulting from frequent train-vehicle collisions, reduce traffic congestion associated with roadway closings, and end trains running directly through the area's most populated corridors.
- Encourage development of an east/west transit corridor along the existing CSX railroad right-of-way, extending from Pass Christian to Biloxi, to alleviate congestion on US 90 and Pass Road.
- Encourage development of additional north/south routes to alleviate congestion on US 49 and Cowan/Lorraine Road.
- Encourage development of an East Harrison County Connector, a controlled access freeway connecting I-10 to US 90, to reduce congestion on I-10, I-110, and US 90.

Table 5.15–2
Summary of Regional Conservation Practices (RCPs) (continued)

• Encourage development of a Gulfport Connector, a controlled access freeway in the vicinity of the Port of Gulfport connecting I-10 to US 90, to reduce congestion on I-10, I-110, and US 90, and to provide better access for truck traffic from I-10 to the Port of Gulfport and to relieve congestion on US 49.
Visual and Aesthetic Resources • Encourage planning that (1) provides for landscaping, preserves a sense of countryside, and preserves and enhances scenic views of rivers, lakes, water, and other aesthetically pleasing natural attributes, (2) promotes cleanliness and maintenance of places, structures, and buildings, (3) supports the presence of and preserves open spaces and scenery, and (4) promotes visual order, cohesiveness, and compatibility. • Encourage development planning and actions that preserve places and buildings of cultural and historical significance. • Encourage redevelopment planning and actions that address visual and aesthetic shortcomings such as built areas of high contrast (e.g., adjacent or mixed-use commercial and industrial areas having excessive poles, wires, and signs); places with crowding, congestion, narrow roads, and similar restrictions; and areas with disorder, chaos, and the lack of a uniform style. • Encourage development planning and actions that minimize light pollution through measures such as (1) avoiding or minimizing outdoor lighting, (2) employing automatic controls to extinguish lighting whenever it is not needed, (3) using motion detectors to turn lights on when needed (e.g., security applications), (4) focusing lighting downward, (5) avoiding uplighting of trees and architectural details, and (6) avoiding the use of mercury vapor lamps. • Encourage adoption or enforcement of local zoning ordinances to limit areas where neon lights and flashing signs are allowed.

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SECTION 7.0: BIBLIOGRAPHY

A. Garner Russell & Associates, Inc. 2000. *Sewer Master Plan for the City of Gulfport.*

A. Garner Russell & Associates, Inc. 2000. *Water Master Plan for the City of Gulfport.*

Alexander, Mary Ellen. 1998. Long Beach, Mississippi. In *Marine Resources and History of the Mississippi Gulf Coast*, Volume 1, *History, Art, and Culture of the Mississippi Gulf Coast.* Mississippi Department of Marine Resources, pp. 79–104. Jackson, MS.

Allan, Jim, City Manager, City of Gautier. 2002, February 13. Personal communication.

ASC (Area Sources Committee). 1996. *Biogenic Sources Preferred Methods.* Emission Inventory Improvement Program.

Arnold, C.L., and C.J. Gibbons. 1996. Impervious Surface Coverage: The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association*. 62(2):243–259.

Aultman, Tim, Mississippi Department of Environmental Quality. 2002, February 5. Personal communication.

Baker, Margaret. 2002, February 21. Gautier's expansion is official on Sunday. *Biloxi Sun Herald*.

Barnwell, Claiborne, Mississippi Department of Transportation. 2002. Personal communication.

Bay St. Louis Public Works Department. *General Information on Bay St. Louis.* <http://www.ci.bay-st-louis.ms.us/public/public.html>.

Bay St. Louis/Waveland School District. 2001, December 5. Personal communication.

Beiser, Laura Cook, and Stacey Dungan. Nonpoint Source Pollution, Mississippi Department of Environmental Quality (MDEQ). In *Marine Resources and History of the Mississippi Gulf Coast* Volume II, pp. 403–413. Mississippi Department of Marine Resources.

Bellsouth Telecommunications, Inc. 2002. *State Facts & Resources.* <www.bellsouth.com/community/ms/bscomm_msfacts.htm>. Accessed February 2002.

Belokon, Wally, Mississippi Automated Resource Information System (MARIS) Technical Center, Jackson, MS. 2001, December. Personal communication.

Biloxi School District. 2001, December 5. Personal communication.

Brewer, J.S. 1998. Patterns of plant species richness in a wet slash-pine (Pinus elliottii) savanna. *Journal of the Torrey Botanical Society* 125(3):216–224.

Burden of fixing sewer may fall on residents. 2002, February 3. *Sun-Herald.*

Burdick, D.M., D. Cushman, R. Hamilton, and J.G. Gosselink. 1989. Faunal changes and bottomland hardwood forest loss in the Tensas watershed, Louisiana (USA). *Conservation Biology* 3(3): 282–292.

BLS (Bureau of Labor Statistics). 2001. *Employment Status of the Civilian Noninstitutional Population, 1938 to Date*. <http://www.bls.gov/cps/cpsaat1.pdf>. Accessed December 3, 2001.

Burk-Kleinpeter, Inc. 2000. *Moving in the Right Direction.*

Busnel, R.G., and J. Fletcher, eds. 1978. *Effects of Noise on Wildlife.* Academic Press, New York, NY.

Campton, John, Engineer, Kiln Water & Fire Protection District. 2002, February 13. Personal communication.

Cavanaugh, W., and G. Tocci. No date. Environmental Noise: The Invisible Pollutant. *ESC* 1(1, Fall 1998). <http://www.nonoise.org/library/envarticle/index.htm>. Accessed October 2, 2001.

CO-OPS (Center for Operational Oceanographic Products and Services). 2002. *NOAA-NOS-CO-OPS Water Level Station*. <http://www.co-ops.nos.noaa.gov/cgi-bin/station_info.cgi?stn=8747766 +Waveland,+MS>. Accessed February 3, 2002.

Chambers, J.R. 1992. Coastal Degradation and Fish Population Losses. In *Stemming the Tide of Coastal Fish Habitat Loss. Proceedings of a Symposium on Conservation of Coastal Fish Habitat*, ed. R.H. Strous. pp. 45–50.

Christmas, J.Y., ed. 1973. *Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi.* Gulf Coast Research Laboratory, Ocean Springs, MS.

City of Biloxi. 2001. *Biloxi 2001 General Market Analysis.* Biloxi, MS.

City of Biloxi. 2002. *Major Public Works Projects.* <http://www.biloxi.ms.us/major_projects.htm>. Accessed February 2002.

City of Ocean Springs. No date. *Local Government: Ocean Springs, Mississippi.* <http://www.oceansprings-ms.com/city.htm>.

Coast Electric Power Association. 2002. *Coast Electric Power Association's History.* <http://www.coastepa.com/About_CEPA/history.php>. Accessed February 2002.

CEI (Coastal Environments, Inc.). 1999. *Mississippi Coastal Area Comprehensive Plan GIS Map Series*. Coastal Environments, Inc., Bay St. Louis, MS.

CEI (Coastal Environments, Inc.). 2001. *Mississippi Coastal Area GIS Data*. Coastal Environments, Inc., Bay St. Louis, MS.

Coblentz, B. 2000a. *Mississippi Crop Report: Mississippi Oysters Post Quality Year.* Mississippi Office of Agricultural Communications.

Coblentz, B. 2000b. *River Flood Could Hurt Gulf Oysters.* Mississippi Office of Agricultural Communications.

Collins, Patrick, Planning Director, City of Gulfport. 2002, February 14. Personal communication.

Copeland, C. 1999. *Nationwide permits for wetlands projects: Permit 26 and other issues and controversies*. 97-223 ENR. Congressional Research Service, Washington, DC.

Cornwell, David A., and Mackenzie L. Davis. 1991. *Introduction to Environmental Engineering, Second Edition*.

CCBNEP (Corpus Christi Bay National Estuary Program). 1996. *Characterization of Nonpoint Sources and Loadings to Corpus Christi Bay National Estuary Program Study Area*, ed. C. Baird, M. Jennings, D. Ockerman, and T. Dybala. Texas Natural Resource Conservation Commission, Austin, TX.

Crawford, Melinda, Director of Finance, Gulfport-Biloxi International Airport. 2002, January 17. Personal communication.

Dahl, T.E. 2000. *Status and Trends of Wetlands in the Conterminous United States 1986 to 1997*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

DeAngelis, Richard, and Elmer Nelson. 1969. Hurricane Camille August 5-22, 1969. In *U.S. Department of Commerce, Environmental Science Services Administration's Climatological Data, National Summary*, Vol. 20, No. 8, 1969. <http://www.mathstat.usouthal.edu/~lynn/ hurricanes/Camille.html>. Accessed January 31, 2002.

Discord and debate – Gulfport water, sewer woes top candidates' list. 2001, June 3. *Sun-Herald.*

Dooling, R.J. No date. *The Effects of Environmental Noise on Communication in Birds*. <http://www.bsos.umd.edu/psyc/dooling/enviro~1.htm>. Accessed October 1, 2001.

Drainage pleas answered, Orange Grove will get relief. 2001, November 8. *Sun-Herald.*

Dramstad, W.E., J.D. Olson, and R.T.T. Forman. 1996. *Landscape Ecology Principles in Landscape Architecture and Land Use Planning*. Island Press, Washington, DC.

Eco-Systems, Inc. 2000. Water Quality and On-Site Wastewater Treatment. In *Attachments to the Mississippi Gulf Coast Rural Wastewater Planning Initiative.* Gulf Regional Planning Commission.

Eleuterius, L.N., and S.B. Jones. 1969. A floristic and ecological study of pitcher plant bogs in south Mississippi. *Rhodora* 71:29–34.

Eleuterius, L.N., and G.J. Miller. 1976. Observations on Seagrasses and Seaweeds in Mississippi Sound Since Hurricane Camille. *Journal of the Mississippi Academy of Sciences.* 21:58–63.

Eleuterius, L.N. 1972. The marshes of Mississippi. *Castanea* 37(3): 153–168.

Eleuterius, L.N. 1973. The Distribution of Certain Submerged Plants in Mississippi Sound and Adjacent Waters. In *Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi, Phase IV: Biology*, ed. J.Y. Christmas, pp 191–197. Gulf Coast Research Laboratory, Ocean Springs, MS.

Eleuterius, L.N. 1998. Mississippi Coastal Plant Habitats. In *Marine Resources and History of the Mississippi Gulf Coast, Volume II*, pp.141–165. Mississippi Department of Marine Resources, Jackson, MS.

Ellis, Dan. 1998. A History of Pass Christian. In *Marine Resources and History of the Mississippi Gulf Coast,* Volume 1, *History, Art, and Culture of the Mississippi Gulf Coast,* pp. 55–74. Mississippi Department of Marine Resources, Jackson, MS.

ESC (Electronic Systems Center). 2000. *Kessler Air Force Base Digital Airport Surveillance Radar Environmental Assessment.* <http://www.hanscom.af.mil/ESC-BP/pollprev/eaweb/Keesler/frames_keesler.htm>. Accessed February 14, 2002.

ESRI (Environmental Systems Research Institute). 1998. *ESRI Data & Maps [GIS Coverages]*. Environmental Systems Research Institute, Redlands, CA.

Eubanks, T. 1994. *The Piping Plover in Texas: Winter Survey Guidelines.* Report for Great Lakes/Northern Great Plains Piping Plover Recovery Team.

Fagan, D., Mississippi Department of Transportation, Planning Division. 2002, January. Personal communication.

FRA OSA (Federal Railroad Administration, Office of Safety Analysis). No date. *PC Accident Prediction System.*

Ferrill, Wendy. 2003. *City of Ocean Springs Inspection Report*.

Fletcher, Kristin M. 2002. *Mississippi and Alabama Reach TMDL Consent Decrees.* <http://www.olemiss.edu/orgs/masglp/tmdl.htm>. Accessed February 2002.

Frallic, Bruce, Executive Director of Gulfport-Biloxi International Airport. 2002, January 17 and February 4. Personal communications.

Furr, Jay B., City of Biloxi, Engineering Department. 2002, February 25. Personal communication.

Gautier closer to tripling city size. 2002, January 29. *Sun-Herald.*

Gautier utility dubious of city's capabilities. 2002, February 5. *Sun-Herald.*

Glover, Dr. Bill, SRWMD. 2002, February 19. Personal communication.

Gosseling, J.G., E.P. Odum, and R.M. Pope. 1974. *The Value of the Tidal Marsh.* Report LSU-SG-74-03. Center for Wetland Resources, Louisiana State University, Baton Rouge.

Goudie, A. 1994. *The Human Impact on the Natural Environment*. The MIT Press, Cambridge, MA.

GWSTF (Governor's Water and Sewer Task Force). 2001. *State of Mississippi*. pp 9–12.

Guillory, V., H. Perry, P. Steele, T. Wagner, W. Keithly, B. Pellgrin, J. Petterson, T. Floyd, B. Buckson, L. Hartman, E. Holder, and C. Moss. 2001. *The Blue Crab Fishery of the Gulf of Mexico, United States: A Regional Management Plan.* Gulf States Marine Fisheries Commission, Ocean Springs, MS.

GMFMC (Gulf of Mexico Fishery Management Council). 1998. *Generic Amendment for Addressing Essential Fish Habitat Requirements in the Fishery Management Plans of the Gulf of Mexico.* Report No. NA87FC0003. Gulf of Mexico Fishery Management Council, Tampa, FL.

GRPC (Gulf Regional Planning Commission). 1998. *Proposed Harrison County Multimodal Transportation Plan Transit Component.* Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 1999a. *1998 Mississippi Coast Statistical Digest*. Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 1999b. *Harrison County Comprehensive Plan.* Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 2000. *1999 Mississippi Coast Statistical Digest*. Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 2001a. *2000 Mississippi Coast Statistical Digest*. Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 2001b. *Mississippi Coast Rural Wastewater Planning Initiative.* Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 2002a. *GIS Data for South Mississippi.* Gulf Regional Planning Commission, Gulfport, MS.

GRPC (Gulf Regional Planning Commission). 2002b. *Coastal Mississippi MARIS Data.* Gulf Regional Planning Commission, Gulfport, MS.

GSERC (Gulf South Economic Research Center). 2001. *The Mississippi Coast Economy*. Gulf South Economic Research Center. <http://www.gserc.usm.edu/files/MSCoastEconomy.htm.>. Accessed November 27, 2001.

GBIA (Gulfport-Biloxi International Airport). 2002. *Airport Growth Statistics.* <http://www.gulfcoast.org/gpt/stats.htm>. Accessed January 28 and June 26, 2002.

Gulfport School District. 2002, December 5. Personal communication.

Gunter, G. 1981. Status of turtles on the Mississippi coast. *Gulf Research Reports* 7(1):89–92.

Haig, S.M. 1992. Piping Plover. In *The Birds of North America, No. 2.*, ed. A. Poole, P. Stettenheim, and F. Gill. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC.

Haig, S.M., and J.H. Plissner. 1992. *The 1991 International Piping Plover Census.* U.S. Fish and Wildlife Service, Twin Cities, MN.

Haig, S.M., and J.H. Plissner. 1993. Distribution and abundance of piping plovers: Results and implications of the 1991 International Census. *Condor* 95:145–156.

Hancock Bank. 1982. *The Coast of Mississippi, Its Past and Progress.* Moran Publishing Corporation, Baton Rouge, LA.

Hancock County Building Inspection and Permits. 2001, December 20. Personal communication.

Hancock County School District. 2001, December 5. Personal communication.

Harris, C. 1979. *Handbook of Noise Control.* 2d ed. McGraw-Hill Book Company, New York, NY.

HCDC (Harrison County Development Commission). 2001a. *Gulf Coast Major Employers*. <http://www.mscoast.org/Major_Employers/major_employers.pdf>. Accessed November 27, 2001.

HCDC (Harrison County Development Commission). 2001b. *2000 Annual Report*. Harrison County Development Commission, Gulfport, MS.

Harrison County School District. 2001, December 5. Personal communication.

Harrison County Tourism Commission. No date. *Mississippi Gulf Coast Fun Times! Guide*. Rowell Publishing Company, Jackson, MS.

Harrison County Tourism Commission. 2001. *Mississippi Gulf Coast*. <http://www.gulfcoast.org>. Accessed December 5, 2001.

Hefner, J.M., B.O. Wilen, T.E. Dahl, and W.E. Frayer. 1994. *Southeast Wetlands: Status and Trends, Mid-1970s to Mid-1980s*. U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region, Atlanta, GA, and U.S. Environmental Protection Agency, Region 4, Atlanta, GA.

Hemphill, Jerry, Hancock County Port Authority. 2002, January 16. Personal communication.

Hode, Ralph, City of Gautier. 2002, February 13. Personal communication.

Holden, S. L., Mississippi Department of Environmental Quality. 2002, January 9. Personal communication.

Holland, A.F., G.H.M. Riekerk, S.B. Lerberg, L.E. Zimmerman, D.M. Sanger, G.I. Scott, M.H. Fulton, B.C. Thompson, J.W. Daugomah, J.C. DeVane, K.M. Beck, and A.R. Diaz. 1997. *The Tidal Creek Project Summary Report.* South Carolina Department of Natural Resources, Marine Resources Research Institute and U.S. National Marine Fisheries Science Center, Southeast Fisheries Science Center.

Holloman, Cathy Z. 1998. Nonpoint Source Pollution in Coastal Mississippi. In *Marine Resources and History of the Mississippi Gulf Coast*, Volume II, pp. 415–424. Mississippi Department of Marine Resources.

Holloman, Cathy Z., and Mark W. LaSalle, Ph.D. 1995. *Modification of Septic Tank Requirements.* Mississippi State University, Mississippi Agricultural and Forestry Experimental Station, Mississippi Cooperative Extension Service, and Mississippi Department of Marine Resources.

Holloway, Elton, Mississippi Department of Transportation. 2002, January. Personal communication.

Horner, R.R., J.J. Skupien, E.H. Livingston, and H.E. Shaver. 1994. *Fundamentals of Urban Runoff Management: Technical and Institutional Issues*. Terrene Institute, Washington, DC, in cooperation with U.S. Environmental Protection Agency, Washington, DC.

Hudson, P., Mississippi Department of Transportation, Port of Gulfport. 2002, January 28. Personal communication.

Hyatt, Robert D. 1980. *Cultural Resources Survey of Proposed Interstate Highway No. 110 Between Chartres Street, Biloxi, and U.S. Highway No. 90* (51-0110-01-001-10), Harrison County, MS. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Jackson County School District. 2001, December 5. Personal communication.

Johnston, C.A. 1994. Cumulative impacts to wetlands. *Wetlands* 14(1):49–55.

Jordan, R.A. 1998. Species Profile: *Pine Snakes (Pituophis melanoleucus ssp.) on Military Installations in the Southeastern United States.* Technical Report SERDP-98-5. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Keesler Air Force Base. 1998. *Area Joint Land Use Study.* U.S. Department of Defense, Washington, DC.

King, S.E., and J.B. Grace. 2000. The effects of gap size and disturbance type on invasion of wet pine savanna by cogongrass, *Imperata cylindrica* (*Poaceae*). *American Journal of Botany* 87(9):1279–1286.

Krizman, Ron. 2000. Regulatory Branch Chief, U.S. Army Corps of Engineers–Mobile District. 2000, May. Personal communication.

Kuenzi, A.J., F.R. Moore, and T.R Simons. 1991. Stopover of neotropical landbird migrants on East Ship Island following trans-Gulf migration. *Condor* 93(4):869–883.

Lago, P.K. 1991. A survey of arthropods associated with gopher tortoise burrows in Mississippi (USA). *Entomological News* 102(1):1–13.

Landreneau, Donovan. 2000. *Atlantic Tropical Storms and Hurricanes Affecting the United States: 1899-2000.* NOAA Technical Memorandum NWS SR-206. <http://www.srh.noaa.gov/lch/research/trophis.htm>. Accessed January 31, 2002.

Lauro, James. 1990. *Cultural Resources Survey.* MDAH Report #90-155. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Lauro, James. 1998. *Cultural Resources Survey of the Broadwater Beach Resort Complex, Harrison County, Mississippi.* Prepared for Michael Baker Jr., Inc., Jackson, MS. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Lee, Richard, Division Engineer, Mississippi Department of Transportation, District 6. 2002, January 31. Personal communication. Llanos, M. 2001. *Major Endangered Species Pact OK'd.* MSNBC. <http://www.msnbc.com/news/620588.asp?pne=msn>. Accessed August 29, 2001.

Long Beach School District. 2001, December 5. Personal communication.

Mann, C. Baxter, Jr. 2000. *A Phase I Cultural Resource Survey of the East Harrison County Connector, Harrison County, Mississippi.* MDOT Project No. 94-1145-00-001-10/101212001000. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2000, June 22. Letter to Susan Ivester Rees, U.S. Army Corps of Engineers, Mobile District.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2001, February 4. Letter to Claiborne Barnwell, Mississippi Department of Transportation. In *Draft Environmental Impact Statement, East Harrison County Connector.*

Mann, T. 2003. Personal communication. Zoologist, MS Natural Heritage Program, MS Museum of Natural Science.

Manuel, Larry, Port of Biloxi. 2002, January 17. Personal communication.

Marsh, W. M. 1998. *Landscape Planning: Environmental Applications*. John Wiley & Sons, Inc., New York, NY.

Mason, W.T., Jr., and J.P. Clugston. 1993. Foods of the gulf sturgeon (*Acipenser oxyrinchus desotoi*) in the Suwanee River, Florida. *Transactions of the American Fisheries Society* 122:378–385.

McClelland, J., C. Rakocinski, S. LeCroy, and R. Heard. 1998. *Assessment of Benthic Habitats Within the Proposed Broadwater Marina/President Casino Expansion Site, Gulfport, Mississippi*. Prepared for Michael Baker, Inc., Coraopolis, PA.

McGahey, Sam, Senior Archaeologist, Mississippi Department of Archives and History. 2001, July 27 and September. Personal communications.

McGraw, Doug, Diamondhead Water & Sewer District. 2002, February 19. Personal communication.

Meyer-Arendt, K.J. 1989. Estuarine marsh loss in Mississippi, 1956-1985. *Mississippi Geology* 9(4):9–11.

Miller, G.J., and S.B. Jones. 1967. The vascular flora of Ship Island, Mississippi. *Castanea* 32:84–99.

Miller, Mark. No date. *Round Island Lighthouse Breakwater*. <http:www.rsca.org/mgfb/Reports/97/Round%20Island%20Lighthouse%2097/>. Accessed January 31, 2002.

MARIS (Mississippi Automated Resource Information System). 1992. *1992 Land Use and Land Cover Data for Hancock, Harrison, and Jackson Counties, Mississippi*. MARIS Technical Center, Jackson, MS. Imagery was originally classified by Stennis Space Center, Hancock County, MS.

MARIS (Mississippi Automated Resource Information System). 2000. *2000 Land Use and Land Cover Data for Hancock, Harrison, Jackson, Pearl River, Stone, and George Counties, Mississippi*. MARIS Technical Center, Jackson, MS. Prepared for Mississippi Department of Marine Resources (DMR) Comprehensive Resource Management Plan (CRMP).

MARIS (Mississippi Automated Resource Information System). 2001. *GIS Data for Mississippi* <http://www.maris.state.ms.us>.

Mississippi Business Journal. 1998, August 31-September 6. *Groundwater Critical to Mississippi Economic Development.*

Mississippi Business Journal. 2000, January 10-16. *Business 2000: The Coast.*

Mississippi Code. Title 43, Chapter 39 (Public Welfare: Relocation Assistance) [effective July 1, 1972]. <http://198.187.128.12/mississippi/lpext.dll?f=templates&fn=fs-main.htm&2.0>. Accessed February 22, 2002.

MDAH (Mississippi Department of Archives and History). 2000. *Comprehensive Historic Preservation Plan for the State of Mississippi*. <www.mdah.state.ms.us/hpres/plan.html#one>. Accessed February 2003.

MDECD (Mississippi Department of Economic and Community Development), Division of Tourism Development. No date. *Mississippi Travel Planner*. Mississippi Department of Economic and Community Development, Ocean Springs, MS.

MDOE (Mississippi Department of Education). 2001. *Mississippi Department of Education 2001 Annual Report, Revenue by Source by District 1999-2000*. <http://www.mde.k12.ms.us/account/2001 report/Rev01.htm>. Accessed November 27, 2001.

MDEQ (Mississippi Department of Environmental Quality). No date. *Specific Design Criteria and Specifications (Draft)*. Mississippi Department of Environmental Quality, Office of Pollution Control, Surface Water Division.

MDEQ (Mississippi Department of Environmental Quality). 2000. *Ground-Water Study of Historical Water-Level and Water-Quality Data in Jackson County, Mississippi*. Open-file Report 99-102. Mississippi Department of Environmental Quality, Office of Land and Water Resources.

MDEQ (Mississippi Department of Environmental Quality). 2002a. *Registered UST and LUST Sites Database.* <http://www.deq.state.ms.us>. Accessed February 2002.

MDEQ (Mississippi Department of Environmental Quality). 2002b. *MS CERCLA/Uncontrolled Sites File List.* <http://www.deq.state.ms.us>. Accessed February 2002.

MDEQ (Mississippi Department of Environmental Quality). 2002. *Office of Pollution Control – Hazardous Waste Division.* <http://www.deq.state.ms.us>. Accessed February 2002.

MDEQ OPC (Mississippi Department of Environmental Quality, Office of Pollution Control, Air Division). 2002. *What is the Air Division?*. <http://www.deq.state.ms.us/newweb/opchome.nsf/pages/air>.

MDMR (Mississippi Department of Marine Resources). 1998a. *Marine Resources and History of the Mississippi Gulf Coast, Mississippi's Coastal Environment,* Volume II. Mississippi Department of Marine Resources, Biloxi, MS.

MDMR (Mississippi Department of Marine Resources). 1998b. Bootlegging: An Historical Perspective. In *Marine Resources and History of the Mississippi Gulf Coast*, Vol. 1, *History, Art, and Culture of the Mississippi Gulf Coast*, pp. 41–52. Mississippi Department of Marine Resources, Biloxi, MS.

MDMR (Mississippi Department of Marine Resources). 2001. *Comprehensive Resource Management Plan GIS Data for Hancock, Harrison, Jackson, George, Pearl River, and Stone Counties, Mississippi*. Mississippi Department of Marine Resources, Biloxi, MS.

MESC (Mississippi Employment Security Commission). 2001. *Annual Averages.* <http://www.mesc.state.ms.us>. Accessed December 3, 2001.

MFC (Mississippi Forestry Commission). 2000. *Best Management Practices for Forestry in Mississippi.* MFC Publication #107.

MGC (Mississippi Gaming Commission). 2001. *Quarterly Reports – Regional Data*. <http://www.mgc.state.ms.us>. Accessed November 29, 2001.

Mississippi Gaming Road Capacity Analysis. 1996, November.

Mississippi Gulf Coast Golf Association. 2001. Official Website of the Mississippi Gulf Coast Golf Association. <http://MSGolfCoast.com.> Accessed December 6, 2001.

Mississippi Office of Land and Water Resources. No date. *Groundwater Information.*

Mississippi Power Company. 2002. *News and Issues.* <http://www.southerncompany.com/mspower/about/about.asp?mnuOpco=mpc&mnuType=sub&mnultem=ni>. Accessed February 2002.

Mississippi PSC and PUS (Mississippi Public Service Commission and Public Utilities Staff). 2002. <http://www.psc.state.ms.us>. Accessed January 2002.

Mississippi State Department of Health. 2002. *The State of Mississippi's Public Water System Capacity Development Program, A Report to the Governor*. Mississippi State Department of Health, Jackson, MS.

Mississippi SHPO (State Historic Preservation Office). 2001. *Historic and Archaeological Sites in Hancock, Harrison, and Jackson Counties, Mississippi.* Mississippi State Historic Preservation Office, Jackson, MS.

MSU (Mississippi State University). 1995. *Modification of Septic Tank Requirements.* Mississippi State University, Mississippi Agricultural and Forestry Experiment Station, Mississippi Cooperative Extension Service, Coastal Research and Extension Center.

MSU (Mississippi State University). 2003. *Mississippi's Marine Resources.* <http://www.msstate.edu/dept/crec/marine.html>.

MSU CREC (Mississippi State University, Coastal Research and Extension Center). No Date. *Environmental Research: Monitoring Coastal Wetlands/Chevron Refinery*. <http://www.msstate.edu/dept/crec/envires.html>. Accessed January 31, 2002.

Mississippi Storm Water Pollution Prevention Plan (SWPPP). No date. *Guidance Manual for Construction Activities.*

Moncrieff, C.A., T.A. Randall, and J.D. Caldwell. 1998. *Mapping of Seagrass Resources in Mississippi Sound.* Gulf Coast Research Laboratory, Ocean Springs, MS.

Moore, R.R., P. Kerlinger, and T.R. Simons. 1990. Stopover on a Gulf Coast barrier island by spring trans-Gulf migrants. *Wilson Bulletin* 102(3):487–500.

Moran, Seymour, & Associates, Inc., and Southern Consultants, Inc. 1999. *Ocean Springs Water System Analysis, Prepared for The City of Ocean Springs, Mississippi, Volume I.* Prepared for the City of Ocean Springs, MS, by Moran, Seymour, & Associates and Southern Consultants, Inc.

Moran, Seymour, and Associates, Inc. 2003, May 5. Memorandum addressing water and sewer improvements.

Moreton, Rebecca Larche. 1998. The French Language of the Coast. In *Marine Resources and History of the Mississippi Gulf Coast*, Volume 1, *History, Art, and Culture of the Mississippi Gulf Coast*, pp. 11–16. Mississippi Department of Marine Resources, Biloxi, MS.

Morris, Christopher. 1992. *Dictionary of Science and Technology*. Academic Press, Inc.

Moss Point School District. 2001, December 5. Personal communication.

NASA (National Aeronautics and Space Administration). 2001. *Environmental Resource Document*. Stennis Space Center Environmental Assurance Program, National Aeronautics and Space Administration.

Nasar, J.L. 1998. *The Evaluative Image of the City*. SAGE Publications, Thousand Oaks, CA.

NCDC (National Climate Data Center). 2002. *Storm Events Database*. <http://www4ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>. Accessed January 31, 2002.

NMFS (National Marine Fisheries Service). 1998. *Marine Recreational Fisheries Statistics Survey. MRFSS Facts and Figures: Mississippi 1998*. <http://www.st.nmfs.gov>.

NMFS (National Marine Fisheries Service). 2000. *Fisheries Statistics and Economics*. <http://www.st.nmfs.gov/>.

NMFS (National Marine Fisheries Service). 2001a. *Threatened and Endangered Species*. <http://nmfs.noaa.gov/prot-res/species/turtles>.

NMFS (National Marine Fisheries Service). 2002. *Habitat Connections: Wetlands, Fisheries, & Economics in the Gulf of Mexico Coastal States*. <http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconnections/>.

NPS (National Park Service). 1994. *Report to Congress. Report on Effects of Aircraft Overflights on the National Park System*. National Park Service, Washington, DC.

NPS (National Park Service). 2001. *Gulf Islands National Seashore*. <http://www.nps.gov/guis>. Accessed December 6, 2001.

NRCS (Natural Resources Conservation Service). 1997. *Average Annual Precipitation- Mississippi*. <http://www.wrcc.dri.edu/pcpn/ms.gif>.

NRCS (Natural Resources Conservation Service). 2001. *1997 National Resources Inventory*. Summary Report. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, DC.

NRC (National Research Council). 2001. *Compensating for Wetland Losses Under the Clean Water Act*. National Research Council, Committee on Mitigating Wetland Losses, Board on Environmental Studies and Toxicology, Water Science and Technology Board, Division on Earth and Life Studies. National Academy Press, Washington, DC.

NRDC (Natural Resources Defense Council). 2001. *Testing the Waters: A Guide to Water Quality at Vacation Beaches*. Natural Resources Defense Council, New York, NY.

National Small Flows Clearinghouse. 1993. *A National Small Flows Clearinghouse Summary of Onsite Systems in the United States.*

NSS (Nature Sounds Society). 2001. *Effects of Noise on Wildlife.* <http://www.naturesounds.org/conservENW.html>. Accessed September 25, 2001.

Natureserve. 2000. *An Online Encyclopedia of Life: Comprehensive Report: Red-Cockaded Woodpecker.* <http://www.natureserve.org/>. Accessed October 9, 2000.

Natureserve. 2001a. *An Online Encyclopedia of Life: Comprehensive Report: Black Pine Snake.* <http://www.natureserve.org/>. Accessed November 13, 2001.

Natureserve. 2001b. *An Online Encyclopedia of Life: Comprehensive Report: Eastern Indigo Snake.* <http://www.natureserve.org/>. Accessed September 17, 2001.

Natureserve. 2001c. *An Online Encyclopedia of Life: Comprehensive Report: Gopher Tortoise* <http://www.natureserve.org/>. Accessed October 4, 2000.

Natureserve. 2001d. *An Online Encyclopedia of Life: Comprehensive Report: Louisiana Quillwort.* <http://www.natureserve.org/>. Accessed September 17, 2001.

Natureserve. 2001e. *An Online Encyclopedia of Life: Comprehensive Report: Mississippi Sandhill Crane.* <http://www.natureserve.org/>. Accessed September 17, 2001.

Natureserve. 2001f. *An Online Encyclopedia of Life: Comprehensive Report: Pearl Darter* <http://www.natureserve.org/>. Accessed November 13, 2001.

Natureserve Explorer. 2002. *An Online Encyclopedia of Life.* <http://www.natureserve.org/explorer>. Accessed January 2, 2002.

Neel-Schaffer, Inc. 1991. *Draft Mississippi Gulf Coast Urbanized Area 2025 Interim Transportation Plan.*

Nelson, Karen. 2002, February 2. Gautier annex costly but worth it. *Biloxi Sun Herald*.

Nicholls, J.L. 1989. Distribution and Other Ecological Aspects of Piping Plovers *(Charadrius melodus)* Wintering Along the Atlantic and Gulf Coasts. Master's thesis. Auburn University, Auburn, AL.

Nicholls, J.L., and G.A. Baldassarre. 1990. Habitat selection and interspecific associations of piping plovers along the Atlantic and Gulf Coasts of the United States. *Wilson Bulletin* 102:581–590.

NPC (Noise Pollution Clearinghouse). 2001. *About Noise, Noise Pollution.* <http://www.nonoise.org>. Accessed August 22, 2001.

OSHA (Occupational Safety and Health Administration). 2001. *SIC Division I: Services*. <http://www.osha.gov/cgi-bin/sic/sicser3>. Accessed May 15, 2001.

Ocean Springs School District. 2001, December 5. Personal communication.

Oivanki, Stephen, and Joseph Suhayda. 1994. *Past and Future Erosion Trends at Belle Fontaine, Jackson County, Mississippi.* <http://geology.deq.state.ms.us/coastal/Oivanki,etal,1994b.htm>. Accessed January 31, 2002.

Oivanki, Stephen M. 1998. Geology and Geomorphology of the Mississippi Gulf Coast. In *Marine Resources and History of the Mississippi Gulf Coast,* Volume II, pp.253–270. Mississippi Department of Marine Resources, Biloxi, MS.

Otvos, Ervin G. 1998. Mississippi's Coast: Geology in a Nutshell. In *Marine Resources and History of the Mississippi Gulf Coast,* Volume II, pp.231–252. Mississippi Department of Marine Resources, Biloxi, MS.

Parsons, Brinkerhoff, Quade, Douglas, Inc. 2000. *Comprehensive Assessment of the Ports of Mississippi.*

Pascagoula District School District. 2001, December 5. Personal communication.

Pass Christian School District. 2001, December 5. Personal communication.

PBS&J. 2001. *East Harrison County Connector Draft Environmental Impact Statement.*

Pearce, Kenny, and Greg A. Mikell. 2000. *Phase IA Cultural Resources Investigation for a Proposed Fiber-Optic Line through Hancock, Harrison, and Jackson Counties, Mississippi.* Prepared for Gremminger and Associates, Inc., Victoria, TX, by Panamerican Consultants, Inc., Tuscaloosa, AL

Perry, H.M. 1975. The blue crab fishery in Mississippi. *Gulf Research Reports* 5(1):39–57.

Pessin, L.J., and T.D. Burleigh. 1941. Notes on the forest ecology of Horn Island, Mississippi. *Ecology* 22(i):70–78.

Peterson, Patrick. 1999, November 7. A big stink. *Biloxi Sun Herald.*

Peterson, Patrick. 2000, June 16. Landfill expansion approved. *Biloxi Sun Herald.*

Plog, Barbara, A., ed. 1993. *Fundamentals of Industrial Hygiene*. 3d ed. National Safety Council, Itasca, IL.

Posadas, B.C. 2000. *Economic Profile of Seafood Harvesting in Coastal Mississippi*. Mississippi State University Coastal Research and Extension Center, Biloxi, MS.

Powell, M.H. 1998. Biloxi, Queen City of the Gulf Coast. In *Marine Resources and History of the Mississippi Gulf Coast,* Volume 1, *History, Art, and Culture of the Mississippi Gulf Coast,* pp 130–160. Mississippi Department of Marine Resources, Biloxi, MS.

Puckett, C., and R. Franz. 2001. *Gopher Tortoise: a Species in Decline.* <http://edis.ifas.ufl.edu/Body_UW048>. Accessed August 27, 2001.

Ramseur, George, Jr., Director, Old Fort Bayou Mitigation Bank, The Nature Conservancy, Ocean Springs, MS. 2002, May 8. Personal communication.

Regional Economic Models, Inc. 2001. *Three-area EDFS-53 Model Consisting of Hancock County, Harrison County, and Jackson County, Mississippi*. Regional Economic Models, Inc., Amherst, MA.

Rummel, R.G. 2002. *Black bear activities in Mississippi. Black Bear Conservation Committee Newsletter* 10(1). <http://bbcc.org/Newsletters/Volume10/Mississippi_Update.html>.

Scallan, Melissa M. 2001a, October 17. Gulfport to buy 3 utilities; upgrade of Orange Grove water, sewer also planned. *Biloxi Sun Herald*.

Scallan, Melissa M. 2001b, October 30. Gulfport expected to get sewer loan. *Biloxi Sun Herald.*

Scallan, Melissa M. 2001c, November 7. Gulfport may require more drainage from subdivisions. *Biloxi Sun Herald.*

Scallan, Melissa M. 2001d, November 18. City's catch-22: Gulfport needs growth, but it strains aging utilities. *Biloxi Sun Herald.*

Schneider, C.B., and S.W. Sprecher. 2000. *Wetlands Management Handbook*. ERDC/EL SR-00-16. Wetlands Regulatory Assistance Program, Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Schubert, D.J., and J. Smith. 2000. *The Impacts of Off-Road Vehicle Noise on Wildlife. The Road-RIPorter* 5(1).<http://www.wildlandscpr.org/notes/biblionotes/ORV_noise_wildlife.html>. Accessed September 25, 2001.

Scruggs, Donavon, Planning Director, City of Ocean Springs. 2002, February 13. Personal communication.

Sims, Douglas C. 1999. *A Reconnaissance Level Survey of 7 Submerged Vessel Locations in the Biloxi and Tchoutacabouffa Rivers, Harrison County, Mississippi.* MDAH Report #99-022. Mississippi Department of Archives and History, Jackson, MS.

Singing River Electric Power Association. 2002. *Singing River Electric – About Us.* <http://www.singingriver.com/informat.htm>. Accessed February 2002.

Stackpoole, Jim, Traditions Planned Community. 2002, February 14. Personal communication.

State Data Center of Mississippi. 2001a. *[Census] Block polygons with Selected Public Law Data 2000 Redistricting Tiger/Line Files [GIS Coverages for Hancock, Harrison, Jackson, Pearl River, and Stone Counties, Mississippi]*. <http://www.olemiss.edu/depts/sdc/>.

State Data Center of Mississippi. 2001b. *[Table of] Percent Population Change for Mississippi Counties 1970, 1980, 1990, 2000*. <http://www.olemiss.edu/depts/sdc/countygro.pdf>.

Stedman, S., and D.W. Brown. 2000. Catching the link between wetlands and fisheries management. Environmental Law Institute. *National Wetlands Newsletter* 22(6).

Stewart, Lindsey, Mississippi Department of Environmental Quality. 2002. Personal communication.

Strom, S., and K. Nathan. 1998. *Site Engineering for Landscape Architects.* John Wiley & Sons, Inc., New York, NY.

Sullivan, Charles L. 1985. *The Mississippi Gulf Coast: Portrait of a People.* Windsor Publications, Inc., Northridge, CA.

Sumner, D.M., B.E. Wasson, and Stephen J. Kalkhoff. 1989. *Geohydrology and Simulated Effects of Withdrawals on the Miocene Aquifer System in the Mississippi Gulf Coastal Area*. U.S. Geological Survey WRI 87-4172. U.S. Geological Survey.

Supervisor seeks water, sewer funds; restaurant among projects planned for corridor. 2000, October 15. *Biloxi Sun-Herald.*

Taylor, David, Gulf Regional Planning Commission. 2002, January 9 and 17. Personal communications.

Taxation with frustration it means new services, new taxes. 1994, February 20. *Biloxi Sun-Herald.*

TPWD (Texas Parks and Wildlife Department). 2001. *Threatened and Endangered Species.* <http://www.tpwd.sate.tx.us/nature/endang/animals/>.

Thayer, G.W., D.W. Wolfe, and R.B. Williams. 1975. The impact of man on seagrass systems. *American Scientist* 63:288–296.

Thurman, Harold. 1991. *Introductory Oceanography.* 6th ed. Macmillan Publishing Company, New York, NY.

TRB (Transportation Research Board). 1998. *Highway Capacity Manual.* Report 309. Transportation Research Board.

TranSystems Corporation. 2001. *Mississippi Gulf Coast Regional Goods Movement Study.*

Turner, R.E. 1977. Intertidal vegetation and commercial yields of penaeid shrimp. *Transactions of the American Fisheries Society* 106:411–416.

Turner, R.E. 2000. Wetland management IS fisheries management for Gulf of Mexico shrimp. Environmental Law Institute. *National Wetlands Newsletter* 22(6).

Twedt, Steve, Mississippi Department of Transportation, District 6. 2002, January 31. Personal communication.

USACE (U.S. Army Corps of Engineers). 1987. *Corps of Engineers Wetlands Delineation Manual*. Technical Report Y-87-1. U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS.

USACE (U.S. Army Corps of Engineers). 2001. *Individual Permits and Nationwide Permit Data.* U.S. Army Corps of Engineers.

USACE, Mobile District (U.S. Army Corps of Engineers, Mobile District). 2000. *Draft Environmental Impact Statement for Proposed Destination Broadwater Project, Biloxi, Mississippi*. Prepared by U.S. Army Corps of Engineers, Mobile District, with technical assistance from EDAW, Inc., Atlanta, GA.

USDA, Forest Service (U.S. Department of Agriculture, Forest Service). 1995. *Description of Ecoregions of the United States.* Misc. Publication 1391. Compiled by Robert G. Bailey, U.S. Department of Agriculture, Forest Service, Washington, DC.

USDA-NRCS (U.S. Department of Agriculture, Natural Resource Conservation Service). 2001. *State Soil Geographic (SSURGO) GIS Data for Hancock, Harrison, Jackson, Pearl River, and Stone Counties, Mississippi*. U.S. Department of Agriculture, Natural Resource Conservation Service, Washington, DC.

USDA (U.S. Department of Agriculture). 1975. *Soil Survey of Harrison County, Mississippi.* U.S. Department of Agriculture, Soil Conservation Service and Forest Service, Washington, DC.

USDA (U.S. Department of Agriculture). 1981. *Soil Survey of Hancock County, Mississippi.* U.S. Department of Agriculture, Soil Conservation Service and Forest Service, Washington, DC.

USDA (U.S. Department of Agriculture). 1983. *Soil Survey of Pearl River County, Mississippi.* U.S. Department of Agriculture, Soil Conservation Service and Forest Service, Washington, DC.

US DOC, BEA (U.S. Department of Commerce, Bureau of Economic Analysis). 2001. *Total Full-time and Part-time Employment by Industry – Hancock, Harrison, and Jackson Counties, Mississippi*. <http://www.bea.doc.gov/bea/regional/reis>. Accessed November 29, 2001.

US DOC, Census. 1995. *Population of Counties by Decennial Census: 1900 to 1990*. U.S. Department of Commerce, Bureau of the Census. <http://www.census.gov/population/cencounts/ms190090.txt>. Accessed November 28, 2001.

US DOC, Census (U.S. Department of Commerce, Bureau of the Census). 2001a. *State and County QuickFacts.* <htttp://www.census.gov>. Accessed November 28, 2001.

US DOC, Census (U.S. Department of Commerce, Bureau of the Census). 2001b. FedStats. <http://www.fedstats.gov>. Accessed December 7, 2001.

US DOC, Census (U.S. Department of Commerce, Bureau of the Census). 2001c. *General Housing Characteristics: 2000*. <http://factfinder.census.gov/servlet/GCTTable?ds_name=DEC_2000_SF1_U&geo_id=04000US28&_box_head_nbr=GCT-H5&format=ST-2>. Accessed December 3, 2001.

US DOC, Census (U.S. Department of Commerce, Bureau of the Census). 2001d. *Geographic Changes for Census 2000 and Glossary*. <http://www.census.gov/geo/www/tiger/glossary.html#glossary>. Accessed March 11, 2002.

USDOE, NCES (U.S. Department of Education, National Center for Education Statistics). 2001. *Common Core of Data: Information on Public Schools and School Districts in the United States.* <http://nces.ed.gov/ccd>. Accessed December 4, 2001.

USDOJ, FBI (U.S. Dept. of Justice, Federal Bureau of Investigation). 2002. *Uniform Crime Reporting Program Data [United States]: County-Level Detailed Arrest And Offense Data, 1985-2000* [Computer files]. 2nd ICPSR ed. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [producer and distributor], 2002. <http://www.icpsr.umich.edu/NACJD/archive.html>. Accessed October 20, 2002.

USEPA (U.S. Environmental Protection Agency), Office of Water. No date. *Mississippi Drinking Water*. <http://www.epa.gov/safewater/dwinfo/ms.htm>.

USEPA (U.S. Environmental Protection Agency). 1974. *Information of Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety*. EPA/ONAC 550/9-74-004. U.S. Environmental Protection Agency, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 1998a. *Climate Change and Mississippi.* EPA 236-F-98-007m. U.S. Environmental Protection Agency, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 1998b. *Better Assessment Science Integrating Point and Nonpoint Sources (BASINS 2.0).* U.S. Environmental Protection Agency, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 1999. *The Ecological Condition of Estuaries in the Gulf of Mexico.* EPA 620-R-98-004. U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 2000. *Storm Water Phase II Final Rule, Small Construction Program Overview.* U.S. Environmental Protection Agency, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 2001a. *303(d) Listed Waters – Mississippi Coastal – 03170009.*<http://www.epa.gov/iwi/303d/0317009_303d.html>. Accessed September 26, 2001.

USEPA (U.S. Environmental Protection Agency). 2001b. *Status and trends*. <http://www.epa.gov/OWOW/wetlands/vital/status.html>. Accessed November 13, 2001.

USEPA (U.S. Environmental Protection Agency). 2001c. *Better Assessment Science Integrating Point and Nonpoint Sources (BASINS) GIS Data for the Coastal Mississippi Watershed*. U.S. Environmental Protection Agency, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 2001d. Permit Compliance System [USEPA database]. U.S. Environmental Protection Agency, Washington, DC. Accessed December 7, 2001.

USEPA (U.S. Environmental Protection Agency). 2002. *Beach Watch - Water Quality Monitoring Data for Specific Beaches*. <http://www.epa.gov/waterscience/beaches/data.html>. Accessed April 23, 2002.

USEPA OAR (U.S. Environmental Protection Agency, Office of Air and Radiation). 2001a. *Air Quality.*<http://www.epa.gov/oar/oaqps/cleanair.html>.

USEPA OAR (U.S. Environmental Protection Agency, Office of Air and Radiation). 2001b. *AIRdata Monitor Values Report*. <http://www.epa.gov/agweb/>.

USEPA OAR (U.S. Environmental Protection Agency, Office of Air and Radiation) 2002a. *Green Book.* <http://www.epa.gov/oar/oaqps/greenbk/>.

USEPA OAR (U.S. Environmental Protection Agency, Office of Air and Radiation). 2002b. *Ozone: Good up High, Bad Nearby.* <http://www.epa.gov/oar/oaqps/gooduphigh/#what>.

USEPA, OAR (U.S. Environmental Protection Agency, Office of Air and Radiation). 2002c. *AIRGraphics* <http://www.epa.gov/agweb/>.

USEPA and MDEQ (U.S. Environmental Protection Agency and Mississippi Department of Environmental Quality). 2002. *Envirofacts Permit Compliance System (PCS) Database.* <http://www.epa.gov/envirofw/html/pcs/pcsoverview.html>. Accessed February 2002.

USFWS (U.S. Fish and Wildlife Service). 1987. *Habitat Management Guidelines for the Bald Eagle in the Southeast Region.* U.S. Fish and Wildlife Service, Southeast Regional Office.

USFWS (U.S. Fish and Wildlife Service). 1989. *Alabama Red-bellied turtle Recovery Plan.* U.S. Fish and Wildlife Service, Jackson, MS.

USFWS (U.S. Fish and Wildlife Service). 1990a. *Gopher Tortoise Recovery Plan.* U.S. Fish and Wildlife Service, Jackson, MS.

USFWS (U.S. Fish and Wildlife Service). 1990b. *Recovery Plan for the Interior Population of the Least Tern (Sterna antillarum).* U.S. Fish and Wildlife Service, Twin Cities, MN.

USFWS (U.S. Fish and Wildlife Service). 1993. *Yellow-blotched Map Turtle (Graptemys flavimaculata) Recovery Plan.* U.S. Fish and Wildlife Service, Jackson, MS.

USFWS (U.S. Fish and Wildlife Service). 1994. *Draft Revised Recovery Plan for Piping Plovers Breeding in the Great Lakes and Northern Great Plains.* U.S. Fish and Wildlife Service, Twin Cities, MN.

USFWS (U.S. Fish and Wildlife Service). 1995. *Louisiana Black Bear Recovery Plan.* U.S. Fish and Wildlife Service, Jackson, MS.

USFWS (U.S. Fish and Wildlife Service). 1996a. *Recovery Plan for Louisiana quillwort (Isoetes louisianensis Thieret).* U.S. Fish and Wildlife Service, Atlanta, GA.

USFWS (U.S. Fish and Wildlife Service). 1996b. *Draft Environmental Assessment: Restoration of Avian Diversity on Monomoy National Wildlife Refuge.* U.S. Fish and Wildlife Service, Chatham, MA.

USFWS (U.S. Fish and Wildlife Service). 1998a, October 7. Letter to Mr. Henry Borovich, Post, Buckley, Schuh & Jernigan, Inc., from Larry E. Goldman, U.S. Fish and Wildlife Service, Daphne, AL.

USFWS (U.S. Fish and Wildlife Service). 1998b. *Sea Turtles.* <http://www.fws.gov>.

USFWS (U.S. Fish and Wildlife Service). 2000. Endangered and Threatened Wildlife and Plants; Proposed Rule to List the Mississippi Gopher Frog Distinct Population Segment of Dusky Gopher Frog as Endangered. U.S. Fish and Wildlife Service. *Federal Register*, 50 CFR Part 17., Vol. 65, No. 100.

USFWS (U.S. Fish and Wildlife Service). 2001a. *ESA Basics: Over 25 years of protecting endangered species.* <http://endangered.fws.gov/pubs/esa%20basics.pdf>. Accessed April 13, 2001.

USFWS (U.S. Fish and Wildlife Service). 2001b. *Candidate and Listing Priority Assignment Form: Pituophis melanoleucus lodingi.* <http://es.southeast.fws.gov/pdf/BPSform.PDF>. Accessed November 13, 2001.

USFWS (U.S. Fish and Wildlife Service). 2001c. *Species Account: Brown Pelican, from Endangered and Threatened Species of the Southeastern United States (The Red Book).* <http://endangered.fws.gov/i/b/sab2s.html>. Accessed November 13, 2001.

USFWS (U.S. Fish and Wildlife Service). 2001d. *Mississippi Sandhill Crane (Grus canadensis pulla) Fact Sheet.* <http://endangered.fws.gov/i/b/sab4n.html>. Accessed September 17, 2001.

USFWS (U.S. Fish and Wildlife Service). 2001e. *Candidate and Listing Priority Assignment Form: Percina aurora.* <http://es.southeast.fws.gov/pdf/PD.PDF>. Accessed November 14, 2001.

USFWS (U.S. Fish and Wildlife Service). 2001f. *National Wetlands Inventory (NWI) GIS Data for Selected Quadrangles in Coastal Mississippi*. U.S. Fish and Wildlife Service, Arlington, VA.

USFWS (U.S. Fish and Wildlife Service). 2001g. *Threatened and Endangered Species in the Southeast Region.* <http://endangered.fws.gov>.

USFWS (U.S. Fish and Wildlife Service). 2001h. Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for Wintering Piping Plovers. U.S. Fish and Wildlife Service. *Federal Register*, July 10, 2001, (Volume 66, Number 132), 50 CFR Part 17, RIN 1018-AG13, pp. 36037–36086.

USFWS (U.S. Fish and Wildlife Service). 2001i. *Critical Habitat for Piping Plover (Charadrius melodus)* <http://plover.fws.gov>. Accessed February 17, 2001.

USFWS (U.S. Fish and Wildlife Service). 2003a. Personal communication.

USFWS (U.S. Fish and Wildlife Service). 2003b. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Gulf Sturgeon. *Federal Register*, March 19, 2003, 50 CFR Part 17, Vol. 68. No. 53.

USGS (U.S. Geological Survey). 1970. *1:250,000 Scale Quadrangle Map of Mobile, Alabama-Mississippi.* U.S. Geological Survey, Reston, VA.

USGS (U.S. Geological Survey). 1972. *Geographic Information Retrieval Analysis System (GIRAS) Land Use and Land Cover Data for the Mobile, Alabama and Hattiesburg, Mississippi 1-Degree Quadrangles*. U.S. Geological Survey, Reston, VA.

USGS (U.S. Geological Survey). 1978. *Quality of Water and Dye Dispersion Characteristics in Jourdan River and St. Louis Bay, Hancock and Harrison Counties, Mississippi*. Open File Report 78-584. Prepared in cooperation with Mississippi Air and Water Pollution Control Commission. U.S. Geological Survey, Jackson, MS.

USGS and USEPA (U.S. Geological Survey and U.S. Environmental Protection Agency). 1992. *Multi-Resolution Land Cover (MRLC) Data for Mississippi, a Component of the National Land Cover Dataset (NLCD)*. U.S. Geological Survey and U.S. Environmental Protection Agency, Reston, VA.

USGS (U.S. Geological Survey). 1998a. *Ground Water Atlas of the United States, Arkansas, Louisiana, Mississippi.* <http://capp.water.usgs.gov/gwa/ch_f/F-text1.html>.

USGS (U.S. Geological Survey). 1998b. *Estimated Use of Water in the United States in 1995.* USGS Circular 1200. U.S. Geological Survey, Reston, VA.

USGS (U.S. Geological Survey). 2000. *Water Resources Data, Mississippi, Water Year 2000*. Water-Data Report MS-00-1. U.S. Geological Survey, Reston, VA.

USGS (U.S. Geological Survey). 2001a. *The Coastal Streams Basin*. <http://ms.water.usgs.gov/ms_proj/eric/coast.html>. Accessed September 26, 2001.

USGS (U.S. Geological Survey). 2001b. *GIS Point Coverage of [1970 and] 1980 Census Tract Populations. From USGS Water Resources National Spatial Data Infrastructure (NSDI) Node.* <http://water.usgs.gov/lookup/getgislist>.

USM COMS (University of Southern Mississippi, College of Marine Sciences). 2002a. *Beach Monitoring Program*. <http://www.coms.usm.edu/GCRL/outreach/beachmon.htm>. Accessed April 23, 2002.

USM COMS (University of Southern Mississippi, College of Marine Sciences). 2002b. *Mississippi Beaches Closure History*. <http://www.coms.usm.edu/msbeach/closehis.htm>. Accessed February 14, 2002.

Veal, Mary S., and David D. Burrage. 1996. *Coastal Zone Impacts of the Dockside Casino Industry: The Mississippi Experience.* Proceedings of a workshop held in Biloxi, MS. May 7–8, 1996.

Walters, Harold, Hancock County Port Authority. 2002, January 16. Personal communication.

Wells, H.W. 1961. The fauna of oyster beds, with special reference to salinity factor. *Ecological Monographs* 31(3):239–266.

Wicker, K.M., D.W. Roberts, G. Junkin, and R.E. Emmer. 1992. *Mississippi Coastal Zone Nearshore Water Quality Assessment*. Prepared for Mississippi Department of Wildlife, Fisheries, and Parks, Bureau of Marine Resources; Mississippi Secretary of State, Public Trust Tidelands Fund; and U.S. Department of Commerce, Office of Ocean and Atmospheric Administration, by Coastal Environments, Inc., and Rod E. Emmer and Associates.

Wieland, R.G. 1993. Marine and Estuarine Habitat Types and Associated Ecological Communities of Mississippi Coast. Mississippi Department of Wildlife, Fisheries and Parks, Mississippi Natural Heritage Program, Mississippi Museum of Natural Science. 25 pp.

Wiley, D., Mississippi Department of Environmental Quality. 2002, January 10. Personal communication.

Wilson, A. 1998. Light pollution: efforts to bring back the night sky. *Environmental Building News* 7(8).

WLOX-TV. No date. *Future Of Jackson County Industrial Pipeline Up In The Air.* <http://www.wlox.com/Global/story.asp?S=193100>.

WHO (World Health Organization). 2001. *Occupational and Community Noise*. Fact Sheet No. 258. <http://www.who.int/inf-fs/en/fact258.html>. Accessed September 26, 2001.

Yarrow, Kenneth, Gulf Regional Planning Commission. 2002, January 9 and February 14. Personal communication.

Zieman, J.C., and R.T. Zieman. 1989. The ecology of the seagrass meadows of the west coast of Florida: a community profile. *U.S. Fish and Wildlife Survey.* 85(7.25).

Zimmerman, R.J., T.J. Minello, and G. Zamora. 1984. Selection of vegetated habitat by brown shrimp, *Penaeus aztecus*, in a Galveston Bay saltmarsh. 82:325–336.

Zonik, C., and M. Ryan. 1995. Ecology and Conservation of Wintering Piping Plovers and Snowy Plovers. Unpublished interim report. University of Missouri, Columbia, MO.

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SECTION 8.0: PERSONS CONSULTED

Allan, Jim. City Manager, City of Gautier. February 13, 2002.

Aultman, Tim. Mississippi Department of Environmental Quality. February 5, 2002.

Barnwell, Claiborne. Mississippi Department of Transportation. 2002.

Belokon, Wally. Mississippi Automated Resource Information System (MARIS) Technical Center, Jackson, Mississippi. December 2001.

Bozack, Jim. City of Gulfport Water and Sewer. February 14, 2002.

Campbell, Kacy. US Environmental Protection Agency, Region 4. December 2003.

Campton, John. Engineer, Kiln Water & Fire Protection District. February 13, 2002.

Collins, Patrick. Planning Director, City of Gulfport. February 14, 2002.

Crawford, Melinda. Director of Finance, Gulfport-Biloxi International Airport. January 17, 2002.

Crim, Kimberly. Executive Director, Biloxi Chamber of Commerce. February 5, 2002.

Dedeaux. Dedeaux Utility Company, Inc. February 13, 2002.

DiGeorge, Frank P., III. Chief Harbor Engineer, Mississippi Port Authority at Gulfport. January 9, 2002.

Doe, Chris. Op-Tech and Harrison County Wastewater and Solid Waste Management District (HCWSWMD). February 15, 2002.

Elliott, Kevin. Chief Operator, Mississippi Gulf Coast Regional Wastewater Authority (MGCRWA). February 19, 2002.

Eubanks, Jerry. US Dept. of Interior, National Parks. December 2003.

Fagan, D. Mississippi Department of Transportation, Planning Division. January 2002.

Foster, Marc. GIS Specialist, Mississippi Department of Marine Resources (DMR) Comprehensive Resource Management Plan (CRMP), Biloxi, Mississippi. September 2001.

Fox, Catherine. US Environmental Protection Agency, Region 4. December 2003.

Frallic, Bruce. Executive Director, Gulfport-Biloxi International Airport. January 17, 2002 and February 4, 2002.

Frugé, Doug. US Fish and Wildlife Service. December 2003.

Furr, Jay B. City of Biloxi, Engineering Department. February 13 and February 25, 2002.

Glover, Dr. Bill. Plant Manager, South Regional Wastewater Management District (SRWMD). February 19, 2002.

Gregg, Daniel. US Fish and Wildlife Service. December 2003.

Goldman, Larry. US Fish and Wildlife Service. December 2003.

Haas, Hugo (Dutch). Kiln Water and Fire Protection District. February 12, 2002.

Hamilton, Sam. US Fish and Wildlife Service. December 2003.

Hancock County Building Inspection and Permits. 2001. December 20, 2001.

Hemphill, Jerry. Hancock County Port Authority. January 16, 2002.

Hode, Ralph. City of Gautier. February 13, 2002.

Holden, S. L. Mississippi Department of Environmental Quality. January 9, 2002.

Hollin, Ken. GIS Specialist, Coastal Environments, Inc, Bay Saint Louis, Mississippi. September 2001.

Holloway, Elton. Mississippi Department of Transportation. January 2002.

Hopper, Reid. Executive Director, Coast Transit Authority. January 17, 2002.

Hudson, P. Mississippi Department of Transportation, Port of Gulfport. January 28, 2002.

Johnson, Doug. US Environmental Protection Agency, Region 4. December 2003.

Lee, Richard. Division Engineer, Mississippi Department of Transportation, District 6. January 31, 2002.

Manuel, Larry. Port of Biloxi. January 17, 2002.

McGahey, Sam. Senior Archaeologist, Mississippi Department of Archives and History, Jackson, Mississippi, July 27, 2001 and September 2001.

McGraw, Doug. Plant Operator, Diamondhead Water and Sewer District. February 19, 2002.

Miller, Gerald. US Environmental Protection Agency, Region 4, December 2003.

Minerals Management Service, OCS Survey Group, Denver, CO. December 2003.

Morgan, Robert. Archaeologist, Mississippi Department of Archives and History, Jackson, Mississippi, September 2001.

Overly, Pat. Gulf Regional Planning Commission (GRPC). February 21, 2002.

Overly, Paul. GRPC. February 19, 2002.

Parrish, G. Wayne. Ports & Waterway, Director MDOT. December 17, 2001.

Powell, Bill. City of Gulfport Engineering Department. February 19, 2002.

Ramseur, George, Jr. Director, Old Fort Bayou Mitigation Bank, The Nature Conservancy, Ocean Springs, Mississippi. May 8, 2002.

Riemann, Kris. City of Gulfport Public Works. February 19, 2002.

Scruggs, Donavon. Planning Director, City of Ocean Springs. February 13, 2002.

Shumate, Sheila (Tina). Mississippi Department of Marine Resources. January 9, 2002.

Stackpoole, Jim. Traditions Planned Community. February 14, 2002.

Stewart, Lindsey. Mississippi Department of Environmental Quality. 2002.

Taylor, David. Gulf Regional Planning Commission. January 9, 2002 and January 17, 2002.

Terry, Rickey. Chief, Commercial Control Branch, Surface Water Division, MDEQ. February 5, 2002.

Twedt, Steve. Mississippi Department of Transportation, District 6. January 31, 2002.

Vick, Cecil. Federal Highway Administration. March 12, 2002.

Walters, Harold. Hancock County Port Authority. January 16, 2002.

Wiley, D. Mississippi Department of Environmental Quality. January 10, 2002.

Yarrow, Kenneth. Gulf Regional Planning Commission. January 9 and February 14, 2002.

Zimmerman, Buddy. Bay St. Louis Utilities. February 13, 2002.

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SECTION 9.0: GLOSSARY

Aerobic. Having oxygen as part of the environment.

Aesthetics. The study, science, or philosophy of beauty and judgments concerning beauty. In scenery management, it describes landscapes that give visual and sensory pleasure.

Alluvium. A deposit of sediment left by a stream on the stream's channel or floodplain.

Altitude. Vertical elevation above sea level.

Anaerobic. Not having oxygen as part of the environment.

Ancillary. Something being secondary to something else.

Aquaculture. The science and business of raising marine or freshwater food fish under controlled conditions for commercial purposes.

Aquatic. Having to do with surface water.

Aquatic community. An association of interacting populations of aquatic organisms in a given waterbody or habitat.

Aquifer or aquifer system. Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.

Aquifer recharge. Infiltration of precipitation and/or surface water downward into the deeper parts of an aquifer.

Archaic Period. A prehistoric time period dated to between approximately 8000 B.C. and 1000 B.C.

Atmospheric attenuation. The depletion of electromagnetic energy in the atmosphere due to absorption or diffusion.

Attainment/nonattainment. Describes in a regional context if the area meets or exceeds the National Ambient Air Quality Standards.

Balance. A visual stability produced, and an equilibrium established, in a landscape by natural forces or human intervention.

Barrier island. A dynamic, long, narrow, wave-built island lying parallel to the shore.

Bathymetry. A depth profile relative to sea level.

Beach replenishment. The process of rebuilding a beach by adding sand to it.

Bioaccumulation. The process by which a compound is taken up by an aquatic organism, both from water and through food.

Bioassay. A test used to evaluate the relative potency of a chemical or a mixture of chemicals by comparing its effect on a living organism with a standard preparation on the same organism.

Bioavailability. A measure of the physicochemical access that a toxicant has to the biological processes of an organism.

Bioconcentration. A process by which a compound is absorbed through epithelial tissues or consumption and remains within the organism. As more of a compound enters the organism, the amount increases.

Biological assessment. An evaluation of the biological condition of a waterbody using biological surveys and other direct measurements of resident biota.

Biological Oxygen Demand (BOD) 5. A measure of the amount of dissolved oxygen consumed by living organisms (mainly bacteria) while processing organic wastes for a 5 day period generally at 20 degrees C.

Biomagnification. The process by which the concentration of a compound increases in species occupying successive trophic levels.

Bottomland hardwood. A type of forested wetland consisting of deciduous hardwood trees tolerant of periodic flooding. Usually found on floodplains adjacent to rivers and streams. Bottomland hardwoods include the wetlands referred to in the text as "deciduous/mixed bottomland forest/swamp."

Brackish. Water between fresh and saline.

Breakwater. A man-made structure of rocks and concrete for protecting a shore area, harbor, anchorage, or basin from waves.

Census tract. A small, relatively permanent statistical subdivision of a county or statistically equivalent entity, delineated for data presentation purposes by a local group of census data users or the geographic staff of a regional census center in accordance with U.S. Census Bureau guidelines. Designed to be relatively homogeneous units with respect to population characteristics, economic status, and living conditions at the time they are established, census tracts generally contain between 1,000 and 8,000 people, with an optimum size of 4,000 people. Census tract boundaries are delineated with the intention of being stable over many decades, so they generally follow relatively permanent visible features. However, they may follow governmental unit boundaries and other invisible features in some instances; the boundary of a state or county is always a census tract boundary. (Source: US DOC, Census, 2001d)

Characteristic. Qualities that constitute a character or that characterize a landscape; a distinguishing trait, feature, or quality.

Coastal subsidence. The sinking or settling of land to a lower level in response to various natural and man-made causes.

Coherence. The quality or state of being united in principles and relationships or to be logically and aesthetically connected.

Composition. Assembly and organization of components in a landscape.

Comprehensive plan. The materials, written and/or graphic, including but not limited to maps, charts, studies, resolutions, reports, and other descriptive material, that identify the goals, objectives, principles, guidelines, policies, standards, devices, and instruments for the immediate and long-range protection, enhancement, growth, and development of the locality.

Confined aquifer. An aquifer that is overlain by a confining bed which has a significantly lower hydraulic conductivity than the aquifer.

Consumptive use. Use of water that is not cycled back into the aquifer system.

Contaminant. An undesirable substance not normally present or a high concentration of a naturally occurring substance.

Contrast. Diversity or distinction of adjacent parts. Effect of striking differences in form, line, color, or texture of a landscape.

Criteria Pollutants. The six pollutants considered harmful to humans and the environment. These are sulfur dioxide, carbon monoxide, ozone, nitrogen oxides, lead, and particulate matter.

Cultural landscape. Human-altered landscapes.

Cultural resources. Buildings or other structures; historic or prehistoric sites or districts; objects; sunken vessels; traditional cultural properties.

Deepwater habitats. Permanently flooded lands lying below the deepwater boundary of wetlands.

Delta. The alluvial deposit at the mouth of a river.

Density. The level of concentration of buildings, including their total volume, within a given area. Often expressed as a ratio, for example, dwelling units per acre or floor/area ratio.

Developer. An individual or a group of individuals who prepare raw land for improvement by installing roads, utilities, and the like. Also, a builder who constructs improvements on real estate.

Development. The process of preparing raw land so that it becomes suitable for the erection of buildings; involves clearing and grading the land and installing roads and utility services.

Deviation. Departure from the existing landscape character or from landscape character goals.

Discharge. A quantity of water per time that flows through a stream or river channel.

Distinctive. Extraordinary and special landscapes that are attractive and stand out from common landscapes.

Disturbance. A discrete event, either natural or human-induced, that causes a change in the existing condition of an ecological system.

Dynamic equilibrium. A state of balance between opposing actions (withdrawal and recharge of groundwater) that is dynamic (has changes in both directions that are equal).

Emergent wetland. A wetland type featuring herbaceous plants that are rooted in saturated soils but have vegetation that grows mostly above the surface of the water.

Enhancement. A short-term management prescription with the express purpose of increasing positive scenic attributes where few exist.

Eocene. An epoch of the Tertiary between the Paleocene and the Oligocene or the corresponding system of rocks.

Episodic. Related to one of a series of related events.

Erosion. The detachment of soil particles by the influence of water or wind.

Estuaries. That portion of a river, stream, or other body of water having an unimpaired connection with the open sea where freshwater meets salt water.

Evapotranspiration. The combined loss of water from a given area by evaporation from the soil surface and by transpiration from plants.

Existing scenic integrity. Current state of the landscape considering previous human alterations.

Forested wetlands. Wetlands characterized by woody vegetation that is 6 meters tall or taller. All water regimes are included except subtidal.

Formation. Any igneous, sedimentary, or metamorphic rock represented as a unit; any sedimentary bed or consecutive series of beds sufficiently homogeneous or distinctive to be a unit.

Geochemical. The effects of geological and chemical influences on a system such as an aquifer system.

Geosyncline. A basin in which thousands of meters of sediments have accumulated, with accompanying progressive sinking of the basin floor explained only in part by the load of sediments. Common usage includes both the accumulated sediments themselves and the geometrical form of the basin in which they are deposited. All folded mountain ranges were built from geosynclines, but not all geosynclines have become mountain ranges.

Glare. Direct light shining from a fixture (luminaire) that makes it difficult to see or causes discomfort.

Groin. A low, artificial, wall-like structure of durable material extending from the land to seaward for a particular purpose, such as to prevent coast erosion.

Ground water. The water contained in interconnected pores located below the water table in an unconfined aquifer or located in a confined aquifer.

Gulf-Atlantic Coastal Flats Region. A physiographic region of the conterminous United States that extends north to south from southern New Jersey to the southern tip of Texas along the Atlantic and Gulf of Mexico coasts and inland to the edge of the Gulf Atlantic Rolling Plain physiographic region. It is a continuous region along the coast except for an interruption by the Lower Mississippi Alluvial Plain physiographic region, a narrow band where the Mississippi River enters the Gulf of Mexico.

Gulf Formational Period. A prehistoric time period dated to between approximately 2000 B.C. and 100 B.C.

Habitat fragmentation. The disruption of large areas of habitat into smaller, separate units. Fragmentation involves both a total loss of habitat area and the isolation of remaining habitat patches, which prevents interaction between some organisms located in the fragments and renders them effectively separate populations.

Harmony. Combination of parts of a landscape into a pleasing or orderly whole. A proportionate arrangement of form, line, color, and texture.

Hazardous Air Pollutants (HAPs). Includes 188 pollutants that are known or suspected to cause cancer and other health problems in humans which the EPA is required to regulate under the CAA.

Historic Districts. Districts or neighborhoods with unique historical or architectural qualities that, if protected, present a chance to continue important elements of the culture of the community.

Hydric soils. Soils that tend to hold water and that are often wet.

Hydrology. A science dealing with the properties, distribution, and circulation of water, specifically the study of water and its behavior on the surface of land, in the soil and underlying rocks, and in the atmosphere, particularly with respect to evaporation and precipitation.

Impeding layer. In an aquifer system, a geologic unit, usually made of clay that slows down ground water flow in the direction perpendicular to this layer.

Impervious surface. A land use, usually paved, that does not allow infiltration of water into the soil (e.g. a parking lot).

Imperviousness. The sum of roads, parking lots, sidewalks, rooftops, driveways, patios, and other impermeable surfaces in a given area.

Incise. To cut.

Infrastructure. Services and facilities provided by either local government or developers, including roads, highways, water, sewerage, emergency services, parks and recreation, and so forth.

Intactness. Untouched or unaltered, especially by anything that harms or diminishes its character.

Interface. Where two systems or units meet each other. The salt water interface is where fresh water and ground water meet in an aquifer system.

Ischemic heart disease. A disorder caused by lack of oxygen to the tissues of the heart, in which the muscles of the heart are affected and the heart cannot pump properly. The term “ischemia” means that there is not enough blood and oxygen getting to the heart.

Jetty. A long, narrow structure extending into the water to afford a berthing place for vessels, to serve as a promenade, and the like.

Land use regulations. Include zoning, subdivision, special use permit, or site plan regulation or other regulation that prescribes the appropriate use of property or the scale, location, and intensity of development.

Landscape. An area composed of interacting ecosystems that repeat because of geology, landform, soils, climate, biota, and human influences throughout the area.

Landscape analysis. A range of activities involved in understanding and evaluating a landscape.

Landscape character. Particular attributes, qualities, and traits of a landscape that give it an image and make it identifiable or unique.

Landscape visibility. Accessibility of the landscape to viewers, referring to one's ability to see and perceive landscapes.

Lenticular. Lens shaped.

Light pollution. The upward and outward distribution of light, either directly from fixtures or indirectly from reflection off the ground or other surfaces.

Light trespass. The shining of light onto neighboring properties when that light is intrusive or objectionable.

Littoral. In marine ecosystems, the shore area or intertidal zone, where periodic exposure and submersion by tides are normal.

Marine. Having to do with the sea.

Marsh. A wetland with predominantly nonwoody vegetation.

Miocene. An epoch of the Tertiary between the Pliocene and the Oligocene or the corresponding system of rocks.

Mississippian Period. A prehistoric time period dated to between approximately A.D. 1200 and A.D. 1600.

Mitigation banking. Wetland restoration, creation, enhancement, and, in exceptional circumstances, preservation undertaken expressly for the purpose of compensating for unavoidable wetland losses in advance of development actions, when such compensation cannot be achieved at the development site or would not be as environmentally beneficial. It typically involves the consolidation of small, fragmented wetland mitigation projects into one large contiguous site. Units of restored, created, enhanced, or preserved wetlands are expressed as "credits" that may subsequently be withdrawn to offset "debits" incurred at a project development site.

National Ambient Air Quality Standards. National standards for pollutants that are considered harmful to humans and the environment.

Natural landscape character. Landscape character that originated from natural disturbances, such as wildfires, glaciation, or succession of plants from pioneer to climax species, or human disturbances, such as inadvertent plant succession through fire prevention.

Nonpoint source pollution. Pollution emanating from a nondistinct source such as herbicides found in surface water that are the result of agricultural use of these chemicals in the region.

National Register of Historic Places. The nation's official list of buildings, structures, objects, sites, and districts considered worthy of preservation because of their significance in American history, architecture, archaeology, engineering, and culture.

Nutrient. An element or compound essential to life, usually referring to nitrogen and phosphorus.

Oligocene. An epoch of the Tertiary between the Eocene and Miocene or the corresponding system of rocks.

Paleo-Indian Period. A prehistoric time period dated to between approximately 10,000 B.C. and 8000 B.C.

Palustrine wetlands. All nontidal wetlands dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts is below 0.5‰. They also include wetlands lacking such vegetation, but with all the following four characteristics: (1) an area less than 8 hectares (20 acres); (2) the lack of active wave-formed or bedrock shoreline features; (3) a water depth in the deepest part of the basin less than 2 meters at low water; and (4) salinity due to ocean-derived slats less than 0.5‰.

Pathogen. A disease-producing agent usually applied to a living organism, generally bacteria.

Pattern. An arrangement of parts, elements, or details that suggests a design or somewhat orderly distribution.

Per capita. For each person.

Percolate. The downward movement of water through soil or through an aquifer.

Permeability. The ease with which fluids (water or gas) penetrate or move through a layer of soil or sediments in an aquifer.

Permit. An authorization from a governmental entity to proceed with a certain regulated activity. Typically, permits include a grading permit to change the contours of a site to accommodate a site improvement; a zoning compliance permit (usually approved as part of a building permit), which authorizes a change of use or a new tenant, if the same use, if consistent with the uses allowed in that zoning district by the zoning ordinance; a building permit, which authorizes interior or exterior structural work consistent with the community's building code; a trade (plumbing, electrical, mechanical) permit, which authorizes specific types of work consistent with appropriate codes; and a street occupancy/right-of-way permit, which allows work in or occupancy of the right-of-way, including sidewalk construction and repair and blocking of sidewalks or street lanes.

Phase I cultural resources survey. A survey to identify any previously unknown subsurface archaeological sites.

Pine savanna. A pine forest with widely spaced longleaf or slash pine trees growing in wet soils that support diverse understory vegetation including grasses, shrubs, and carnivorous plants.

Plant community. A distinct and reoccurring assemblage of plants that are naturally associated with each other. Used interchangeably with natural community or vegetative community, for example, a longleaf pine forest.

Pleistocene. The earlier epoch of the Quaternary or the corresponding system of rocks.

Pliocene. The latest epoch of the Tertiary or the corresponding system of rocks.

Point source pollution. Pollution emanating from one distinct source, such as an outfall pipe.

Potentiometric surface. A surface that represents the level to which water will rise in tightly cased wells. If the head varies significantly with depth in the aquifer, then there may be more than one potentiometric surface. The water table is a particular potentiometric surface for an unconfined aquifer.

Pumping center. An area where there is a concentration of ground water pumping. If pumping continues, this will result in a lowering of the water table in an unconfined aquifer or of the potentiometric surface in a confined aquifer.

Recharge. Infiltration moving downward into the deeper parts of an aquifer.

Region of Influence (ROI). The geographic area in which the predominant social and economic impacts from the proposed action are likely to take place.

Regional Economic Models, Inc. Policy Insight Model (REMI). A dynamic economic model that forecasts how changes in the economy and adjustments to those changes will occur on a year-by-year basis. REMI integrates key aspects of Input/Output (I/O) models, Computer Generated Equilibrium (CGE) models, and econometric models.

Regression. In geologic context, this refers to the depositional environment when a body of water is moving outward, away from land, such as during a period of sea level lowering.

Rip rap. A layer of broken rock, cobbles, boulders, or fragments of sufficient size to resist the erosive forces of flowing water and wave action.

Runoff. The proportion of the precipitation in an area that is discharged from the area through stream channels.

Saltwater intrusion. The movement, as a result of human activity, of saline ground water into an aquifer formerly occupied by fresh water.

Scenery. General appearance of a place or a landscape, or features of a landscape.

Scenic. Of or relating to landscape scenery, pertaining to natural or natural appearing scenery; constituting or affording pleasant views of natural landscape attributes or positive cultural elements.

Scenic attractiveness. The scenic importance of a landscape based on human perceptions of the intrinsic beauty of landform, rockform, waterform, and vegetation pattern.

Scenic integrity. State of naturalness or, conversely, the state of disturbance created by human activities or alteration. Integrity is stated in degrees of deviation from the existing landscape character.

Seagrasses. Aquatic plants that are rooted in saturated soils but generally do not grow above the surface of the water.

Sea wall. An embankment or a wall for protection against waves or tidal action along a shore or waterfront.

Sediments. An assemblage of individual mineral grains that were deposited by some geological agent such as water, wind, ice, or gravity.

Sensitive land use. Involves buildings, amenity areas, or outdoor spaces where routine or normal activities occurring at reasonable expected times would experience one ore more adverse effects from contaminant discharges generated by a nearby major facility. Sensitive land uses may be part of the natural or built environment and include such uses as residences, day care centers, educational and health facilities, places of worship, or outdoor recreation areas.

Sewage effluent. The liquid part of sewage or wastewater.

Sewage sludge. Settled sewage solids combined with varying amounts of water and dissolved materials.

Shore. Seaward edge of coast between low tide and effective wave action.

Shoreline. The line separating land and water that fluctuates as water rises and falls.

Shrub/scrub wetlands. Areas dominated by woody vegetation less than 6 meters (20 feet) tall. The species include tree shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions. All water regimes except subtidal are included.

Siltation. The deposition of finely divided soil and rock particles upon the bottom of streams and riverbeds.

Silviculture. The art of producing and caring for a forest, usually for the production of wood products such as lumber or paper.

Skyglow. A brightening of the night sky caused by the scattering of artificial light by aerosol particles (e.g., water droplets and fine particles) in the air.

Soil texture. A group of characteristics that describe soil.

Sprawl. Low-density, automobile-dependent development beyond the edge of service and employment areas.

State Historic Preservation Officer. An individual who administers the national historic preservation program at the state level, reviews National Register of Historic Places nominations, maintains data on historic properties that have been identified but not yet nominated, and consults with federal agencies during Section 106 review. SHPOs are designated by the governor of their state or territory. Federal agencies seek the views of the appropriate SHPO when identifying historic properties and assessing the effects of an undertaking on historic properties. Agencies also consult with SHPOs when developing Memoranda of Agreement.

Storm surge. The rise in the level of the ocean that results from the decrease in atmospheric pressure associated with hurricanes and other storms.

Stormwater runoff. Water and associated material draining into streams and lakes as the result of a storm.

Subdivision. The legal division of a parcel into a number of lots for the purpose of development and sale. The authority to review and approve subdivisions may be granted to local planning boards by the local legislature. The standards to be applied and the procedures to be followed by the planning board are contained in state law and in subdivision regulations that are adopted by the local legislature. Subdivision regulations provide public control over subdivisions of land into lots for sale and development and typically contain requirements and standards regarding the size and shape of lots; the design and construction of streets, water and sewer lines, and other public facilities; protection of the environment; and other concerns.

Surficial exposure. Where a geologic unit is exposed at the surface.

Suspended load. The amount of material a stream carries in suspension.

Suspension. A method of sediment transport in which the turbulence of a fluid is able to keep particles supported in the fluid.

Swamp. A forested wetland.

Swells. Persistence of wind-formed waves after wind ceases.

Terrace deposits. Deposits from a terrace depositional area. A terrace is a nearly level surface, relatively narrow, bordering a stream or body of water and terminating in a steep bank. The term is often modified to indicate origin, as in stream terrace and wave-cut terrace.

Tide. The alternate rising and falling of the surface of the ocean caused by the gravitational attraction of the moon and sun.

Transgression. In geologic context, the depositional environment when a body of water is moving inward, toward land, such as during a period of sea level rising.

Tributary. A stream that joins another stream or body of water.

Unity. Landscape with a quality or state of being made whole or a condition of harmony.

Urban landscape. Landscape character that has resulted from extensive human activities, no longer appearing natural, such as conversion of native landscapes into an extensively altered landscape (e.g., a town, city, or metropolitan area).

View. Something that is looked toward or kept in sight, especially a broad landscape or panorama.

Viewshed. Total visible area from a single observer position, or the total visible area from multiple observer positions.

Visual. A mental image attained by sight.

Water table. The upper surface of groundwater in an unconfined aquifer, or that level below which the soil is saturated with water.

Watershed. A region or area bounded peripherally by a divide and draining ultimately to a particular water course or body of water.

Wave. Regular movement on a surface or within a material when energy travels through it. On the surface of a waterbody it is in the form of a curving ridge.

Wetland. Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Official designation as a wetland requires that an area have three diagonstic characteristics: (1) vegetation that is typically adapted to areas having the hydrologic and soil conditions mentioned; (2) hydric soil or soil with characteristics associated with reducing soil conditions; and (3) permanent or periodic inundation at mean water depths = 6.6 feet, or saturated soil at the surface some time during the growing season of the prevalent vegetation. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wetland delineation. Identifying a boundary between a wetland and an upland.

Wetland mitigation. Restoring or enhancing wetlands in areas that have been degraded by farming or other land alterations, or by creating new wetlands.

Woodland Period (Middle and Late Woodland). Prehistoric time periods dated to between approximately 100 B.C. and A.D. 1100.

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Pearlington Public Library
6096 First Avenue
Pearlington, MS 39572

Waveland Library Literacy Center
333 Coleman Avenue
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Harrison County Library System

Biloxi Public Library
139 Lameuse Street
Biloxi, MS 39530

Division Street Study Center
595 Division Street
Biloxi, MS 39530

D'Iberville Public Library
10391 Auto Mall Parkway
D'Iberville, MS 39540

Gulfport Public Library
1300 21st Avenue
Gulfport, MS 39501

Isiah Fredericks Study Center
3312 Martin Luther King, Jr Boulevard
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Margaret Sherry Memorial Library
2141 Popps Ferry Rd
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Orange Grove Public Library
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Pass Christian Public Library
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West Biloxi Library
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Pascagoula/Headquarters Library
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INDEX

A

Aesthetic quality, 4-114; 5-45; 5-127
Alkalinity, 4-139
Archaeological sites, 4-224-234; 4-244-245; 5-99-102; 5-133; 5-141
Architectural integrity, 5-124
Arsenic, 4-125; 4-139; 4-142; 4-145-147; 4-154; 4-158; 5-50; 5-55; 5-61
Atmospheric attenuation, 4-94
Attainment, 4-79; 4-84-87; 5-103-106; 5-133, 5-141

B

Back Bay, 1-3; 1-5; 4-27; 4-41; 4-50-51; 4-55; 4-56; 4-72; 4-83; 4-115; 4-124; 4-138; 4-162; 4-177, 4-181, 4-183-184, 4-187; 4-198-199, 4-207; 4-209-210; 4-227; 4-248; 5-100; 5-123
Bayou La Croix, 4-115; 4-118-119; 4-127-137; 4-147-159; 5-28; 5-34; 5-40; 5-54-59; 5-115; 5-131
Biloxi Bay, 4-32; 4-36-37; 4-47; 4-99; 4-115; 4-122-138; 4-161; 4-170-171; 4-177-180; 4-193; 4-219; 4-225, 4-231; 4-248; 5-30; 5-36; 5-41; 5-46; 5-70-71; 5-75; 5-78-80; 5-84; 5-97; 5-123; 5-140
Biloxi River, 4-113-119; 4-123; 4-127-137; 4-147-156; 4-177; 4-206; 4-210; 5-28; 5-33-40; 5-54-60; 5-115; 5-131
BOD5, 4-130-131; 4-139; 4-152; 5-49; 5-51; 5-54-61; 5-131
Bottomland hardwood, 4-127; 4-165-166, 4-169, 4-170; 4-201; 4-205; 4-212; 5-69; 5-74; 5-76; 5-80; 5-94; 5-132; 5-139

C

Cadmium, 4-132-134; 4-139; 4-142; 4-145-147; 4-154-155; 4-158; 5-49
Cane Creek, 4-115; 4-119-121; 4-127; 4-129-138; 4-147-156; 5-28; 5-34; 5-40
Chlorides, 4-139; 4-141
Chromium, 4-134-135; 4-139; 4-142; 4-145-147; 4-155; 4-158, 4-159; 5-49
Copper, 4-132, 4-135; 4-136; 4-139; 4-142 ; 4-145-147; 4-155-156; 4-158; 5-49; 5-53-62
Criteria pollutants, 4-84; 4-86; 5-103-105
Cultural resources, 4-224-245; 5-99-102

D

Deepwater habitats, 4-166; 4-172
De Lisle, 4-115; 4-118-120; 4-127-138; 4-147-152; 5-40; 5-54-59; 5-131
Dissolved oxygen, 4-119-125; 4-128; 4-131; 4-139; 4-141; 4-145; 4-151-152; 4-159; 5-45; 5-49; 5-50; 5-54-61; 5-66

E

Emergent wetland, 4-19-37; 4-127-128; 4-166-179; 4-222-223; 5-23-46; 5-69-95; 5-132; 5-139
Estuary, 4-128; 4-161; 4-169; 4-181; 4-187; 4-190; 4-196; 4-200; 4-210; 4-226; 5-65; 5-87; 5-91
Eutrophication, 4-108; 4-131; 4-141; 4-145; 4-148, 4-150; 4-152; 4-159; 4-182; 5-44-45

F

Forested wetlands, 4-166; 5-73; 5-95

G

H

Habitat fragmentation, 4-222; 5-45; 5-93
Hazardous Air Pollutants (HAPs), 4-84; 5-103
Historic architectural resources, 4-237; 4-247
Historic districts, 4-224; 4-237-247; 5-100-102; 5-126; 5-141
Hydrology, 4-168; 4-174-176; 4-212, 4-214; 5-43; 5-75; 5-82; 5-94

I

Iron, 4-110; 4-139
Ischemic heart disease, 4-92
Islands, The, 4-115; 4-126-127; 4-137; 4-147; 5-28; 5-34; 5-40

J

Jourdan River, 5-28-29; 5-33-34; 5-38; 5-40; 5-60; 5-115; 5-131

K

L

Land cover, 4-18-37; 5-22-48

Land use, 4-18-37; 5-22-48
Landscape analysis, 4-176
Lead, 4-84-85; 4-132; 4-139; 4-142; 4-145-147; 4-156-158; 5-103
Lower Wolf River, 4-115, 4-119-121; 4-127-138; 4-147-156; 5-28; 5-34; 5-40; 5-59; 5-131

M

Marsh, 4-96; 4-99; 4-104-106; 4-161; 4-165-168; 4-177; 4-180; 4-190; 4-195-210; 4-235; 4-247
Mercury, 4-140-147; 4-156; 4-158; 5-127; 5-143
Mitigation banking, 5-76

N

National Ambient Air Quality Standards, 4-84-86; 5-103
Nitrogen, 4-49; 4-87; 4-90; 4-130-132; 4-139-141; 4-145; 4-151; 4-159; 4-199; 5-44; 5-49-61; 5-103
Nonattainment, 4-79; 4-84-87; 5-103-106; 5-133, 5-141

O

Old Fort Bayou, 4-51; 4-55; 4-115; 4-120; 4-123-162; 4-177; 5-27-67; 5-110; 5-113-115; 5-129; 5-131

P

Palustrine wetlands, 4-173
Pathogens, 4-46-47; 4-119-128; 4-141-142; 4-145; 4-148-150; 5-44-66; 5-131
pH, 4-110; 4-122-125; 4-139-140; 4-144; 4-148; 4-159; 5-50; 5-55; 5-60-61
Phenols, 4-140; 4-142
Phosphorus, 4-131-133; 4-141; 4-145; 4-152-153; 4-159; 5-44; 5-49; 5-52-61
Pine savannah, 4-166-169; 4-173-174; 4-201; 4-206; 4-222; 5-23; 5-69; 5-73-76; 5-80; 5-95; 5-132; 5-139

Q

R

REMI, 2-4; 5-3-8; 5-12-14; 5-18; 5-24; 5-49; 5-101; 5-117
Rotten Bayou, 4-115; 4-121; 4-127; 4-129-137; 4-149; 4-159; 4-227; 5-28; 5-34; 5-38; 5-40; 5-54-61; 5-131

S

Scenic attractiveness, 5-125; 5-128
Scenic integrity, 5-124-125, 5-128
Seagrasses, 4-180-183; 4-188; 4-196; 4-199-201; 4-209; 4-213; 5-71; 5-83-92; 5-140
Sediment, 4-56-57; 4-96-99; 4-108-115; 4-126-130; 4-141-150; 4-154-161; 4-169; 4-181-184; 4-198-201; 4-214-215; 4-221-223; 5-44-67; 5-72-77; 5-82-99; 5-131; 5-137-141
Septic tank, 4-43-46; 4-51-55; 4-100-110; 4-118; 4-121; 4-124; 5-15; 5-44; 5-63-69; 5-112-117; 5-131-137; 5-142
Sewage, 4-57; 4-108-110; 4-118-123; 4-143; 4-200; 4-215; 4-221; 4-223; 5-43; 5-62; 5-75; 5-90; 5-97; 5-140
Swamp, 4-19-37; 4-96; 4-99; 4-127; 4-163-169; 4-180; 4-212; 4-235; 5-23-41; 5-70-72; 5-80

T

Tannic acids, 4-140-144
Tchoutacabouffa River, 4-115; 4-125; 4-138; 4-177; 4-206; 4-244
303(d) list, 4-118
Turbidity, 4-125, 4-139; 4-141; 4-145; 4-181; 4-199-200; 5-50; 5-55; 5-61; 5-83; 5-89; 5-139
Turkey Creek, 4-54; 4-115; 4-120; 4-123-159; 4-177; 5-27-42; 5-47-61; 5-67; 5-110-115; 5-129-131
Tuxachanie Creek, 4-115; 4-125; 4-127; 4-129-159; 5-28; 5-34; 5-38; 5-40; 5-54-61; 5-115; 5-131

U

Upper Jourdan River, 4-115; 4-120-122; 4-127; 4-129-138; 4-147-156; 5-28-29; 5-33-34; 5-38-40; 5-60; 5-115; 5-131
Upper Wolf River, 4-115; 4-120; 4-122; 4-127; 4-129-137; 5-28; 5-34-35; 5-40; 5-60; 5-131

V

W

Water quality, 4-137-142

Wetland, 4-168-179; 5-76-82
Wetland delineation, 4-163; 4-176
Wetland mitigation, 4-176; 5-24; 5-80-82; 5-132

X

Y

Z

Zinc, 4-132; 4-136-147; 4-156-159; 5-49; 5-53-62

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ACRONYMS AND ABBREVIATIONS

AADT	Annual Average Daily Traffic
ADF	Average Daily Flow
AMR	American Medical Response
ANRA	Airport Noise and Recovery Act of 1990
ATU	Aerobic Treatment Unit
BMPs	Best Management Practices
CAA	Clean Air Act
CDPA	Control Data Processing Authority
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CTA	Coast Transit Authority
CZM	Coastal Zone Management
DMR	Department of Marine Resources
ECED	Environmental Compliance and Enforcement Division
EFH	Essential Fish Habitat
EMS	Emergency Medical Services
EPD	Environmental Permits Division
ESA	Endangered Species Act
FAA	Federal Aviation Authority
FHWA	Federal Highway Administration
GIS	Geographic Information System
GRPC	Gulf Regional Planning Commission
GUD	Gautier Utility District
HAP	Hazardous Air Pollutants
HCWSWMD	Harrison County Wastewater and Solid Waste Management District
HUC	Hydrologic Unit Code
HWD	Hazardous Waste Division
IC	Illinois Central Railroad
ILS	Instrument Landing Systems
KCS	Kansas City Southern Railroad
LOS	Level of Service
LULC	Land Use/Land Cover
LUST	Leaking Underground Storage Tank
MAAQS	Mississippi Ambient Air Quality Standards
MACT	Maximum Achievable Control Technology
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MGCRWA	Mississippi Gulf Coast Regional Wastewater Authority
MGD	Million Gallons/Day
MPO	Metropolitan Planning Organization
MSNHP	Mississippi Natural Heritage Program
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act of 1969
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NSI	National Sediment Inventory
NWP	Nationwide Permit
OAQPS	Office of Air Quality Planning and Standards
OASPL	Overall Sound Pressure Level
OLWR	Mississippi Office of Land and Water Resources
OSDS	On-site Disposal System
OSW	Office of Solid Waste
PCN	Pre-Construction Notification
PSD	Prevention of Significant Deterioration
RCP	Regional Conservation Practice
RCRA	Resource Conservation and Recovery Act of 1976
ROI	Region of Influence
SAV	Submerged Aquatic Vegetation
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SR	State Route
SRWMD	South Regional Wastewater Management District
STORET	USEPA STOrage and RETrieval database system

SWPPP	Storm Water Pollution Prevention Plan
T&E	Threatened and Endangered
TCC	Technical Coordinating Committee
TDS	Total Dissolved Solids
TED	Turtle Excluder Device
TPC	Transportation Planning Policy Committee
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UST	Underground Storage Tank
VOC	Volatile Organic Compounds
WHO	World Health Organization
WWTP	Wastewater Treatment Plant