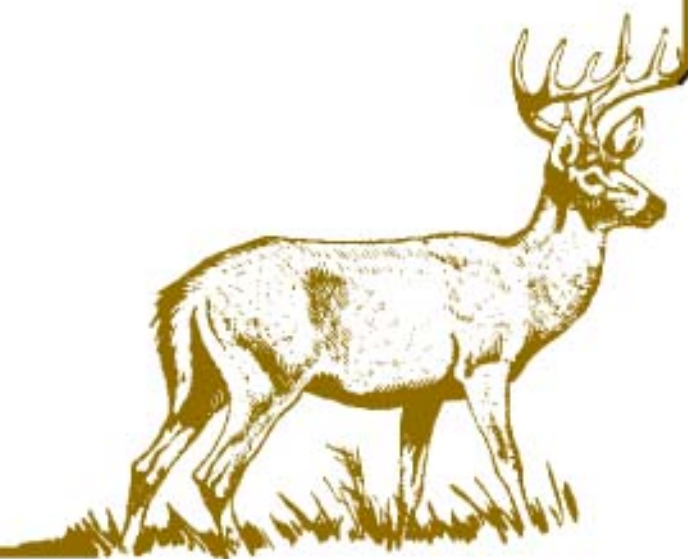


ENVIRONMENTAL CONSEQUENCES

CHAPTER

4



CHAPTER 4

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter analyzes on a programmatic level, the potential impacts on the socioeconomic, physical, biological, and cultural environment from implementation of the alternatives considered in this Oil and Gas Management Plan/Environmental Impact Statement (Plan/EIS). This is a programmatic management plan that establishes a general framework for managing oil and gas operations. By itself, it does not authorize any on-the-ground activities. The National Park Service will authorize specific projects by reviewing and approving operator-submitted plans of operations or special use permit applications. Before doing so, the NPS will conduct further analysis in accordance with the National Environmental Policy Act of 1969, the National Historic Preservation Act of 1966 (NHPA), the Endangered Species Act of 1973, and other applicable federal laws. The following topics analyzed in this chapter are the same as those addressed in Chapter 3:

- Nonfederal Oil and Gas Development
- Air Quality
- Geologic Resources
- Water Resources
- Floodplains
- Vegetation
- Wetlands
- Fish and Wildlife
- Species of Special Concern
- Cultural Resources
- Visitor Use and Experience
- Adjacent Land Uses and Resources

Other resources or issues that were considered and evaluated, but not carried forward for more detailed analysis in the Plan/EIS, are described at the end of Chapter 1.

Impact Intensity Thresholds

The NPS describes the severity of impacts using four intensity levels: negligible, minor, moderate, and major. Impact intensity thresholds are defined in this section for each impact topic to establish the threshold or magnitude at which an impact could be considered negligible, minor, moderate or major. The NPS defines “measurable effects” as moderate or greater effects. “No measurable effects” equates to minor or less effects. “No measurable effect” is used by the NPS in determining the appropriate level of NEPA compliance documentation.

Future nonfederal oil and gas operations that meet or exceed the impact intensity threshold defined for a major impact as defined in this chapter for a particular impact topic would trigger the requirement to prepare an EIS, rather than an EA, to accompany the Plan of Operations, unless mitigation measures are employed to reduce the intensity of the adverse impact. The impact intensity thresholds that are presented are derived from government regulatory standards, available scientific documentation, previously prepared environmental documents, and the professional judgment of National Park Service (NPS) resource specialists.

The impact intensity thresholds presented in this chapter were developed specifically for this Oil and Gas Management Plan/Environmental Impact Statement, and specifically for Big Thicket National Preserve. These impact intensity thresholds are used in all NEPA analyses for all types of proposals in the Preserve. Over time, as new information becomes available about the resources in the Preserve, or as NPS policies or government regulatory standards change, these impact intensity threshold definitions may be revised.

Organization of Impact Discussions

This chapter is organized by impact topic. The format of the impact analyses may vary among impact topics, but generally includes the following sections: (1) an “Introduction” that provides an overview of the resource; (2) a “Methodology for Assessing Impacts” that summarizes data analysis methods used in evaluating impacts and includes impact intensity threshold definitions; and (3) separate discussions of the impacts attributable to nonfederal oil and gas operations for Alternatives A, B, and C. Within the discussion of impacts for each alternative, the analysis is organized by type of oil and gas operation and includes “Geophysical Exploration,” “Drilling and Production” (including the placement of flowlines and gathering lines; and the construction of transpark oil and gas pipelines, and access and other surface activities within their associated right-of-way corridors), and “Plugging/Abandonment/Reclamation.” For a description of types of oil and gas operations, refer to Appendix D. The NPS follows the plugging procedures as discussed in Appendix I. In some cases, these operations are combined, if the analysis is applicable to more than one operation. For the most part, the impact analyses are qualitative and not site specific. Quantitative, site specific, detailed information will be provided in environmental assessments/environmental impact statements that will be tiered off of this EIS for a proposed plan of operations or directional drilling application.

Operating stipulations and mitigation measures are an integral part of all alternatives and are intended to avoid or minimize adverse impacts on Preserve resources and values. These measures are presented by type of oil and gas operation in Chapter 2, Parts I and III.

Impacts are described in terms of context, duration, and intensity. The context or extent of the impact may be localized or widespread. “Localized” impacts would affect the operations area, but would generally not extend beyond 1,500 feet from a well/production pad or 100 feet from an access road or flowline. “Widespread” or regional impacts would extend beyond the area of localized effects. The duration of impacts could be short-term ranging from weeks to three years in duration, or long-term extending up to 20 years or longer. Generally, short-term impacts would apply to data-gathering (i.e., non-manipulative surveys required to collect site-specific physical, biological, and cultural resource information performed prior to selecting the least-damaging location to site operations and to design and mitigate potential impacts), construction activities and geophysical exploration operations; and long-term impacts would apply to roads, production operations, and flowlines and pipelines. The intensity of an impact is described as negligible, minor, moderate or major. Impacts are either beneficial or adverse. A beneficial impact describes a positive change in the condition or appearance of the resource or a change that moves the resource toward a desired condition; whereas, an adverse impact describes a change that moves the resource away from a desired condition or detracts from its appearance or condition. Where the intensity of an impact can be described quantitatively, the numerical data are presented.

The following types of impacts are also evaluated:

- Direct and Indirect Impacts – Direct impacts are caused by the action and occur at the same time and place. Indirect impacts are caused by the action and are later in time or farther removed in distance.

- Cumulative Impacts – A cumulative impact is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions (in the NPS, major actions are synonymous with significant actions) actions taking place over a period of time (see 40 CFR Part 1508.7). The cumulative impact analysis area for each resource topic may cover a different geographic area, depending on the specific resource being evaluated.

A conclusion statement is provided for each impact topic, and under each alternative. The conclusion statement includes an impairment analysis. Impairment analysis is performed for Preserve resources and values only; therefore, there is no impairment analysis for nonfederal oil and gas development, visitor use and experience, or adjacent land uses and resources. Impairment is described on pages 1-2 and 1-3, under the heading “NPS Organic Act and General Authorities Act.”

This chapter ends with a comparative analysis of the alternatives pertaining to the following topics:

- Relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity;
- Irreversible or irretrievable commitments of resources; and,
- Unavoidable adverse impacts that cannot be avoided should the action be implemented.

Directional Drilling from Outside the Preserve

The focus of the analysis under all of the resource topics (with the exception of Adjacent Land Uses and Resources) is on operations inside the Preserve because Preserve resources would more likely be impacted by operations that are sited inside of the Preserve. After presenting a description of impacts from drilling and production operations inside the Preserve, the analysis expands to describe potential impacts from directional drilling from outside the Preserve. Currently, most of the wells producing hydrocarbons underlying the Preserve are directional wells whose surface locations are outside the Preserve (see Table 3.2). The NPS’s regulatory authority under the 9B regulations, and for issuing directional drilling exemptions under § 9.32(e), is limited in scope to only that portion of the operations occurring inside the Preserve (see Chapter 1, and Chapter 2, Part II). Depending on the proximity of the well to the Preserve boundary, site-specific environmental conditions, and mitigation measures employed, impacts from directional drilling on Preserve resources and values could vary widely, from no adverse impacts, to moderate, adverse impacts. Generally, directional drilling is not anticipated to result in major adverse impacts because directional drilling proposals would need to meet minimum state and federal requirements. The NPS conducts a NEPA analysis for each directional drilling proposal. In the event that there could be major, adverse impacts, the NPS would need to prepare an environmental impact statement (EIS) prior to making a decision on the proposed operation. An operator is likely to preclude the requirement for an EIS by applying the necessary mitigation measures. Impacts on Preserve resources and values would likely be substantially less than predicted in this Plan/EIS because it is anticipated that most wells would be directionally drilled from outside the Preserve to develop oil and gas resources underlying the Preserve.

IMPACTS ON NONFEDERAL OIL AND GAS DEVELOPMENT

Introduction

The impacts on nonfederal oil and gas development have been assessed because provisions in the Plan/EIS could affect how, where, and to what extent an operator could conduct nonfederal oil and gas operations in the Preserve. The application of Current Legal and Policy Requirements and operating stipulations in certain areas of the Preserve (described as Protected Areas under Alternative A, and SMAs under Alternatives B and C) have been analyzed to differentiate between the impacts of the alternatives presented in this plan.

The terminology used in this section is derived from the National Park Service's 36 CFR 9B regulations. Mineral owners who have title to the subsurface mineral estate in the Preserve may include individuals and the State of Texas. Lessees are individuals or corporations that lease oil and gas rights from the mineral owner. An operator is authorized to conduct operations in the Preserve and may include the mineral owner or lessee, or an individual or corporation designated by such to conduct operations.

This section does not discuss transpark pipeline rights-of-way in detail. Currently, the operator's right to access their pipeline rights-of-way is regulated by the issuance of a Special Use Permit by the National Park Service. All other aspects of pipeline operations in the Preserve are regulated by the U.S. Department of Transportation (49 CFR Parts 190-195) and State regulations, rather than by the National Park Service's regulations governing nonfederal oil and gas operations at 36 CFR 9B. Rights-of-way pipelines would be regulated by the NPS 36 CFR 9B regulations if hydrocarbons produced from within the Preserve are transported through these pipelines.

Methodology for Assessing Impacts

Impacts were qualitatively assessed by comparing where surface uses would be permitted for oil and gas development in the Preserve and determining whether this could affect a mineral owner's, lessee's, or operator's ability to conduct operations. The RFD scenario presented in Chapter 2 projects the number of wells that are anticipated to develop the hydrocarbons underlying the Preserve over the next 15 – 20 years. Specific locations of hydrocarbon accumulations in the Preserve are unknown, and the NPS cannot speculate where operators would conduct their operations. Because of the uncertainties of the petroleum industry and the financial considerations inherent in each operation, it is not possible to quantify the impacts on oil and gas development. Therefore, the estimates of the intensity of impact (negligible, minor, moderate, and major) presented in the following section are qualitative. This Plan/EIS describes programmatically, the impacts that could occur on nonfederal oil and gas development. As individual projects are proposed, site specific impact analyses would be conducted (as required under the National Environmental Policy Act), which would further refine the assessment of environmental effects. This assessment of impacts is based on best professional judgement and has been developed through review of relevant literature and through discussions with National Park Service staff and project consultants.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are defined as follows:

- Negligible:** The impact on operators' rights of access to their mineral estates, and the impact on nonfederal oil and gas development would be so slight that it would not be of any measurable or perceptible consequence.
- Minor:** The impact on operators' rights of access to their mineral estates, and the impact on nonfederal oil and gas development would be small and of little consequence.

- Moderate:** The impact on operators' rights of access to their mineral estates, and the impact on nonfederal oil and gas development would be measurable and of consequence.
- Major:** The impact on operators' right of access to their mineral estates, and the impact on nonfederal oil and gas development would be measurable and of substantial consequence.

Impacts on Nonfederal Oil and Gas Development under Alternative A (No Action/Current Management)

Project Planning: In the past, there has been no comprehensive plan guiding nonfederal oil and gas operations in the Preserve. Current Legal and Policy Requirements, mitigation measures and operating stipulations have previously been communicated to the operator on a case-by-case basis during project scoping and have been incorporated into project plans during plan development and review. Resource specific performance standards pertaining to nonfederal oil and gas operations have not been prepared prior to this planning effort. Without a comprehensive plan, it has been difficult to consistently apply Current Legal and Policy Requirements to operations throughout the Preserve. This has made project oversight by Preserve staff difficult and limits the operator's ability to efficiently plan nonfederal oil and gas operations in the Preserve. A comprehensive oil and gas management plan that describes Protected Areas and Current Legal and Policy Requirements would provide minimum protection to Preserve resources and values. However, other resources and values most susceptible to potential impacts from nonfederal oil and gas operations would not be formally designated as Special Management Areas under this alternative. Resources and values, and applicable performance standards, operating stipulations and mitigation measures would need to be defined on a case-by-case basis while preparing plans of operations or directional drilling applications. This could result in project delays. Nevertheless, a comprehensive management plan that defines Protected Areas and Current Legal and Policy Requirements would provide a minimum level of operator certainty about areas that should be avoided during nonfederal oil and gas operations, resulting in a minor beneficial impact.

Geophysical Exploration: The acquisition of 3-D seismic data could be permitted outside of protected areas, provided that all Current Legal and Policy Requirements are met and surface disturbances are either avoided or minimized (see Table 2.4). There would be increased costs for operators to comply with all current legal and policy requirements and to conduct operations that are least damaging to Preserve resources and values compared to operating outside the Preserve, and could result in a minor to moderate adverse impact on operators.

Drilling and Production: Drilling proposals would be evaluated on a case-by-case basis to determine the effect on Preserve resources. In addition to the protected areas described above, where the no surface use or timing stipulations would be applied, the application of Current and Legal Policy Requirements could result in the identification of additional areas where the no surface use or timing stipulations, and other mitigation measures would be applied (see Chapter 2, Part III).

Where it is determined that Preserve resources and values would be adversely impacted from drilling and production operations, operators may be required to directionally drill prospects from an alternate surface location to develop oil and gas resources underlying the Preserve. Directionally drilling a well would increase operating costs and the duration of operations but should not prevent commercial development of nonfederal hydrocarbons in the Preserve. Depending on the ability of the operator to conduct operations within the specified constraints, there could be minor to moderate, adverse impacts on nonfederal oil and gas development.

Due to the geographic nature of the Preserve comprising 12 distinct units, many which are narrow riparian corridors, the trend for developing the nonfederal oil and gas underlying the Preserve in

recent years has been to drill directional wells from surface locations outside the Preserve to reach bottomhole targets beneath the Preserve. If a drilling operation were conducted outside the Preserve to access nonfederal oil and gas underlying the Preserve, there would be operational costs associated with using lands adjacent to the Preserve (including surface use agreements and loss-of-use payments). The cost of conducting operations outside the Preserve may be offset if the operator is granted an exemption under § 9.32(e) from all or a portion of the NPS 36 CFR 9B Plan of Operations requirements. The operator's costs could be reduced outside of the Preserve, because fewer resource protection measures may be required, and costs to construct access roads and drilling pads may be reduced if operations are conducted in previously disturbed areas. If flowlines and gathering lines are installed along existing road corridors, they may not be as costly to maintain as inside of the Preserve.

Plugging/Abandonment/Reclamation: Under Current Legal and Policy Requirements, an operator is required to provide a description, schedule, and cost estimate for reclamation of an operations site inside of the Preserve. For a directional drilling exemption with mitigation under § 9.32(e), operators would submit an abbreviated Application. The NPS requires specific plugging requirements (see Appendix I) for directional wells only if the proposed wellbore would intersect usable quality groundwater zones beneath the Preserve. NPS review and approval of plans and applications (for exemptions with mitigation), and subsequent monitoring of well abandonment and site reclamation is expected to ensure that Preserve resources are returned to approximate pre-disturbance conditions, and that natural conditions and processes are restored. In the event that an operator does not comply with the conditions of the approved Plan of Operations, the NPS has the option of retaining all or a portion of the operator's performance bond to ensure that plugging and abandonment operations are completed by a contractor.

Site reclamation would be more costly in the Preserve compared to non-parklands due to the regulatory requirements imposed on nonfederal oil and gas operations. Added costs that may be associated with NPS requirements for plugging and reclamation may result in a minor to moderate, adverse impact if operators decide not to proceed with development plans.

Cumulative Impacts: The cumulative impact analysis area for oil and gas development consists of the Railroad Commission of Texas District 3. District 3 includes 29 counties in East Texas and the 7 counties surrounding the Preserve. District 3 is representative of the types of hydrocarbon development and geologic plays as those found in the Preserve.

Since the discovery of Spindletop in 1901, the economy of the area has been heavily dependent upon the oil and gas industry. Much of the employment in the area surrounding the Preserve is associated with the oil and gas industry, as well as support industries (retail/wholesale trade, health and education services, construction). The cities of Beaumont, Port Arthur and Orange, known as the Golden Triangle area, make up one of the largest petrochemical and refining complexes in the world. Eleven natural gas production and transportation companies serve the Golden Triangle's power needs of industry and homes along the upper Texas and Louisiana Gulf Coast (Beaumont Chamber of Commerce, 1999).

Most oil and gas activity and pipeline construction occurred between the late 1920's and early 1970's in East Texas. Within the Preserve, there are 71 transpark pipeline segments, between 125 and 155 wells (most had been plugged and abandoned prior to the Preserve's establishment), and 15 miles of oil and gas access roads. Currently, there are 9 nonfederal oil and gas surface operations in the Preserve, comprising 6 wells, 1 saltwater disposal well, a flowline and tank battery associated with a well located outside the Preserve, and an access road associated with directional wells located outside the Preserve. Eight wells inside the Preserve have been plugged and reclamation is ongoing on 13.2 acres. In addition, there are 39 directional wells that have been drilled from outside the Preserve to bottomhole locations beneath the Preserve (as of June 1, 2005).

During the period from January 2004 through January 2005, 1,272 drilling permits were issued by the Railroad Commission of Texas in the 29 counties comprising District 3. For the seven-county area encompassing the Preserve (Hardin, Jasper, Jefferson, Liberty, Orange, Polk, and Tyler Counties), 356 drilling permits were issued, comprising 28 percent of the District-wide total. Production for 2004 in District 3 totaled 40,929,218 bbls of oil and condensate, and 647,023,981 mcf natural gas and casinghead gas. In the 7-county area encompassing the Preserve, production of oil from all sources totaled 12,164,350 bbls (30 percent of the District total), and 177,198,300 mcf natural gas from all sources (27 percent of the District total) (RRC 2004).

From 1998 through 2000, no wells were drilled in or outside the Preserve to develop the underlying hydrocarbons. From 2001 through June 2005, 19 directional wells were drilled from surface locations outside the Preserve to reach bottomhole targets beneath the Preserve. During 2004 and up until June 1, 2005, applicants received § 9.32(e) exemption determinations for 15 additional directional wells. The historic drilling activity in the Preserve is further described in the Nonfederal Oil and Gas Operations section in Chapter 3.

The RFD scenario developed for this Plan/EIS projects that up to 40 additional wells could be drilled over the next 15 to 20 years to develop hydrocarbons underlying the Preserve. During 1998 to 2004, companies acquired 3-D seismic data over 5 units of the Preserve. Availability of the 3-D data may stimulate near-term exploratory drilling, development, and/or additional geophysical exploration in and around the Preserve. Therefore, much of the activity projected under the RFD scenario could occur over the next five to ten years (pers. comm., Peppiatt, Pathfinder 2/17/00).

Advances in geophysical exploration technology (3-D seismic) and increases in oil and gas prices have contributed to increased exploratory drilling in the region. Given the degree of exploration maturity of the area, the potential for undiscovered hydrocarbons is considered good, but the chance for discovering a large field is small (USGS 1999). Except for the short-term increase in exploration and drilling activity, an overall decline in oil and gas drilling and production is expected over the long-term. As new oil and gas discoveries occur and are developed, older operations would be abandoned and reclaimed. Cumulatively, the increased exploratory drilling activity and new field development resulting from 3-D seismic in the region, would essentially be offset by the overall decline of drilling activity (and production) in the region, resulting in negligible cumulative, adverse impacts on oil and gas development.

Conclusions under Alternative A (No Action/Current Management)

Project Planning: Implementation of a comprehensive management plan to guide nonfederal oil and gas operations in the Preserve that describes Current Legal and Policy Requirements, performance standards, mitigation measures, and operating standards would facilitate project oversight by Preserve staff, and project planning and implementation by oil and gas operators. This information would result in fewer project uncertainties, unnecessary expenditures, or time delays during the permitting process, resulting in a minor beneficial impact on oil and gas development.

Geophysical Exploration: There would be increased costs for operators to comply with Current Legal and Policy Requirements in the Preserve, which could result in minor to moderate, adverse impacts.

Drilling and Production: Drilling targets could be reached through directionally drilling wells from outside Protected Areas, which would increase the operator's drilling costs and duration of operations. Depending on the geographical extent of the area where drilling and production would not be permitted, and the ability of the operator to conduct operations within the specified

constraints, could result in a minor to moderate, adverse impact on nonfederal oil and gas development.

Plugging/Abandonment/Reclamation: Nonfederal oil and gas operations would be more costly in the Preserve, and may result in minor to moderate, adverse impacts on oil and gas operators.

Cumulative Impacts: The level of oil and gas activity in and around the Preserve would not be expected to change appreciably from current levels, and overall, there should be negligible cumulative, adverse impacts on oil and gas development.

Impacts on Nonfederal Oil and Gas Development under Alternative B (Preferred Alternative)

Project Planning: An oil and gas management plan would be prepared that would include the formal designation and protection of certain areas of the Preserve called SMAs where resources are particularly susceptible to adverse impacts from oil and gas operations or where the resources are essential to maintain the ecological integrity of the Preserve. The oil and gas management plan would clearly articulate Current Legal and Policy Requirements, performance standards, mitigation measures and SMA stipulations that are relevant to nonfederal oil and gas operations in the Preserve. The development of an oil and gas management plan would facilitate project oversight by Preserve staff, and project planning and implementation by oil and gas operators. This information would result in fewer project uncertainties, unnecessary expenditures, or time delays during the permitting process, resulting in a minor to moderate beneficial impact on oil and gas development. Implementation of Alternative B would also allow comprehensive and consistent management of nonfederal oil and gas operations by Preserve staff to meet the objectives of avoiding and minimizing damage, and preventing impairment, to resources and values in the Preserve.

Geophysical Exploration: Where operations are not permitted, geophysical surveys would need to be designed to acquire high quality data while avoiding the No Surface Use areas. Timing stipulations in the Birding Hot Spots and Hunting Areas SMAs would require scheduling operations so that they would avoid adverse impacts on specific resources. These operating stipulations could result in a minor to moderate adverse impact on geophysical exploration operations. Throughout the rest of the Preserve, there should be no adverse impacts on exploratory operations resulting from actions proposed under Alternative B.

Drilling and Production: Oil and gas underlying SMAs with the No Surface Use stipulation could be accessed through directional drilling from outside SMA boundaries, or, in the case of the Riparian Corridor SMA, from sites already disturbed and accessible within the SMA where approved under the floodplain guidelines. Directional drilling would be more likely to occur under Alternative B than under Alternative A, because of the designation of SMAs in this alternative. Directional drilling techniques would be feasible in the linear corridor units using standard drilling technology. More expensive and higher risk drilling methods may be needed to reach some interior portions of the larger SMAs. Increased drilling costs and operational risks may reach a point where operators decide not to drill certain wells. If an operator decides not to directionally drill a well to reach the hydrocarbons underlying a SMA, nonfederal oil and gas operations may slightly decline inside the Preserve and the RFD scenario presented in Chapter 2 may not be attainable. Depending on the geographical extent of the SMA and the ability of the operator to conduct operations within the specified constraints, could result in minor to moderate, adverse impacts on nonfederal oil and gas development.

If a drilling operation were conducted outside the Preserve to access nonfederal oil and gas underlying the Preserve, there would be costs associated with using lands adjacent to the Preserve (including surface use agreements and loss-of-use payments). The cost of conducting operations outside the Preserve may be offset if the operator is granted an exemption under § 9.32(e) from all or a portion of the NPS Plan of Operations requirements. The operator's costs could also be reduced outside of the Preserve because fewer resource protection measures may be required. Costs to construct access roads and drilling pads may also be reduced if operations are conducted in previously disturbed areas.

Plugging/Abandonment/Reclamation: The same as Alternative A, site reclamation would be more costly in the Preserve, due to the regulatory requirements imposed on nonfederal oil and gas operations. However, consistent, guidance on reclamation requirements would be provided to operators through the oil and gas management plan and could reduce plugging and reclamation costs resulting in minor, adverse impacts.

Cumulative Impacts: The same as Alternative A, there are anticipated to be negligible cumulative, adverse impacts on oil and gas development. With the advances in geophysical exploration technology (3-D seismic) there has been a recent increase in exploratory drilling in the region. Except for the short-term increase in activity, the overall decline in oil and gas drilling and production is expected to continue over the long-term. As new oil and gas discoveries are made and are developed, older operations would be abandoned and reclaimed.

Conclusions under Alternative B (Preferred Alternative)

Project Planning: The development of an oil and gas management plan that clearly articulates Current Legal and Policy Requirements, performance standards, mitigation measures, and SMA stipulations would facilitate project planning, resulting in minor to moderate, beneficial impacts.

Geophysical Exploration: There would be increased costs for operators to comply with Current Legal and Policy Requirements in the Preserve, which could result in minor to moderate, adverse impacts.

Drilling and Production: Drilling targets could be reached through directionally drilling wells from outside the SMAs, which would increase the operator's drilling costs and duration of operations. Depending on the geographical extent of the SMA, and the ability of the operator to conduct operations within the specified constraints, could result in minor to moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Guidance provided to operators during project planning and implementation should reduce plugging and reclamation costs. In addition, where operations are conducted outside the Preserve, reclamation may be less costly, depending on the extent of reclamation, resulting in minor, adverse impacts.

Cumulative Impacts: Same as Alternative A, the level of oil and gas activity in and around the Preserve would not be expected to change appreciably from current levels, and overall, there should be negligible cumulative, adverse impacts on oil and gas development.

Impacts on Nonfederal Oil and Gas Development under Alternative C (Maximum Resource Protection)

Project Planning: The same as Alternative B, an oil and gas management plan would be prepared that would include the formal designation and protection of certain areas of the Preserve where resources are particularly susceptible to adverse impacts from oil and gas operations or where the resources are essential to maintain the ecological integrity of the Preserve. The plan would clearly articulate Current Legal and Policy Requirements, performance standards, mitigation measures and SMA stipulations for nonfederal oil and gas operations in the Preserve. The development of an Oil and Gas Management Plan would facilitate project oversight by Preserve staff, and project planning and implementation by oil and gas operators. This information would result in fewer project uncertainties and unnecessary expenditures or time delays during the permitting process, resulting in a minor to moderate, beneficial impact on oil and gas development. Implementation of Alternative C would also allow comprehensive and consistent management of nonfederal oil and gas operations by Preserve staff to meet the NPS mandate to protect Preserve resources and values from impairment.

Geophysical Exploration: Operators could use existing seismic and well data to develop prospects beneath these areas, but could not acquire new data within the SMAs. If there is no existing data to image the subsurface within a SMA, there could be a minor to major adverse impact where operators are attempting to develop prospects in these areas. Throughout the rest of the Preserve, there should be no adverse impacts on exploratory operations resulting from actions described under Alternative C.

Drilling and Production: Drilling targets within the SMAs could only be reached through directionally drilling wells from outside the SMA, which would increase the operator's drilling costs, risk, and duration of operations. Directional drilling techniques would be feasible in the linear corridor units using proven drilling technology. More expensive and higher risk drilling methods may be needed to reach some interior portions of the larger SMAs (i.e., Riparian Corridors, and Rare Forested Wetland Communities SMAs). Increased drilling costs and operational risks may reach a point where operators decide not to drill certain wells. If an operator chooses to not directionally drill a well to reach oil and gas underlying a SMA, nonfederal oil and gas operations may slightly decline inside the Preserve and the RFD scenario presented in Chapter 2 may not be attainable. Depending on the geographical extent of the SMA and the ability of the operator to conduct operations within the specified constraints, could result in minor to major, adverse impacts on nonfederal oil and gas development.

If it is determined that the area considered for nonfederal oil and gas operations is "...subject to, or threatened with, uses which are, or would be, detrimental to the purposes and objectives of this Act" (Big Thicket National Preserve enabling legislation - P.L. 93-439), the NPS would notify Congress of its intent to begin acquisition of the mineral interest and would seek appropriations for the acquisition of the mineral rights.

If a drilling operation is conducted outside the Preserve to access nonfederal oil and gas underlying the Preserve, there would be costs associated with using lands adjacent to the Preserve (including surface use agreements and loss-of-use payments). The cost of conducting operations outside the Preserve may be offset if the operator is granted an exemption under § 9.32(e) from the NPS Plan of Operations requirements. The operator's costs could also be reduced outside of the Preserve, because costs to construct access roads and drilling pads may be reduced if operations are conducted in previously disturbed areas and if pipelines are installed along existing road corridors, so that maintenance costs may be reduced.

Plugging/Abandonment/Reclamation: The same as Alternatives A and B, site reclamation would be more costly for operations occurring inside the Preserve, due to the regulatory requirements imposed on nonfederal oil and gas operations. However, consistent, guidance on

reclamation requirements would be provided to operators through the oil and gas management plan and could reduce plugging and reclamation costs resulting in minor, adverse impacts.

Cumulative Impacts: The same as Alternatives A and B, there are anticipated to be negligible cumulative, adverse impacts on oil and gas development. With the advances in geophysical exploration technology (3-D seismic) there has been a recent increase in exploratory drilling in the region, but except for the short-term increases in activity, the overall decline in oil and gas drilling and production is expected to continue over the long-term. As new oil and gas discoveries are made and are developed, older operations would be abandoned and reclaimed. Within the Preserve, the level of oil and gas activity may decrease from current levels, because of the No Surface Use stipulation in SMAs.

Conclusions under Alternative C (Maximum Resource Protection)

Project Planning: Same as Alternative B, the development of an oil and gas management plan that clearly articulates Current Legal and Policy Requirements, performance standards, mitigation measures, and SMA stipulations would facilitate project planning, resulting in minor to moderate, beneficial impacts.

Geophysical Exploration: Exploration operations would not be permitted in the SMAs where the No Surface Use stipulation would be applied on 37,088 acres or in SMAs during specified times (52,307 acres), or within 500 feet of waterways (unless specifically authorized in an approved plan of operations).

Exploration operations may decline inside the Preserve. If there is not adequate data to image the subsurface, there could be minor to major, adverse impacts.

Drilling and Production: Drilling targets within the SMAs could only be reached through directionally drilling wells from outside the SMA, which would increase the operator's drilling costs and duration of operations. Nonfederal oil and gas drilling operations may decline inside the Preserve. Depending on the geographical extent of the SMA and the ability of the operator to conduct operations within the specified constraints, could result in a minor to major, adverse impact.

Plugging/Abandonment/Reclamation: Same as Alternative B, guidance provided to operators during project planning and implementation should reduce plugging and reclamation costs. In addition, where operations are conducted outside the Preserve, reclamation may be less costly, depending on the extent of reclamation, resulting in minor, adverse impacts.

Cumulative Impacts: Same as Alternatives A and B, the level of oil and gas activity in and around the Preserve would not be expected to change appreciably from current levels, and overall, there should be negligible cumulative, adverse impacts on oil and gas development.

IMPACTS ON AIR QUALITY

Introduction

Big Thicket National Preserve is designated a Class II area under the Prevention of Significant Deterioration (PSD) provisions of the Clean Air Act. The Preserve lies within several Texas counties that are not in compliance with the National Ambient Air Quality Standard for ground-level ozone.

Nonfederal oil and gas operations in and surrounding the Preserve could affect air quality in the Preserve and regional airsheds.

Methodology for Assessing Impacts

The RFD scenario and data available from the State's air quality management program were used to qualitatively assess the environmental impacts on air quality of the Preserve and region. Exact locations of future operations are unknown. It is assumed that activities would occur in a similar distribution as compared to locations of existing activities. The assessment of impacts is based on best professional judgement and has been developed through discussions with NPS staff and through review of relevant literature.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are defined as follows:

- | | |
|--------------------|---|
| Negligible: | Impacts would result in a change to air quality that would be slight and perceptible, but would not affect the Preserve's protected limits within the Class II air shed. |
| Minor: | Impacts would result in a change to air quality, but the change would be small and of little consequence, and would not affect the Preserve's protected limits within the Class II air shed. Mitigation measures, if needed to offset adverse effects, would be simple and successful. |
| Moderate: | Impacts would result in a perceptible and measurable change to air quality that would be long-term and localized, but would not affect the Preserve's protected limits within the Class II air shed. Mitigation measures, if needed to offset adverse effects, would be extensive and likely successful. |
| Major: | Impacts would result in a change to air quality that could be severely perceptible and measurable for long periods of time, and/or would affect the Preserve's protected limits within the Class II air shed. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed. |

The analysis of air quality impacts described in this section is based on potential changes from baseline conditions. If oil and gas operations anticipated under the RFD scenario could emit air pollutants, the impact is considered to be "adverse" under NEPA guidelines. It should be understood, however, that some increases in air pollution emissions within a given airshed may be allowed without being considered "adverse" under Clean Air Act programs.

Under all three alternatives, the exploration and production of oil and gas has the potential to impact air quality from the following sources:

- suspended particulate matter (dust) generated from construction of access roads, wellpads, production facilities, flowlines, gathering lines and pipelines, and site reclamation activities; combustion of diesel-powered equipment; the oil and gas itself; routine emission of noxious vapors from storage tanks; vehicle exhaust; and traffic on paved and unpaved roads;
- accidental spills of volatile petroleum products, resulting in emissions of hydrocarbons or volatile organic compounds, and other pollutants such as hydrogen sulfide (H₂S);

- emissions of carbon monoxide (CO), and oxides of nitrogen (NO_x) from vehicle and stationary gasoline and diesel engines (including electric generators from construction machinery and vehicles transporting equipment); and
- flaring of gas during well testing and production operations.

Under all alternatives, air quality in all areas of the Preserve would receive protection under Current Legal and Policy Requirements, particularly 36 CFR 9B regulations, which require utilization of least-damaging methods. Section 9.41(a) of the regulations require operations be sited a minimum 500 feet from visitor use, administrative and other use areas; and waterways, unless specifically authorized by an approved plan of operations. The effects from operations conducted inside the Preserve or from directional drilling and production from outside the Preserve on the Class II air quality are anticipated to range from negligible to minor, because of the limited extent of projected operations under the RFD scenario, and because all operations must comply with state and federal regulations. Operations conducted inside the Preserve would also have to comply with NPS requirements in order to receive approval for the Plan of Operations; therefore, operators inside the Preserve would be required to follow operating procedures to minimize emissions. These include use of blowout preventers; a prohibition on burning of vegetation, construction debris, or site-produced wastes; use of clean (i.e., low sulfur) fuels; proper maintenance of engines; use of pollution control devices on vehicles (e.g., catalytic converters); and inspection and maintenance of flares and treater facilities. However, the application of Current Legal and Policy Requirements, and project-specific operating stipulations, could result in variations in how, where, and to what extent resource protection is applied.

A description of impacts on air quality from specific types of oil and gas operations under each alternative follows.

Impacts on Air Quality under Alternative A (No Action/Current Management)

Geophysical Exploration: Air quality would be impacted primarily due to increased vehicle use to transport seismic work crews, and equipment to drill shotholes. Combustion engine emissions include volatile organic compounds, nitrogen oxides, carbon monoxide, and sulfur oxides. The primary pollutants of concern are nitrogen oxide compounds (NO_x) which are formed in the high temperature, pressure, and excess-air environment of combustion in diesel engines. Lesser amounts of carbon monoxide (CO) and hydrocarbons are also emitted. Some sulfur dioxide (SO₂) is emitted due to the burning of gasoline and diesel (which can contain minor amounts of sulfur). The amount of engine emissions depends on the number and type of gasoline or diesel-fueled vehicles and shothole drilling equipment used and the length of use. Due to the short-term nature that 3-D seismic surveys occur, these emissions would result in negligible, adverse impacts that would be short-term (weeks or months). For large-size particulates and CO emissions, impacts would be localized. However, for other pollutants, like VOCs and NO_x (or even SO₂ which transforms to SO₄ fine particles downwind), these impacts may be localized, as well as contribute to regional air quality impacts.

Drilling and Production: Vehicles and heavy equipment used for the construction and maintenance of access roads, wellpads, flowlines, and pipelines; and well drilling could introduce nitrogen oxides, volatile organic compounds, carbon monoxide, sulfur dioxide, and odors from operating large engines, pumps and auxiliary equipment, resulting in, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), negligible to minor, adverse impacts on air quality.

Hydrocarbons and treatment chemicals could be released during drilling, production, or transport and could adversely impact air quality. Hydrocarbons could volatilize and enter the atmosphere. In the vicinity of the leak or spill, concentrations of gas and other constituents could present health hazards to animal and plant life. In addition, this could provide a source for explosion or fire. These impacts could be serious on a very local level, with minor to major, adverse impacts; however, with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to minor, and be short-term. These impacts would be localized as well as contribute to regional air quality impacts.

Drilling would involve continuous operation of combustion engines over a 30 to 45-day drilling period. This would introduce emissions of nitrogen oxides (NO_x), carbon monoxide (CO), and sulfur dioxide (SO_2). Large diesel engines, which are used to power the drill, rigs, pumps, and auxiliary equipment emit nitrogen oxide compounds (NO_x) as primary pollutants of concern. These are formed in the high temperature, pressure, and excess-air environment of combustion diesel engines. Smaller amounts of carbon monoxide (CO) and hydrocarbons would also be emitted. Some sulfur dioxide (SO_2) would be emitted due to the burning of gasoline and diesel (which contain minor amounts of sulfur). The amount of engine emissions depends on the drilling rig size (horsepower), percent sulfur in the fuel burned, gallons of diesel fuel burned per hour, the hours per day, number of days the diesel rigs operate, and the use of any control devices.

Hydrogen sulfide (H_2S) presents a serious localized air quality concern because it is extremely toxic at very small concentrations. Hydrogen sulfide, if encountered, is extremely hazardous to normal oil field operations because of potential adverse health effects, and it contributes to metal fatigue in drilling equipment. Past drilling operations in the Preserve have not encountered hydrogen sulfide-bearing zones. However, if zones containing gas or fluids under pressure are encountered, the drilling mud system is adjusted to prevent the release of hydrogen sulfide. Drilling is discontinued until the pressure is stabilized and there is essentially no gas entering the hole. The small amount of gas that could reach the surface is vented from the system by use of a de-gasser unit and flared (burned). Drilling and producing of hydrocarbons containing toxic gases can be performed safely and without incident if the necessary precautions are taken and appropriate safety procedures are followed.

Odors from drilling and production operations could affect visitors and park employees. The possibility and extent for odor would depend on wind speed and direction and the nature of the drilling equipment and material encountered during drilling operations (particularly hydrogen sulfide-bearing zones). Odor would be more noticeable during light breezes and less evident during periods of stronger winds.

Particulate matter emissions would be greatest during construction of roads, pads, flowlines and transpark oil and gas pipelines, due to the higher number of vehicles and earthmoving activities. Greater use of motor vehicles during construction of access roads and pads, and during drilling, would increase particulate matter from vehicle exhaust and dust from paved and unpaved roads. Exhaust from machinery used during construction and drilling would also contribute to an increase in particulate matter. As a result of increased particulate matter emissions, visibility may be slightly impacted during construction and drilling in the localized area where these activities are undertaken. There could be some added impact on regional visibility due to transport of fine particulate matter and haze produced by secondary aerosols (i.e., particulate matter formed from gaseous emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and volatile organic compounds (VOC), in particular).

The amount of air pollution generated over the productive life of oil or gas wells depends on the characteristics of the product and the production practices used. Emissions associated with production are usually considerably less than the emissions from well drilling. However, over the life of some production operations, emissions could exceed those of drilling operations. Wells that do not produce hydrogen sulfide (H_2S) in the oil, natural gas, or associated gas products are less likely to cause air pollution than wells that do produce hydrogen sulfide. Oil and gas production operations would release gaseous pollutants such as carbon monoxide (CO), hydrocarbons, nitrogen oxides (NO_x), and sulfur

dioxide (SO₂). These air pollutants would be released by separation facilities, disposal of liquid waste and unwanted gas, burning of waste petroleum products, routine emission of objectionable odors, and venting of noxious vapors from storage tanks.

Photochemical reactions between hydrocarbons and nitrogen oxides (NO_x) produce ozone. While the concentration of all these pollutants would increase as the fields are developed, the levels are expected to be low and are required to comply with federal and State standards and conform to the Texas air quality State Implementation Plan (SIP). The extent of impacts caused by increases in pollutants may range from areas in close proximity to each well to longer ranges, low level contributions to regional impacts, like ozone and haze formation.

Proper maintenance of gasoline and diesel-fueled engines and use of low sulfur fuels are important in minimizing exhaust emissions. The use of pollution control devices on vehicles (e.g., catalytic converters) would reduce unnecessary emissions. Inspection and maintenance of production equipment such as flares and treater facilities is necessary to ensure that deteriorated components and equipment are detected and replaced or repaired.

Mitigation should reduce the intensity of impacts from drilling and production operations to localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, flowlines, gathering lines, and pipelines), negligible to minor, adverse impacts on air quality.

Wells directionally drilled and produced from outside the Preserve to develop hydrocarbons beneath the Preserve could impact air quality in the Preserve. Directional wells in the past have been drilled within 100 to 1,500 feet from Unit boundaries. Depending on proximity to the Preserve boundary, prevailing winds, site-specific environmental factors, and mitigation measures employed, impacts on the Preserve could range from no impact to indirect, short- to long-term, minor, adverse impacts. Impacts could be localized, as well as contribute to regional air quality impacts

Plugging/Abandonment/Reclamation: Increased vehicle use and removal of roads, pads, flowlines and pipelines could increase particulate matter emissions. Leaks and spills of hydrocarbons could occur during well plugging, shutting down and abandoning/removing flowlines and pipelines and use of heavy equipment and vehicles during reclamation activities, resulting in emissions of gaseous pollutants and presenting a potential source for explosion or fire, but with mitigation, impacts would result in short-term, negligible, adverse impacts on air quality at sites throughout the Preserve. These impacts could be localized, as well as contribute to regional air quality impacts.

Impacts on air quality in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short-term, negligible, adverse impacts. Impacts could be localized as well as contribute to regional air quality impacts.

Cumulative Impacts: The cumulative impact analysis area for air quality includes the seven-county area encompassing the Preserve. Impacts on air quality in the Preserve from oil and gas operations could result from 41 existing wells located within and outside the Preserve, leaks or spills from 71 transpore oil and gas pipelines; and future operations including RFD-projected Preserve-wide geophysical exploration on up to 465 acres, and drilling of an estimated 40 wells with production of an estimated 27 wells from locations within or outside the Preserve. As some operations are developed, others would be plugged, abandoned, and reclaimed; therefore, impacts would be distributed over time. Other Preserve activities that could contribute to air quality impacts include prescribed fires and routine maintenance of Preserve unpaved roads.

Due to the fragmented nature of the Preserve's management units, the spectrum of adjacent land uses which would contribute more appreciably to the air quality in the region includes: nonfederal oil and gas

activities of a substantially greater number as compared to operations in the Preserve (from January 2004 – January 2005, 1,272 drilling permits were issued by the Railroad Commission of Texas in the 29 counties comprising District 3. For the seven-county area encompassing the Preserve, 356 drilling permits were issued, comprising 28 percent of the District-wide total. In contrast, from 1998 through 2000, no wells were drilled in or outside the Preserve to develop the underlying hydrocarbons, and from 2001 – 2005, there has been an average of five wells directionally drilled from surface locations outside the Preserve to reach bottomhole targets beneath the Preserve); industrial sources including pulp mills, oil refineries, and petro-chemical manufacturing plants; public utilities; and urban sources. Odors associated with pulp mill operations in the region are periodically noticeable, and some air pollution may occur from burning associated with the preparation of sites by private timber companies.

Two emission source categories were considered in the cumulative impact analysis. The Preserve lies within several Texas counties that are classified as nonattainment for ozone (Hardin, Liberty, Orange, and Jefferson Counties). Additional emissions of NO_x and volatile organic compounds (VOCs), the primary precursors of ozone formation may exacerbate existing ozone levels. Both pollutants are common emissions of oil and gas exploration and production operations. Fine fraction particulate matter (PM) emissions are also a concern. The Big Thicket region has been found to comprise high levels of PM_{2.5} measured during a 2-month special study period (1996) at 18 sites on both sides of the US-Mexico border. Air quality monitoring was performed at NPS and non-NPS locations in Texas, including Big Thicket National Preserve and Big Bend National Park, Texas. Fine sulfate particles comprised a significant portion of the PM_{2.5} measured at the Preserve. It is likely that additional industrial activity associated with oil and gas production will contribute to PM_{2.5} formation through emissions of SO₂, NO_x, and VOCs that are transformed in the atmosphere to fine particulate matter. If PM_{2.5} levels are increased in the region, the Big Thicket region could be classified as a Nonattainment Area for the fine particle NAAQS.

While the NPS can exercise more stringent air quality mitigation standards than currently exist under State (TCEQ) and federal (EPA) requirements under the Clean Air Act, air quality in the region would be contingent on the state and federal ambient air quality standards, air pollution control requirements, and air quality management programs of the appropriate state and federal authorities. Therefore, while existing and new oil and gas operations in the Preserve are expected to result in mostly localized, negligible to minor, adverse impacts on air quality in the Preserve, increased population growth and development outside the Preserve could result in cumulative, moderate to major adverse impacts on the regional airsheds. But, with adherence to State and federal ambient air quality standards, air pollution control requirements, and air quality management programs specified in State Implementation Plans, air quality in regional airsheds are expected to be maintained or improved.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Use of vehicles to transport seismic work crews and equipment, and shothole drilling equipment could increase emissions of sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons in areas where geophysical exploration could be permitted on up to 465 acres of the Preserve, resulting in short-term, negligible, adverse impacts on air quality. These impacts could be localized, as well as contribute to regional air quality impacts.

Drilling and Production: The construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase particulate matter emissions. Well drilling could introduce nitrogen oxides, volatile organic compounds, carbon oxides, sulfur oxides, and odors from operating large engines, pumps and auxiliary equipment. Emissions could continue during production at lower levels; but could exceed emissions from drilling over the life of production operations. Mitigation should reduce impacts to short-term (construction activities and drilling operations) to long-term (roads, production operations,

and flowlines and pipelines), negligible to minor, adverse impacts on air quality. Hydrocarbons or treatment chemicals could be released during drilling, production, or transport. Hydrocarbons could volatilize and enter the atmosphere, and provide a source for explosion or fire, with minor to major, adverse impacts on air quality; but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to minor. Impacts on air quality in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short- to long-term, minor, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Plugging/Abandonment/Reclamation: Vehicle use and removal of roads, pads, flowlines and pipelines could increase particulate matter emissions. Leaks and spills of hydrocarbons could occur during well plugging, shutting down and abandoning/removing flowlines and pipelines, or from use of heavy equipment and vehicles during reclamation activities, resulting in emissions of gaseous pollutants and providing a source for explosion or fire; but with mitigation, impacts would result in short-term, negligible, adverse impacts on air quality at sites throughout the Preserve. Impacts on air quality in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Cumulative Impacts: Over time, protection provided to air quality in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of this resource, a cumulative, beneficial impact on air quality in the Preserve. Activities that contribute to air quality impacts outside the Preserve such as oil and gas operations, pulp mills, oil refineries, and petro-chemical manufacturing plants, public utilities, and urbanization could result in cumulative, moderate, adverse impacts on the regional airsheds. But, with adherence to State and federal ambient air quality standards, air pollution control requirements, and air quality management programs specified in State Implementation Plans, air quality in the regional airsheds are expected to be maintained or improved.

Impairment Analysis: Because there would be no major adverse impacts to air quality whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment to Preserve air quality.

Impacts on Air Quality under Alternative B (Preferred Alternative)

SMAs would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. In addition to SMA operating stipulations, by applying applicable Current Legal and Policy Requirements, including 36 CFR 9B regulations, which have been described in Chapter 2, Parts II and III, and under Alternative A, impacts on air quality should be substantially reduced throughout the Preserve.

Geophysical Exploration: Similar to Alternative A, use of vehicles to transport seismic work crews and equipment, and shothole drilling equipment could increase emissions of sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons, resulting in short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Drilling and Production: Due to the designation of SMAs, it is possible that some wells may be directionally drilled from outside the SMAs, and from outside the Preserve, to develop hydrocarbons underlying the SMAs. As a result, new drilling and production operations would be distanced from SMAs and would have less effect on air quality in SMAs, especially for larger-sized particulates and

odors that could settle out or dissipate close to the sources outside the SMAs. Emissions of more regional pollutants like fine particulates and ozone/haze precursors could still have effects as described under Alternative A.

Similar to Alternative A, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase particulate matter emissions. Well drilling could introduce nitrogen oxides, volatile organic compounds, carbon monoxide, sulfur dioxide, and odors from operating large engines, pumps and auxiliary equipment. Emissions could continue during production at lower levels; but could exceed emissions from drilling over the life of production operations. Mitigation should reduce impacts to short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), negligible to minor, adverse impacts on air quality within areas where drilling and production could occur in or directionally from outside the Preserve. Hydrocarbons or treatment chemicals could be released during drilling, production, or transport. Hydrocarbons could volatilize and enter the atmosphere, and provide a source for explosion or fire, with minor to major, adverse impacts on air quality; but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to minor. Air quality in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short- to long-term, minor, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Existing operations (24.2 acres) and transpark pipelines (589 acres) would continue to adversely impact air quality in the Preserve.

Plugging/Abandonment/Reclamation: Similar to Alternative A, increased vehicle use and removal of roads, pads, flowlines and pipelines could increase particulate matter emissions. Leaks and spills of hydrocarbons could occur during well plugging, shutting down and abandoning/removing flowlines and pipelines, or from use of heavy equipment and vehicles during reclamation activities, resulting in emissions of gaseous pollutants and providing a source for explosion or fire; but with mitigation, impacts would result in short-term, negligible, adverse impacts on air quality at sites throughout the Preserve. Impacts on air quality in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Cumulative Impacts: Similar to Alternative A, existing and future oil and gas operations, and other activities in the Preserve, in combination with increased population growth and development surrounding the Preserve could result in cumulative, moderate to major, adverse impacts on the regional airsheds. But, with adherence to State and federal ambient air quality standards, air pollution control requirements, and air quality management programs specified in State Implementation Plans, air quality in regional airsheds are expected to be maintained or improved. Designation of SMAs with operating stipulations under Alternative B would better ensure that air quality in the Preserve is protected.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, exploration operations would result in short-term, negligible, adverse impacts on air quality within the areas of operation on up to 465 acres in the Preserve. These impacts could be localized, as well as contribute to regional quality impacts.

Drilling and Production: Similar to Alternative A, construction and maintenance of drilling and production operations in the Preserve would result in short to long-term, negligible to minor, adverse

impacts on air quality. Impacts on air quality in the Preserve from directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short- to long-term, minor, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Plugging/Abandonment/Reclamation: Similar to Alternative A, plugging, abandonment, and reclamation of new operations located outside SMAs; and for existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in short-term, negligible, adverse impacts on air quality. Impacts on air quality in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Cumulative Impacts: Similar to Alternative A, with cumulative, moderate, adverse impacts on the regional airsheds; but air quality in the Regional airsheds are expected to be maintained or improved. The designation of SMAs with the No Surface Use stipulations would better ensure that air quality in these areas of the Preserve are protected.

Impairment Analysis: Because there would be no major adverse impacts to air quality whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment to Preserve air quality.

Impacts on Air Quality under Alternative C (Maximum Resource Protection)

SMAs would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to geophysical exploration in all SMAs, except for the Hunting Areas and Birding Hot Spots SMAs that would have timing restrictions. The No Surface Use stipulation would be applied to drilling and production operations in all SMAs, except for the Hunting Areas SMA. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including 36 CFR 9B regulations (which have been described in Chapter 2, Parts II and III, and under Alternative A), should substantially reduce impacts on air quality throughout the Preserve.

Geophysical Exploration: Similar to Alternatives A and B, vehicle use to transport seismic work crews and equipment, and to drill shotholes could increase emissions of sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons, resulting in short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

The No Surface Use stipulation year-round in SMAs covering 37,088 acres may result in the modification of project designs for 3-D seismic surveys. As a result, it may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. As a result, impacts could occur inside or outside of the Preserve, and are dependant upon the location and layout of the seismic grid. Despite the greater number of vehicles and equipment for concentrated operations, impacts would be similar to Alternatives A and B, with short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Drilling and Production: Due to the designation of SMAs covering 46,273 acres, where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. As a result, new drilling and production operations would be distanced from SMAs and would have less effect on air quality in SMAs, especially for larger-sized particulates and odors that could settle out or dissipate close to the sources outside the SMAs. Emissions of more regional pollutants like fine particulates and ozone/haze precursors could still have effects as described under Alternatives A and B.

Similar to Alternatives A and B, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase particulate matter emissions. Well drilling could introduce nitrogen oxides, volatile organic compounds, carbon monoxide, sulfur dioxide, and odors from operating large engines, pumps and auxiliary equipment. Emissions could continue during production at lower levels; but could exceed emissions from drilling over the life of production operations. Mitigation should reduce impacts to short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), negligible to minor, adverse impacts on air quality. Hydrocarbons or treatment chemicals could be released during drilling, production, or transport. Hydrocarbons could volatilize and enter the atmosphere, and provide a source for explosion or fire, with minor to major, adverse impacts on air quality; but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to minor. Impacts on air quality in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short- to long-term, minor, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Existing operations on 613 acres (including 9 existing oil and gas operations on 11 acres and 8 plugged wells with ongoing reclamation on 13.2 acres, and 71 transpark pipelines and activities in their associated rights-of-way on 589 acres) could contribute to air quality degradation if hydrocarbons or treatment chemicals are leaked or spilled, or during routine maintenance operations if transported oil and gas products are exposed and volatilized to the atmosphere.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, increased vehicle use and removal of roads, pads, flowlines and pipelines could increase particulate matter emissions. Leaks and spills of hydrocarbons could occur during well plugging, shutting down and abandoning/removing flowlines and pipelines, or from use of heavy equipment and vehicles during reclamation activities, resulting in emissions of gaseous pollutants and providing a source for explosion or fire; but with mitigation, impacts would result in short-term, negligible, adverse impacts on air quality at sites throughout the Preserve. Impacts on air quality in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Cumulative Impacts: Similar to Alternatives A and B, with cumulative, moderate to major, adverse impacts on the regional airsheds; but, with adherence to State and federal ambient air quality standards, air pollution control requirements, and air quality management programs specified in State Implementation Plans, air quality in the regional airsheds are expected to be maintained or improved. The designation of SMAs over a larger area with the No Surface Use stipulation would better ensure that air quality in these areas of the Preserve are protected.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Where geophysical exploration could be permitted, impacts would be similar to Alternatives A and B, with short-term, negligible, adverse impacts on air quality near areas on

up to 465 acres of the Preserve. These impacts could be localized, as well as contribute to regional air quality impacts.

Drilling and Production: Similar to Alternatives A and B, with short to long-term, negligible to minor, adverse impacts on air quality localized around operations on up to 241 acres of the Preserve. Due to the designation of SMAs over a larger area where operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons beneath the Preserve. Impacts on air quality in the Preserve from directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short- to long-term, minor, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, with short-term, negligible, adverse impacts on air quality. Impacts on air quality in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, short-term, negligible, adverse impacts. These impacts could be localized, as well as contribute to regional air quality impacts.

Cumulative Impacts: Similar to Alternatives A and B, with cumulative, moderate, adverse impacts on the regional airsheds; but, air quality in the regional airsheds are expected to be maintained or improved. The designation of SMAs over a larger area with the No Surface Use stipulation would provide greater assurance that air quality in these areas of the Preserve are protected.

Impairment Analysis: Because there would be no major adverse impacts to air quality whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment to Preserve air quality.

IMPACTS ON GEOLOGIC RESOURCES

Introduction

Nearly half of the Preserve is located within floodplains and wetlands containing soils that are particularly susceptible to impacts from oil and gas operations. Disturbance to slopes would accelerate erosion, made easier by the heavy and sustained rainfall typical of the region, which averages 55 inches annually.

Methodology for Assessing Impacts

Actions projected under the RFD scenario were analyzed against mapped landcover classifications, which have been entered in the Preserve's geographic information system (GIS) database. Mapping involved delineating soils by Hydrologic Soil Group; mapping the 100 and 500-year floodplains, slopes, and defining the general location of sand mounds. The assessment of impacts is based on best professional judgement and was developed through discussion with NPS staff, consultants, and a review of relevant literature.

Impact Intensity Thresholds. Impacts on geologic resources could include:

- construction of roads, well pads, and/or flowlines could result in disturbance to poorly-drained soils that support riparian or wetland vegetation, the loss of long-term productivity, and reduced potential for successful reclamation;
- project construction could disturb slopes, which would result in long-term erosion;
- release of oil and gas or other contaminating and hazardous substances into the environment would impact soils;
- increased erosion rates or reduction in soil productivity and stability could prevent successful reclamation with native species and composition; and
- following project completion, more than two years could be required to reestablish ground cover needed to stabilize the site and minimize erosion of soils.

The thresholds of change for the intensity of an impact are defined as follows:

- Negligible:** Impacts would result in a change to geologic resources, but the change would be so slight that it would not be of any measurable or perceptible consequence.
- Minor:** Impacts would result in a change to geologic resources, but the change would be small and of little consequence and would be expected to be short-term and localized. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
- Moderate:** Impacts would result in a change to geologic resources that would be measurable, long-term, and localized. Mitigation measures, if needed to offset adverse effects, could be extensive, but would likely be successful.
- Major:** Impacts would result in a change to geologic resources that would be measurable and result in substantial consequences on a regional scale for long periods of time or to be permanent. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed.

Impacts on Geologic Resources under Alternative A (No Action/Current Management)

Under Alternative A, geologic resources throughout the Preserve would receive protection under Current Legal and Policy Requirements, including the 36 CFR 9B regulations, which require utilization of least-damaging methods. Through the application of Current Legal and Policy Requirements, impacts on geologic resources should be substantially reduced throughout the Preserve. However, there could be variations in how, where, and to what extent resource protection is applied. At this time, operational issues related to the protection of geologic resources are done on a case-by-case basis.

Geophysical Exploration: Off-road vehicle use, and shothole drilling and detonation could result in soil erosion, compaction, rutting, contamination, and blow-outs with localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve.

The primary impacts from geophysical exploration on geologic resources, including disturbance to sand mounds, would result from the use of overland vehicles to transport equipment and personnel. Vehicles are typically used in seismic operations to transport survey crews, water for drilling shotholes, shothole drilling equipment, geophones and cables. Vehicles could damage and kill plants, increasing the potential for soil erosion. Soil Hydrologic Groups "C" and "D" typically found in lowland areas (wetlands and floodplains) are very susceptible to adverse impacts from oil and gas operations. The NPS study, "Impact of Oil/Gas Development on Vegetation and Soils of Big Thicket National Preserve" (Fountain and Rayburn, 1987), found that upland soils allow deeper root penetration than seasonally wet (hydrologic) soils. Sloped sites and wet soils with shallow-rooted vegetation (typically found in wetlands and floodplains) were found to be the most susceptible to disturbance. Vegetation with shallow roots tends to be uprooted when run over by vehicles, while deeper-rooted plants would bend but later resume normal appearance. Also, loose alluvial soils and moist clays have low bearing capacities and are very susceptible to vehicle use.

Vehicles could also cause soil compaction, and reduce the soil's water-holding and infiltration capacities. Soil compaction would reduce vegetation's root-penetration capabilities and hinder plant growth and soil formation. Compacted soils increase runoff of surface waters and accelerate soil erosion. Vehicles could also cause deep rutting of soils if operations are conducted when soils are saturated, which would also contribute to erosion and increased runoff along ruts made by vehicles.

In most areas of the Preserve, the use of overland vehicles for geophysical exploration operations would not be permitted, thereby eliminating many of the adverse impacts associated with their use. Drilling shotholes with a hand-held auger could be done in areas where vehicle access would cause damage and unnecessary loss of vegetation, or where wet or saturated soils would be damaged by vehicle use. Since 1998, the 3-D seismic mini-shot hole technique has been used in the Preserve to minimize resource impacts. This method involves drilling shallow shotholes in a cluster or tight linear pattern with a hand-held portable-drilling tool. With this technique, equipment can be carried on foot or transported via helicopter, thereby reducing adverse impacts from overland vehicle use. During the initial application of this technique, detonation of a large number of the shotholes resulted in craters and blowouts, indicating that explosive charge size may have been too large for the shothole depth. While the mini-shothole technique may increase the chances of blowouts and craters, the risk of this occurring has been substantially reduced with improved project designs. If craters or blowouts were to occur, they would be reclaimed following completion of the 3-D seismic survey.

Several other mitigation measures provided for under Current Legal and Policy Requirements would help to minimize impacts on soils from exploration operations. The NPS's Nonfederal Oil and Gas Rights Regulations, at 36 CFR § 9.41(a), require that "Surface operations shall at no time be conducted within 500 feet of the banks of perennial, intermittent or ephemeral watercourses; or within 500 feet of the high pool shoreline of natural or man-made impoundment; or within 500 feet of the mean high tideline; or within 500 feet of any structure of facility (excluding roads) used for unit interpretation, public recreation or for administration of the unit, unless specifically authorized by an approved plan of operations." This operating requirement would eliminate direct impacts on soil resources within these areas. Nonfederal oil and gas operations could be exempt from this requirement as long as the operations utilize least-damaging methods to avoid or minimize adverse impacts on Preserve resources and values.

Also, no new roads would be allowed for geophysical exploration under Current Legal and Policy Requirements. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated soils to prevent soil compaction or rutting (particularly on Soil Hydrologic Groups "C" and "D" commonly found in floodplains and wetlands).

Explosive charges must be positioned where they would not cause soil damage. Shotholes would not be placed on slopes greater than 3 percent or on small terraces where there is a high probability for lateral blowouts. This mitigation measure should result in avoid directly impacting soils.

Drilling and Production: Where new wells could be located, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could erode, compact and rut soils, introduce non-native construction materials, and reduce soil permeability, resulting in localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), moderate, adverse impacts. Hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to minor.

Impacts on soils from construction of roads and drill pads would result from clearing of vegetation, exposing soils to erosion, and then compacting and introducing non-native fill materials to construct elevated access roads and pads. If there are no existing roads into the area, access roads would have to be constructed. A 30-foot-wide road, including shoulders and turnouts, one mile in length, would disturb approximately 3.63 acres of soil. Elevated pads for exploratory drilling and production operations may disturb as much as 2.4 acres of soil per site.

Soil erosion can be caused by raindrop splash, surface water movement, and by mass wasting. Raindrops loosen and dislodge soil particles as they strike the soil surface. Sheet erosion affects large areas with unconcentrated waterflows. Concentration of surface waters forms small, shallow channels (rills) that are up to a few inches deep. The convergence of rills forms gullies that can be several feet wide and deep. Large volumes of water and sediment can be transported downslope through gullies. Mass wasting is the loss of rocks and sediment and is caused by collapsing or headcutting of gully walls, gully bottoms, and stream banks. The loss is usually measured in cubic yards. The extent to which these erosional features (sheetwash, rills, and gullies) are present on a landscape indicates the severity of the erosion problem.

Slopes are particularly susceptible to erosion caused from road and wellpad construction. Avoidance of steep slopes and sensitive soils is required under Current Legal and Policy Requirements and is the most cost-effective and sensible approach that would avoid adverse impacts. Soil displacement and losses cannot be predicted with any degree of accuracy until soil studies have been done for a Plan of Operations. If there are no other practicable alternatives to constructing roads and pads on slopes, construction would be permitted if least-damaging methods are utilized. In all areas of the Preserve, and particularly for operations constructed on slopes greater than 3 percent, establishment of 70 percent native grass cover would be required within 3 months of initiating reclamation to minimize soil erosion.

Soil compaction related to road and wellpad construction reduces porosity and increases the soil's bulk density. Soil compaction occurs on roads and wellpads when vehicles or other heavy objects cross or are placed on the soil surface. A decrease in soil porosity causes a reduction of available water and oxygen for plant growth (Alexander and McLaughlin, 1990). In extreme cases, compaction can extend to a depth of 2 feet (the majority of the root zone). This may be an irreversible impact if compaction happens when the soil profile is wet. Soil Hydrologic Groups "C" and "D" are most common in wetlands and floodplains and have a relatively higher clay content, compact more easily, and have a lower bearing capacity (approximate bearing capacity: 2.8 lb/in² to 57.0 lb/in²) than sandy soils (approximate bearing capacity: 7.1 lb/in² to 85.0 lb/in²). To protect soils, the use of vehicles when soils are wet or saturated would not be permitted except on access roads and wellpads. The use of fill materials for the construction of access roads, wellpads and berms around wellpads is required to protect soils in the Preserve. Use of fill materials would protect the soils from erosion and would maintain the soil structure that is essential for re-establishment of vegetation following the completion of operations. Once drilling

and production operations are completed, the fill would be removed, exposing the underlying, undisturbed soils.

In addition to construction-related impacts associated with development of the access roads and wellpads, another primary impact to soils is the potential for releases of hazardous or contaminating substances during drilling or production operations. In most cases, primary and secondary containment on a wellpad should prevent the release of drilling muds, diesel fuel, oil and gas, and other substances beyond the drilling pad. But if a blow-out were to occur during drilling, standard containment may not prevent the release of contaminants into the surrounding environment.

The composition of the drilling mud depends on the types of formations being drilled, project economics, water availability, subsurface temperatures and pressures, and other factors. Mud can be composed of freshwater, or a mixture of water, oil, chemicals, clays, and weighting materials. Chemical additives such as alkalis, bactericides, soluble chromates, and corrosion inhibitors are often used to optimize well drilling. Weighting materials are often added to prevent formation fluids from flowing into the well as it is being drilled. Drilling mud can be highly toxic or relatively benign. The drilling mud and cuttings from the well account for the largest volume of waste generated at the wellsite. According to Current Legal and Policy Requirements, the drilling mud (including drill cuttings and waste fluids) at operations in the Preserve must be completely containerized in tanks for offsite disposal at a state approved facility.

Drilling operations in the Preserve should not encounter formations with hydrogen sulfide (H₂S), or high pressures and associated uncontrolled flows of oil, gas, brine, or fresh water. Safety precautions such as the use of properly weighted drilling muds and blow-out preventers are expected to ensure safe drilling operations that would prevent blowouts and the release of contaminants.

Since production operations could last for 20 years or longer, the potential for leaks and spills of hazardous or contaminating substances from production operations (including flowlines and pipelines) is greater than for any other type of oil and gas operation. Impacts on soils may occur from accidental discharge of drilling fluids during workovers, hazardous waste spills including diesel fuel, well blowouts, and rupture of flowlines and pipelines. Chronic small leaks and spills, could spread through various pathways, and over an extended period of time, could become significant and costly to remediate. The intensity of the impact would depend on the type of substance spilled, (hydrocarbons, produced waters, chemicals, solvents, and fuels), and the size of area impacted, and could be a minor to major adverse impact on geologic resources, but with mitigation, there should be negligible to minor adverse impacts on geologic resources. Releases of contaminating or hazardous substances normally require in-situ treatment or the removal of all of the contaminated soil and replacement with soil brought in from outside the Preserve.

Under Current Legal and Policy Requirements, risks associated with accidental releases of hazardous and contaminating substances are reduced to negligible by a variety of operating stipulations. Careful siting of operations would avoid moderate or steep slopes, reducing the potential for downslope contamination with oil, gas or other hazardous substances. Other considerations for locating a production site would include avoiding close proximity to wetlands, floodplains, or waterways. Other mitigation techniques include the use of less toxic or hazardous substances, storing the minimum quantity of contaminating and hazardous substances at operations locations, storing barrels or smaller containers of chemicals with secondary containment, using automatic shut-off valves on wells and on flowlines on each side of crossings of waterways and other sensitive resource areas, constructing berms and installing liners at production tank facilities and increasing their capacity to accommodate high precipitation events, and including a Spill Notification and Response Plan in the Plan of Operations.

In the event of a release of contaminating or hazardous substances into the environment, the NPS promptly notifies the National Response Center. In the event an operator does not respond promptly or

effectively to clean up a release, the NPS proceeds through the National Contingency Plan for cleanup, for which the operator is financially responsible. Cleanup attainment levels are to the baseline soil and surface/ground water chemistry, which is determined prior to beginning operations. When a release occurs, the NPS requires the operator to collect samples for lab analyses according to the NPS Guideline for the Detection and Quantification of Contamination at Oil and Gas Operations (Appendix F). In the event that contaminating or hazardous substances are not removed or reduced to predisturbance levels, the NPS may utilize the Park System Resource Protection Act to recover costs associated with the residual damages to park resources.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact geologic resources in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as steepness of slope and direction, and surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on geologic resources in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Surface subsidence caused by fluid withdrawals from beneath Big Thicket National Preserve is not expected because of the properties (depth, porosity, compaction, hydropressure, etc.) of the target reservoirs and adjacent overlying sediments. There is no evidence that past production has contributed to any subsidence in the Preserve. While subsidence related to oil and gas withdrawals is possible, conditions conducive to it occurring (very shallow, high porosity reservoirs combined with high fluid withdrawal volumes, or fractures extending from reservoir depths to the surface) are not known to exist in or near the Preserve.

Plugging/Abandonment/Reclamation: Well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, disturb and contaminate soils, but with mitigation, would result in localized, short- to long-term, negligible to minor, adverse impacts at sites throughout the Preserve. Incorrectly removing fill materials could result in exposing and eroding the underlying soils and disrupting surface water hydrology. Contamination from hydrocarbons and produced water still persists at several of these inactive and abandoned oil and gas operations. Until cleanup is successfully completed, there would be adverse impacts on geologic resources.

Contamination from hydrocarbons and produced water still persists at several of the inactive and abandoned oil and gas operations. Until cleanup is successfully completed, there would be adverse impacts on geologic resources.

Current Legal and Policy Requirements require the operator to conduct baseline soil chemical analyses so that if there is a release of hazardous or contaminating substances, the operator can remove or remediate the contaminants to acceptable levels and reclaim the site to pre-disturbance conditions.

Indirect impacts on geologic resources from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed. Therefore, impacts could range from no impact to indirect, localized short-term, minor, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for geologic resources covers the Lower Neches River Watershed which extends from the B.A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area has

been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact natural resources, including soils in the region.

Abandoned, ongoing and future oil and gas operations within and outside of the Preserve could adversely affect geologic resources. Existing (24.2 acres) and abandoned operations (unreclaimed sites comprising 376 acres), and transpark pipelines (589 acres) totaling 989 acres in the Preserve would continue to adversely affect geologic resources until the sites are reclaimed. Future oil and gas operations that are projected to occur on up to 465 acres for exploration operations and on up to 241 acres for drilling and production operations may also adversely affect geologic resources. Short-term impacts (1 to 3 years) could result from geophysical exploration (3-D seismic surveys) and short and long-term impacts could occur from the construction, maintenance and use of access roads, wellpads, flowlines or transpark oil and gas pipelines. While the total direct surface disturbance from oil and gas operations could be as high as 1,695 acres in the Preserve, it is expected that as some operations are being developed, others would be reclaimed to pre-disturbance conditions. Reclamation of existing access roads and wellpads within and outside of the Preserve would be a beneficial impact on soils. The removal of fill materials such as gravel and oyster shell, and recontouring and revegetating disturbed areas should reduce soil erosion and re-establish surface drainage flows.

Geologic resources (primarily soils) under all alternatives could be adversely affected by agricultural and forestry operations; urban and residential development; road construction, publicly owned facilities (water impoundments, water diversion structures, and sewage treatment), and oil and gas operations in and outside of the Preserve. Agricultural, forestry, and construction activities may cause compaction and rutting, reduce permeability, and increase erosion and deposition of sediments that could alter the topography, increase turbidity in streams, modify surface water flows and indirectly adversely affect vegetation, and fish and wildlife. Urban, residential, and agricultural run-off (such as fertilizers and oil; and leachate from septic systems); and accidental leaks and spills of oil, produced water, or other contaminating substances from oil and gas operations could contaminate sediments and soils. Water impoundments (i.e., Steinhagen Reservoir) and water diversion canals can increase or decrease water levels and alter the duration and frequency of stream flows, which indirectly affects the extent of flooded or saturated soils. Water impoundment structures (dams) also reduce sediment movement throughout the river system which can affect a variety of downstream natural resources.

The information provided by geologic resource surveys of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact. Over time, protection provided to geologic resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed, adversely impacting geologic resources. Overall, past, present, and future oil and gas development, along with other types of ground disturbing activities inside and outside the Preserve, should have cumulative, negligible to minor, adverse impacts on geologic resources.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Off-road vehicle use, and shothole drilling and detonation could result in soil erosion, compaction, rutting, contamination, and blow-outs with localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve.

Drilling and Production: The construction and maintenance of access roads, wellpads, flowlines, and pipelines could erode, compact and rut soils, introduce non-native construction materials, and reduce soil permeability, resulting in localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), moderate, adverse impacts on

up to 241 acres of the Preserve. Hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to minor. Indirect impacts on geologic resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, disturb and contaminate soils, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on geologic resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, minor, adverse impacts.

Cumulative Impacts: Over time, protection provided to geologic resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed adversely impacting geologic resources. The cumulative impact of nonfederal oil and gas operations within and outside the Preserve; oil and gas sites that are not reclaimed to predisturbance conditions; and other ground disturbing activities outside the Preserve could increase soil compaction, erosion and contamination, and alter soil chemistry resulting in cumulative, negligible to minor, adverse impacts on geologic resources.

Impairment Analysis: Because there would be no major adverse impacts to geologic resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve geologic resources.

Impacts on Geologic Resources under Alternative B (Preferred Alternative)

SMAs would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current and Legal Policy Requirements, including 36 CFR Part 9B regulations (which have been described in Chapter 2, Parts II and III), impacts on soils and other geologic resources should be substantially reduced throughout the Preserve.

Geophysical Exploration: Similar to Alternative A, in all other areas of the Preserve where exploration operations could be permitted, off-road vehicle use, and shothole drilling and detonation could result in soil erosion, compaction, rutting, contamination, and blow-outs with localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve. Where geophysical operations would be permitted, mitigation measures required under Current Legal and Policy Requirements would protect geologic resources in these areas (which have been described in Chapter 2, Parts II and III, and under Alternative A).

Drilling and Production: There would be no direct impacts on geologic resources in SMAs covered by the No Surface Use stipulation. New drilling or production operations (including the construction of roads and flowlines) would not be allowed in the riparian corridor unless the operation complies with the floodplain guidelines. If permitted, these operations would have to be sited adjacent to existing roads or within previously disturbed areas. Limiting drilling and production operations on 25,539 acres in the Riparian Corridors SMA would substantially reduce adverse impacts on Soil Hydrologic Groups "C" and

“D” that are very susceptible to adverse impacts from oil and gas operations. Drilling and production operations would also not be permitted in all Ecological Research and Monitoring SMAs. Soils and other geologic features in these areas would also be protected by the No Surface Use stipulation.

Similar to Alternative A, in all other areas of the Preserve where drilling and production operations could be permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could erode, compact and rut soils, introduce non-native construction materials, and reduce soil permeability, resulting in localized, short- to long-term, moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on geologic resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more, for roads, production operations, and flowlines and pipelines. Leaks and spills during construction activities or drilling or production operations, and blowouts during drilling operations could adversely impact geologic resources in the Preserve. The intensity of the impact would depend on the type of substance spilled, (hydrocarbons, produced waters, chemicals, solvents, and fuels), and the size of area impacted, and could result in minor to major, adverse impacts on soils. But, with the application of mitigation measures, and prompt response in the event of a spill, these impacts could be negligible to minor. Nonfederal oil and gas operations that predate this planning effort on 989 acres, including existing operations on 24.2 acres, abandoned and unreclaimed sites comprising 376 acres, and transpark pipelines on 589 acres and their associated rights-of-way would continue to adversely impact geologic resources in the Preserve.

It is anticipated, under Alternative B, that some wells may be directionally drilled from outside the SMAs to develop hydrocarbons underlying the SMAs. The intensity of impacts on soils is dependant upon where the operation is located with respect to soil type, whether the operation is sited inside or outside of the Preserve, and on the resource protection measures that are employed. Indirect impacts on geologic resources in the Preserve from drilling and production of directional wells from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative. Generally, the soils in upland areas are composed of Soil Hydrologic Groups “A” and “B” that are well to excessively drained, with a high silt and sand content, and moderate to high permeabilities. In comparison to bottomland soils, a spill in higher permeability upland soils could result in a greater chance for deeper penetration into the soils. Conversely, Soil Hydrologic Groups “C” and “D” typically found in lowland areas (wetlands and floodplains) are poorly drained, clayey soils with low permeabilities. There should be less adverse impacts from drilling and production operations on soils in upland areas than on soils found in wetlands and floodplains. However, if leaks and spills were to occur, the fluids could be transported downslope into surface waters and/or infiltrate into the groundwater, with minor to major, adverse impacts on water quality. But, with mitigation and quick response in the event of a spill, these adverse impacts should be negligible to moderate.

Where drilling and production operations would be permitted under Alternative B, mitigation measures should minimize adverse impacts on geologic resources. These include using fill materials to construct access roads and wellpads, not allowing the construction of access roads and wellpads on steep slopes, using containerized mud systems, constructing a berm around the wellpad, storing the minimum quantity of contaminating and hazardous substances at operations locations, storing barrels or smaller containers of chemicals with secondary containment, using automatic shut-off valves for disposal wells and on flowlines on each side of crossings of waterways and other sensitive resource areas, constructing berms and installing liners at production tank facilities and increasing capacity to accommodate high precipitation events, and including a Spill Notification and Response Plan in the Plan of Operations.

Surface subsidence caused by fluid withdrawals from beneath Big Thicket National Preserve is not expected because of the properties (depth, porosity, compaction, hydropressure, etc.) of the target reservoirs and adjacent overlying sediments. There is no evidence that past production has contributed

to any subsidence in the Preserve. While subsidence related to oil and gas withdrawals is possible, conditions conducive to it occurring (very shallow, high porosity reservoirs combined with high fluid withdrawal volumes, or fractures extending from reservoir depths to the surface) are not known to exist in or near the Preserve.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, disturb and contaminate soils, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on geologic resources in the Preserve from reclaiming of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative B would be the same as described for Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of geologic resources in the SMAs. Over time the additional protection afforded the Riparian Corridors SMA would protect soils that are particularly susceptible to adverse impacts from oil and gas operations or are essential to maintain the ecological integrity of the Preserve. Mitigation measures such as prohibiting vehicle use on wet or flooded soils would further protect soils in the Preserve. Land uses that could adversely affect geologic resources include; agricultural and forestry operations; urban and residential development; road construction, publicly owned facilities (water impoundments, water diversion structures, and sewage treatment plants), and oil and gas operations in and outside of the Preserve. Over time, protection provided to geologic resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed adversely impacting geologic resources resulting in cumulative, negligible to minor adverse impacts.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, exploration operations would result in localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternative A, the construction and maintenance of drilling and production operations would result in localized, short- to long-term, moderate, adverse impacts on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to minor. Indirect impacts on geologic resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternative A, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on geologic resources. Indirect impacts on geologic resources in the Preserve from reclamation directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, minor, adverse impacts.

Cumulative Impacts: The impacts would be the same as Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of geologic resources in the SMAs. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, negligible to minor, adverse impacts on geologic resources.

Impairment Analysis: Because there would be no major adverse impacts to geologic resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve geologic resources.

Impacts on Geologic Resources under Alternative C (Maximum Resource Protection)

SMAs would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to geophysical exploration in all SMAs, except for the Hunting Areas and Birding Hot Spots SMAs that would have timing stipulations. The No Surface Use stipulation would be applied to drilling and production operations in all SMAs, except for the Hunting Areas SMA. Many of the SMAs designated under Alternative C where the No Surface Use stipulation would apply contain geologic resources that are highly susceptible to adverse impacts from oil and gas operations (i.e., sand mounds, and Soil Hydrologic Groups "C" and "D" commonly located in wetlands and floodplains). In the remaining areas of the Preserve, where operations could be permitted, the application of Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations (which have been described in Chapter 2, Parts II and III, and under Alternative A), should substantially reduce impacts on geologic resources throughout the Preserve.

Geophysical Exploration: Many of the SMAs under this alternative are situated in lowland areas containing Soil Hydrologic Groups "C" and "D" which are highly susceptible to adverse impacts from vehicle use during nonfederal oil and gas operations. The No Surface Use stipulation in these areas would protect the hydrologic soils from any adverse impacts from geophysical exploration operations.

In areas of the Preserve where exploration operations could be permitted, off-road vehicle use, and shothole drilling and detonation could result in soil erosion, compaction, rutting, contamination, and blow-outs. The No Surface Use designation in SMAs covering 39,088 acres may result in the modification of project designs for 3-D seismic surveys. It may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. The modification of project designs could result in impacts similar to Alternatives A and B, with short-term, negligible to minor, adverse impacts on geologic resources on up to 465 acres outside of the SMAs. These adverse impacts could occur inside or outside the Preserve, and the intensity of the impact is dependent upon the layout of the seismic grid.

Where geophysical operations would be permitted, mitigation measures required under Current Legal and Policy Requirements would protect geologic resources in these areas. Surface operations cannot be conducted within 500 feet of waterways, or visitor use and administrative areas unless specifically authorized by an approved plan of operations (3 CFR § 9.41(a)). New roads may not be constructed for geophysical exploration. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated soils to prevent soil compaction or rutting (particularly in floodplains and wetlands). Explosive charges

must be positioned where they would not cause soil damage. Shotholes would not be placed on slopes greater than 3 percent or on small terraces where there is a high probability for lateral blowouts.

Drilling and Production: The No Surface Use stipulation in SMAs would protect these soils from any adverse impacts from construction and maintenance activities that could cause erosion, compaction, rutting, or loss of permeability. Also, many of the designated SMAs are situated in areas of the Preserve (i.e., Riparian Corridors and Rare Forested Wetlands Communities SMAs) containing Soil Hydrologic Groups “C” and “D” which are highly susceptible to adverse impacts from overland vehicle use during nonfederal oil and gas operations.

Similar to Alternatives A and B, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could erode, compact and rut soils, introduce non-native construction materials, and reduce soil permeability, resulting in localized, short- to long-term, moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on geologic resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines. Leaks and spills during construction activities or drilling or production operations, and blowouts during drilling operations could adversely impact geologic resources in the Preserve. The intensity of the impact would depend on the type of substance spilled, (hydrocarbons, produced waters, chemicals, solvents, and fuels), and the size of area impacted, and could result in minor to major, adverse impacts on soils. But, with the application of mitigation measures, and prompt response in the event of a spill, these impacts could be negligible to minor. Nonfederal oil and gas operations that predate this planning effort on 989 acres, including existing operations on 24.2 acres, abandoned and unreclaimed sites comprising 376 acres, and transpark pipelines on 589 acres and their associated rights-of-way would continue to adversely impact geologic resources in the Preserve.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of indirect impacts on geologic resources in the Preserve would depend on proximity to the Preserve, site-specific environmental conditions such as steepness of slope and direction, and surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on geologic resources in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

If the operations are conducted inside the Preserve, by directionally drilling to avoid SMAs, they are likely to occur in upland areas since drilling and production operations would not be permitted within the 500-year floodplain unless there is no practicable alternative. Generally, the soils in upland areas are composed of Soil Hydrologic Groups “A” and “B” that are well to excessively drained, with a high silt and sand content, and moderate to high permeabilities. Conversely, “C” and “D” soils typically found in lowland areas (wetlands and floodplains) are poorly drained, clayey soils with low permeabilities. There should be less adverse impacts from drilling and production operations on soils in upland areas than on soils found in wetlands and floodplains. However, if leaks and spills were to occur, the fluids could be transported downslope into surface waters and/or infiltrate into the groundwater, with minor to major, adverse impacts on water quality. But, with mitigation and quick response in the event of a spill, these adverse impacts should be negligible to moderate.

Where drilling and production operations would be permitted under Alternative C, mitigation measures should minimize adverse impacts on geologic resources. These include: (1) using fill materials to construct access roads and wellpads, (2) not allowing the construction of access roads and wellpads on steep slopes, (3) using containerized mud systems, constructing a berm around the wellpad, (4) storing the minimum quantity of contaminating and hazardous substances at operations locations, (5) storing barrels or smaller containers of chemicals with secondary containment, (6) using automatic shut-off valves for disposal wells and on flowlines on each side of crossings of waterways and other

sensitive resource areas, (7) constructing berms and installing liners at production tank facilities and increasing the capacity of storage tanks to accommodate high precipitation events, (8) and including a Spill Notification and Response Plan in the Plan of Operations.

Surface subsidence caused by fluid withdrawals from beneath Big Thicket National Preserve is not expected because of the properties (depth, porosity, compaction, hydropressure, etc.) of the target reservoirs and adjacent overlying sediments. There is no evidence that past production has contributed to any subsidence in the Preserve. While subsidence related to oil and gas withdrawals is possible, conditions conducive to it occurring (very shallow, high porosity reservoirs combined with high fluid withdrawal volumes, or fractures extending from reservoir depths to the surface) are not known to exist in or near the Preserve.

Plugging/Abandonment/Reclamation: There would be more acreage designated as SMAs under Alternative C, where exploration, drilling and production would not be permitted; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas. Similar to Alternatives A and B, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, disturb and contaminate soils, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Incorrectly removing road and pad fill could result in exposing and eroding the underlying soils and disrupting of surface water hydrology.

Indirect impacts on geologic resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to short-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative C would be the same as described for Alternatives A and B except that the No Surface Use stipulation would be applied in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development which would ensure widespread protection of geologic resources in the Preserve. Over time the protection afforded in the Sand Mounds, Riparian Corridors, and Rare Forested Wetland Communities SMAs would protect soils that are particularly susceptible to adverse impacts from oil and gas operations or are essential to maintain the ecological integrity of the Preserve. Mitigation measures such as prohibiting vehicle use on wet or flooded soils would further protect soils in the Preserve. Land uses that could adversely affect geologic resources include: agricultural and forestry operations; urban and residential development, road construction, publicly owned facilities (water impoundments, water diversion structures, and sewage treatment), and oil and gas operations in and outside of the Preserve. Over time, protection provided to geologic resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed adversely impacting geologic resources resulting in cumulative, negligible to minor adverse impacts.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Similar to Alternatives A and B, exploration operations would result in localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternatives A and B, drilling and production could be permitted in other areas of the Preserve, with localized, short to long-term, negligible to moderate, adverse impacts on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a

spill these impacts could be negligible to minor. Indirect impacts on geologic resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: There would be more acreage designated as SMAs under Alternative C, where exploration, drilling and production would not be permitted; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas.

Similar to Alternatives A and B, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on geologic resources. Indirect impacts on geologic resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, minor, adverse impacts.

Cumulative Impacts: The impacts would be the same as Alternatives A and B, except that the No Surface Use stipulation would be applied in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development which would ensure widespread protection of geologic resources in the Preserve. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, negligible to minor, adverse impacts on geologic resources.

Impairment Analysis: Because there would be no major adverse impacts to geologic resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve geologic resources.

IMPACTS ON WATER RESOURCES

Introduction

Water plays a dominant role in maintaining the ecological integrity of the Preserve, and protection of water resources is a very high management priority. Four of the twelve management units in the Preserve are riparian corridors. All 12 units are dominated by major waterways and surface water flow. Nearly half of the Preserve is floodplains, and over 40 percent is wetlands. Abundant rainfall, averaging 55 inches of precipitation annually, could contribute to erosion of soils and increase sediment load in rivers and streams caused by nonfederal oil and gas operations. Oil and gas operations have the potential to release pollutants into surface and ground waters, which can threaten Preserve resources.

Methodology for Assessing Impacts

Actions projected under the RFD scenario were analyzed against mapped land-type delineations, which have been entered in the Preserve's geographic information system database. Resources that have been mapped include wetlands, 100- and 500-year floodplains, and surface waters. The degree of potential impacts on water resources from oil and gas development would depend on the types and locations of operations and the mitigation measures used to reduce impacts. The assessment of

impacts is based on best professional judgement and was developed through discussions with NPS staff and consultants and a review of relevant literature.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are as follows:

- Negligible:** Impacts would result in a change to water resources and/or floodplains, but the change would be so slight that it would not be of any measurable or perceptible consequence.
- Minor:** Impacts would result in a change to water resources and/or floodplains, but the change would be small and of little consequence and would be expected to be short-term and localized. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
- Moderate:** Impacts would result in a change to water resources and/or floodplains that would be measurable, long-term, and localized. Mitigation measures, if needed to offset adverse effects, could be extensive, but would likely be successful.
- Major:** Impacts would result in a change to water resources and/or floodplains that would be measurable and have substantial consequences on a regional scale for long periods of time or to be permanent. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed.

Impacts on Water Resources under Alternative A (No Action/Current Management)

Under Alternative A, SMAs would not be formally designated. Protected areas comprising 56,538 acres and other areas of the Preserve would be provided protection under Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations. Interpretation and application of Current Legal and Policy Requirements, and project-specific considerations, could result in variations in how, where, and to what extent resource protection is applied in the Preserve. If appropriate identification of water quality concerns is not made and avoidance or mitigation techniques are not applied, impacts on water resources could be the greatest under Alternative A.

Surface water quality can be directly affected by altering or disrupting surface flow (e.g., velocity, quantity or direction), increasing turbidity and sediment loads, or introducing hazardous and contaminating substances into stream systems. The following sections provide descriptions of impacts on water resources that could result from specific types of oil and gas operations.

Geophysical Exploration: Where exploration operations could be permitted, the loss or modification of vegetation, off-road vehicle use, and shothole drilling and detonation could increase turbidity and sedimentation, and degrade water quality in surface waters with localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve. Shothole drilling and detonation are expected to have negligible, adverse impacts on groundwater quality and quantity in the Preserve.

The primary impacts from geophysical exploration on water resources would result from the use of overland vehicles to transport equipment and personnel. Vehicles are typically used in seismic operations to transport survey crews, water for drilling shotholes, shothole drilling equipment, and geophones and cables. Vehicles could damage and kill plants, increasing the potential for soil erosion,

turbidity, and sedimentation in waterways. However, in most areas of the Preserve, seismic operations could be done with smaller, lightweight vehicles or on foot, using the mini-shothole technique (see discussion under Impacts on Geologic Resources). This would minimize impacts on vegetation, soils, and subsequently on water resources from the use of vehicles.

Seismic operations are anticipated to have negligible effects on groundwater quantity or quality. Shothole detonation could dislodge or mobilize clays within an aquifer and cause a decrease in water quality, or a reduction in groundwater flow. These effects are very uncommon and usually of short duration, unless the aquifer has limited geographic extent such as a localized perched water table. Explosives that are occasionally left undetonated in shotholes could introduce small quantities of organic chemical compounds that are biodegradable within two to three years. The small quantity of explosives (usually ½-pound) spaced approximately 110 to 440 feet apart is not expected to appreciably impact groundwater chemistry. Soils such as fragipans that support surface waters in wetlands areas, are susceptible to adverse impacts from oil and gas operations and could conceivably be disturbed by shothole drilling, and possibly fractured from the detonation of explosives in shotholes. However, through Current Legal and Policy Requirements, operators are required to conduct soil surveys in the proposed project area, and must avoid the remote possibility of fracturing or splitting aquitards by offsetting shotholes or using smaller explosive charges. Therefore, the NPS anticipates no more than negligible, adverse impacts from geophysical exploration on the Beaumont Clay Unit or other aquitards; or on the quantity or quality of the groundwater in the Preserve.

Where geophysical operations would be permitted, mitigation measures required under Current Legal and Policy Requirements would protect water resources in these areas. Surface operations cannot be conducted within 500 feet of waterways, or visitor use and administrative areas unless specifically authorized by an approved plan of operations (36 CFR § 9.41(a)). New roads may not be constructed for geophysical exploration. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated soils to prevent soil compaction or rutting (particularly in floodplains and wetlands). Explosive charges must be positioned where they would not cause soil damage. Shotholes would not be placed on slopes greater than 3 percent or on small terraces where there is a high probability for lateral blowouts.

Drilling and Production: In accordance with Current Legal and Policy Requirements (Director's Order 77-2 for Floodplain Management), drilling and production operations would not be permitted within the 500-year floodplain unless there is no practicable alternative. Where permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase soil erosion, turbidity and sedimentation, and alter flow characteristics and hydrologic functions of surface waters with localized, short- to long-term, minor to moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on water resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines. Surface and groundwater in the Preserve could be contaminated if drilling muds, hydrocarbons, produced waters, or treatment chemicals are released during drilling, production, or transport, with moderate to major, adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate.

Prior to conducting operations, the operator must collect site-specific water resources data such as stream discharge, precipitation, runoff, soils, slope, vegetation cover, current sediment loading, etc., for a quantitative impact assessment on water resources to be included in the Plan of Operations. If the incremental increase of sediment loads into surface and groundwater is small relative to the current load, the adverse impacts from drilling and production operations would likely be minor. If the incremental increase of sediment loads is large relative to the current loads, the resulting sedimentation could alter stream channel morphology, degrade water quality, and damage aquatic habitats. Assuming the successful implementation of mitigation measures, such as erosion and sediment

controls and other least-damaging methods, impacts on water quality and aquatic habitat would likely be minor.

Surface water quality could be impacted by the construction, use, and maintenance of access roads used for oil and gas operations. The potential for adverse impacts from roads would be greatest where extensive cut and fill was necessary to construct the roadway. Road construction and maintenance could expose soils to erosion, which could move downslope and fill in depressions and increase turbidity and sedimentation in surface waters. Compacted road fill could also reduce infiltration rates on road surfaces. Additional roads in the Preserve could increase access, which in turn could result in additional land disturbance and erosion. If roads are used during wet conditions, rutting could occur and may concentrate surface waterflows. However, proper siting, engineering design, construction, and maintenance of roads would substantially reduce impacts associated with road construction, use, and maintenance.

Access roads and pads could disrupt natural surface flow patterns and may result in an increase or decrease in the amount of water in some areas (including wetlands). The proper siting and alignment of roads and pads, and the placement of adequate culverts under access roads, and appropriate drainage on and around drilling and production pads, adverse impacts on water resources would be minimized.

NPS regulations under 36 CFR § 9.41(a) require a setback of 500 feet from waterways for all oil and gas operations, unless specifically authorized by an approved plan of operations. Therefore, increased erosion and sedimentation in surface waters from access roads, drilling and production pads is expected to be minor. Increased sediment loads would be more likely at stream crossings during the construction of bridges, and during the construction or replacement of flowlines and transpark oil and gas pipelines. Current Legal and Policy Requirements such as obtaining Clean Water Act Section 404 permits prior to undertaking any work in waterways would mitigate impacts at stream crossings.

Oil and gas drilling operations are not expected to impact surface and groundwater quantity from surface and groundwater withdrawals. According to 36 CFR § 9.35, water for nonfederal oil and gas operations may not be taken from within the Preserve unless approval is granted in a plan of operations. If an operator requests to use water within the Preserve, the NPS would evaluate the potential effects on in-stream flows of tributary channels and groundwater quantity prior to approval of the plan. If adverse effects are anticipated, the request would be denied and the operator would have to obtain water from outside the Preserve.

Water resources could become contaminated if hazardous or contaminating substances are released during drilling operations. Blowouts could occur and release hydrocarbons, water, and drilling mud, but the use of blow-out preventers should prevent an uncontrolled contaminant release during drilling operations. There could also be accidental spills of drilling mud, diesel fuel, and other chemicals during drilling operations. Primary and secondary containment systems such as containerized mud systems, impermeable wellpad liners, and berms around the perimeter of the wellpad should prevent the release of hazardous and contaminating substances into surface and groundwaters.

Drilling operations in the Preserve should not encounter formations with hydrogen sulfide (H₂S), or high pressures and associated uncontrolled flows of oil, gas, brine, or fresh water. Safety precautions such as the use of properly weighted drilling muds and blow-out preventers are expected to ensure safe drilling operations that would prevent blowouts and the release of contaminants.

It is possible that drilling and production operations could adversely impact groundwater quality if adequate mitigation measures are not employed. If drilling mud, fuels, or other chemicals are spilled on the ground and there is no impermeable liner on the wellpad, the fluids could infiltrate into shallow aquifers. During drilling operations and prior to casing the well, groundwater quality is protected because drilling muds form a "mud cake" on the walls of the wellbore which minimizes the loss of fluids

into the surrounding formations. Faulty installation or corrosion of production casing may go undetected for years and could adversely impact groundwater, if hydrocarbons and/or produced waters migrate into an aquifer and contaminate groundwater. However, proper placement and cementing of casing through all useable aquifers according to the minimum standards required by the Railroad Commission of Texas should adequately protect groundwater from contamination with hydrocarbons and produced waters.

Since production operations could last for 20 years or longer, the potential for leaks and spills of hazardous or contaminating substances from production operations (including flowlines and pipelines) is greater than for any other phase of oil and gas operation. Adverse impacts on water quality may occur from accidental leaks and spills of drilling fluids during workovers, hazardous waste spills including diesel fuel, well blowouts, rupture of flowlines and pipelines, and spills from tanker trucks. Chronic small leaks and spills, could spread through various pathways, and over an extended period of time, could become significant and costly to remediate. The intensity of the impact would depend on the type of substance spilled (hydrocarbons, produced waters, chemicals, solvents, and fuels), and the size of area impacted, and could be a minor to major, adverse impact on water resources. However, with mitigation there should be negligible to moderate adverse impacts on water resources. Releases of contaminating or hazardous substances normally require in-situ treatment of soils, surface and groundwater, or the removal of all of the contaminated soil and replacement with soil brought in from outside the Preserve.

The transport of hydrocarbons has the potential to adversely affect water quality. Production pipelines can rupture from corrosion of the pipe, or from failure of a flange, valve, or seal. Transpore oil and gas pipelines are generally larger in diameter and under more pressure than the smaller flowlines and pose the potential for a large volume release. The escaping fluids could contaminate surface and groundwater and could have major adverse impacts on water quality in and downstream from the Preserve. In lieu of transporting hydrocarbons via pipelines, the product could be transported by tanker truck. This method has a greater potential for leaks and spills during transfer of fluids to the tanker, in addition to the potential for vehicular accidents in which the tank contents could be spilled.

If there is an accidental release of a hazardous or contaminating substance, the NPS promptly notifies the National Response Center. In the event an operator does not respond promptly or effectively to clean up a release, the NPS proceeds through the National Contingency Plan for cleanup, for which the operator is financially responsible. Cleanup attainment levels are to the baseline surface/ground water chemistry, which is determined prior to beginning operations. When a contaminant release occurs, the NPS requires the operator to collect samples for lab analyses according to the NPS Guideline for the Detection and Quantification of Contamination at Oil and Gas Operations (Appendix F). If hazardous or contaminating substances are not removed or reduced to predisturbance levels, the NPS may utilize the Park System Resource Protection Act to recover costs associated with the residual damages to park resources.

Mitigation measures required under Current Legal and Policy Requirements are expected to prevent the contamination of surface and groundwater. Siting drilling and production operations 500 feet from waterways as required under at 36 CFR § 9.41(a), unless specifically authorized by an approved plan of operations, would reduce the likelihood of spills entering waterways. Also, careful siting of wellpads away from moderate or steep slopes would minimize the potential of contaminating or hazardous substances being transported down-slope and into streams. The use of automatic shut-off valves on flowlines and pipelines on each side of a stream crossing would reduce the volume of a hydrocarbon release. Additional mitigation measures that would protect water resources include: using least contaminating and hazardous substances, storing the minimum quantity of contaminating and hazardous substances at operations locations, storing barrels or smaller containers of chemicals in "coffins" or other secondary containment, constructing berms and installing liners at drilling operations and at production facilities and increasing capacity within the firewall to accommodate high precipitation events, and including a Spill Notification and Response Plan in the Plan of

Operations. Routine monitoring by operators and the NPS should promptly identify and correct potential problems and is expected to avoid or minimize adverse impacts from leaks and spills of hazardous and contaminating substances.

Twenty plugged and abandoned wells located within the active meander belt of the Neches River could potentially impact water resources. As described in Chapter 3 – Affected Environment, river migration has exposed two of these wells so that they are now located approximately 40 feet from the eastern bank of the Neches River. Even though these two exposed wells are marked with solar powered warning lights, the potential exists for collision from boats or flood debris, which could breach the well casing. If this occurs, remaining fluids in the wellbore could contaminate the Neches River, resulting in a major adverse impact. Eighteen other plugged and abandoned wells are located within the active meander belt of the Neches River and could be exposed when the river migrates.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact water resources in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions, particularly surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on water resources in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, sedimentation in waterways, alter surface water flows, and contaminate surface and groundwater, but with mitigation, would result in localized, short-term, negligible to moderate, adverse impacts at sites throughout the Preserve.

Reclamation of drill pads, roads, and other disturbed areas under most conditions should reduce erosion rates to predisturbance levels within two to five years. Over time, these practices could eliminate the adverse impacts caused by drilling and production operations, if fill materials are completely removed, sites are properly prepared by ripping compacted areas, sites are recontoured to match original contours, and proper seed mixtures and revegetation techniques are utilized.

Indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for water resources covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area has been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact water resources in the area.

Abandoned, ongoing and future oil and gas operations within and outside of the Preserve could adversely affect water resources. Existing (24.2 acres) and abandoned operations (unreclaimed sites comprising 376 acres), and transpark pipelines (589 acres) totaling 989 acres in the Preserve may continue to adversely affect water resources until the sites are reclaimed. Future oil and gas operations

that are projected to occur on up to 465 acres for exploration operations and on up to 241 acres for drilling and production operations may also adversely affect water resources. Short-term impacts (1 to 3 years) could result from geophysical exploration (3-D seismic surveys) and short-term and long-term impacts could occur from the construction, use and maintenance of access roads, wellpads, flowlines, and transpark oil and gas pipelines. While the total direct surface disturbance from oil and gas operations could be as high as 1,695 acres in the Preserve, it is expected that as some operations are being developed, others would be reclaimed to pre-disturbance conditions. Indirect cumulative, adverse impacts on water resources could occur from these operations, and may include increased turbidity and sedimentation in waterways, and contamination from accidental leaks and spills of hazardous and other contaminating substances (oil, drilling mud, produced water, and treatment chemicals). Reclamation of existing oil and gas operations, including access roads and wellpads within and outside the Preserve would be a beneficial impact on water resources. Recontouring and revegetating disturbed areas should reduce soil erosion and re-establish surface drainage flows. For more detailed information, the reader is referred to the analysis of environmental impacts pertaining to oil and gas operations under each alternative.

Land uses that could potentially impact water quality in the region include: residential development, agricultural and forestry activities, oil and gas development, and publicly owned facilities (water impoundments, water diversion structures, and sewage treatment plants).

Water quality could be impacted by various activities in and around the Preserve. Water quality could be adversely impacted by contamination from surface runoff and from accidental leaks and spills of hydrocarbons, drilling muds, produced water, and treatment chemicals during oil and gas operations. Nutrient and organic enrichment caused by runoff from fertilizer use, leaching from septic systems, and sewage effluent may increase organic matter and subsequently reduce dissolved oxygen in sediments and the water column. The combustion of fossil fuels may increase the acidity of surface waters. The encroachment of saltwater in the lower Neches River and Pine Island Bayou from the Gulf of Mexico may locally increase the salinity in surface and groundwater. (A permanent saltwater barrier is on the Neches River just south of the Preserve. Temporary saltwater barriers on the Lower Neches and Pine Island Bayou have been installed to mitigate the encroachment of saltwater into the Preserve). Ground disturbances would expose sediments to erosion, which in turn can increase turbidity in surface waters. Excavation activities associated with construction, the installation of subsurface drainage, and extensive groundwater or surface water withdrawals for agricultural, industrial, or residential uses may disrupt surface and subsurface water flow, which could cause reductions in water levels and/or changes in frequency, duration, or extent of water distribution.

With the exception of reduced turbidity and chloride concentrations, water quality data show regional water quality has declined somewhat, with declines in dissolved oxygen and alkalinity, and increases in pH and sulfate concentrations (Hall and Bruce, 1996). Regional decline in dissolved oxygen may be related to increasing water temperature or increased organic loading (Hall and Bruce, 1996). Organic loading from agricultural run-off, sewage effluent, leaching from septic systems (e.g., fecal coliform bacteria, oxygen-demanding substances, and nutrients), and decaying vegetation exert a demand on dissolved oxygen. Increasing water temperature could result from changes in land use (such as conversion of forest to pasture or rural to urban), changes in the amount of shade along watercourses, forestry operations, or increasing air temperatures due to long-term climatic fluctuations or global warming (Hall and Bruce, 1996). Water quality data from 1975 to 1983 have identified produced water (brine or saltwater) from oil fields in Saratoga, Sour Lake, and Batson as recurring contributors to elevated chlorides in Pine Island Bayou. However, the Lower Neches River Valley Authority (LNVA 1994) found no exceedances for chloride since 1985. Overall, chloride concentrations have declined (improved) in the Lower Neches, Little Pine Island Bayou, Turkey Creek, and Menard Creek – partly attributed to declining releases of oil field brine and reduced saltwater (seawater) intrusion (Hall and Bruce, 1996).

While providing for flood and sediment control, habitat for fish and wildlife, recreation, and hydropower for general electricity, the construction and operation of Sam Rayburn and Steinhagen Reservoirs have changed the flow characteristics of the Neches River. These impoundments have reduced the frequency and duration of both high and low flows on the Neches River (Gooch, 1996 and Hall, 1996). In addition, changes in the overall amount and timing of stream flows may directly affect stream channel morphology (structure or form), rate of river migration, sedimentation, water quality, and the amount and type of aquatic habitat. Indirectly, these changes could affect the growth, mortality, and regeneration of vegetation along riparian corridors. Changes in species composition and distribution of floodplain forest communities in the Preserve (i.e., in the floodplain of the Jack Gore Baygall/Neches Bottom Unit) are mainly attributed to the Rayburn and Steinhagen reservoirs (Hall, 1996).

Water diversions such as the Lower Neches River Valley Authority Canal may affect flooding frequency and duration by reducing (or increasing) the amount of water flowing through stream channels (Pearlstine et al., 1985). A number of water diversions exist within the Neches River Basin, although most of the diversions are at the south end of the Preserve and do not substantially alter the volume of flows within the Preserve's water corridor units (Harcombe and Callaway, 1997). Due to projected water needs for central and south Texas, the "Trans-Texas Water Program" is considering, among other options, the transfer of water between the Sabine River Basin and the San Jacinto River Basin. Although avoiding impacts on the Preserve has been one factor for reviewing route alternatives, the possibility exists for disturbance to water corridor units from construction, fragmentation of habitat, and/or changes in water circulation or quantity (Harcombe and Callaway, 1997).

The quality and quantity of groundwater in the region represents an important resource for southeast Texas (for further information, see Chapter 3 – Water Resources). The Gulf Aquifer System has been used extensively for groundwater development, and in part continues to provide water for municipal, industrial, and agricultural uses in Beaumont, Silsbee, Kountze, and Sour Lake. The Texas Water Commission, as part of its Statewide groundwater assessment program, has used the DRASTIC methodology to evaluate the vulnerability of aquifers to pollution (Texas Water Commission, 1989). Using this methodology, the preliminary assessment indicates that the entire Preserve would be moderately to very vulnerable to groundwater contamination from both agricultural and industrial sources (Allen, 1999). Groundwater can be adversely impacted by both natural and human causes. Natural contaminants include salt from salt domes, sulfur and associated mineral deposits, naturally radioactive materials, and chemicals associated with petroleum deposits (Lamar University, 1996). Adverse impacts on groundwater could result from improper handling, storage, or transport of toxic, hazardous, or contaminating substances; sewage effluent; runoff from agricultural and forestry operations (e.g., fertilizer use); contamination of water supplies by pathogenic or disease-causing microorganisms; and extensive use. Past and present adverse impacts on groundwater have ranged from minor to major. If not properly managed and maintained, storage tanks, saltwater injection wells, and pipelines for oil and gas operations may threaten groundwater quality in the Preserve and region.

The information provided by water resource surveys of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact. Over time, protection provided to water resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed, adversely impacting water resources. Therefore, cumulative impacts on water resources are expected to be minor to moderate under Alternative A.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: The loss or modification of vegetation, off-road vehicle use, and shothole drilling and detonation could increase turbidity and sedimentation, and degrade water quality in

surface waters with short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve. Shothole drilling and detonation of explosives in shotholes are expected to have negligible, adverse effects on groundwater quality and quantity in the Preserve.

Drilling and Production: Under Current Legal and Policy Requirements, drilling and production operations would not be permitted within the 500-year floodplain unless there is no practicable alternative. Where permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase soil erosion, turbidity and sedimentation, and alter flow characteristics and hydrologic functions of surface waters with short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), minor to moderate, adverse impacts on up to 241 acres of the Preserve. Surface and groundwater in the Preserve could be contaminated if drilling muds, hydrocarbons, produced waters, or treatment chemicals are released during drilling, production, or transport, with moderate to major, adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate. Indirect impacts on water resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, sedimentation in waterways, alter surface water flows, and contaminate surface and groundwater, but with mitigation, would result in localized, short-term, negligible to moderate, adverse impacts at sites throughout the Preserve. Indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, minor, adverse impacts.

Cumulative Impacts: Over time, protection provided to water resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed, adversely impacting water resources. The cumulative impact of nonfederal oil and gas operations in and outside the Preserve; oil and gas sites that are not reclaimed to predisturbance conditions; ground disturbing activities; and water impoundments outside the Preserve could increase sediment loads in streams, alter surface water flows and stream morphology, and introduce hazardous and contaminating substances into surface and groundwaters, resulting in cumulative, minor to moderate, adverse impacts on water resources.

Impairment Analysis: Because there would be no major adverse impacts to water resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve water resources.

Impacts on Water Resources under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current and Legal Policy Requirements, including 36 CFR 9B regulations (which have been described in Chapter 2, Parts II and III, and under Alternative A), impacts on water resources should be substantially reduced throughout the Preserve.

Geophysical Exploration: The designation of the Riparian Corridors and the Rare Forested Wetlands Communities SMAs where vehicle use would not be permitted on or across saturated soils in

Soil Hydrologic Groups “C” and “D” soils would indirectly protect water quality. This operating stipulation would eliminate the potential for vegetation damage, increased soil erosion and increased turbidity and sedimentation in surface waters as a result of vehicle use. The No Surface Use stipulation for geophysical exploration in the Ecological Research and Monitoring Plots would also indirectly protect water quality because vehicles and shothole detonation would not be permitted in these areas.

Similar to Alternative A, in all other areas of the Preserve where exploration operations could be permitted, the loss or modification of vegetation, off-road vehicle use, and shothole drilling and detonation could increase turbidity and sedimentation, and degrade water quality in surface waters with short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve. Shothole drilling and detonation are expected to have negligible, adverse effects on groundwater quality and quantity in the Preserve.

The primary impacts from geophysical exploration on water resources would result from the use of overland vehicles to transport equipment and personnel. Vehicles are typically used in seismic operations to transport survey crews, water for drilling shotholes, shothole drilling equipment, and geophones and cables. Vehicles could damage and kill plants, increasing the potential for soil erosion, turbidity, and sedimentation in waterways. However, in most areas of the Preserve, seismic operations could be done with smaller, lightweight vehicles or on foot, using the mini-shothole technique. This would minimize impacts on vegetation, soils, and subsequently on water resources from the use of vehicles.

With mitigation, geophysical exploration should result in negligible adverse impacts on groundwater quality and quantity. Shothole detonation could dislodge or mobilize clays within an aquifer and cause a decrease in water quality, or a reduction in groundwater flow. These effects are very uncommon and usually short duration, unless the aquifer has limited geographic extent. Explosives that are occasionally left undetonated in shotholes could introduce small quantities of organic chemical compounds that are biodegradable within two to three years.

Where geophysical operations would be permitted, mitigation measures required under Current Legal and Policy Requirements would protect water resources in these areas. Surface operations cannot be conducted within 500 feet of waterways, or visitor use and administrative areas unless specifically authorized by an approved plan of operations (36 CFR § 9.41(a)). New roads may not be constructed for geophysical exploration. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated soils to prevent soil compaction or rutting (particularly in floodplains and wetlands). Explosive charges must be positioned where they would not cause soil damage. Shotholes would not be placed on slopes greater than 3 percent or on small terraces where there is a high probability for lateral blowouts.

Drilling and Production: Drilling and production operations would not be permitted within designated SMAs where the No Surface Use stipulation would be applied. The No Surface Use stipulation in the Riparian Corridors applies, except operations could be permitted adjacent to existing roadways and within previously disturbed areas, where operations would result in no new direct impacts on water resources in the Preserve.

The 500-foot offset required under 36 CFR § 9.41(a), unless specifically authorized by an approved plan of operations, would protect surface waters from direct impacts from drilling and production operations. Indirect impacts could occur in the designated SMAs as a result of drilling and production operations sited near the SMAs; however, these impacts would be expected to be minor and localized. However, operations on 989 acres including existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) operations, and transpark pipelines (589 acres) would continue to adversely impact water resources in the Preserve.

Similar to Alternative A, in all other areas of the Preserve where drilling and production operations could be permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase soil erosion, turbidity and sedimentation, and alter flow characteristics and hydrologic functions of surface waters with short to long-term, minor to moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on water resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines. Leaks and spills during construction activities or drilling or production operations, and blowouts during drilling operations could adversely impact water resources in the Preserve. The intensity of the impact would depend on the type of substance spilled, (hydrocarbons, produced waters, chemicals, solvents, and fuels), and the size of area impacted, and could result in moderate to major, adverse impacts on water resources. But, with the application of mitigation measures, and prompt response in the event of a spill, these impacts could be negligible to moderate.

It is possible under Alternative B that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. Similar to Alternative A, indirect impacts on water resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative. Adverse impacts on water resources should be minor in these upland areas because the operations would not be sited near waterways. However, if there is an accidental leak or spill of a hazardous or contaminating substance, the fluids could be transported downslope into surface waters and/or infiltrate into the groundwater, with minor to major, adverse impacts on water quality. But, with mitigation and quick response in the event of a spill, these adverse impacts should be negligible to moderate.

Where drilling and production operations would be permitted, the following mitigation measures would avoid or minimize adverse impacts on water resources: proper siting, design, construction and maintenance of access roads and drilling pads, using containerized mud systems, lining the wellpad with impermeable materials, constructing a berm around the wellpad, storing the minimum quantity of contaminating and hazardous substances at operations locations, storing barrels or smaller containers of chemicals inside secondary containment, using automatic shut-off valves for disposal wells and on flowlines on each side of crossings of waterways and other sensitive resource areas, constructing berms and installing liners at production tank facilities and increasing the secondary containment capacity of storage tanks to accommodate high precipitation events, and including a Spill Notification and Response Plan in the Plan of Operations. Routine monitoring by operators and the NPS should promptly identify and correct potential problems and is expected to avoid or minimize adverse impacts from leaks and spills of hazardous and contaminating substances.

Plugging/Abandonment/Reclamation: The designation of SMAs would increase the acreage where the No Surface Use stipulation would be applied to exploration, drilling and production operations; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas. Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities outside of the SMAs could cause soil erosion, sedimentation in waterways, alter surface water flows, and contaminate surface and groundwater, but with mitigation, would result in localized, short-term, negligible to moderate, adverse impacts at sites throughout the Preserve. Indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, moderate, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative B would be the same as those described for Alternative A except that the formal designation of SMAs (such as the Riparian Corridors and Rare Forested Wetland Communities SMAs), and the application of specific protection measures in these SMAs, would provide consistent protection of water resources in the Preserve. Over time, protection provided to water resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed, adversely impacting water resources. The cumulative impact of nonfederal oil and gas operations within and outside the Preserve; oil and gas sites that are not reclaimed to predisturbance conditions; ground disturbing activities; and water impoundments upstream of the Preserve could increase sediment loads in streams, alter surface water flows and stream morphology, and introduce hazardous and contaminating substances into surface and groundwater, resulting in cumulative, minor to moderate, adverse impacts on water resources.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, exploration operations could be permitted in other areas of the Preserve, with short-term, negligible to minor, adverse impacts on surface and groundwater on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternative A, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, resulting in short- to long-term, minor to moderate, adverse impacts on water resources on up to 241 acres of the Preserve. However, leaks and spills could result in moderate to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to moderate. Indirect impacts on water resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternative A, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to moderate, adverse impacts on water resources. Indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short-term, moderate, adverse impacts.

Cumulative Impacts: The impacts would be the same as described for Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of water resources in and adjacent to the SMAs. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, minor to moderate, adverse impacts on water resources.

Impairment Analysis: Because there would be no major adverse impacts to water resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve water resources.

Impacts on Water Resources under Alternative C (Maximum Resource Protection)

Special Management Areas would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to all types of operations in all SMAs, except for the Hunting Area SMA, which has a timing stipulation for geophysical exploration. The total acreage of the Preserve in which operating stipulations would apply covers 75,293 acres. Many of the SMAs designated under Alternative C where the No Surface Use stipulation would apply are adjacent to the stream network in the Preserve (i.e., the Riparian Corridors SMA) or are dependant upon water resources to maintain their ecological integrity (i.e., Rare Forested Wetlands SMA, Ecological Research and Monitoring Plots SMA). By applying all applicable Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations (which have been described in Chapter 2, Parts II and III, and under Alternative A), impacts on water resources should be substantially reduced throughout the Preserve.

Geophysical Exploration: Where geophysical operations are permitted, the loss or modification of vegetation, off-road vehicle use, and shothole drilling and detonation could increase turbidity and sedimentation, and degrade water quality in surface waters.

Many of the SMAs under this alternative are situated in wetlands and floodplains containing soils which are highly susceptible to adverse impacts from vehicle use during geophysical exploration operations. The No Surface Use stipulation in these areas would protect Soil Hydrologic Groups "C" and "D" from any adverse impacts from these operations, and would indirectly protect water resources adjacent to these areas.

The No Surface Use designation in SMAs may result in the modification of project designs for 3-D seismic surveys. It may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. The modification of project designs could result in impacts similar to Alternatives A and B, with localized, short-term, negligible to minor, adverse impacts on surface water resources on up to 465 acres. These adverse impacts could occur inside or outside the Preserve, and the intensity of the impact is dependent upon the layout of the seismic grid, and the proximity of the operations to water resources.

Mitigation measures required under Current Legal and Policy Requirements would protect water resources in the areas where geophysical operations would be permitted. Surface operations cannot be conducted within 500 feet of waterways, or visitor use and administrative areas unless specifically authorized by an approved plan of operations (3 CFR § 9.41(a)). New roads may not be constructed for geophysical exploration. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated or flooded soils to prevent soil compaction or rutting (particularly in floodplains and wetlands). Explosive charges must be positioned where they would not cause soil damage. Shotholes would not be placed on slopes greater than 3 percent or on small terraces where there is a high probability for lateral blowouts.

Drilling and Production: The potential for direct impacts on water resources from accidental leaks and spills would be substantially reduced under Alternative C because operations would not be permitted in the Riparian Corridors SMA (25,539 acres), in the Ecological Research and Monitoring Areas (74 acres), in Rare Forest Wetland Communities (5,087 acres) or within 500 feet of waterways. Many of the SMAs under this alternative are situated in floodplains and wetlands containing soils which are highly susceptible to adverse impacts from vehicle use during nonfederal oil and gas operations. The No Surface Use stipulation in these SMAs would protect the Soil Hydrologic Groups "C" and "D" from any adverse impacts from construction and maintenance activities that could cause erosion,

compaction, rutting, or loss of permeability, and would indirectly protect water resources adjacent to these areas.

Similar to Alternatives A and B, where drilling and production operations are permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could increase soil erosion, turbidity and sedimentation, and alter flow characteristics and hydrologic functions of surface waters with short- to long-term, minor to moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on water resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines. Surface and groundwater in the Preserve could be contaminated if drilling muds, hydrocarbons, produced waters, or treatment chemicals are released during drilling, production, or transport, with moderate to major, adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate. However, operations on 989 acres (including transpark pipeline corridors, and existing and abandoned operations) would continue to adversely impact water resources in the Preserve.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on water resources is dependent upon where the operation is located (uplands vs. lowlands), if the operations are conducted inside or outside of the Preserve, on the resource protection measures that are employed. Similar to Alternative B, indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within the 500-year floodplain. Adverse impacts on water resources should be minor in these upland areas because the operations would not be sited near waterways. However, if there is an accidental leak or spill of a hazardous or contaminating substance, the fluids could be transported downslope into surface waters and/or infiltrate into the groundwater, with minor to major, adverse impacts on water quality. But, with mitigation and quick response in the event of a spill, these adverse impacts should be negligible to moderate.

Where drilling and production operations would be permitted, the following mitigation measures would avoid or minimize adverse impacts on water resources; proper siting, design, construction and maintenance of access roads and drilling pads, using containerized mud systems, lining the wellpad with impermeable materials, constructing a berm around the wellpad, storing the minimum quantity of contaminating or hazardous substances at operations locations, storing barrels or smaller containers of chemicals inside secondary containment, using automatic shut-off valves for disposal wells and on flowlines on each side of crossings of waterways and other sensitive resource areas, constructing berms and installing liners at production tank facilities and increasing the secondary containment capacity to accommodate high precipitation events, and including a Spill Notification and Response Plan in the Plan of Operations. Routine monitoring by operators and the NPS should promptly identify and correct potential problems and is expected to avoid or minimize adverse impacts from leaks and spills of hazardous and contaminating substances.

Plugging/Abandonment/Reclamation: There would be more acreage designated as SMAs than under Alternative B where exploration, drilling and production operations would not be permitted; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas. Similar to Alternatives A and B, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities outside of the SMAs could cause soil erosion, sedimentation in waterways, alter surface water flows, and contaminate surface and groundwater, but with mitigation, would result in localized, short-term, negligible to

moderate, adverse impacts at sites throughout the Preserve. Similar to Alternative B, indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative C would be the same as those described for Alternatives A and B except that the No Surface Use stipulation would be applied in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development which would ensure widespread protection of water resources in the Preserve. Over time, protection provided to water resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed, adversely impacting water resources. The cumulative impact of nonfederal oil and gas operations in and outside the Preserve; oil and gas sites that are not reclaimed to predisturbance conditions; ground disturbing activities; and water impoundments upstream of the Preserve could increase sediment loads in streams, alter surface water flows and stream morphology, and introduce hazardous and contaminating substances into surface and groundwater, resulting in cumulative, minor to moderate, adverse impacts on water resources.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Exploration operations would result in short-term, negligible to minor, adverse impacts on surface and groundwater on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternatives A and B, the construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, resulting in short to long-term, minor to moderate, adverse impacts on water resources on up to 241 acres of the Preserve. However, leaks and spills could result in moderate to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to moderate. Indirect impacts on water resources in the Preserve from drilling and production of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, plugging, abandonment, and reclamation of new operations located outside SMAs, and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to moderate, adverse impacts on water resources. Indirect impacts on water resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The impacts would be the same as Alternatives A and B, except that the No Surface Use stipulation would be applied in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development which would ensure widespread protection of water resources in the Preserve. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, minor to moderate, adverse impacts on water resources.

Impairment Analysis: Because there would be no major adverse impacts to water resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as

a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve water resources.

IMPACTS ON FLOODPLAINS

Introduction

Floodplains comprise approximately one-half of the Preserve, and most of the Preserve's wetlands are located in floodplains. The regulatory floodplains (100-year and 500-year) in the Preserve have been mapped by the Federal Emergency Management Agency and are shown on Figure 3.3. As shown in Figure 3.2, the 500-year floodplain is not appreciably larger than the 100-year floodplain. The "riparian corridor" (designated as a SMA under Alternatives B and C) lies within the 100-year floodplain. The Riparian Corridor SMA is defined by the presence of the Floodplain Hardwood and Floodplain Hardwood Pine Forest, and where the surface waters are not bordered by these vegetation communities, the riparian corridor is delineated as an area extending 300 feet from streambanks. The riparian corridor is depicted on the SMA maps for each unit in the Preserve on Figures 2.7 to 2.17.

The beneficial values of floodplains and riparian corridors are described in Chapter 3. Impacts that could occur from oil and gas development in floodplains are summarized in the following section. The impacts on floodplains under each alternative would be similar to those described in the Impacts on Geologic Resources, Water Resources, and Vegetation sections. The reader is referred to these sections of Chapter 4 for a more detailed description of the activities and their associated impacts.

Methodology for Assessing Impacts

Actions under the RFD scenario were analyzed against mapped land-type delineations, which have been entered in the Preserve's geographic information system database. Mapping involved using the Federal Emergency Management Agency 100- and 500-year floodplain maps. Assessment of impacts was based on best professional judgement and was developed through discussions with NPS staff and consultants.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are as follows:

- Negligible:** Impacts would result in a change to water resources and/or floodplains, but the change would be so slight that it would not be of any measurable or perceptible consequence.
- Minor:** Impacts would result in a change to water resources and/or floodplains, but the change would be small and of little consequence and would be expected to be short-term and localized. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
- Moderate:** Impacts would result in a change to water resources and/or floodplains that would be measurable, long-term, and localized. Mitigation measures, if needed to offset adverse effects, could be extensive, but would likely be successful.
- Major:** Impacts would result in a change to water resources and/or floodplains that would be measurable and have substantial consequences on a regional scale for long periods of time or to be permanent. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed.

Impacts on Floodplains under Alternative A (No Action/Current Management)

Under Alternative A, SMAs would not be formally designated. Protected areas comprising 56,538 acres and other areas of the Preserve would be provided protection under Current Legal and Policy Requirements (CLPR), including the NPS 36 CFR 9B regulations, and NPS Director's Order 77-2, Floodplain Management. Interpretation and application of CLPR, and project-specific considerations, could result in variations in how, where, and to what extent resource protection is applied.

Geophysical Exploration: The primary impacts from geophysical exploration on floodplains are similar to those described for geologic resources, vegetation, and water resources; and would be from the use of overland vehicles to transport equipment and personnel. Vehicles could damage and kill plants, reduce the soil's water-holding and infiltration capacities, compact and rut soils, reduce the vegetation's root-penetration capabilities, and hinder plant growth and soil formation. Soil Hydrologic Groups "C" and "D" typically found in lowland areas (wetlands and floodplains) are very susceptible to adverse impacts from oil and gas operations. In general, these soils have high clay contents, low permeabilities, are moderately to highly compactable, and have low infiltration rates and recharge potentials. Wet or saturated soils are the most sensitive to disturbance from overland vehicle use. Exposed, compacted soils increase runoff of surface waters and accelerate soil erosion. Erosion of floodplain soils could increase turbidity and sedimentation in surface waters. Leaks and spills from off-road vehicles could harm or kill vegetation, and contaminate soils and surface and groundwater. With required mitigation, there would be localized, short-term, negligible to minor, adverse impacts on floodplain resources, including soils, water, and vegetation from geophysical exploration on up to 465 acres in the Preserve.

In most areas of the Preserve, the use of overland vehicles for geophysical exploration operations would not be permitted, thereby eliminating the adverse impacts associated with their use. Drilling shotholes with a hand-held auger could be done in areas where vehicle access would cause damage and unnecessary loss of vegetation, or where soils would be damaged by vehicle use. Where overland vehicles would not be permitted, equipment can be carried on foot or transported via helicopter.

The drilling of seismic shotholes are expected to have localized, negligible, adverse impacts on floodplain resources. There could be small blow-outs measuring up to several feet in diameter from the detonation of explosives in seismic shotholes. Upon completion of operations any areas damaged from geophysical exploration would be reclaimed.

The NPS's Nonfederal Oil and Gas Rights Regulations, at 36 CFR § 9.41(a), require that operations shall at no time be conducted within 500 feet of waterways, unless specifically authorized by an approved plan of operations." This operating requirement should eliminate direct impacts on floodplains where this requirement would site operations outside of the floodplain, or where the floodplain is larger would substantially reduce the potential for adverse impacts. Nonfederal oil and gas operations could be exempted from the 500-foot offset requirement as long as the operations utilize least-damaging methods to avoid or minimize adverse impacts on Preserve resources and values.

Several additional mitigation measures provided for under Current Legal and Policy Requirements would help to minimize impacts on floodplain resources. The construction of new roads for geophysical exploration would not be permitted under Current Legal and Policy Requirements. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated soils to prevent soil compaction or rutting (particularly in floodplains and wetlands).

Drilling and Production: Where drilling and production operations are permitted in floodplains under Alternative A, the construction and maintenance of access roads, wellpads, flowlines, and

pipelines could remove vegetation, expose soils to erosion, compact and rut soils, and introduce non-native construction materials (i.e., gravel) and exotic vegetation, reduce soil permeability, and introduce sediments in waterways with localized, minor to moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on floodplain resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines.

Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling and production operations, or during the transportation of hydrocarbons (via flowline, pipeline or tanker truck). The intensity of the impact would depend on the type of substance spilled, and the size of area impacted, and could result in minor to major, adverse impacts on floodplain resources. But with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate.

If there were an increase in flood hazards or a loss of beneficial floodplain values from drilling and production operations, it would be a major adverse impact, but should not occur due to required mitigation. Siting of drilling or production operations in a floodplain could also pose a safety hazard to oil and gas operator's workers and contractors, Preserve staff, and visitors. Flood warning systems should adequately notify the operator and Preserve staff of the approach of major storms, including hurricanes. This should allow sufficient time to take all necessary actions at oil and gas facilities to avoid or reduce the potential impacts of flooding or high winds. Mitigation measures that are required to "floodproof" drilling and production operations include; shutting-in the well, securing storage tanks, removing hydrocarbons from storage tanks and replacing them with water, and removing excess containers of contaminating and hazardous chemicals from the site.

Indirect effects on floodplains may result if sites are developed outside, but adjacent to, floodplains/riparian areas, when lateral drainage is interrupted by road or well-site construction or increased erosion impacts the water quality of stream systems.

There would be no direct impacts on floodplain resources and values where Current Legal and Policy Requirements would not permit drilling and production operations on 7,500 acres (includes the Royal Fern Bog Research Plot and visitor use and administrative areas) or within 500 feet of waterways. However, operations on 989 acres (including transpark pipeline corridors, and existing and abandoned operations) would continue to adversely impact floodplains in the Preserve.

The NPS's 36 CFR 9B regulations provide specific protection to waterways under § 9.41(a), described under geophysical operations. Even more specific floodplain protection is provided in the NPS Director's Order 77-2, Floodplain Management, which states that oil and gas operations must avoid floodplains or minimize the potential impacts. The intent of the directive is to recognize and protect beneficial floodplain/riparian values and to avoid long-term surface occupancy in floodplains, and to minimize impacts when there is no practicable alternative to locating operations in a regulatory floodplain. In interpreting the Director's Order 77-2, the NPS directive requires operators to avoid or minimize developments and activities that could result in increasing flood hazards and reducing the beneficial value of floodplains, including storage of hazardous or contaminating substances, within 100- and 500-year floodplains. However, surface occupancy is permitted for limited phases of operations, if there is no other practicable alternative, and if floodplain/riparian impacts are minimized.

The environmental analysis conducted during the Plan of Operations evaluation process would identify alternative locations for siting roads, flowlines, drill pads and production operations, and would identify the least damaging locations and methods. Examples of least-damaging methods for placement of flowlines and wellpads in a regulatory floodplain include precautionary measures such as automatic shut-off valves on flowlines that cross riparian and wetland sites, berm and liner installation at storage tank locations, and increasing tank battery berm capacity to reduce the risk of contaminants overflowing berms during high precipitation events. Current Legal and Policy Requirements, Chapter 2, Part II,

provides further discussion of preventative measures that pertain to protecting floodplain resources and values.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact floodplains in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as steepness of slope and direction, and surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on floodplains in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could increase soil erosion, alter surface water flows, increase sedimentation in waterways, and contaminate soils, surface and groundwater. Abandonment and reclamation could require cutting and clearing of vegetation. Required mitigation measures should result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve.

Indirect impacts on floodplains in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for floodplain resources covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area for floodplain resources is determined primarily by waterflow through the Preserve; consequently, activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact floodplain resources (including soils, vegetation and water resources).

Abandoned, ongoing and future oil and gas operations within and outside of the Preserve could adversely affect floodplain resources. Existing (24.2 acres) and abandoned operations (unreclaimed sites comprising 376 acres), and transpark pipelines (589 acres) totaling 989 acres in the Preserve would continue to adversely affect floodplain resources (where they are sited in floodplains) until the sites are reclaimed. The RFD scenario developed for this Plan/EIS projects that future oil and gas operations may occur on up to 465 acres for exploration operations and on up to 241 acres for drilling and production operations may also adversely affect floodplain resources. Short-term impacts (1 to 3 years) could result from geophysical exploration (3-D seismic surveys) and short- and long-term impacts could occur from the construction, use and maintenance of access roads, wellpads, flowlines, and transpark oil and gas pipelines. New drilling and production operations are not likely to occur within floodplains because NPS Floodplain Guidelines do not permit drilling and production operations within the 500-year floodplain unless there is no practicable alternative. While the total direct surface disturbance from oil and gas operations could be as high as 1,695 acres in the Preserve, it is expected that as some operations are being developed, others would be reclaimed to pre-disturbance conditions.

Indirect cumulative, adverse impacts on floodplain resources may include increased turbidity and sedimentation in waterways, and contamination from accidental leaks and spills of hazardous and other contaminating substances (oil, drilling mud, produced water, treatment chemicals). Reclamation of existing oil and gas operations, including access roads and wellpads within and outside the Preserve

would be a beneficial impact on floodplain resources. Recontouring and revegetating disturbed areas should reduce soil erosion and re-establish surface drainage flows. For more detailed information, the reader is referred to the analysis of environmental impacts pertaining to oil and gas operations under each alternative.

Oil and gas operations within and outside of the Preserve in conjunction with other activities can adversely affect vegetation, soils, water resources, fish and wildlife habitat, research, educational, and recreational opportunities; groundwater recharge or discharge; water flows, and maintenance of biodiversity of vegetation and wildlife in the region.

Vegetation disturbance and/or removal can occur from residential and urban development, forestry activities, the construction or use of roads, well pads, and pipelines. Habitat fragmentation can occur where vegetation is removed for residential and urban development, and during the construction of pipelines, roads, and wellpads.

Adverse impacts on soils from numerous ground disturbing activities include compaction and rutting, reduced permeability, erosion, changes in soil composition, and soil contamination. Agricultural, forestry, and construction activities may increase erosion and deposition of sediments that could alter the topography, modify surface water flows and indirectly adversely affect vegetation, fish and wildlife. Water impoundments and water diversion canals can increase or decrease water levels and/or alter the duration and frequency of stream flows, which indirectly affects the extent of flooded or saturated soils.

Water quality and quantity could be impacted by various activities in and around the Preserve. Water quality could be adversely impacted by contamination from surface runoff and from accidental leaks and spills of hydrocarbons, drilling muds, produced water, and treatment chemicals during oil and gas operations. Nutrient and organic enrichment caused by runoff from fertilizer use, leaching from septic systems, and sewage effluent may increase organic matter and subsequently reduce dissolved oxygen in sediments and the water column. The combustion of fossil fuels may increase the acidity of surface waters. The encroachment of saltwater in the lower Neches River and Pine Island Bayou from the Gulf of Mexico, may locally increase the salinity in surface and groundwater. Temporary saltwater barriers on the Lower Neches and Pine Island Bayou are installed to mitigate the encroachment of saltwater into the Preserve. Ground disturbances would expose sediments to erosion, which in turn can increase turbidity in surface waters. Excavation activities associated with construction, the installation of subsurface drainage, and extensive groundwater or surface water withdrawals for agricultural, industrial, or residential uses may disrupt surface and subsurface water flow, which could cause reductions in water levels and/or changes in frequency, duration, or extent of water distribution.

While providing for flood and sediment control, habitat for fish and wildlife, recreation, and hydropower for general electricity, the construction and operation of the Sam Rayburn and Steinhagen Reservoirs have changed the flow characteristics of the Neches River. These impoundments have reduced the frequency and duration of both high and low flows on the Neches River (Gooch, 1996 and Hall, 1996). In addition, changes in the overall amount and timing of stream flows may directly impact stream channel morphology (structure or form), rate of river migration, sedimentation, water quality, and the amount and type of aquatic habitat. Indirectly, these changes could affect the growth, mortality, and regeneration of vegetation along riparian corridors. Changes in species composition and distribution of floodplain forest communities in the Preserve (i.e., in the floodplain of the Jack Gore Baygall/Neches Bottom Unit) are mainly attributed to the Rayburn and Steinhagen reservoirs (Hall, 1996).

Water diversions such as the Lower Neches River Valley Authority Canal may affect flooding frequency and duration by reducing (or increasing) the amount of water flowing through stream channels (Pearlstine et al., 1985). A number of water diversions exist within the Neches River Basin, although most of the diversions are at the south end of the Preserve and do not substantially alter the volume of flows within the Preserve's water corridor units (Harcombe and Callaway, 1997). Due to projected water needs for Central and South Texas, the "Trans-Texas Water Program" is considering, among

other options, the transfer of water between the Sabine River Basin and the San Jacinto River Basin. Although avoiding impacts on the Preserve has been one criterion for reviewing route alternatives, the possibility exists for disturbance to water corridor units from construction, fragmentation of habitat, and/or changes in water circulation or quantity (Harcombe and Callaway, 1997).

There are numerous federal, state and local laws, regulations, policies and guidelines in-place that control or limit development in floodplains. These resource protection measures, in conjunction with mitigation measures employed in the Preserve should result in cumulative, minor to moderate, adverse impacts on floodplain resources and values in the region. The information provided by floodplain assessments of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: The loss or modification of vegetation, off-road vehicle use, and shothole drilling and detonation could result in soil erosion, compaction, and rutting; soil contamination; increased turbidity and sedimentation; and surface water degradation on up to 465 acres of the Preserve, a localized, short-term, negligible to minor, adverse impact.

Drilling and Production: The construction and maintenance of access roads, wellpads, flowlines, and pipelines could remove vegetation, expose soils to erosion, compact and rut soils, and introduce non-native construction materials and exotic vegetation, reduce soil permeability, and introduce sediments in waterways with localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), minor to moderate, adverse impacts on up to 241 acres of the Preserve. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with moderate to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate. If there were an increase in flood hazards or a loss of beneficial floodplain values, it would be a major adverse impact, but should not occur due to required mitigation. Indirect impacts on floodplains in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, alter surface water flows, increase sedimentation in waterways, and contaminate soil and surface and groundwater, but with mitigation, should result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on floodplains in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: Over time, protection provided to floodplains in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while adjacent lands could continue to be developed adversely impacting floodplains. Overall, there would be cumulative, minor to moderate, adverse impacts given the protection afforded floodplains, under national regulations, NPS guidelines and policies.

Impairment Analysis: Because there would be no major adverse impacts to floodplains whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as

a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve floodplain resources or values.

Impacts on Floodplains under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to up to 75,293 acres. By applying applicable Current and Legal Policy Requirements, including 36 CFR 9B regulations, and NPS Director's Order 77-2, Floodplain Management (which have been described in Chapter 2, Parts II and III, and under Alternative A), adverse impacts on floodplain resources and values should be substantially reduced throughout the Preserve.

Geophysical Exploration: Geophysical exploration would result in localized, short-term, negligible to minor, adverse impacts on floodplain resources, including soils, water, and vegetation on up to 465 acres of the Preserve. The primary impacts from geophysical exploration on geologic resources, vegetation, and water resources would be from the use of overland vehicles to transport equipment and personnel. Vehicles could damage and kill plants, reduce the soil's water-holding and infiltration capacities, compact and rut soils, reduce the vegetation's root-penetration capabilities, and hinder plant growth and soil formation. Soil Hydrologic Groups "C" and "D" typically found in lowland areas (wetlands and floodplains) are very susceptible to adverse impacts from oil and gas operations. In general, these soils have high clay contents, low permeabilities, are moderately to highly compactable, have low infiltration rates and recharge potentials. Wet or saturated soils are the most sensitive to disturbance from overland vehicle use. Exposed, compacted soils increase runoff of surface waters and accelerate soil erosion. Erosion of floodplain soils could increase turbidity and sedimentation in surface waters. Leaks and spills from off-road vehicles could harm or kill vegetation, and contaminate soils and surface and groundwater. In most areas of the Preserve, the use of overland vehicles for geophysical exploration operations would not be permitted, thereby eliminating the adverse impacts associated with their use.

The drilling of seismic shotholes are expected to have localized, negligible, adverse impacts on floodplain resources. There could be small blow-outs measuring up to several feet in diameter from the detonation of explosives in seismic shotholes. Upon completion of operations any areas damaged from geophysical exploration would be reclaimed.

The NPS's Nonfederal Oil and Gas Rights Regulations, at 36 CFR § 9.41(a), require that operations shall not be conducted within 500 feet of waterways, or visitor use and administrative areas, unless specifically authorized by an approved plan of operations. This operating requirement would eliminate direct impacts on floodplain resources within these areas. Nonfederal oil and gas operations could be exempt from this requirement as long as the operations utilize least-damaging methods to avoid or minimize adverse impacts on Preserve resources and values.

Several additional mitigation measures provided for under Current Legal and Policy Requirements would help to minimize impacts on floodplain resources. The construction of new roads for geophysical exploration would not be permitted under Current Legal and Policy Requirements. Vehicle use would be prohibited on Preserve roads when they are wet enough to cause damage to the roadbed. Off-road vehicle travel would not be permitted on saturated soils to prevent soil compaction or rutting (particularly in floodplains and wetlands).

Drilling and Production: The designation of the Riparian Corridors SMA where the No Surface Use stipulation would be applied would eliminate direct impacts on floodplain resources (including soils,

vegetation and water resources). Under NPS Director's Order 77-2, Floodplain Management, operations would not be permitted within the 500-year floodplain (which encompasses the riparian corridor) unless there is no practicable alternative. If operations are permitted within the Riparian Corridors SMA, they must be sited adjacent to existing roads or within previously disturbed areas. No new roads would be permitted in these areas. Indirect impacts such as accidental leaks and spills, and increased erosion could still occur from drilling and production operations that are sited outside of these areas, to develop hydrocarbons underlying the floodplain/riparian corridors.

The protection of resources in the Rare Forested Wetland Communities and Rare Vegetation Communities SMAs would also protect floodplain resources because some of these areas are located within in the floodplain/riparian corridors. Drilling and production operations would not be permitted in these areas, resulting in no new direct adverse impact on floodplain resources.

Similar to Alternative A, where operations are permitted within the floodplain, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could remove vegetation, expose soils to erosion, compact and rut soils, and introduce non-native construction materials (i.e., gravel) and exotic vegetation, reduce soil permeability, and introduce sediments in waterways with localized, minor to moderate, adverse impacts on up to 241 acres of the Preserve. Impacts on floodplain resources would be short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines. However, Current Legal and Policy Requirements should limit the intensity and geographic extent of adverse impacts in floodplains.

It is possible under Alternative B that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. Similar to Alternative A, indirect impacts on floodplains in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative. Adverse impacts on water resources should be minor in these upland areas because the operations would not be sited near waterways. Uplands areas contain soils (Soil Hydrologic Groups "A" and "B") that are typically less susceptible to adverse impacts from oil and gas operations than soils found in floodplains. However, if there is an accidental leak or spill of a hazardous or contaminating substance, the fluids could be transported downslope into surface waters and/or infiltrate into the groundwater, with minor to major, adverse impacts on floodplain resources. But, with mitigation and quick response in the event of a spill, these adverse impacts should be reduced to negligible to moderate.

The NPS's 36 CFR 9B regulations provide specific protection to waterways under § 9.41(a), described under Geophysical Exploration. Even more specific floodplain protection is provided in the NPS Director's Order 77-2, Floodplain Management, which states that oil and gas operations must avoid floodplains or minimize the potential impacts. The intent of the directive is to recognize and protect beneficial floodplain/riparian values and to avoid long-term surface occupancy in floodplains, and to minimize impacts when there is no practicable alternative to locating operations in a regulatory floodplain. In interpreting the Director's Order 77-2, the NPS directive requires operators to avoid or minimize developments and activities that could result in increasing flood hazards and reducing the beneficial value of floodplains, including storage of hazardous or contaminating substances, within 100- and 500-year floodplains. However, surface occupancy is permitted for limited phases of operations, if there is no other practicable alternative, and if floodplain/riparian values can be maintained.

The environmental analysis conducted during the Plan of Operations evaluation process would identify alternative locations for siting roads, flowlines, drill pads and production operations, and would identify the least damaging locations and methods. Examples of least-damaging methods for placement of

flowlines and wellpads in a regulatory floodplain include precautionary measures such as automatic shut-off valves on flowlines that cross riparian and wetland sites, berm and liner installation at storage tank locations, and increasing tank battery berm capacity to reduce the risk of contaminants overflowing berms during high precipitation events. Current Legal and Policy Requirements, Chapter 2, Part II, provides further discussion of preventative measures that pertain to protecting floodplain resources and values.

Plugging/Abandonment/Reclamation: The designation of SMAs would increase the acreage where the No Surface Use stipulation would be applied to exploration, drilling and production operations. If drilling and production operations are permitted in floodplains under Alternative B, there could be new operations to reclaim. Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, alter surface water flows, sedimentation in waterways, and contaminate soil and surface and groundwater, but with mitigation, should be localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on floodplains in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative B would be the same as described for Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of floodplain resources in the SMAs. The designation of SMAs in the Preserve, specifically the Riparian Corridors, and Rare Forested Wetland Communities SMAs would ensure widespread protection of floodplain resources that are particularly susceptible to adverse impacts from oil and gas operations or are essential to maintain the ecological integrity of the Preserve. Oil and gas operations within and outside of the Preserve in conjunction with other activities can adversely affect vegetation, soils, water resources, fish and wildlife habitat, research, educational, and recreational opportunities; groundwater recharge or discharge; water flows, and maintenance of biodiversity of vegetation and wildlife in the region. Land uses that could adversely affect floodplain resources include; agricultural, forestry and construction operations; urban and residential development; road construction, publicly owned facilities (water impoundments, water diversion structures, and sewage treatment facilities), and oil and gas operations within and outside of the Preserve. Over time, protection provided to floodplain resources in the Preserve under Current Legal and Policy Requirements is expected to improve the condition of these resources, while floodplains on adjacent lands could continue to be developed, resulting in cumulative, minor to moderate adverse impacts on floodplain resources and values in the region.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, exploration operations would result in localized, short-term, negligible to minor, adverse impacts on floodplain resources on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternative A, the construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, resulting in localized, short- to long-term, minor to moderate, adverse impacts on floodplain resources. However, leaks and spills could result in moderate to major, adverse impacts, but with the application of mitigation measures, the impacts could be negligible to moderate. Indirect impacts on floodplains in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located in floodplains/riparian corridors could cause soil erosion, alter surface water flows, increase sedimentation in waterways, and contaminate soil and surface and groundwater resulting in localized, short-term, negligible to minor, adverse impacts on floodplains. Indirect impacts on floodplains in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The impacts would be the same as described for Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of floodplains in and adjacent to the SMAs. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, minor to moderate, adverse impacts on floodplain resources.

Impairment Analysis: Because there would be no major adverse impacts to floodplains whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve floodplain resources or values.

Impacts on Floodplains under Alternative C (Maximum Resource Protection)

Special Management Areas would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to all types of operations in all SMAs, except for the Hunting Area SMA which has a timing stipulation for geophysical exploration. The total acreage of the Preserve in which operating stipulations would apply covers 75,293 acres. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including 36 CFR 9B regulations, and NPS Director's Order 77-2, Floodplain Management (which have been described in Chapter 2, Parts II and III, and under Alternative A), should substantially reduce impacts on floodplain resources.

Geophysical Exploration: The Preserve's riparian corridors would be formally designated as SMAs, and the No Surface Use stipulation would be applied. Floodplains within 500 feet of waterways would continue to be protected under Current Legal and Policy Requirements (36 CFR § 9.41(a)) that would not permit operations in these areas, unless specifically authorized by an approved plan of operations. Within the SMAs, there would be no direct adverse impacts from exploration operations; however, indirect impacts from operations in adjacent areas could result in impacts ranging from no impact to localized, short-term, negligible adverse impacts.

Due to the designation of large SMAs where geophysical exploration would not be permitted, the modification of project designs could concentrate operations outside of the SMAs. As a result, it may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. These adverse impacts could occur inside or outside the Preserve, and are dependent upon the location and layout of the seismic grid. As a consequence, the concentration of vehicles and equipment, and the footprint of exploration operations could be greater; and impacts on soils, vegetation and water resources could be greater on up to 465 acres that would include some floodplains. The intensity of the impact is

dependent upon the mitigation measures employed, the layout of the seismic grid, and the specific resources that area impacted by the operation, resulting in localized, short-term, negligible, adverse impacts.

Drilling and Production: Many of the SMAs under this alternative are situated in floodplains containing Soil Hydrologic Groups “C” and “D” which are susceptible to adverse impacts from vehicle use during nonfederal oil and gas operations. The No Surface Use stipulation in these SMAs would protect the hydrologic soils from any adverse impacts from construction and maintenance activities that could cause erosion, compaction, rutting, or loss of permeability, prevent the damage or loss of vegetation, and would indirectly protect water resources adjacent to these areas.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of indirect and direct impacts on floodplain resources and values is dependent upon where the operation is located (uplands vs. lowlands), if the operations are conducted inside or outside of the Preserve, on the resource protection measures that are employed. Similar to Alternatives A and B, indirect impacts on floodplains in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to short- to long-term, moderate, adverse impacts.

If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within the 500-year floodplain. Adverse impacts on floodplains should be minor because the operations would not be sited within floodplain areas. However, if there is an accidental leak or spill of a hazardous or contaminating substance, the fluids could be transported downslope, with minor to major, adverse impacts on floodplain resources. But, with mitigation and quick response in the event of a spill, these adverse impacts should be negligible to minor.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation of new operations located outside SMAs, and of existing and abandoned operations, and transpark pipelines located in floodplains/riparian corridors, could cause soil erosion, alter surface water flows, increase sedimentation in waterways, and contaminate soil and surface and groundwater resulting in localized, short-term, negligible to minor, adverse impacts on floodplains. Indirect impacts on floodplains in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to short-term, moderate, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative C would be the same as described for Alternatives A and B except that the No Surface Use stipulation would be applied in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development. The designation of SMAs in the Preserve, specifically the Riparian Corridors, and Rare Forested Wetland Communities SMAs would ensure widespread protection of floodplain resources that are particularly susceptible to adverse impacts from oil and gas operations or are essential to maintain the ecological integrity of the Preserve. Oil and gas operations within and outside of the Preserve in conjunction with other activities can adversely affect vegetation, soils, water resources, fish and wildlife habitat, research, educational, and recreational opportunities; groundwater recharge or discharge; water flows; and maintenance of biodiversity of vegetation and wildlife in the region. Land uses that could adversely affect floodplain resources include: agricultural, forestry and construction operations, urban and residential development, road construction, publicly owned facilities (water impoundments, water diversion structures, and sewage treatment facilities), and oil and gas operations in and outside of the Preserve. Over time, protection provided to floodplain resources in the Preserve under Current Legal and Policy

Requirements is expected to improve the condition of these resources, while floodplains on adjacent lands could continue to be developed, resulting in cumulative, minor to moderate adverse impacts on floodplains and values in the region.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Exploration operations would not be permitted in the Riparian Corridors SMA, or within 500 feet of waterways (unless specifically authorized in an approved plan of operations); therefore, there should be no direct adverse impacts on floodplain resources in the Preserve. Indirect impacts could range from no impact to localized, short-term, negligible and adverse.

Drilling and Production: Drilling and production operations would not be permitted in the Riparian Corridors SMA, or within 500 feet of waterways (unless specifically authorized in an approved plan of operations). Leaks and spills from existing operations in floodplains or from operations conducted outside of floodplains could result in indirect, moderate to major, adverse impacts on floodplains, but with the application of mitigation measures, the impacts could be negligible to minor. Similar to Alternatives A and B, indirect impacts on floodplains in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: There would be more acreage designated as SMAs under Alternative C, where exploration, drilling and production would not be permitted; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas.

Similar to Alternatives A and B, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on floodplains. Indirect impacts on floodplains in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The impacts would be the same as Alternatives A and B, except that the No Surface Use stipulation in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development would ensure widespread protection of water resources in the Preserve. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, minor to moderate, adverse impacts on floodplain resources.

Impairment Analysis: Because there would be no major adverse impacts to floodplains whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve floodplain resources or values.

IMPACTS ON VEGETATION

Introduction

The vegetation of Big Thicket National Preserve is an essential contributor to its ecological value and diversity. As noted in Chapter 3, Big Thicket National Preserve is known for its biodiversity, with approximately 1,300 species of trees, shrubs, forbs, and grasses within its boundaries. Vegetation is important to the overall health of the Preserve and provides habitat for wildlife. It also prevents erosion and is a primary factor in the Preserve's high recreational value.

Methodology for Assessing Impacts

Actions under the RFD scenario were analyzed against the types of vegetation in Big Thicket National Preserve that could be impacted. The vegetation types were defined and described based on the sources cited in Chapter 3. Impacts on uplands vegetation are analyzed in this section; impacts on wetlands vegetation are analyzed in the next section. The assessment of impacts is based on best professional judgement and was developed through discussions with Preserve staff and EIS team members, and a review of relevant literature.

Impact Intensity Thresholds. The thresholds of change of an impact are defined as follows:

- Negligible:** Impacts would result in a change to native vegetation, their habitats, or the natural processes sustaining them, but the change would be so slight that it would not be of any measurable or perceptible consequence.
- Minor:** Impacts would result in a change to native vegetation, their habitats, or the natural processes sustaining them, but the change would be small and of little consequence and would be expected to be short-term and localized. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
- Moderate:** Impacts would result in a change to native vegetation, their habitats, or the natural processes sustaining them, and the change would be measurable, long-term, and localized. Mitigation measures, if needed to offset adverse effects, could be extensive, but would likely be successful.
- Major:** Impacts would result in a change to native vegetation, their habitats, or the natural processes sustaining them, and the change would be measurable and have substantial consequences on a regional scale for long periods of time or to be permanent. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed.

Impacts on Vegetation under Alternative A (No Action/Current Management)

Under Alternative A, SMAs would not be formally designated. Protected areas comprising 56,538 acres and other areas of the Preserve would be provided protection under Current Legal and Policy Requirements, including the NPS 36 CFR 9B regulations. Vegetation that is particularly susceptible to adverse impacts from oil and gas operations or are essential to maintain the ecological integrity of the Preserve would need to be identified during the planning/development and review of Plans of Operations, so that avoidance or mitigation measures are applied to minimize impacts on vegetation.

The NPS's 36 CFR 9B regulations require utilization of least-damaging methods, reclamation of disturbed areas with the goal of reestablishing native vegetation communities and preventing invasion of non-native (exotic) species. The application of Current Legal and Policy Requirements, and project-specific operating stipulations, could result in variations in how, where, and to what extent resource protection is applied.

Currently, there is no formal protection provided for rare vegetation communities (includes Sandhill Pine Forest, Upland Pine Forest, American Beech- Southern Magnolia-Loblolly Pine Forest, and any old growth tree or trees within these or other community types). Adverse impacts on rare vegetation communities would be primarily from drilling and production operations. Therefore, impacts on vegetation are likely to be greatest under Alternative A because variations in protection may occur under different park administrations, resulting in different interpretations and applications of policy and different levels of protection. If these vegetation communities are disturbed or destroyed as a result of nonfederal oil and gas operations, it would be considered a major adverse impact.

Because of the extensive vegetation cover in Big Thicket National Preserve, any oil and gas activity would most likely result in some adverse impact to vegetation, since it would be almost impossible to avoid vegetated areas. Also, the avoidance of vegetated wetlands would tend to focus oil and gas operations to non-wetland, upland vegetation communities.

A description of impacts on vegetation from specific types of oil and gas operations is provided below.

Geophysical Exploration: Where exploration operations could be permitted, vegetation could be cut or trimmed along source and receiver lines; and could be crushed, damaged or uprooted by off-road vehicles. Compacted and rutted soils could reduce germination and root penetration. Leaks and spills could harm or kill vegetation. Mitigation could reduce the intensity of impacts to localized, short-term, negligible to minor, adverse impacts on vegetation on up to 465 acres of the Preserve.

The degree in which geophysical exploration could adversely impact vegetation would depend on the type of survey conducted, equipment and vehicles used, vegetation type, and site conditions where the survey is conducted. It is expected that all future surveys in the Preserve would utilize 3-D seismic technology and follow Current Legal and Policy Requirements in the planning and conduct of operations. Three-dimensional exploration involves a relatively extensive grid pattern of holes filled with explosive charges and receiver lines placed in and on the ground. These surveys typically require vegetative trimming, drilling of shotholes, and associated access clearing.

Current Legal and Policy Requirements provide for use of mitigation to limit the impacts on vegetation associated with seismic surveys. For example, trimming of vegetation for survey lines would be limited to a 3.5 foot width (understory vegetation only), and no tree limbs greater than 3 inches in diameter may be cut (see Chapter 2, Part II, for more information). The use of GPS could also be encouraged to reduce the need for line-of-sight surveys. Drilling of shotholes could involve use of off road vehicles of various types, which could result in damage to vegetation. However, there are smaller, light-weight, or other low-impact vehicles available for use. Also, there is the option of using portable hand drills to drill shallow shotholes, which would limit the need for vehicles to drill deep holes. The use of helicopters to bring in supplies and equipment would greatly limit the extent of vegetation trimming and disturbance and the amount of time spent on the ground. Other mitigation available to limit direct and indirect impacts on vegetation include locating staging and fueling areas out of sensitive vegetation communities, maintaining and inspecting vehicles and equipment to prevent leaks and spills and using drip pans during refueling, providing for prompt response in the event of spills, developing and implementing an exotic vegetation control plan, and using existing roads for access whenever possible.

Vegetation trimmed for survey lines or disturbed during shothole drilling would recover over the short-term. Different types of vegetation would be expected to recover at different rates, as noted in Fountain

and Rayburn (1987). This study of exploration operations (pre-3-D seismic) found that slope communities (and wetlands) were the most sensitive to disturbance, with the highest percent of damaged or killed vegetation. Upland soils allowed deeper root penetration than slope or wetland soils, and these deeper rooted plants would bend and recover when run over by a survey vehicle, while the shallow rooted stems tended to be uprooted. However, they found that vegetation recovery was rapid on most sites, with lines 3-4 years old very hard to even locate, indicating the short-term nature of seismic survey impacts on vegetation. It is important to note that old seismic survey lines investigated by Fountain and Rayburn involved the use of large articulating ORVs such as an Ardco buggy. The use of this type of large equipment would not be permitted in the Preserve today, due to the availability of alternative equipment and methods that would result in considerably fewer adverse surface impacts.

Under Alternative A, fire monitoring plots and long-term monitoring plots do not receive formal protection. These important research vegetation communities would have to be identified and protected during the planning and development of specific exploration Plans of Operations stipulations. With the implementation of the mitigation currently used for 3-D seismic work, especially mini-shotholes and helicopters, adverse impacts should be kept to less than major levels. However, if specific protective measures or offsets are not required, major adverse impacts could occur to these sites, since they are particularly susceptible to adverse impacts that would jeopardize their historical, ecological, and research attributes.

Drilling and Production: Where drilling and production operations could be permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could result in vegetation being routinely maintained along flowlines and pipelines, or totally cleared for construction of roads, pads, flowlines and pipelines. Ground disturbance could promote the introduction of exotic species. These effects could result in localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), moderate, adverse impacts on vegetation on up to 241 acres of the Preserve. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be minor to moderate.

According to the RFD scenario, up to 40 wells could be drilled, with 27 placed in production. This level of development, along with associated access roads, could utilize up to 241 acres of the Preserve. Wellpads are estimated to be 2.4 acres in size, and could last 15 to 20 years, or longer. If a well is productive, the wellpad would be reduced in size to accommodate the production operation. Drilling and production of oil and gas would include direct loss of vegetation and habitat as a result of clearing, contouring, construction and maintenance of the pads, roads, flowlines, pipelines, and other ancillary facilities. Impacts on vegetation from constructing a wellpad and drilling a well would be considered short-term, lasting a few to 6 months, while a producing well may create long-term impacts for 20 years or longer, until the well is plugged and the pad and access road are reclaimed.

According to the studies conducted by Fountain and Rayburn (1987), there are differential responses to direct disturbance among the vegetation community types within Big Thicket. Upland sites that are primarily pine-dominated were deemed the least susceptible to adverse impacts from oil and gas operations, because the predicted time for recovery (based on achieving a species composition similar to that of the original site) was found to be less than for the other vegetative communities that were studied. This is because pines were the primary woody species invading both upland and slope sites, and a return of pines to uplands that were previously dominated by pines reflects a rapid recovery of the sites. Slope sites, on the average, possess the higher diversity and richness, and require a longer time frame to recover. Succession on the slope sites must pass through a pine-dominated seral stage before returning to the potential mixed hardwood pine climax vegetation.

Indirect effects to vegetation could also occur from drilling and production operations. There is a potential for leaks and spills of drilling muds, hydrocarbons, produced waters, or treatment chemicals during drilling, production, or transport, to impact site or off-site soil and groundwater and associated vegetation. Herbicides used to control site vegetation could drift or migrate off-site, causing damage to nontarget vegetation in nearby areas. Observation of areas with high soil chloride levels from spills of produced water suggest that these spills are lethal to forest vegetation and can persist for many years, if not remediated. Other indirect adverse impacts impacting off-site vegetation include the possibility of erosion and sedimentation if runoff from the site occurs. Ground disturbance could also facilitate the invasion of exotic vegetation.

Although drilling and production operations cannot avoid clearing of vegetation, there are mitigation measures under Current Legal and Policy Requirements that could minimize long-term effects. These include using already disturbed areas (including existing pads) for wellpad sites, using existing access roads, and using closed loop, drilling fluid systems and tanks to hold cuttings and fluid which are then disposed off site. In addition, indirect impacts from leaks and spills could be limited by using automatic shutdown, blowout preventers, drip pans, berms, liners, clean-up plans and equipment, and regular flowline testing. Exotic vegetation control plans should be part of every plan of operations, and use of herbicides to keep vegetation off the site should be limited and/or restricted to those that do not readily drift or migrate off site. Silt fences or barriers should be used to eliminate off-site sedimentation.

Under Alternative A, rare vegetation communities (including upland pine forests, beech-magnolia-loblolly pine forests, sandhill pine forests, and old growth trees) do not receive formal protection. These important vegetation communities would have to be identified and protected during the planning and development of specific drilling and production plans of operations stipulations. With the implementation of mitigation, adverse impacts should be kept to less than major levels. However, if specific protective measures or offsets are not required, major adverse impacts could occur to these vegetation communities, since they are particularly susceptible to adverse impacts that would jeopardize their historical, ecological, and research attributes.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact vegetation in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as steepness of slope and direction, and surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on vegetation in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could release oil, and other contaminating and hazardous substances, which could harm or kill vegetation. Abandonment and reclamation could require cutting and clearing of vegetation. With mitigation, these effects would result in localized, short-term, negligible to minor, adverse impacts on vegetation at sites throughout the Preserve.

During reclamation operations, sites are reclaimed by removing any contaminated soil or materials, grading the site to natural contours, replacing topsoil, seeding with a selected mix of native herbaceous vegetation, and possibly planting trees and/or shrubs. Site recovery is monitored and success is determined by some measure of species composition and cover over a set period of time. Abandonment and reclamation could require minimal trimming and clearing vegetation along the periphery of roads and pads, or along flowlines and pipelines if lines are removed. Similar to other types of oil and gas operations, well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could result in

accidental releases of oil, and other contaminating and hazardous substances, which could harm or kill vegetation.

Recovery of vegetation communities would be primarily dependent on location, edaphic (soil) conditions, and type of community desired. Except for rare vegetation communities that are susceptible to the adverse impacts of oil and gas operations, most vegetation communities in the Preserve, especially upland communities, can re-establish vegetation in a relatively short time period. However, many years may be needed to replace the pre-disturbance community with a similar community, especially for slope communities (Fountain and Rayburn, 1987). For most of Big Thicket National Preserve, vegetation communities have a relatively widespread distribution and occur with high frequency in the Preserve and the region, and will recover with time. If access roads are not reclaimed, but continue to be used for other administrative purposes, a long-term adverse impact to vegetation would occur.

Indirect impacts on vegetation in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for vegetation covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area has been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact natural resources, including vegetation in the region.

Land cover data show that approximately 50 percent of the acreage in the analysis area consists of slope forests, upland forests and clearcut cover classes. By comparison, the Preserve contains a larger number of vegetation types.

Cumulative impacts on vegetation in the Preserve include impacts from past, present and reasonably foreseeable future oil and gas operations located within and directionally drilled from locations outside the Preserve; activities in the Preserve that impact vegetation (e.g., Preserve developments including buildings, visitor use areas and roads; and management practices such as prescribed fire management) and other regional construction or development activities that result in removing vegetation or altering conditions that could impact native vegetation.

Using LANDSAT Thematic Mapper imagery taken February 10, 1991, Hall and Harcombe (1997) found distinct differences in land uses/landcover classes inside and outside the Preserve. Developed, urbanized, pasture, and clearcut cover classes comprise approximately 25 percent of the analysis area while accounting for less than one percent the Preserve.

Plugged and abandoned oil and gas wellpads and associated road segments that pre-date the establishment of the Preserve continue to adversely impact 376 acres. Existing oil and gas operations in the Preserve occupy 24.2 acres, and 71 existing transparks oil and gas pipelines utilize 589 acres within associated right-of-way corridors. Impacts have included direct loss of vegetation at oil and gas sites. These combined effects on 989 acres have caused long-term impacts on plant communities within Big Thicket National Preserve, resulting in removal of vegetation or a change (decrease) in site productivity and habitat value for as long as operations areas remain unreclaimed. Under the RFD scenario, a Preserve-wide 3-D seismic survey could utilize up to 465 acres of the Preserve, while

drilling up to 40 wells and production of up to 27 wells could occupy up to 241 acres of the Preserve. Over the long-term, up to 1,695 acres could be directly impacted by oil and gas operations in the Preserve; however, while new operations are occurring, others would be plugged, abandoned, and reclaimed. Any failed mitigation or adverse impacts on vegetation communities or plots under the No Action Alternative would add adverse impacts on these existing adverse impacts.

Existing and future oil and gas operations in the Preserve would be required to meet least-damaging methods and other requirements under Current Legal and Policy Requirements to protect native vegetation and ensure reclamation of disturbed areas. Vegetation that is particularly susceptible to adverse impacts from oil and gas operations or are essential to maintain the ecological integrity of the Preserve would need to be identified during the planning/development and review of Plans of Operations, so that avoidance or mitigation measures are applied to minimize impacts on vegetation. In addition, the Preserve's prescribed fire management program would provide long-term cumulative beneficial impacts on Preserve vegetation by restoring and maintaining vegetation communities and biodiversity. Therefore, cumulative impacts on the vegetation in the Preserve would be minimized and over time, vegetation resources would be improved; a cumulative beneficial impact for vegetation resources of the Preserve.

On lands surrounding the Preserve within the analysis area, population growth and continued development including the construction and operation of the Sam Rayburn and B. A. Steinhagen Reservoirs, pipelines, roads, commercial and private forestry, and residential developments, could result in the long-term incremental loss of natural vegetation communities. Since uplands would be more favorable for development, these vegetation communities would be more prone to incremental losses over time. Developments and activities could also disrupt surface and subsurface water flow necessary to support vegetation in the region and the Preserve, and could particularly affect bottomland forests and wetland hardwood classes in the Preserve. The NPS would ensure that wells directionally drilled from locations outside the Preserve to bottomhole targets underlying the Preserve "pose no significant threat of damage to park resources, both surface and subsurface" (36 CFR § 9.32(e)); however, wellpads outside the Preserve may not be reclaimed to pre-disturbance conditions. It is also likely that areas outside the Preserve would control wildfires and have no active prescribed fire management practices to restore and maintain vegetation communities and biodiversity. Over the long-term, these effects could result in cumulative, minor to moderate, adverse impacts on vegetation in the analysis area, particularly outside the Preserve. The information provided by vegetation surveys of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Where exploration operations could be permitted, vegetation could be trimmed along source and receiver lines; and crushed, damaged or uprooted by off-road vehicles. Compacted and rutted soils could reduce germination and root penetration. Leaks and spills could harm or kill vegetation. Mitigation could reduce the intensity of impacts to localized, short-term, negligible to minor, adverse impacts on vegetation on up to 465 acres of the Preserve. There is no formal protection provided for fire monitoring plots and long term monitoring plots; and if they are not adequately protected could result in major adverse impacts.

Drilling and Production: Where drilling and production operations could be permitted, the construction and maintenance of access roads, wellpads, flowlines, and pipelines could result in vegetation being routinely cut along flowlines and pipelines, or totally cleared for construction of roads, pads, flowlines and pipelines. Ground disturbance could promote the introduction of exotic species. These effects could result in localized, short-term (construction activities and drilling operations) to long-

term (roads, production operations, and flowlines and pipelines), moderate, adverse impacts on vegetation on up to 241 acres of the Preserve. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be minor to moderate. Indirect impacts on vegetation in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

There is no formal protection provided for fire monitoring plots, long-term monitoring plots, and rare vegetation communities; and if they are not adequately protected could result in major adverse impacts.

Plugging/Abandonment/Reclamation: Future operations including RFD-projected Preservewide geophysical exploration on up to 465 acres; and drilling of an estimated 40 wells with production of an estimated 27 wells from locations within or outside the Preserve on up to 241 acres; in addition to existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) operations, and transpark pipelines (589 acres) located throughout the Preserve (some of which are located in protected areas) would be reclaimed in the future.

Well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could release oil, and other contaminating and hazardous substances, which could harm or kill vegetation. Abandonment and reclamation could require cutting and clearing of vegetation. With mitigation, these effects would result in localized, short-term, negligible to minor, adverse impacts on vegetation at sites throughout the Preserve. Indirect impacts on vegetation in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Over time, protection provided to vegetation of the Preserve under Current Legal and Policy Requirements is expected to result in the Preserve maintaining and improving vegetation, with cumulative, beneficial impacts on Preserve vegetation. Adjacent lands could continue to be developed, and native vegetation, particularly rare forested communities, could be incrementally lost. Also, reclamation of oil and gas operations inside or outside the Preserve may not return sites to pre-disturbance conditions. Therefore, Alternative A could result in cumulative, minor to moderate, adverse impacts on vegetation in the region.

Impairment Analysis: Because there would be no major adverse impacts to vegetation whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve vegetation.

Impacts on Vegetation under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current Legal and Policy Requirements, including 36 CFR 9B regulations, which have been discussed in Chapter 2, Parts II and III, and under Alternative A, impacts on vegetation should be substantially reduced throughout the Preserve.

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on vegetation on up to 465 acres of the Preserve associated with vegetation trimming along source and receiver lines; and from being crushed, damaged or uprooted by off-road vehicle use. Compacted and rutted soils could reduce germination and root penetration. Leaks and spills could harm or kill vegetation.

Drilling and Production: Rare and important vegetation communities receive formal protection under Alternative B by designation as SMAs and applying the No Surface Use stipulation. While SMAs receive specific protection from new drilling and production operations, existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres), and transpark pipelines (589 acres) would continue to adversely impact vegetation in the Preserve, some of which are located within SMAs.

It is possible under Alternative B that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. The intensity of impacts on vegetation would be dependant upon where the operation is located with respect to vegetation type, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Indirect impacts on vegetation in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative.

According to the studies conducted by Fountain and Rayburn (1987), there are differential responses to direct disturbance among the vegetation community types within Big Thicket. Upland sites that are primarily pine-dominated were deemed the least susceptible to adverse impacts from oil and gas operations, because the predicted time for recovery (based on achieving a species composition similar to that of the original site) was found to be less than for the other vegetative communities that were studied. This is because pines were the primary woody species invading both upland and slope sites, and a return of pines to uplands that were previously dominated by pines reflects a rapid recovery of the sites. Slope sites, on the average, possess the higher diversity and richness, and require a longer time frame to recover. Succession on the slope sites must pass through a pine-dominated seral stage before returning to the potential mixed hardwood pine climax vegetation.

Similar to Alternative A, the construction and maintenance of drilling and production operations sited in uplands would result in localized, short- to long-term, moderate, adverse impacts on vegetation.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could release oil, and other contaminating and hazardous substances, which could harm or kill vegetation. Abandonment and reclamation could require cutting and clearing of vegetation. With mitigation, these effects would result in localized, short-term, negligible to minor, adverse impacts on vegetation at sites throughout the Preserve, some of which are located within SMAs. Indirect impacts on vegetation in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative B would be similar to those described for Alternative A, but with more certainty of avoiding new adverse impacts on important and rare vegetation in the Preserve. The formal protection provided by designation of fire monitoring plots, long-term monitoring plots, and rare vegetation communities as SMAs and application of the No Surface Use stipulation would result in cumulative, beneficial impacts over time, as the vegetation in these areas

continued to be protected, adding to the amount of old growth and/or mature climax community acreage within the Preserve and the region. This would be especially important if forests outside the Preserve boundary are not similarly protected and are lost over time.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on vegetation on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternative A, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, moderate, adverse impacts on vegetation on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be minor to moderate. Indirect impacts on vegetation in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: The designation of SMAs would increase the acreage where the No Surface Use stipulation would be applied to exploration, drilling and production operations; therefore, plugging, abandonment, and reclamation of new operations would not be located in these areas.

Similar to Alternative A, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on vegetation. Indirect impacts on vegetation in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Similar to Alternative A, with cumulative, minor to moderate, adverse impacts on vegetation in the region. However, protection of vegetation would be more readily attainable in the Preserve due to designation of SMAs where the No Surface Use stipulation would result in no new impacts on vegetation that is particularly susceptible to adverse impacts from oil and gas operations and important to maintaining the ecological integrity of the Preserve.

Impairment Analysis: Because there would be no major adverse impacts to vegetation whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve vegetation.

Impacts on Vegetation under Alternative C (Maximum Resource Protection)

Special Management Areas would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to all types of operations in all SMAs, except for the Hunting Area SMA which has a timing stipulation for geophysical exploration operations.

only. The total acreage of the Preserve in which operating stipulations would apply covers 75,293 acres. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including 36 CFR 9B regulations, which have been described in Chapter 2, Parts II and III, and under Alternative A, should substantially reduce impacts on vegetation.

Geophysical Exploration: The Preserve's rare and important vegetation communities and monitoring plots would experience no direct adverse impacts from exploration operations because they are formally designated as SMAs, and the No Surface Use stipulation would be applied with protective offsets. Vegetation within 500 feet of waterways would continue to be protected under Current Legal and Policy Requirements that would not permit operations in these areas.

Due to the designation of large SMAs where geophysical exploration would not be permitted, the modification of project designs could concentrate operations outside of the SMAs. As a result, it may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. These adverse impacts could occur inside or outside the Preserve, and are dependent upon the location and layout of the seismic grid. As a consequence, the concentration of vehicles and equipment, and the footprint of exploration operations could be greater; and impacts on vegetation could also be greater, resulting in localized, short-term, negligible to moderate, adverse impacts on vegetation on up to 465 acres of the Preserve associated with vegetation trimming along source and receiver lines; and from being crushed, damaged or uprooted by off-road vehicle use. Compacted and rutted soils could reduce germination and root penetration. Leaks and spills could harm or kill vegetation.

Drilling and Production: Due to the designation of SMAs covering 46,273 acres where drilling and production would not be permitted, it is probable that some wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on vegetation would be dependant upon where the operation is located with respect to vegetation type, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted in wetlands or the 500-year floodplain.

According to the studies conducted by Fountain and Rayburn (1987), there are differential responses to direct disturbance among the vegetation community types within Big Thicket. Upland sites that are primarily pine-dominated were deemed the least susceptible to adverse impacts from oil and gas operations, because the predicted time for recovery (based on achieving a species composition similar to that of the original site) was found to be less than for the other vegetative communities that were studied. This is because pines were the primary woody species invading both upland and slope sites, and a return of pines to uplands that were previously dominated by pines reflects a rapid recovery of the sites. Slope sites, on the average, possess the higher diversity and richness, and require a longer time frame to recover. Succession on the slope sites must pass through a pine-dominated seral stage before returning to the potential mixed hardwood pine climax vegetation.

Similar to Alternatives A and B, impacts from the construction and maintenance of drilling and production operations sited in uplands would result in localized, short- to long-term, moderate, adverse impacts on vegetation. Indirect impacts on vegetation in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

While SMAs receive specific protection from new drilling and production operations, existing (24.2 acres) and abandoned (unreclaimed operations on 376 acres), and transpark pipelines (589 acres)

would continue to adversely impact vegetation in the Preserve. Some of these sites are located within SMAs.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could release oil, and other contaminating and hazardous substances, which could harm or kill vegetation. Abandonment and reclamation could require cutting and clearing of vegetation. With mitigation, these effects would result in localized, short-term, negligible to minor, adverse impacts on vegetation at sites throughout the Preserve. Indirect impacts on vegetation in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative C would be similar to those described for Alternatives A and B, but with greater certainty of avoiding new major adverse impacts on important and rare vegetation in the Preserve. The additional protection provided by formal designation of fire monitoring plots, long-term monitoring plots, and rare vegetation communities as SMAs and application of the No Surface Use stipulation would result in cumulative, beneficial impacts over time, as the vegetation in these areas continued to be protected, adding to the amount of old growth and/or mature climax community acreage within the Preserve and the region. This would be especially important if forests outside the Preserve boundary are not similarly protected and are lost over time.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Geophysical exploration would result in localized, short-term, negligible to moderate, adverse impacts on vegetation on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternatives A and B, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, moderate, adverse impacts on vegetation on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be minor to moderate. Indirect impacts on vegetation in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: There would be more acreage designated as SMAs under Alternative C, where exploration, drilling and production would not be permitted; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas.

Similar to Alternatives A and B, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on vegetation. Indirect impacts on vegetation in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Similar to Alternatives A and B, with cumulative, minor to moderate, adverse impacts on vegetation in the region. However, protection of vegetation within the Preserve would be more readily attainable due to more acreage designated as SMAs under Alternative C, with no new

impacts on vegetation that is particularly susceptible to adverse impacts from oil and gas operations and important to maintaining the ecological integrity of the Preserve.

Impairment Analysis: Because there would be no major adverse impacts to vegetation whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve vegetation.

IMPACTS ON WETLANDS

Introduction

As described in Chapter 3, wetlands are a predominant and important ecological component of Big Thicket National Preserve. More than 40 percent of the Preserve is comprised of wetlands, and these areas often coincide with other sensitive and ecologically important resources, such as Soil Hydrologic Groups "C" and "D," floodplains, and riparian corridors. Important wetland functions and values are provided protection under NPS regulations, orders, and policies, as well as Army Corps of Engineers regulations. In general, wetlands must first be avoided, and then, if no practicable alternatives exist, impacts must be mitigated, which usually involves compensation for wetland losses. In areas like Big Thicket, with large expanses of wetlands, avoidance may not always be possible, especially for larger scale seismic surveys. Therefore, Impacts on wetland functions and values could result from oil and gas operations, depending on the locations selected for the operations.

Methodology for Assessing Impacts

The RFD scenario was used to analyze against the types of wetlands in Big Thicket National Preserve that could be impacted by oil and gas operations. The wetland types were defined and described based on the sources cited in Chapter 3. Assessment of impacts is based on best professional judgment and was developed through discussions with Preserve staff and EIS team members, and a review of relevant literature.

Impact Intensity Thresholds. The thresholds of change for the intensity of impacts are defined as follows:

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|--------------------|--|
| Negligible: | Impacts would result in a change to wetlands values and functions, but the change would be so slight that it would not be of any measurable or perceptible consequence. |
| Minor: | Impacts would result in a change to wetlands values and functions that would be small and of little consequence and would not be expected to have any long-term effects. Mitigation measures, if needed to offset adverse effects, would be simple and successful. |
| Moderate: | Impacts would result in a change to wetlands values and functions that would be measurable, long-term, and localized. Mitigation measures, if needed to offset adverse effects, would be extensive and likely successful. |
| Major: | Impacts would result in a change to wetlands values and functions that would be measurable and have substantial consequences on a regional scale for long |

periods of time or to be permanent. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed.

Impacts on Wetlands under Alternative A (No Action/Current Management)

All of Big Thicket's wetlands receive standard protection under Current Legal and Policy Requirements. However, the application of Current Legal and Policy Requirements, and project-specific operating stipulations, could result in variations in how, where, and to what extent resource protection is applied. Wetland areas would need to be identified during the planning/development and review of Plans of Operations, so that avoidance or mitigation measures are applied to minimize direct and indirect impacts on wetlands. The NPS's 36 CFR 9B regulations require utilization of least-damaging methods, reclamation of disturbed areas with the goal of reestablishing wetland functions and values and preventing invasion of non-native (exotic) species (e.g., Chinese Tallow tree). The NPS's DO 77-1, wetlands protection guidelines set goals to first avoid and then to minimize impacts on wetlands, followed by appropriate compensatory mitigation for any unavoidable adverse impacts. Where wetlands resources may potentially be directly or indirectly impacted, oil and gas operators are required to perform and submit wetlands delineation surveys in the Plan of Operations. NPS mitigation requirements for direct and indirect adverse impacts on wetlands also requires a minimum compensation to be performed prior to or at the time permitted operations commence. The minimum compensation ratio is 1:1; however, a higher ratio for compensation may be required if (1) the functional values of the site being impacted are determined to be high and the restored wetlands will be of lower value; (2) it will take a number of years for the restored site to become fully functional; (3) the likelihood of full restoration success is unclear. As soon as possible after completing a permitted operation, but no later than 6 months, reclamation of the disturbed wetlands site must begin which would result in restoring wetland functions and values.

There are several wetland communities in Big Thicket recognized as being particularly rare, or important for their long-term research purposes. One of the ecological research and monitoring areas, the Royal Fern Bog Research Plot, is currently provided formal protection under Current Legal and Policy Requirements. It is recognized as a Research Natural Area Subzone in the Preserve's General Management Plan (1980), and only non-manipulative research by NPS and research personnel may occur in this area. In addition to the Royal Fern Bog Research Plot, other areas that currently receive specific protection under Current Legal and Policy Requirements are visitor use and park administrative areas (with a 500-foot offset), and areas within 500 feet of waterways.

Currently, there is no formal protection provided for rare forested wetland communities (including wetland baygall shrub thickets, swamp cypress-tupelo forests, wetland pine savannas, and any old growth trees within these or other community types). Adverse impacts on these rare forested wetland communities would be primarily impacted by drilling and production operations. Therefore, impacts on wetlands are likely to be greatest under Alternative A because rare and other important wetland areas are not identified in advance of project planning and are not provided specific protection. As a result, variations in protection may occur under different park administrations, resulting in different interpretations and applications of policy and different levels of protection. If these wetland communities are disturbed or destroyed as a result of nonfederal oil and gas operations, it would be considered a major adverse impact. These important and rare wetland communities would be formally designated as SMAs under Alternatives B and C.

A description of impacts on wetlands from specific types of oil and gas operations is provided below.

Geophysical Exploration: Where exploration operations could be permitted, wetland vegetation could be trimmed along source and receiver lines, and crushed, damaged or uprooted by off-road vehicle use. Where soils are compacted or rutted, surface hydrology and plant growth could be altered. Leaks and spills could pollute soil and water, and harm or kill vegetation. Mitigation should reduce impacts to result in localized, short-term, negligible to minor, adverse impacts on wetlands on up to 465 acres of the Preserve.

Impacts on wetlands from seismic surveys would depend on the type of survey done, the equipment and vehicles used, the type of vegetation, and the season of the year. It is expected that all future surveys in the Preserve would utilize 3-D seismic technology and follow the Current Legal and Policy Requirements in their Plans of Operations. During such surveys, a grid pattern of source and receiver lines would require survey line cuts, drilling of shotholes, and associated access clearing. Such actions could result in direct and indirect adverse impacts on wetland vegetation and soils, and possibly local hydrology. Under the RFD scenario, up to 465 acres would be impacted by seismic survey line cuts, shothole drilling, and detonation of explosives in shotholes. The actual number of wetland acres impacted would depend on the location of the seismic surveys.

Current Legal and Policy Requirements provide for the use of least-damaging methods to limit the impacts associated with seismic surveys. For example, under current environmental requirements included in recent Plans of Operation for seismic work, cutting of vegetation for survey lines is limited to a 3.5 to 6-foot width (understory vegetation only), and no tree limbs greater than 3 inches in diameter may be cut. The use of GPS is encouraged to reduce the need for line-of-sight surveys.

Drilling of shotholes could involve use of off-road vehicles of various types, which could compact and rut soils and damage vegetation. However, adverse impacts could be minimized with the use of smaller, light-weight, or other low-impact vehicles. Wide-tired or light-weight vehicles would rut soils less, minimizing disturbance to the root zone for wetland vegetation. Floatation-type tires would lessen compaction of wetland soils, avoiding ruts that may alter wetland hydrology. Also, there is the option of using mini-shotholes, which would limit the need for vehicles to drill deep holes and allow the use of portable hand drills. The use of helicopters to bring in supplies and equipment would greatly limit the amount of time spent on the ground, as well as the extent of ground and vegetation disturbance (although increasing short-term noise impacts).

Other mitigation measures available to limit direct and indirect adverse Impacts on wetlands from seismic surveys include keeping staging and fueling areas out of sensitive vegetation, using leak protection methods, providing for rapid cleanup of spills, properly plugging shotholes, developing and implementing an exotic weed control plan, and using existing roads for access whenever possible. In addition, consideration could be given to conducting surveys during drier seasons, if possible. Finally, there is concern about drilling shotholes in wetlands that have developed over fragipans. If wetlands have formed due to perched water conditions over the fragipans, and the fragipan layers are penetrated or disrupted by drilling of shotholes, there may be drainage of the wetland and disruption to the community that would be difficult to restore. Site-specific surveys during the planning and development of Plans of Operations would be required, and avoidance would be used if fragipans are found.

Localized soil disturbance could indirectly impact wetland productivity and functioning, but recovery would be expected to occur within a short time if proper mitigation is followed. Vegetation cut for survey lines or disturbed during shothole placement and detonation of explosives in shotholes would also be expected to recover over the short-term. As noted in Fountain and Rayburn (1987), a study of seismic surveys (pre-3-D seismic) found that wetlands were one of the most sensitive to disturbance, with the highest percent of damaged or killed vegetation. Upland soils allowed deeper root penetration than slope or wetland soils, and these deeper rooted plants would bend and recover when run over by a survey vehicle, while the shallow rooted stems tended to be uprooted. However, they found that

vegetation recovery was relatively rapid on most sites, and that survey lines 3 – 4 years old were very hard to locate, indicating the short-term nature of impacts from seismic surveys.

Drilling and Production: In areas of the Preserve where drilling and production operations could be permitted, the construction and maintenance of roads, wellpads, flowlines, and pipelines in or adjacent to wetlands could require the placement of fill material, removal of vegetation, and disruption of soils and surface hydrology, which would alter beneficial wetland functions and values. In the rare event that direct and/or indirect impacts on wetlands cannot be avoided, mitigation to select a least-damaging site to locate operations and to minimize direct and indirect wetland impacts could result in localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), minor to moderate, adverse impacts on Preserve vegetation on up to 241 acres of the Preserve, which could include wetland vegetation if wetlands are not avoided. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate.

Impacts could be considered major if rare and highly productive wetland communities (rare forested wetland communities) meet the major impact threshold defined in this EIS. Under Alternative A, precautions included in case-by-case Plan of Operations/EAs would reduce most impacts to less than major levels.

Under any alternative, wetlands would be avoided as sites for drilling and production, and operators would have to show that there are no practicable alternatives for siting their operations in wetlands. In addition, operators are required to avoid floodplains, which would also result in the avoidance of many of the Preserve's wetlands. However, if wetlands cannot be avoided, drilling and production could occur within or near Preserve wetland communities. Drilling and production of oil and gas could involve clearing, contouring, and construction of the wellpad, roads, flowlines, and other ancillary facilities. All ground-disturbing activities have the potential to have adverse impacts on wetland vegetation, soils and/or hydrology. Oil and gas drilling and production would create similar but varying amounts of surface disturbance, depending on the size of the project and length of time involved. Under the RFD scenario, wellpads are estimated to be 2.4 acres in size, and up to 241 acres could be impacted. The actual number of wetland acres impacted would depend on the location of the well/production pads and access roads, and ancillary facilities, particularly flowlines and pipelines. Drilling operations and impacts would be considered short-term, lasting a few to 6 months, while a producing well may create long-term impacts for 20 years or longer, until the site is abandoned and reclaimed.

The types of impacts on wetlands associated with drilling and production would include not only the visible loss of vegetation and disruption to soils, but the effects on the functions and values of the wetland community. Typical functions and values of wetlands include high productivity, fish and wildlife support, erosion and sedimentation control, dampening storm effects and flood control, water purification, and nutrient cycling. Wetlands also play a major role in the biodiversity of Big Thicket National Preserve and add to its cultural and scientific value. Different wetland types have different levels of importance for these various functions, and site-specific functions and values would be assessed and included in the development of mitigation plans for any wetland disturbance that triggers NPS and Section 404 permitting.

Replacement time is also an issue for Preserve wetlands. Some of the wetlands are forested wetlands, such as the bottomland hardwoods and cypress-tupelo swamps, and are extremely difficult to successfully reclaim or restore, even over a very long period of time (Clewett and Lea, 1990).

Changes in wetland hydrology and drainage patterns could result from surface disturbance, and indirect impacts could occur to off-site wetlands, due to compaction of soils, rutting, use of fill that alters natural drainage patterns, and placement of flowlines or ditches. Flooding or draining of wetlands could occur due to these activities on the site or on nearby lands. Prohibiting vehicular traffic during periods when soils are saturated or flooded, and use of light-weight, large-tired vehicles could help to reduce adverse impacts on soils. Also, earthen pits for disposal of drilling muds and cuttings would not be permitted in the Preserve. A closed loop, containerized drilling mud system would be required for both drilling and workover operations, and tanks would be used to hold drill cuttings or fluids prior to off-site disposal.

As described under the geophysical exploration discussion, above, another issue related to Preserve wetlands is the potential for disturbance of fragipans and associated wetlands. In areas of the Preserve where such conditions are suspected, surveys should be done as part of the planning/development of Plan of Operations and permitting process to ensure that fragipans are not perforated by drilling or production operations.

Indirect impacts on off- and on-site wetlands could also occur due to sedimentation from ground disturbance and erosion. Proper erosion control devices and the proper placement of culverts along access roads would minimize these impacts. Oil and gas releases or accidental spills and leaks of hazardous chemicals could also threaten wetland communities, especially if the chemicals are transported to off-site targets. Produced water spills could be toxic to wetland vegetation and cause long-term soil sterilization, if not remediated. Noxious or exotic weeds could also spread into wetlands from oil and gas operations if proper precautions are not taken. Chinese tallow-tree is a particularly invasive exotic species in the Big Thicket region and has been problematic and costly to control in previous oil and gas operations in the Preserve.

Mitigation measures under Current Legal and Policy Requirements would apply to many of the above concerns. In addition to the mitigation already mentioned, additional measures would include using already disturbed areas (especially existing access roads and wellpads), using blowout prevention equipment on wells, providing adequate secondary containment (berms and liners), having spill contingency plans and equipment on site; and conducting regular flowline testing. Weed control plans, particularly for herbicide application, should also be included as part of any Plan of Operation.

In addition to impact minimization measures, compensation requirements would go into effect during site-specific permitting and Plan of Operations approval if wetlands cannot be practicably avoided. The NPS no-net loss policy and DO 77-1 require a minimum 1:1 compensation ratio for direct and indirect impacts on wetlands, to be performed prior to, or at the time of impacts. This is a functional replacement, and the required ratio may be increased to 2:1 or more if the compensation wetland would not provide the same functions as the impacted wetland, or the wetland type and function requires a very long period of time to develop. Section 404 permitting requirements would also need to be met, and these involve compensatory mitigation to be determined on a project-by-project basis, usually at a minimum of a 2:1 ratio.

In any case, if drilling and production operations are sited in wetlands, there would be a direct loss of wetland acreage for the well/production pad and any associated roads, which may or may not be totally mitigated, depending on the success of eventual reclamation of the operations area. As noted by Kentula (1996), it is difficult to make a definitive statement about the ability to replace wetland functions. The lack of information on ecologically mature mitigation projects limits the ability to predict whether or not the functions of project wetlands can replace the functions of natural wetlands, and replacing forested wetlands and bogs is most problematic. Both Kentula (1996) and Clewell and Lea (1990) note that forested wetlands are complex and require a long time for woody vegetation to mature. According to the case studies reviewed by Clewell and Lea, a wide variety of forest establishment techniques have been explored, some with initial success, but none of them

proven. Forested wetland creation/restoration projects that are carefully planned and executed will be successful in terms of species establishment, but functional equivalency to natural forested wetlands has not been documented. Hydrology is the critical factor during wetland reclamation and creates much more variability and uncertainty than in the reclamation of non-wetland sites. Competent supervision and monitoring during restoration are also essential.

Contacts with several wetland scientists familiar with wetland mitigation in this region confirm that forested wetlands such as bottomland hardwoods and swamp communities are difficult to replace through restoration (pers. comm., Orr, Theriot, 1999). There have been no mitigation banks established in the area for bottomland forest (nearly all are for emergent marshes), and mitigation projects for shrub and forested wetlands have not been in existence long enough to really see if they are successful. Therefore, avoidance of these areas, especially rare and highly productive wetlands, is extremely important (pers. comm., Orr, 1999).

Given the uncertainty about forested wetland compensation and length of time to achieve functionality, there is the possibility that localized, major adverse impacts could result if wetlands cannot be avoided and are impacted by oil and gas drilling and production. If the restored wetlands do not replace the lost functions and values to the extent required by the mitigation plan, a major, long-term adverse impact would occur. Other potential impacts described above would be short-term and minor to moderate in nature.

Under Alternative A, impacts could occur in all wetland communities, with the exception of the fire and long-term monitoring plots, and the Royal Fern Bog Research Plot, based on the specific protection afforded these areas under Current Legal and Policy Requirements, through direction provided in the Preserve's General Management Plan (1980). However, indirect impacts could occur to these areas, since the GMP does not provide for protective offsets, but these impacts could be avoided by siting oil and gas facilities away from these areas.

Under Alternative A, rare forested wetlands (includes wetland baygall shrub thickets, swamp cypress-tupelo forests, wetland pine savannas, and any old growth trees within these or other community types) do not receive formal protection. These important wetland vegetation communities would have to be identified and protected during the planning and development of Plans of Operations. With the implementation of mitigation, adverse impacts should be kept to less than major levels. However, if specific protective measures or offsets are not required, major adverse impacts could occur to these vegetation communities, since they are particularly susceptible to adverse impacts that would jeopardize their ecological attributes.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact wetlands in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as steepness of slope and direction, and surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on wetlands in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting-down, abandoning and removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, sedimentation in waterways, alter surface water flows, and result in leaks and spills of fuels, and other contaminating and hazardous substances, but with mitigation would result in localized, negligible to minor, adverse impacts at sites throughout the Preserve. Impacts could be short- or long-term, lasting until reclamation of impacted wetlands successfully restores wetland functions and values. Impacts could be considered major and adverse if reclamation does not successfully restore wetland functions and values.

For impacts on wetlands, compensatory mitigation involves restoration as described above. Proper plugging of the wells would ensure that hydrocarbon contamination would not occur in the future. Success of compensatory mitigation would be dependant on the conditions of the site-specific mitigation plan. If the site is not properly recontoured and the natural hydrology is altered, or contamination remains, and the potential for restoration of the natural community is not possible, then a major, long-term impact would occur. With the implementation of a site-specific mitigation plan that requires site clean up, remediation of contaminated water or soils, restoration of hydrology, and planting of native vegetation, impacts should be reduced to negligible to minor, adverse impacts, unless rare or important wetlands (rare forested wetland communities) are involved and their integrity or value is jeopardized.

Indirect impacts on wetlands in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for wetlands covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area has been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact natural resources, including wetlands in the region.

Since the time of Colonial America, wetlands have been regarded as a hindrance to productive land use. Swamplands, bogs, sloughs, and other wetland areas were considered wastelands to be drained, filled, or manipulated to “produce” other than natural services or commodities. (Dahl, 1990). Over a period of 200 years, Texas has lost an estimated 52 percent of its wetlands (Dahl, 1990). Wetland losses are principally attributed to filling, draining, excavating, diverting, clearing, flooding, shading activities, and from adverse impacts from adjacent land uses, grazing, and farming (Texas Parks and Wildlife Department, 1995). Over a 200-year timespan, wetland acreage has diminished to the point where environmental and even socio-economic benefits (i.e., groundwater supply and water quality, shoreline erosion, floodwater storage and trapping of sediments, and climatic changes) are now seriously threatened (Dahl, 1990).

As described in the previous chapter, the Preserve comprises at least 40 percent wetlands, consisting primarily of palustrine wetlands (31,530 acres), but also includes a small acreage of riverine (3,125 acres) and lacustrine (60 acres) wetland systems. These wetland systems represent less than 20% of the analysis area. Loss of palustrine forested wetlands (bottomland hardwood and floodplain forests) in the analysis area are mainly attributed to upland agriculture and other upland land uses. Long-term viability of wetlands in the analysis area could be influenced by direct loss through developments or indirectly by alteration of surface or subsurface water supply.

Cumulative impacts of any alternative on wetlands within and immediately adjacent to the Preserve include unmitigated wetland losses of an undetermined acreage from oil and gas developments that pre-existed the establishment of the Preserve. Many of these sites have not been properly reclaimed, and it is anticipated that impacts have included direct loss of wetland vegetation and soils, and changes in hydrology around site structures and filled areas. These effects have caused long-term impacts on plant communities within and outside Big Thicket National Preserve, resulting in removal of wetland vegetation or a change (decrease) in site productivity and habitat value. These past unmitigated disturbances, especially those within the Preserve, constitute a cumulative adverse

impact, but until site-specific analysis of each abandoned site (unreclaimed sites comprising 376 acres in the Preserve) is performed, it is difficult to gauge the level of impact. Any additional impacts resulting from operations permitted under the No Action Alternative would add to these cumulative adverse impacts within the Preserve. However, future wetland impacts would be reduced through the application of Current Legal and Policy Requirements, which require operators to avoid wetlands areas for development unless there are no practicable alternatives, requires a standard offset of a minimum 500 feet from waterways (unless specifically authorized by an approved plan of operations), requires Plans of Operations to address reclamation of disturbed wetlands to be performed at the completion of operations prior to undertaking a permitted operation, in addition to also describing in Plans of Operations how restoration of a disturbed wetlands site would be performed to meet the compensatory requirements of both the NPS wetlands protection guidelines and Corps of Engineers Section 404 permitting requirements. In addition, the Preserve's prescribed fire management program would provide long-term cumulative beneficial impacts on wetland pine savannas by restoring and maintaining the wetland vegetation community and biodiversity. Therefore, over time, cumulative impacts on wetlands in the Preserve would be improved, a cumulative beneficial impact for wetland resources of the Preserve.

Wetlands in the analysis area outside the Preserve could be lost by developing wetland areas, and indirectly influenced by any development or activity that causes sedimentation in wetlands or disrupts surface and subsurface water flow. Although these actions are subject to Army Corps of Engineers Section 404 requirements, wetland mitigation has not always been done or been done successfully. Land uses with potential to impact wetlands outside the Preserve, or influence water supply both within the analysis area and in the Preserve include: residential development; commercial and private forestry; oil and gas development; agriculture; and public-owned facilities (e.g., impoundments, water diversion, and sewage treatment). With expected population growth in the analysis area and increased development in the analysis area, it is inevitable that some wetlands could be developed or indirectly impacted by uplands developments; therefore, over the long-term, cumulative moderate adverse impacts on wetlands could occur in the analysis area. Since approximately 97 percent of the lands in Texas are privately-owned, the future of the State's wetlands is closely linked to land-use decisions made by private citizens. The information provided by wetlands delineation of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Where exploration operations could be permitted, vegetation could be trimmed along source and receiver lines; and crushed, damaged or uprooted by off-road vehicle use. Where soils are compacted or rutted, surface hydrology and plant growth could be altered. Leaks and spills could pollute soil and water, and harm or kill vegetation. Mitigation should reduce impacts to result in localized, short-term, negligible to minor, adverse impacts on wetlands on up to 465 acres of the Preserve.

There is no formal protection provided for fire monitoring plots and long term monitoring plots; and if they are not adequately protected could result in major adverse impacts.

Drilling and Production: Where drilling and production operations could be permitted, the construction and maintenance of roads, wellpads, flowlines, and pipelines in or adjacent to wetlands could require the placement of fill material, removal of wetland vegetation, and disruption of soils and surface hydrology, which would alter beneficial wetlands functions and values. In the rare event that direct and/or indirect impacts on wetlands cannot be avoided, mitigation to select a least-damaging site to locate operations and to minimize direct and indirect wetland impacts could result

in localized, short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), minor to moderate, adverse impacts on wetlands on up to 465 acres of the Preserve. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate. Indirect impacts on wetlands in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

There is no formal protection provided to rare forested wetland communities, and if they are not adequately protected could result in major adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting-down, abandoning and removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, sedimentation in waterways, alter surface water flows, and result in leaks and spills of oil, and other contaminating and hazardous substances, but with mitigation would result in localized, negligible to minor, adverse impacts at sites throughout the Preserve. Impacts could be short-term or long-term, lasting until reclamation of impacted wetlands successfully restores wetland functions and values. Impacts could be considered major and adverse if reclamation does not successfully restore wetland functions and values. Indirect impacts on wetlands in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Over time, protection provided to wetlands in the Preserve under Current Legal and Policy Requirements is expected to result in the Preserve maintaining and improving wetlands, with cumulative, beneficial impacts on Preserve wetlands; while adjacent lands could continue to be developed with wetlands incrementally being lost. Also, reclamation of wetlands inside or outside the Preserve may not return sites to pre-disturbance conditions. Therefore, Alternative A is expected to result in cumulative, moderate, adverse impacts on wetlands in the region.

Impairment Analysis: Because there would be no major adverse impacts to wetlands whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve wetlands.

Impacts on Wetlands under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current Legal and Policy Requirements, including 36 CFR 9B regulations and NPS Director's Order 77-1 wetlands protection guidelines, which have been described in Chapter 2, Parts II and III, and under Alternative A, impacts on wetlands should be substantially reduced throughout the Preserve.

Under Alternative B, the types of impacts that could occur to wetlands would be the same as described under Alternative A. However, because SMAs would be designated and provided with specific protection, these impacts would be lessened or eliminated in some SMA areas. Under

Alternatives B (and C), rare forested wetlands are formally designated as SMAs; however, the operating stipulations required for geophysical exploration, and drilling and production operations varies for each alternative.

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on wetlands on up to 465 acres of the Preserve associated with wetland vegetation being trimmed along source and receiver lines; and crushed, damaged or uprooted by off-road vehicle use. Where soils are compacted or rutted, surface hydrology and plant growth could be altered. Leaks and spills could pollute soil and water, and harm or kill vegetation. Geophysical exploration would be permitted in the rare forested wetland communities SMA (which includes wetland baygall shrub thickets, swamp cypress-tupelo forests, wetland pine savannas, and old growth trees), and in all other wetland communities subject to Current Legal and Policy Requirements, including NPS and Corps of Engineers permitting and mitigation policies and requirements. The restriction of vehicle use on or across saturated or flooded soils in hydrologic soil classes "C" and "D," under Current Legal and Policy Requirements, would substantially lessen impacts on wetlands vegetation and soils.

Drilling and Production: Similar to Alternative A, construction and maintenance of drilling and production operations could be permitted in areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on wetlands on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to moderate. However, if reclamation of operations areas that required disturbance of wetlands, or compensatory mitigation is not successful in restoring wetland functions and values, there would be major adverse impacts that could potentially last for the long-term until the desired community type is restored.

It is possible under Alternative B that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. The intensity of impacts on wetlands would be dependant upon where the operation is located with respect to specific types of wetland communities, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Similar to Alternative A, indirect impacts on wetlands in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative. In the rare event that direct and/or indirect impacts on wetlands cannot be avoided, Current Legal and Policy Requirements would guide the selection of the least-damaging site to locate operations.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, sedimentation in waterways, alter surface water flows, and result in leaks and spills of oil, and other contaminating and hazardous substances, but with mitigation would result in localized, negligible to minor, adverse impacts at sites throughout the Preserve. Impacts could be short- to long-term, lasting until reclamation successfully restores wetland functions and values. Impacts could be considered major and adverse if reclamation does not successfully restore wetland functions and values. Indirect impacts on wetlands in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative B would be similar to those described for Alternative A, but with more certainty of avoiding adverse impacts on wetlands communities in the Preserve as a result of the additional protection provided by formally designating wetlands communities as SMAs, with offsets or increased offsets, where operating and timing stipulations would apply. Over time, the additional protection afforded the SMA wetland communities and old growth trees would result in a cumulative beneficial impact for Preserve wetlands, as the older trees in these areas continued to be protected, adding to the amount of old growth and/or mature wetland forest acreage within the Preserve. This is especially important, since the NPS's more stringent wetland protection policies are not in effect for privately-owned wetlands outside the Preserve boundary. These private wetlands could be lost over time, particularly if very small areas are developed and are exempt from Corps of Engineers review; and if they are not adequately replaced or restored, over the long-term the incremental small losses could result in cumulatively large acreage of wetland losses, resulting in cumulative, moderate, adverse impacts on wetlands in the region.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on wetlands on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternative A, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on wetlands on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to moderate. Indirect impacts on wetlands in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: The designation of SMAs would increase the acreage where the No Surface Use stipulation would be applied to exploration, drilling and production operations; therefore, plugging, abandonment, and reclamation of new operations would not occur in these areas.

Similar to Alternative A, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, negligible to minor, adverse impacts on wetlands. Impacts could be short-term or long-term, lasting until reclamation of impacted wetlands successfully restores wetland functions and values; and could be considered major and adverse if reclamation does not successfully restore wetland functions and values. Indirect impacts on wetlands in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Similar to Alternative A, with cumulative, moderate, adverse impacts on wetlands in the region. However, protection of wetland resources would be more readily attainable in the Preserve due to designation of SMAs where the No Surface Use stipulation would result in no new impacts on wetlands that are particularly susceptible to adverse impacts from oil and gas operations and important to maintaining the ecological integrity of the Preserve.

Impairment Analysis: Because there would be no major adverse impacts to wetlands whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve wetlands.

Impacts on Wetlands under Alternative C (Maximum Resource Protection)

SMA's would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to geophysical exploration in all SMA's, except for the Hunting Areas and Birding Hot Spots SMA's that would have timing restrictions. The No Surface Use stipulation would be applied to drilling and production operations in all SMA's, except for the Hunting Areas SMA. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations and the NPS's wetlands protection guidelines (Director's Order 77-1), which have been described in Chapter 2, Parts II and III, and under Alternative A, should substantially reduce impacts on wetlands throughout the Preserve.

Geophysical Exploration: The Preserve's rare forested wetland communities, fire and long-term monitoring plots, and Royal Fern Bog Research Plot would experience no direct adverse impacts from exploration operations because they are formally designated as SMA's, and the No Surface Use stipulation would be applied with protective offsets. SMA's formally designated to protect wetlands include Fire Monitoring Plots and Long-term Monitoring Plots (50-150 foot offset), the Royal Fern Bog Research Plot (150-foot offset), Rare Forested Wetland Communities (including Wetland Baygall Shrub Thickets, Swamp Cypress-Tupelo Forests, Wetland Pine Savannas, and Old Growth Trees), and Riparian Corridors. Wetland areas would also be protected in Visitor Use and Administrative Areas SMA's (500-foot offset), and where they occur within the Rare Vegetation Communities (including Upland Pine Forests, Beech-Magnolia-Loblolly Pine Forests, and Sandhill Pine Forests). Wetlands within 500 feet of waterways would continue to be protected because Current Legal and Policy Requirements would not permit operations in these areas.

In addition to the areas where the No Surface Use stipulation would apply year-round, surface uses for geophysical exploration operations would not be permitted in the Hunting Areas SMA from October 1st through January 15th, or in Birding Hot Spots SMA's from March 1st through May 30th and September 1st through November 30th. These areas comprise 52,272 acres. The timing stipulation would result in no direct impacts on wetlands in these areas during the specified times.

Geophysical exploration could be permitted in other areas of the Preserve. Due to the designation of large SMA's where geophysical exploration would not be permitted, the modification of project designs could concentrate operations outside of the SMA's. As a result, it may be necessary to increase the density of seismic shotholes outside the SMA's to adequately image the subsurface under the SMA's. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. These adverse impacts could occur inside or outside the Preserve, and are dependant upon the location and layout of the seismic grid. Impacts would be similar to Alternatives A and B, with localized short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve, with some acreage associated with wetland vegetation being trimmed along source and receiver lines; and crushed, damaged or uprooted by off-road vehicle use. Where soils are compacted or rutted, surface hydrology and plant growth could be altered. Leaks and spills could pollute soil and water, and harm or kill vegetation.

Drilling and Production: Protection is provided to certain wetland communities by formally designating these areas as SMAs and applying the No Surface Use stipulation. SMAs formally designated to protect wetlands include fire monitoring plots and long-term monitoring plots (with a 150-foot offset), the Royal Fern Bog Research Plot (with a 150-foot offset), rare forested wetland communities (wetland baygall shrub thickets, swamp cypress-tupelo forests, wetland pine savannas, and old growth trees), and riparian corridors. Wetland areas would also be protected in visitor use and administrative areas SMAs (with a 1,500-foot offset), and where they occur within the rare vegetation communities (upland pine forests, beech-magnolia, loblolly pine forests, and sandhill pine forests). Wetlands within 500 feet of waterways would continue to be protected because Current Legal and Policy Requirements would not permit operations in these areas. However, some existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) operations, and transpark pipelines (589 acres) may be impacting, directly or indirectly, wetlands in the Preserve, some of which are located within SMAs.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on wetlands would be dependant upon where the operation is located with respect to specific types of wetland communities, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Similar to Alternatives A and B, indirect impacts on wetlands in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including the riparian corridors SMA). In the rare event that direct and/or indirect impacts on wetlands cannot be avoided, Current Legal and Policy Requirements would guide the selection of the least-damaging site to locate operations.

Similar to Alternatives A and B, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on wetlands on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to moderate. If reclamation of operations areas that required disturbance of wetlands, or compensatory mitigation are not successful in restoring wetland functions and values, the effects would be considered a major adverse impact, and could potentially last for the long-term until the desired community type is restored.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, well plugging, shutting-down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could cause soil erosion, sedimentation in waterways, alter surface water flows, and result in leaks and spills of oil, and other contaminating and hazardous substances, but with mitigation would result in localized, negligible to minor, adverse impacts at sites throughout the Preserve. Impacts could be short- to long-term, lasting until reclamation of impacted wetlands successfully restores wetland functions and values. Impacts could be considered major and adverse if reclamation does not successfully restore wetland functions and values. Indirect impacts on wetlands in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative C would be similar to those described for Alternatives A and B, but with even greater certainty of avoiding adverse impacts on

wetlands communities in the Preserve as a result of the additional protection provided by formally designating wetlands communities as SMAs, with offsets or increased offsets, where operating and timing stipulations would apply. Over time, the additional protection afforded the SMA wetland communities and old growth trees would result in a cumulative beneficial impact for Preserve wetlands, as the older trees in these areas continued to be protected, adding to the amount of old growth and/or mature wetland forest acreage within the Preserve. This is especially important, since the NPS's more stringent wetland protection policies are not in effect for privately-owned wetlands outside the Preserve boundary. These private wetlands could be lost over time, particularly if very small areas are developed and are exempt from Corps of Engineers review; and if they are not adequately replaced or restored, over the long-term the incremental small losses could result in cumulatively large acreage of wetland losses, a cumulative, moderate, adverse impacts on wetlands in the region.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Where geophysical exploration would not be permitted, the modification of project designs could concentrate operations outside of the SMAs. Geophysical exploration could be permitted in other areas of the Preserve, resulting in impacts similar to Alternatives A and B, with localized, short-term, negligible to minor, adverse impacts on up to 465 acres of the Preserve, some of which may occur in wetlands.

Drilling and Production: Similar to Alternatives A and B, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on wetlands on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be negligible to moderate. Indirect impacts on wetlands in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, negligible to minor, adverse impacts on wetlands. Impacts could be short-term or long-term, lasting until reclamation of impacted wetlands successfully restores wetland functions and values; and could be considered major and adverse if reclamation does not successfully restore wetland functions and values. Indirect impacts on wetlands in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Similar to Alternatives A and B, with cumulative, moderate, adverse impacts on wetlands in the region. However, protection of wetland resources within the Preserve would be more readily attainable due to more acreage designated as SMAs under Alternative C, with no new impacts on wetlands that are particularly susceptible to adverse impacts from oil and gas operations and important to maintaining the ecological integrity of the Preserve.

Impairment Analysis: Because there would be no major adverse impacts to wetlands whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3)

identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve wetlands.

IMPACTS ON FISH AND WILDLIFE

Introduction

The Big Thicket is a "biological crossroads" because it is a transition zone between four distinct vegetation types: the moist eastern hardwood forest, the arid southwestern desert, the tropical coastal marsh, and the central prairies. The variety of vegetation, climate, soils, and their interactions in these communities provide habitat for a diversity of fish and wildlife. The NPS perpetuates the native fish and wildlife as part of the natural ecosystem of the Preserve. The management emphasis is to preserve and restore the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native plant and animal populations and their communities and ecosystems in which they occur; restore native plant and animal populations in parks when they have been extirpated by past human-caused actions; and minimize human impacts on native plants, animals, populations, communities, and ecosystems, and the processes that sustain them. (NPS Management Policies, 2001).

Methodology for Assessing Impacts

Assessment of impacts is based on professional judgement and was developed through consultation with NPS staff and other experts in the field, and review of relevant literature.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are defined as follows:

- Negligible:** Impacts would result in a change to a population or individuals of a species or a resource, but the change would be short-term, and well within the range of natural fluctuations. The changes would be so slight that they would not be of any measurable or perceptible consequence to native fish and wildlife species, their habitats, or the natural processes sustaining them.
- Minor:** Impacts would result in a change to a population or individuals of a species or a resource that would not be measurable or expected to be outside the natural range of variability and would not be expected to have any long-term effects on native species, their habitats, or the natural processes sustaining them. Population numbers, population structure, genetic variability, and other demographic factors for species may have small, short-term changes, but long-term characteristics remain stable and viable. Occasional responses to disturbance by some individuals could be expected, but without interference to feeding, reproduction, or other factors impacting population levels. Key ecosystem processes may have short-term disruptions that would be within natural variation. Sufficient habitat would remain functional to maintain viability of all species. Impacts would be outside of critical reproduction periods for sensitive species. Mitigation measures, if needed to offset adverse effects, would be simple and successful.
- Moderate:** Impacts would result in a change to a population or individuals of a species or a resource that would be measurable, long-term, and localized, with

consequences at the population level. Breeding animals of concern are present; animals are present during particularly vulnerable life-stages, such as migration or juvenile states; mortality or interference with activities necessary for survival can be expected on an occasional basis, but is not expected to threaten the continued existence of the species in the park unit. Impacts on native fish and wildlife species, their habitats, or the natural processes sustaining them would be measurable, and they could be outside the natural range of variability for short periods of time. Population numbers, population structure, genetic variability, and other demographic factors for species may have short-term changes, but would be expected to rebound to pre-impact numbers and to remain stable and viable in the long-term. Frequent response to disturbance by some individuals could be expected, with some negative impacts to feeding, reproduction, or other factors impacting short-term population levels. Key ecosystem processes might have short-term disruptions that would be outside natural variation (but would soon return to natural conditions). Sufficient habitat would remain functional to maintain variability of all native fish and wildlife species. Some impacts might occur during critical periods of reproduction or in key habitat for sensitive native species. Mitigation measures, if needed to offset adverse effects, could be extensive, but would likely be successful.

Major: Impacts on native fish and wildlife species, their habitats, or the natural processes sustaining them would be measurable, and they would be expected to be outside the natural range of variability for long periods of time or to be permanent. Population numbers, population structure, genetic variability, and other demographic factors for species might have large, short-term declines with long-term population numbers significantly depressed. Frequent responses to disturbance by some individuals would be expected, with negative impacts to feeding, reproduction, or other factors resulting in a long-term decrease in population levels. Breeding colonies of native species might relocate to other portions of the recreation area. Key ecosystem processes might be disrupted in the long-term or permanently. Loss of habitat may affect the viability of at least some native species. Extensive mitigation measures would be needed to offset any adverse effects and their success would not be guaranteed.

Impacts on Fish and Wildlife under Alternative A (No Action/Current Management)

All of Big Thicket's fish and wildlife is protected under Current Legal and Policy Requirements. However, the application of Current Legal and Policy Requirements, and project-specific operating stipulations, could result in variations in how, where, and to what extent resource protection is applied. The NPS's 36 CFR 9B regulations require a description of the natural environment to be impacted by operations be included in Plans of Operations, and that least-damaging methods are utilized. Reclamation of disturbed areas must reestablish native vegetative communities and provide for the safe movement of native wildlife and the normal flow of surface waters. Fish and wildlife habitat would need to be identified during the planning/development and review of Plans of Operations, so that avoidance or mitigation measures are applied to minimize impacts on fish and wildlife, and reclamation standards may be established prior to conducting operations (including documentation of the natural topographic contours, native vegetative communities, surface water flow patterns, natural topsoil characteristics, and biological survey of fish and wildlife in the project area). Fences shall be erected around existing or future installations, e.g., well, storage tanks, all

high pressure facilities, to protect wildlife. Under Alternative A, SMAs would not be formally designated. Protected areas comprising 56,538 acres and other areas of the Preserve would be provided protection under Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations.

A description of impacts on fish and wildlife from specific types of oil and gas operations is provided below.

Geophysical Exploration: Where exploration operations could be permitted, fish and wildlife could be displaced and experience increased stress and mortality and decreased production while seismic work crews occupy large areas to lay receiver and source lines, drill shotholes, and detonate explosives placed in shotholes. Fish and burrowing wildlife would be susceptible to shock, concussion and mortality from detonation of explosives in shotholes. Elevated noise from intermittent shothole drilling and detonation of explosives in shotholes, vehicles and helicopters could contribute to displacing some fish and wildlife, increasing stress and reducing productivity. These effects could result in localized, short-term, negligible to minor, adverse impacts on fish and wildlife on up to 465 acres of the Preserve.

The degree in which geophysical exploration could adversely impact fish and wildlife would depend on the type of survey conducted, equipment and vehicles used, the specific fish and wildlife habitats that are impacted, and when the survey is conducted (particularly in terms of the life cycle of fish and wildlife species that could be adversely impacted by the proposed exploration operation). It is expected that all future surveys in the Preserve would utilize 3-D seismic technology. Three-dimensional exploration involves the placement of a grid pattern of source lines with explosive charges placed in shotholes below the ground and receiver lines placed in and on the ground that can cover many square miles.

Effects to fish and wildlife from conducting 3-D seismic surveys could include increased displacement, increased risk of mortality, decreased production, and increase in stress levels. These effects could be caused by multiple seismic crews occupying a large area to trim vegetation along 3.5-foot wide receiver and source lines, drill shotholes, detonate explosives, and use vehicles and helicopters.

Displaced wildlife may not be able to find suitable, unoccupied habitat in adjacent areas, and could potentially die of natural causes or displace other wildlife. Undisturbed wildlife normally exhibit patterns of activity and habitat selection that result in the optimization of energy expenditure. Disturbance of normal activity patterns and habitat use through oil and gas operations would have an adverse impact on the amount of available energy and, therefore, the welfare of an individual or a population could suffer. If the animal is unable to compensate for these increases in energy utilization, reproduction, growth, and survival are often greatly reduced.

Localized effects on burrowing wildlife (primarily reptiles, amphibians and small mammals), include shock, concussion, and possibly mortality, resulting from vehicle use, drilling of shotholes, and detonation of explosive charges in shotholes. Fish and wildlife could also be impacted by the noise associated with seismic survey work, particularly detonation of explosives in shotholes, and helicopter and vehicle noise. Impacts related to noise are usually temporary, with fish and wildlife avoiding or moving away from the source, but returning after noise is reduced or eliminated. Seismic survey noise is intermittent, and the loudness depends on the size of the explosive and depth of the shothole. Detonation of explosives in shotholes could be muffled but could be loud and startling due to the intermittent timing of explosive detonations. Helicopter noise is also localized and intermittent. Vibrations from explosive detonations could damage eggs so that they do not incubate.

Under any alternative, protection of water quality and aquatic fish and wildlife would be provided by 36 CFR § 9.41(a), which requires operations to maintain a 500-foot offset from rivers, streams, and other waterbodies, unless specifically authorized by an approved plan of operations. The offset

would avoid or substantially reduce sedimentation and turbidity. The 500-foot offset from waterbodies would protect fish and wildlife utilizing water and the immediate riparian areas within this protective zone. Protection of aquatic habitats would also be provided by the wetlands and floodplains permitting and compliance requirements. Vehicle use would not be permitted on or across saturated or flooded soils in hydrologic soil classes "C" and "D," which would reduce damage to vegetation and soils, but could result in lengthening the time seismic work crews and activities remain in an area.

The potential exists for leaks and spills of diesel fuel from refueling of vehicles and shothole drilling equipment that could pollute habitats, and injure and kill fish and wildlife that come into contact with or ingest hazardous or contaminating substances. However, stringent requirements under Current Legal and Policy Requirements, which include locating staging and fueling areas outside of sensitive environments such as wetlands and floodplains, utilizing drip pans, maintaining and inspecting vehicles and equipment to prevent leaks and spills and using drip pans during refueling, and providing for prompt response in the event of spills, would reduce the potential for spills and adverse impacts on fish and wildlife.

Drilling and Production: Where drilling and production operations could be permitted, the construction and maintenance of roads, wellpads and production pads could result in the direct loss of habitat and habitat fragmentation. Increased mortality could result from vehicles, construction activities, and increased access into previously inaccessible areas, resulting in localized, short-term (construction and well drilling) to long-term (roads, flowlines, pipelines, wells and production operations), minor to moderate, adverse impacts on up to 241 acres of the Preserve. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be minor to moderate.

Many of the impacts on fish and wildlife from drilling and production are associated with construction activities. Fish and wildlife, particularly small mammals, invertebrates, and herpetofauna (reptiles and amphibians) that cannot escape an area during construction could be killed, and increased mortality for small mammals is also likely to occur along access roads.

Fish and other water-dependent species could experience habitat degradation from road construction and use, construction of wellpads, and pipelines in drainages where these species occur. These effects could decrease the long-term viability of populations as a result of increased sedimentation from construction activities and long-term uses, if appropriate mitigation measures are not applied. Some risk of direct mortality to fish and other aquatic species could occur if a pipeline ruptures at a stream crossing or toxic materials (such as diesel fuel) are spilled into streams. In some cases, improved human access to remote streams could result in greater fishing mortality or poaching, which would constitute an indirect effect. These effects would depend on where exploration and production ultimately occur, and careful siting of developments could avoid or minimize these impacts substantially. Because waterways are inherently a part of floodplains (riparian corridors) and wetland areas, they receive added protection under the Executive Orders and NPS implementing guidelines for protection of wetlands and floodplains, and are protected by a 500 foot offset under the NPS's Nonfederal Oil and Gas Rights Regulations, at 36 CFR § 9.41(a), unless specifically authorized by an approved plan of operations. These protective measures would ensure that water levels would be maintained and stream temperatures, and water quality and quantity would be protected. Careful siting of facilities when there are no practicable alternatives to locating an operation or activity in floodplains and wetlands is expected to result in stringent mitigation measures to minimize potential impacts. Therefore, the sediment increases are not expected to change channel processes or affect viability of the fish populations. Required compensatory mitigation for direct and indirect impacts on wetlands could be used to restore wetlands habitats and increase fish and wildlife habitat values.

Construction of oil and gas-related roads, wellpads or flowlines would result in direct loss of habitat. However, identification of fish and wildlife habitat through biological surveys would result in

development of mitigation measures intended to avoid or minimize impacts. These surveys must be performed by biologists having sufficient technical knowledge and/or experience to appropriately time when and how surveys are performed and be qualified to identify species and habitat of the species that are present or may potentially use the area.

Reclamation of disturbed areas associated with access roads, pads, flowlines and pipelines would minimize impacts on fish and wildlife. Where disturbed areas are properly prepared and seeded with native species, reclamation would expedite the return of habitat and reduce the potential for invasion of non-native species. For production operations, these areas and their associated access roads would be unavailable as wildlife habitat for the long-term (i.e., 20 years or longer). Use of already-disturbed areas for siting new operations would minimize loss of fish and wildlife habitat.

Wildlife could also be adversely impacted when access is increased or human access becomes easier, especially in areas that were previously inaccessible. This increases the risk of fish and wildlife mortality, through legal or illegal means. The Preserve Superintendent can close or restrict motorized public access on roads that are to be used for oil and gas development if necessary. With this authority, the NPS can mitigate the effects of increased public access via oil and gas access roads.

Habitat fragmentation from this new access occurs when a timbered landscape is converted to early successional stages of grass/forb. Fragmentation also occurs due to the presence of roads bisecting the landscape. This fragmentation may inhibit some species of wildlife (generally small prey species, i.e., rodents, insects, etc.) to utilize their habitats effectively. The direct effect of modifying or removing vegetation would need to be analyzed on a project-specific basis, particularly if it occurs in a location of necessary habitat for a species group.

Alteration of fish and wildlife habitat and increased access and human intrusion can also allow for the introduction of non-native species. The most invasive non-native species of wildlife is the feral hog that was introduced by early settlers over a hundred years ago. Preferred habitat includes hardwood forests, swamps, and river bottoms (Singer, 1981). These habitats are abundant in the Preserve and none are expected to increase or decrease substantially as a result of oil and gas operations. Many hunting leases adjacent to the Preserve actively manage feral hogs for sport hunting, and it is likely that invasion of feral hogs from these leases will continue to ensure a viable population of feral hogs in the Preserve in perpetuity.

Ground-disturbing activities in wet soils, such as in floodplains and wetlands areas (including riparian corridors), could increase the possibility for introduction and invasion of non-native vegetation such as the Chinese tallow tree. A landscape invaded by Chinese tallow would not support native wildlife populations as fully as a landscape with native vegetation. The potential for introducing the Chinese tallow tree should be avoided or substantially reduced by not allowing vehicle use on or across saturated or flooded soils in hydrologic soil classes "C" and "D."

All construction activities are likely to displace animals along access corridors and near the wellpad during construction, and through the exploration and production phase of the well. Displacement is the major effect to most wildlife species. Displacement of wildlife would continue from the initial wellpad construction phase into exploratory drilling, and if the well is placed in production, during the potentially long life of the producing well. Road and pad development and drilling operations would reduce the usable habitat for large carnivores as well as their prey species. Secure areas for large carnivores and prey species are reduced and the risk of legal and illegal mortality increases. The increase of and ease of access routes for public travel would serve to increase public motorized travel, or if the roads are closed to public motorized travel, they still serve as an access route by foot, horse and mountain bike. New access roads may even serve as travel corridors for large carnivores which may increase their risk of mortality, either legal or illegally. Increased access would also result in the same effects on smaller wildlife species, with increase in direct loss of wildlife through trapping and hunting. Low-speed

roads are not expected to appreciably increase mortality from road kill or should not be barriers to movements of the small wildlife species.

Noise from drilling operations would also impact wildlife. Drilling operations introduce noise with the highest measurements in the 90 dBA range for a period of 30 to 90 days, with noise coming mostly from multiple diesel engines. Therefore, noise impacts could be major, but limited to a localized area and relatively short-term duration.

Also, in spite of careful best-management practices to minimize the release of oil and other contaminating and hazardous substances, in the worst case scenario, releases could potentially escape primary and secondary containment systems and species inhabiting the area could be harmed. If releases are transported into waterways, fish and other species occupying the water could be impacted. The severity of impacts would depend on the type and amount of pollutant released, physical and environmental factors of the site, the method and speed in which cleanup occurs, and the sensitivity of fish and wildlife to these impacts during different stages of their life cycle.

Some facilities associated with production operations (i.e., heater treater units/separator units) could kill bats, migratory birds and raptors through asphyxiation or incineration. To mitigate the residual impacts from these facilities, a cone device, placed on top of all vent stacks, would be required under Current Legal and Policy Requirements. The cones would be constructed in a manner that prevents perching on the vent stacks and subsequent asphyxiation, and eliminates all access into the vent stack pipes. Inaccessibility to the vent stacks would curtail any potential mortality to bats and birds.

Another protective measure requires that all open containers that collect stormwater be netted or covered. This requirement prevents bird and other wildlife species from accessing stormwater that have come in contact with and mixed with oil and gas, and contaminating and hazardous substances.

Selection and use of herbicides and pesticides must be approved by the NPS Integrated Pest Management Coordinator. Therefore, major effects on native fish and wildlife would be avoided.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact fish and wildlife in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as steepness of slope and direction, and surface hydrology; and mitigation measures being employed. Based on these factors, indirect impacts on fish and wildlife in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, flushing and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill fish and wildlife, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve.

Plugging and abandonment operations and site preparation during reclamation would introduce heavy equipment and people, along with increased noise levels for a short time; however, the long-term effect of these activities is to return the area to natural conditions, a beneficial impact to fish and wildlife. Wherever access roads have been built or are used for the primary purpose of allowing access for oil and gas operations, access roads would be reclaimed at the completion of operations. This would return the area to its natural conditions, thereby having a beneficial impact on the Preserve environment. Wherever possible, habitats would be improved to perpetuate the viability of habitats and increase the survivability of species.

As oil and gas operations are plugged and abandoned, fish and wildlife habitat will be reclaimed. And, as new operations are planned, while they are likely to contribute to habitat fragmentation, it is expected to be to a much lesser degree than in the past. This is because Current Legal and Policy Requirements would be applied to avoid and minimize habitat fragmentation, and require operators to utilize least-damaging techniques, which would emphasize siting of new operations in already disturbed areas. Therefore, over the long-term, it is anticipated that fragmentation could be reduced and fish and wildlife habitat could be improved.

Indirect impacts on fish and wildlife in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for fish and wildlife covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area has been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact natural resources, including fish and wildlife in the region.

The long-term protection of fish and wildlife biodiversity in the Preserve depends on the ability of fish and wildlife populations to persist in the disparate configuration of the Preserve. A principal conservation strategy for the Preserve is that the water corridors should enhance the dispersal of fish and wildlife among otherwise isolated units. The degree to which these habitat corridors serve as migration routes or enhance the persistence of fish and wildlife species has not been adequately analyzed. Ultimately, the interplay between habitat characteristics at local sites and the dispersal abilities of species will determine which species persist in the Preserve (pers. comm., Lee Fitzgerald, 1999).

Assessment of fish and wildlife species diversity by Harcombe et al. (1996) suggest regional declines in fish and some stream invertebrate groups, partially attributed to regional modification of waterways. Modification of waterways may change the overall amount and timing of stream flows, directly impacting stream channel morphology (structure or form), rate of meandering or migration, sedimentation, water quality, and the amount and type of aquatic habitat. These changes may indirectly impact the growth, availability, and regeneration of bottomland hardwood forests. A majority of mammals, birds, reptiles, amphibians, fish, and invertebrates depend on bottomland hardwood forests for all or part of their life cycle.

Past and present oil and gas operations in and adjacent to the Preserve adversely impact fish and wildlife. Plugged and abandoned oil and gas wells and associated road segments that pre-date the establishment of the Preserve continue to adversely impact 376 acres inside the Preserve. Thirteen existing oil and gas operations in the Preserve occupy 24.2 acres, and 71 existing transpark oil and gas pipelines utilize 589 acres within associated right-of-way corridors. Impacts have included direct loss of terrestrial habitat at oil and gas sites. Also, construction of roads, flowlines and pipelines that cross rivers and streams increase erosion and sedimentation that adversely impact water quality and aquatic habitats. These combined effects on 989 acres have caused long-term impacts on fish and wildlife communities within the Preserve, resulting in removal of vegetation or a change (decrease) in site productivity and habitat value. These adverse impacts will remain until operations areas are reclaimed. Under the RFD scenario, future oil and gas operations may result in Preserve-wide 3-D seismic surveys that could utilize up to 465 acres of the Preserve, while drilling up to 40 wells and production of up to 27 could occupy up to 241 acres of the Preserve. Over the long-term, up to 1,695 acres could be directly impacted by oil and gas operations in the Preserve; however,

while new operations are occurring, others would be plugged/abandoned/reclaimed. In addition to oil and gas operations within the Preserve, many operations adjacent to the Preserve may have indirect impacts on Preserve resources.

Other activities in the Preserve that could impact fish and wildlife included wildlife harvest (hunting and trapping), non-consumptive recreation in wildlife habitats, and the Preserve's prescribed fire management program. Bag limits are set by the State of Texas to ensure the continuing viability of populations; therefore, over the long-term, hunting and trapping could have beneficial impacts on wildlife populations. Recreational activities in the Preserve focused near developed visitor use areas, trails, canoe routes, and roads have a negligible to minor, adverse impact on fish and wildlife. The Preserve's prescribed fire management program could contribute to short-term habitat loss and result in adverse effects to wildlife including increased stress and mortality, and decreased productivity, but would provide long-term cumulative beneficial impacts on Preserve vegetation by restoring and maintaining wildlife habitats and biodiversity.

Over the long-term, the application of Current Legal and Policy Requirements to avoid or minimize adverse impacts on fish and wildlife in the Preserve, hunting, trapping, prescribed fire management practices, and the reclamation of abandoned operations sites (unreclaimed areas comprising 376 acres), would result in improving fish and wildlife habitat, a cumulative beneficial impact for fish and wildlife of the Preserve. While reclamation rarely succeeds in returning a disturbed area to pre-disturbance conditions, the removal of nonnative fill materials, recontouring and revegetation with native species would return these sites to a more productive habitat. Wherever possible, disturbed areas would be improved to perpetuate the viability of habitats and increase the survivability of species. The information provided by fish and wildlife surveys of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact.

On lands surrounding the Preserve, population growth and continued development including the construction and operation of the Sam Rayburn and B. A. Steinhagen Reservoirs, pipelines, roads, commercial and private forestry, and residential developments, in combination with natural events such as fire, flood and drought, could stress fish and wildlife species that reduce the resiliency of the local populations, resulting in the long-term incremental loss of fish and wildlife, and habitat decline through changes in water quality and quantity, particularly to bottomland hardwood forests. Because of the fragmented nature of the individual units of the Preserve, particularly the narrow riparian corridors, the influence of adjacent land-uses (particularly development activities) and introduction of non-native species that alter fish and wildlife habitat (Chinese tallow tree) or compete with available habitat (feral hog), could reduce the viability of fish and wildlife populations and habitat in the Preserve. Over the long-term, these effects would have cumulative, negligible to minor, adverse impacts on fish and wildlife resources in the region.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Where exploration operations could be permitted, fish and wildlife could be displaced and experience increased stress and mortality and decreased production while seismic work crews occupy large areas to lay receiver and source lines, drill shotholes, and detonate explosives placed in shotholes. Fish and burrowing wildlife would be susceptible to shock, concussion and mortality from detonation of explosives in shotholes. Elevated noise from intermittent shothole drilling and detonation of explosives in shotholes, vehicles and helicopters could contribute to displacing some fish and wildlife, increasing stress and reducing productivity. These effects could result in localized, short-term, negligible to minor, adverse impacts on fish and wildlife up to 465 acres of the Preserve.

Drilling and Production: Where drilling and production operations could be permitted, the construction and maintenance of roads, wellpads and production pads could result in the direct loss of habitat and habitat fragmentation. Increased mortality could result from vehicles, construction activities, and increased access into previously inaccessible areas, resulting in localized, short-term (construction and well drilling) to long-term (roads, flowlines, pipelines, wells and production operations), minor to moderate, adverse impacts on up to 241 acres of the Preserve. Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with minor to major adverse impacts, but with mitigation, and prompt response in the event of a spill, the intensity of adverse impacts could be negligible to moderate. Indirect impacts on fish and wildlife in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, flushing and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill fish and wildlife, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on fish and wildlife in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Over time, protection provided to fish and wildlife resources of the Preserve under Current Legal and Policy Requirements is expected to result in the Preserve protecting fish and wildlife populations, and maintaining and improving habitat, with cumulative beneficial impacts on Preserve fish and wildlife resources; while adjacent lands could continue to be developed with fish and wildlife populations and habitat values incrementally being lost, resulting in cumulative, negligible to minor, adverse impacts on fish and wildlife resources in the region.

Impairment Analysis: Because there would be no major adverse impacts to fish and wildlife whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve fish and wildlife.

Impacts on Fish and Wildlife under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current Legal and Policy Requirements, including 36 CFR 9B regulations, which have been discussed in Chapter 2, Parts II and III, and under Alternative A, impacts on fish and wildlife should be substantially reduced throughout the Preserve.

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on fish and wildlife up to 465 acres of the Preserve. Fish and wildlife could be displaced and experience increased stress and mortality and decreased production while seismic work crews occupy large areas to lay receiver and source lines, drill shotholes, and detonate explosives placed in shotholes. Fish and burrowing wildlife would be susceptible to shock, concussion and mortality from detonation of explosives in shotholes. Elevated noise from intermittent shothole drilling and detonation of explosives in shotholes, vehicles and helicopters could contribute to displacing some fish and wildlife, increasing stress and reducing productivity.

Drilling and Production: It is possible under Alternative B that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. The intensity of impacts on fish and wildlife would be dependant upon where the operation is located with respect to specific fish and wildlife habitat, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Similar to Alternative A, indirect impacts on fish and wildlife in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative. In the rare event that direct and/or indirect impacts on wetlands cannot be avoided, Current Legal and Policy Requirements would guide the selection of the least-damaging site to locate operations.

In SMAs that are geographically small, the added protection would primarily be provided for small mammals and invertebrates that occupy these areas. In larger SMAs, such as rare vegetation communities and rare forested wetland communities, protection from additional fragmentation would benefit all fish and wildlife. The increased offset from visitor use and administrative areas, from a 500-foot offset to a 1,500-foot offset, would reduce the potential impacts of oil and gas operations and activities on riparian areas, providing added protection to fish and wildlife that rely on water and riparian areas for part or all of their life cycles. The 1,500-foot offset from birding hot spots would reduce the possibility of impacts on birds and other wildlife using these areas during nesting, breeding and migration.

While SMAs receive specific protection from new drilling and production operations, existing (24.2 acres) and abandoned (unreclaimed operations on 376 acres), and transpark pipelines (589 acres) would continue to adversely impact fish and wildlife and habitat in the Preserve. Some of these sites are located within SMAs.

Similar to Alternative A, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on fish and wildlife on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be minor to moderate.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill fish and wildlife, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on fish and wildlife in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts would be similar to Alternative A. Over the long-term, the application of Current Legal and Policy Requirements that would be applied to oil and gas operations to avoid or minimize adverse impacts on fish and wildlife in the Preserve, reclamation of abandoned, unreclaimed sites (376 acres) occupied by new operations, in combination with hunting, trapping, and prescribed fire management practices, would result in improving fish and wildlife habitat, a cumulative beneficial impact for fish and wildlife of the Preserve. However, protection of fish and wildlife populations and improvement of habitat would be more readily attainable due to the designation of SMAs where the No Surface Use stipulation would be applied, resulting in no new impacts in these areas.

On lands surrounding the Preserve, population growth and continued development, in combination with natural events such as fire, flood and drought, could cause stress to fish and wildlife species that reduce the resiliency of the local populations, resulting in the long-term incremental loss of fish and wildlife, and habitat decline through changes in water quality and quantity, particularly to bottomland hardwood forests. Because of the fragmented nature of the individual units of the Preserve, particularly the narrow riparian corridors, the influence of adjacent development activities, the introduction of non-native species that alter fish and wildlife habitat or compete with available habitat, could reduce the viability of fish and wildlife populations and habitat in the Preserve. Over the long-term, these effects would have cumulative, negligible to minor, adverse impacts on fish and wildlife resources in the region.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on fish and wildlife on up to 465 acres of the Preserve.

Drilling and Production: Similar to Alternative A, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on fish and wildlife on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be minor to moderate. Indirect impacts on fish and wildlife in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternative A, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on fish and wildlife. Indirect impacts on fish and wildlife in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes

beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Similar to Alternative A, with cumulative, negligible to minor, adverse impacts on fish and wildlife resources in the region; however, protection of fish and wildlife populations and improvement of habitat in the Preserve would be more readily attainable in SMAs where the No Surface Use stipulation would result in no new impacts in these areas, resulting in a cumulative, beneficial impact on fish and wildlife in the Preserve.

Impairment Analysis: Because there would be no major adverse impacts to fish and wildlife whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve fish and wildlife.

Impacts on Fish and Wildlife under Alternative C (Maximum Resource Protection)

SMAs would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to geophysical exploration in all SMAs, except for the Hunting Areas and Birding Hot Spots SMAs that would have timing restrictions. The No Surface Use stipulation would be applied to drilling and production operations in all SMAs, except for the Hunting Areas SMA. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations and the NPS's wetlands protection guidelines (Director's Order 77-1), which have been described in Chapter 2, Parts II and III, and under Alternative A, should substantially reduce impacts on fish and wildlife throughout the Preserve.

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve. The No Surface Use stipulation year-round in SMAs covering 37,088 acres may result in the modification of project designs for 3-D seismic surveys. As a result, it may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. These adverse impacts could occur inside or outside the Preserve, and are dependant upon the location and layout of the seismic grid. Despite the greater number of vehicles and equipment for concentrated operations, impacts would be similar to Alternatives A and B, with localized, short-term, negligible to minor, adverse impacts on fish and wildlife up to 465 acres of the Preserve.

Fish and wildlife could be displaced and experience increased stress and mortality and decreased production while seismic work crews occupy large areas to lay receiver and source lines, drill shotholes, and detonate explosives places in the shotholes. Fish and burrowing wildlife would be susceptible to shock, concussion and mortality from detonation of explosives in shotholes. Elevated noise from intermittent shothole drilling and detonation of explosives, vehicles and helicopters could contribute to displacing some fish and wildlife, increasing stress and reducing productivity.

Drilling and Production: Designation of riparian corridors and some larger vegetation and wetlands communities as SMAs would prevent further fragmentation of fish and wildlife habitat in these areas. Non-manipulative data-collection and surveys may be permitted in SMAs if oil and gas operations are proposed nearby and the influence of indirect impacts could extend into the

boundaries of SMAs. Impacts on fish and wildlife could occur where biological, cultural, and other required resource surveys are conducted and would be short-term and negligible.

While SMAs receive specific protection from new drilling and production operations, existing (24.2 acres), and abandoned (unreclaimed sites on 376 acres) operations, and transpark pipelines (589 acres) would continue to adversely impact fish and wildlife and habitat in the Preserve. Some of these sites are located within SMAs.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on fish and wildlife would be dependant upon where the operation is located with respect to specific fish and wildlife habitat, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Similar to Alternatives A and B, indirect impacts on fish and wildlife in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain unless there is no practicable alternative.

Similar to Alternatives A and B, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on fish and wildlife on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be minor to moderate.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill fish and wildlife, but with mitigation, would result in localized, short-term, negligible to minor, adverse impacts at sites throughout the Preserve. Indirect impacts on fish and wildlife in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts would be similar to Alternatives A and B. Over the long-term, the application of Current Legal and Policy Requirements that would be applied to oil and gas operations to avoid or minimize adverse impacts on fish and wildlife in the Preserve, reclamation of abandoned, unreclaimed sites (376 acres) occupied by new operations, in combination with hunting, trapping, and prescribed fire management practices, would result in improving fish and wildlife habitat, a cumulative beneficial impact for fish and wildlife of the Preserve. However, protection of fish and wildlife populations and improvement of habitat would be more readily attainable due to the substantial acreage of SMAs designated where the No Surface Use stipulation would be applied, resulting in no new impacts in these areas.

On lands surrounding the Preserve, population growth and continued development, in combination with natural events such as fire, flood and drought, could cause stress to fish and wildlife species that reduce the resiliency of the local populations, resulting in the long-term incremental loss of fish and wildlife, and habitat decline through changes in water quality and quantity, particularly to bottomland hardwood forests. Because of the fragmented nature of the individual units of the Preserve, particularly the narrow riparian corridors, the influence of adjacent development activities, the introduction of non-native species that alter fish and wildlife habitat or compete with available habitat, could reduce the viability of fish and wildlife populations and habitat in the Preserve. Over

the long-term, these effects would have cumulative, negligible to minor, adverse impacts on fish and wildlife resources in the region.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Similar to Alternatives A and B, geophysical exploration could be permitted in other areas of the Preserve, resulting in localized, short-term, negligible to minor, adverse impacts on fish and wildlife on up to 465 of the Preserve.

Drilling and Production: Similar to Alternatives A and B, construction and maintenance of drilling and production operations could be permitted in other areas of the Preserve, with localized, short- to long-term, minor to moderate, adverse impacts on fish and wildlife on up to 241 acres of the Preserve. However, leaks and spills could result in minor to major, adverse impacts, but with the application of mitigation measures, and prompt response in the event of a spill these impacts could be minor to moderate. Indirect impacts on fish and wildlife in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, plugging, abandonment, and reclamation of new operations located outside SMAs; and of existing and abandoned operations, and transpark pipelines located throughout the Preserve would result in localized, short-term, negligible to minor, adverse impacts on fish and wildlife. Indirect impacts on fish and wildlife in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Similar to Alternatives A and B, with cumulative, negligible to minor, adverse impacts on fish and wildlife resources in the region; however, protection of fish and wildlife populations and improvement of habitat in the Preserve would be more readily attainable in the substantial acreage of SMAs where the No Surface Use stipulation would result in no new impacts in these areas; resulting in a cumulative, beneficial impact in the Preserve.

Impairment Analysis: Because there would be no major adverse impacts to fish and wildlife whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve fish and wildlife.

IMPACTS ON SPECIES OF SPECIAL CONCERN

Introduction

As described in Chapter 3, 22 federally and State-listed species of special concern are believed to occur permanently or transiently in the Preserve. Appendices G and H include U.S. Fish and Wildlife Service (FWS, 8/04), and Texas Parks and Wildlife Department (TPWD, 11/03) listings of species of special concern that may occur in the counties encompassing the Preserve. The NPS policy is to identify and promote the conservation of federal, State, and locally protected threatened, endangered,

rare, declining, sensitive, or candidate species (hereafter referred to as species of special concern) that are native to and present in the Preserve and their critical habitats.

Methodology for Assessing Impacts

Species of Special Concern are defined as those listed by either FWS as endangered, threatened, candidate, or special concern; or by TPWD as endangered, threatened, or a special concern or imperiled species.

For federally-listed species, the terms “threatened” and “endangered” describe the official federal status of vulnerable species as defined by the Endangered Species Act of 1973. The term “candidate” is used officially by the FWS when describing those species for which sufficient information on the biological vulnerability and threats is available to support issuance of a proposed rule to list, but rule issuance is precluded for some reason. Federal “species of concern” are those for which listing may be warranted, but further biological research and field study is needed to clarify their conservation status.

NPS policies dictate that federal candidate species, species of concern, and State-listed threatened, endangered, candidate, or sensitive species be managed to the greatest extent possible as federally listed threatened or endangered species (NPS 2001). Therefore, all of these special status species are included in this discussion.

The Endangered Species Act terminology used to assess impacts to listed species is as follows:

No effect: When a proposed action would not impact a listed species or designated critical habitat.

May affect/not likely to adversely affect: Effects on special status species or designated critical habitat are discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or completely beneficial.

May affect/likely to adversely affect: When an adverse effect to a listed species or designated critical habitat may occur as a direct or indirect result of proposed actions and the effect is either not discountable or completely beneficial.

Is likely to jeopardize proposed species/adversely modify proposed critical habitat: The appropriate conclusion when the National Park Service or the U.S. Fish and Wildlife Service identify situations in which oil and gas operations could jeopardize the continued existence of a proposed species or adversely modify critical habitat to a species within or outside park boundaries.

The NPS has developed the following threshold definitions under the NEPA guidelines. Each definition corresponds to the FWS definitions used to assess impacts to federally listed species under the Endangered Species Act.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are defined as follows:

Negligible: No state and/or federally-listed species would be impacted or the alternative would impact an individual of a listed species or its critical habitat, but the change would be so slight that it would not be of any measurable or

perceptible consequence to the protected individual or its population. A negligible effect would equate to a "no effect" determination by the FWS.

Minor: An individual or population of a listed species or its critical habitat would be impacted, but the change would be small and of little consequence and would be expected to be short-term and localized. A minor effect would equate to a "may affect" determination by the FWS and would be accompanied by a statement of either "not likely to adversely affect" the species. Mitigation measures, if needed to offset adverse effects, would be simple and successful.

Moderate: An individual or population of a listed species or its critical habitat would be noticeably impacted. The effect could have long-term consequences to the individual, population, or critical habitat. A moderate effect would equate to a "may affect" determination by the FWS and would be accompanied by either a statement of "likely to adversely affect" or "not likely to adversely affect" the species. Mitigation measures, if needed to offset adverse effects, could be extensive, but would likely be successful.

Major: An individual or population of a listed species, or its critical habitat, would be noticeably impacted with a long-term, substantial consequence to the individual, population, or habitat. A major effect would equate to a "may affect" determination by the FWS and would be accompanied by a statement of "likely to adversely affect" the species or critical habitat. Extensive mitigation measures would be needed to offset any adverse effects, and their success would not be guaranteed.

Impacts on Species of Special Concern under Alternative A (No Action/Current Management)

All of Big Thicket's species of special concern are protected under Current Legal and Policy Requirements. The application of Current Legal and Policy Requirements, and project-specific operating stipulations, could result in variations in how, where, and to what extent resource protection is applied. The occurrence of species of special concern and suitable habitat would need to be identified during the planning/development and review of Plans of Operations, so that adverse impacts would be avoided. Potential impacts on species of special concern from geophysical exploration, drilling, or production operations could range from no impacts to major impacts, depending on location, timing, and scope of operations proposed.

The NPS manages federally-listed species and their habitat within the Preserve as mandated under the Endangered Species Act of 1973 (ESA). The ESA, as amended, prohibits the NPS and other federal agencies from implementing any action that is likely to jeopardize the continued existence of a federally-listed species. Furthermore, the act requires that the NPS consult with the FWS on any action it authorizes, funds, or executes that could potentially impact a federally-listed species or its designated habitat.

Species of special concern, as discussed in this section, include federal threatened and endangered candidate species, in addition to State and locally protected threatened, endangered, rare, declining, sensitive, or candidate species that are native to the Preserve and their habitats. These species are afforded the same status as federally-listed species under the ESA. (Management Policies, USDI, NPS 2001)

Oil and gas operations or activities would not be allowed to occur where there may be a potential for adversely impacting a species of special concern. The development, if it were allowed, would only occur after consultation with FWS under the Endangered Species Act was completed.

Under Current Legal and Policy Requirements, Plans of Operations must include a biological survey performed by a qualified biologist when this information is determined to be needed by the NPS, in consultation with FWS and TPWD to evaluate the potential impacts of the proposed operation on species of special concern. The biologist conducting the field survey(s) must have sufficient technical knowledge and/or experience to appropriately time when and how biological surveys shall be performed and be qualified to identify species and habitat of the species of special concern that may occur or be potentially impacted in and adjacent to the proposed operations area. If proposed operations have the potential to impact a species of special concern and/or their habitat, the NPS consults with FWS and TPWD on a project-by-project basis, as per Endangered Species Act requirements, and develops measures to avoid impacting species of special concern.

There is a remote possibility for the incidental take of an individual from a species of special concern as a result of any oil and gas operation or activity. During the course of oil and gas operations, it is possible that mortality to an individual of a population could result from vehicle use, construction activities, seismic operations, or in the rare event of a spill of contaminating or hazardous substances that escapes containment systems, enters the environment, and comes into contact with a species of special concern. Any incidental take of a federally-listed species will be reported to the NPS and the FWS and all other species of special concern would be reported immediately to the NPS. The potential for an incidental take of an individual of a species of special concern would be identified by the NPS during project planning and would require Section 7 consultation with FWS and issuance of an incidental take permit.

Geophysical Exploration: Where exploration operations could be permitted, exploration operations and their effects would be expected to avoid impacting species of special concern and their habitat which would be identified through biological surveys, when determined to be needed by the NPS through consultation with the FWS and TPWD. When species of special concern and their habitat are found to be within the project area, mitigation measures including avoidance of species of special concern (including sufficient distance offsets and/or timing restrictions to nesting and other sensitive periods in a given species' life cycle) would result in avoiding impacts.

Potential effects from exploration operations on protected fish and wildlife species could be increased displacement, increased risk of mortality, decreased production, and increased stress levels from seismic survey activities and associated noise. Potential effects on protected plants could be loss or damage from cutting or trimming vegetation along source and receiver lines; and being crushed, damaged or uprooted by off-road vehicles. Compacted and rutted soils could reduce germination and root penetration. Leaks and spills could harm or kill plants, fish and wildlife. These effects could be caused by seismic crews occupying a large area to trim vegetation along 3.5-foot wide receiver and shot lines, drilling shotholes, detonating explosives in shotholes, and using vehicles and helicopters.

Under any alternative, protection of water quality is provided by 36 CFR § 9.41(a), which requires operations to be offset 500 feet from rivers, streams, and other waterbodies, unless specifically authorized by an approved plan of operations, which would minimize erosion and sedimentation and other impacts on water quality and quantity that could adversely impact aquatic life. The standard 500-foot offset from water bodies would protect fish and wildlife utilizing water and the vegetation within this protective zone. Through project-specific consultation with the FWS and TPWD under the Endangered Species Act, the offset could be increased. The 500-foot standard offset would provide primary protection to blue sucker, creek chubsucker and paddlefish, the caddisfly and dragonfly, alligator snapping turtle, timber rattler, Navasota Ladies'-Tresses, and a variety of migratory birds that utilize stream and riparian areas. Additional protection to these habitats would be provided by the

wetlands and floodplains Executive Orders, NPS Director's Orders and project specific permitting requirements.

Species of special concern that occupy mature pine forests, uplands longleaf pine and oak forests found in upland environments include Bachman's sparrow, red-cockaded woodpecker, Southeastern Myotis and Rafinesque's big-eared bats, smooth green snake and Louisiana pine snake; and plants including Slender gay feather, Texas trailing phlox, and white firewheel. These species would be protected under the required mandated in Endangered Species Act and other CLPR.

Surface disturbances caused by off-road vehicle use, drilling of shotholes, detonation of explosives in shotholes; and trimming of vegetation could reduce the amount of habitat available for use by species of special concern. However, at the completion of operations, reclamation of disturbed areas would be required, and recovery of vegetation is expected to occur over the short-term.

Through the Endangered Species Act, required biological surveys, and/or assessments and consultations with the U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department would result in identification of potential impacts on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern.

Drilling and Production: Where drilling and production operations could be permitted, potential adverse impacts on species of special concern could occur from the construction and maintenance of roads, wellpads, flowlines and pipelines. The RFD scenario projects the drilling of 40 wells with production of up to 27 wells. Along with associated roads and facilities, new drilling and production operations could occupy up to 241 acres of the Preserve. Drilling and production operations could range in duration from short-term (weeks or months for construction of roads, wellpads, flowlines and pipelines; and well drilling) to long-term lasting 20 years or longer (roads, flowlines, pipelines, wells and production operations).

Construction and maintenance of roads, pads, flowlines and pipelines could require the clearing of vegetation and habitat loss. Potential effects on species of special concern would depend on where drilling and production operations are located. Careful siting of developments that is based on biological survey and/or assessment results could avoid or minimize these impacts substantially.

Through the Endangered Species Act, required biological surveys and/or assessments and consultations with FWS and TPWD would result in identification of potential impacts on federally-listed species and their habitat, and the application of mitigation measures that should result in no adverse impacts.

Water-dependent species (including paddlefish, blue sucker, creek chubsucker, Texas heelsplitter, caddisfly and dragonfly) could be impacted by the construction and long-term maintenance of roads, pads, flowlines and pipelines if stream crossings result in alteration of streamflow, water quality, or temperature; or if there is increased sedimentation. In some cases, increased access to remote streams could result in greater fishing mortality or poaching, which would constitute an indirect adverse effect. Under all alternatives, waterways are protected by a 500-foot offset under 36 CFR § 9.41(a), unless specifically authorized by an approved plan of operations; and because waterways are inherently a part of floodplains (riparian corridors) and wetland areas, and receive added protection under various regulatory and policy requirements, streamflows, water quality or temperature would be protected from disturbance and water levels would be maintained. Careful siting of facilities when there are no practicable alternatives to locating an operation or activity in floodplains and wetlands is expected to result in stringent mitigation measures to avoid potential adverse impacts. Required compensation for direct and indirect impacts on wetlands could be used to restore wetland habitats and increase species of special concern habitat values.

Construction and maintenance of roads, wellpads, flowlines and pipelines could contribute to habitat fragmentation. Fragmentation occurs when a timbered landscape is converted to early successional stages of grass/forb and also occurs due to the presence of roads across the landscape. Habitat fragmentation may inhibit some species of wildlife (generally small prey species, i.e., rodents, insects, etc.) to utilize their habitats effectively. The direct effect of vegetation removal would need to be analyzed on a project-specific basis, particularly if it occurs in a location of critical importance to a species of special concern. In general, areas of the Preserve that have potential to be converted from forested vegetation to a grass/forb stage or bare soil condition are minimal, and this would not be considered a major adverse impact when analyzed in context of the larger landscape.

Displacement of wildlife would continue from initial wellpad construction into exploratory drilling, and if the well is placed in production, during the life of the producing well. Road and wellpad development and drilling operations would reduce the usable habitat for large carnivores as well as their prey species. Secure areas for large carnivores and prey species are reduced and the risk of mortality is increased. The increase of and ease of access routes for public travel would serve to increase public motorized travel or if the roads are closed to public motorized travel they still serve as an access route by foot, horse and mountain bike. New access roads may even serve as travel corridors for large carnivores which may increase the potential of mortality either legal or illegally.

Increased access would also result in the same effects on small carnivores, with an increase in direct loss of small carnivores resulting from mortality through trapping and hunting. Low-speed roads are not expected to appreciably increase mortality from road kill or to be barriers to movements of the small wildlife. The Preserve Superintendent can close or restrict motorized public access on roads that are to be used for oil and gas development if necessary. With this authority, the NPS can mitigate the effects of increased public access caused by road construction and long-term operation of production facilities.

Noise from drilling operations would also impact protected wildlife species. Drilling operations introduce noise with the highest measurements in the 90 dBA range for a period of 30 to 90 days, with noise coming mostly from multiple diesel engines. Therefore, noise impacts could be major concern, but limited to a localized area and relatively short-term duration.

Some facilities associated with production operations (i.e., heater treater units/separator units) could cause the mortality of bats, migratory birds and raptors through asphyxiation or incineration. To mitigate the residual impacts from these facilities, a cone device placed on top of all vent stacks, would be required under Current Legal and Policy Requirements. The cones would be constructed in a manner that prevents perching on the vent stacks and subsequent asphyxiation, and eliminates all access into the vent stack pipes. Inaccessibility to the vent stacks would curtail any potential mortality to species of special concern of bats and birds.

Another operating stipulation requires that all open containers that collect stormwater be netted or covered. This requirement prevents birds and other wildlife species from accessing stormwater that may have contacted and mixed with oil and gas, and other contaminating and hazardous substances.

Selection and use of herbicides and pesticides must be approved by the NPS Integrated Pest Management Coordinator, and is kept to a minimum. Therefore, effects on species of special concern would be avoided.

It is possible that some wells may be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on species of special concern is dependent upon where the operation is located with respect to species and their habitats, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. For wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve, the connected actions occurring outside the Preserve boundaries could

include constructing and maintaining access roads, well/production pads, and flowlines/pipelines; drilling the well; producing the well; plugging and abandoning the well; and site reclamation. The in-park operations associated with directional wells would consist of the wellbore crossing into the Preserve, usually several thousand feet or more below the surface. Therefore, for most directional wells drilled that are exempted under 36 CFR § 9.32(e), the NPS regulatory authority would be limited to applying mitigation to the in-park operations to ensure protection of groundwater resources beneath the park. Because the in-park operations would typically have no effect on species of special concern or their habitats on the surface, the NPS would have no Section 7 responsibilities under the Endangered Species Act. However, the NPS would assume the “lead” role in carrying out Section 7 responsibilities under the Endangered Species Act if there are no other federal entities with broader regulatory involvement for the connected actions proposed outside the park. The FWS may not require oil and gas operators outside the Preserve to apply the same degree of mitigation as the NPS applies on parklands. Further, oil and gas operators outside the Preserve are not required to survey for or protect Federally-listed plant species or State-listed species. Indirect impacts on species of special concern and their habitats in the Preserve from drilling and production of wells drilled from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in adverse impacts ranging from no impact to localized to widespread, short- to long-term, moderate adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down, abandoning and removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill protected plants, fish and wildlife, but by applying the consultation requirements under the ESA; performing biological surveys of the area that could be potentially impacted by proposed plugging, abandonment, and reclamation operations; identifying species of special concern and applying appropriate mitigation, there should be no adverse impacts on species of special concern.

Plugging and abandonment operations and site preparation during reclamation would introduce heavy equipment and people, along with increased noise levels for a short time; however, the long-term effect of these activities is to return natural conditions to the operations area. Access roads that have been developed or allowed to remain open for the primary purpose of allowing access for oil and gas operations would be reclaimed at the completion of operations. This would return the area to its natural conditions. Wherever possible, habitats would be improved to perpetuate the viability of habitats and increase the survivability of species of special concern.

Similar to the discussion under the Drilling and Production section, indirect impacts on species of special concern and their habitats in the Preserve from plugging/abandonment/reclamation of directional wells drilled from outside the Preserve to reach bottomholes beneath the Preserve could result in adverse impacts. Impacts could range from no impact to indirect, short- to long-term, localized, minor, adverse impacts on species of special concern and their habitats in the Preserve.

Cumulative Impacts: The cumulative impact analysis area for species of special concern covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area is the same as what has been defined for all natural resources. The analysis area has been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact natural resources, including species of special concern in the region.

Existing surface disturbances, including existing (24.2 acres) and abandoned (unreclaimed sites on 376 acres) operations, and 71 transpark oil and gas pipelines (589 acres); in combination with other Preserve developments and activities, including park roads, visitor use areas, recreational activities, hunting and trapping, and prescribed fire management practices, have reduced the amount of

habitat available for use by species of special concern. It is difficult to accurately determine the types of habitat that were developed prior to the establishment of the Preserve. Since the establishment of the Preserve, however, development decisions have been applied under a well defined regulatory process that limited any additional impacts on species of special concern.

It is possible that some past developments have altered habitat utilized by species of special concern. Past impacts have included direct loss of terrestrial habitat at oil and gas sites. Also, the construction of roads, flowlines and pipelines that cross rivers and streams; or wellpads developed near rivers and streams, increased erosion and sedimentation that adversely impact water quality and aquatic habitats. These combined effects on 989 acres have caused long-term impacts on vegetation, fish and wildlife in the Preserve, resulting in removal of vegetation or a change (decrease) in site productivity and habitat value. These adverse impacts will remain until disturbed areas are reclaimed.

Under the RFD scenario, future oil and gas operations could involve 3-D seismic surveys that could utilize up to 465 acres of the Preserve; while drilling up to 40 wells and production of up to 27 wells could occupy up to 241 acres of the Preserve. Over the long-term, up to 1,695 acres could be directly impacted by oil and gas operations in the Preserve; however, while new operations are occurring, others would be plugged, abandoned, and reclaimed.

Existing and future oil and gas operations would be required to comply with Current Legal and Policy Requirements to protect species of special concern, particularly the Endangered Species Act. Plans of Operations must include a biological survey performed by a qualified biologist when this information is determined to be needed by the NPS, in consultation with the U.S. Fish and Wildlife Service and Texas Parks and Wildlife Service to evaluate the potential impacts of the proposed operation on species of special concern. The biologist conducting the field survey(s) must have sufficient technical knowledge and/or experience to appropriately time when and how biological surveys shall be performed and to identify species and habitat of species of special concern that may occur or be potentially impacted in and adjacent to the proposed operations area. If proposed operations have the potential to impact a species of special concern and/or its habitat, the NPS consults with the U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department on a project-by-project basis, as per Endangered Species Act requirements, and develops measures to avoid impacting species of special concern. The information provided by biological resource surveys of proposed operations in the Preserve would increase the NPS's knowledge of the resource in the Preserve, a cumulative, negligible, beneficial impact.

For species of special concern whose viability is not reliant on large, unfragmented areas, the long-term protection of species of special concern and their habitat in the Preserve would continue to receive added protection, so these species and their habitat would likely increase.

Over the long-term two federally-listed species of special concern known to occur in the Preserve and the analysis area are expected to improve. Implementation of the 1985 U.S. Fish and Wildlife Service Red-Cockaded Woodpecker Recovery Plan in the Pineywoods Region of East Texas (which includes the Preserve) would continue from federal and state agencies, The Woodlands Corporation, Louisiana-Pacific, Temple-Inland, and Champion International (pers. comm., Jeffrey Reid, 1999). Although improvement in red-cockaded woodpecker groups in the Pineywoods Region is anticipated, urbanization, agriculture, and short rotation forestry practices have severely fragmented red-cockaded woodpecker habitat (Lay and Swepston, 1973). Continued implementation of the Preserve's Draft Texas Trailing Phlox Recovery Plan (1994) and ongoing conservation efforts by the Nature Conservancy of Texas and others are expected to benefit phlox in Hardin, Polk and Tyler Counties.

Reclamation of disturbed areas in the Preserve must reestablish natural topographic contours, native vegetative communities and provide for the safe movement of native wildlife and the normal

flow of surface waters. Wherever possible, habitats would be improved to perpetuate the viability of habitats and increase the survivability of species of special concern. The NPS would ensure that wells directionally drilled from locations outside the Preserve to bottomhole targets underlying the Preserve “pose no significant threat of damage to park resources, both surface and subsurface” (36 CFR § 9.32(e)); however, wellpads outside the Preserve may not be reclaimed to pre-disturbance conditions which could result in long-term decrease in site productivity and habitat value. Any adverse impacts on protected plants, fish and wildlife habitat resulting from reclamation operations would add to the existing adverse impacts on species of special concern and their habitat within and adjacent to the Preserve.

Other activities in the Preserve that could impact protected plants, fish and wildlife included wildlife harvest (hunting and trapping), non-consumptive recreation, and the Preserve’s prescribed fire management program. Over the long-term, hunting and trapping could have beneficial impacts on wildlife populations. Recreational activities in the Preserve are focused near developed visitor use areas, trails, canoe routes, and roads. These developments and activities have a negligible, adverse impact on protected plants, fish and wildlife. The Preserve’s prescribed fire management program could contribute to short-term habitat loss, wildlife displacement, and increase erosion and sedimentation, but would provide long-term cumulative beneficial impacts on Preserve vegetation, particularly to the Texas trailing phlox, and improved habitat for protected wildlife species.

In combination with human activities, including the Preserve’s prescribed fire management program, recreational uses, and nonfederal oil and gas operations, natural events such as fire, flood, and drought, could all contribute to cumulative adverse effects on fish and wildlife. These cumulative effects cause stress that reduces the resiliency of the local wildlife populations. While some of these influences, particularly, the Preserve’s prescribed fire management program, natural fire and flood events, would have short-term, adverse effects; over the long-term, their cumulative impacts could be beneficial for species of special concern and their habitat. Over the long-term, the application of Current Legal and Policy Requirements, particularly a well defined regulatory process under the Endangered Species Act, would result in no adverse impacts on species of special concern in the Preserve, with improvement of habitat for some species of special concern, a cumulative beneficial impact for species of special concern of the Preserve.

There is a remote possibility for the incidental take of an individual from a species of special concern as a result of any oil and gas operation or activity. During the course of oil and gas operations, it is possible that mortality to an individual of a population could result from vehicles, construction activities, seismic operations, or in the rare event of a spill of contaminating or hazardous substances that escapes containment systems, enters the environment, and comes into contact with a species of special concern. The incidental take of an individual of a species of special concern would be a major adverse impact.

On lands surrounding the Preserve, population growth and continued development including the construction and operation of the Sam Rayburn and B. A. Steinhagen Reservoirs, pipelines, roads, commercial and private forestry, and residential developments, in combination with natural events such as fire, flood and drought, could increase displacement of species of special concern, and increase stress that reduce the resiliency of local populations, resulting in the long-term incremental loss of species of special concern, and habitat decline primarily influenced through changes in water quality and quantity, particularly to bottomland hardwood forests. Because of the fragmented nature of the individual units of the Preserve, particularly the narrow riparian corridors, the influence of adjacent land-uses (particularly development activities) and introduction of non-native species that alter fish and wildlife habitat (Chinese tallow-tree) or compete with available habitat (feral hog), could reduce the viability of species of special concern and habitat in the Preserve.

Water withdrawals outside the Preserve could result in cumulative adverse impacts on aquatic habitats both within and outside the Preserve. Of the species of special concern that could occur in

the 7 counties containing units of the Preserve most occupy bottomland hardwood forests and elsewhere, while 8 rely on such habitats. Three species that were in partly dependant on bottomland hardwood forests are presumed extirpated from the Preserve and State. The 3 species are the ivory-billed woodpecker, Bachmann's warbler, and the red wolf. Assessment of diversity of major fish and wildlife species by Harcombe et al. (1996) suggest regional declines in fish and some stream invertebrate groups, partially attributed to regional modification of waterways. Modification of waterways may change the overall amount and timing of stream flows, directly impacting stream channel morphology (structure or form), rate of meandering or migration, sedimentation, water quality, and the amount and type of aquatic habitat. These changes may indirectly impact the growth, availability, and regeneration of bottomland hardwood forests. Water withdrawals that alter water quantity, quality and temperature, particularly in the upper portions of Big Sandy Creek, Beech Creek, or Lower Neches River could cumulatively affect the viability of populations of 3 state-protected fish species that occur in these water segments within the Preserve.

Over the long-term, these effects would have cumulative, minor to moderate, adverse impacts on species of special concern in the region.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration, Drilling and Production, and Plugging/Abandonment/Reclamation: The potential impacts on species of special concern would be the same as those described under the impacts on vegetation, and fish and wildlife, discussed in the sections above. As per CLPR, particularly the Endangered Species Act, the NPS would not permit any action that is likely to jeopardize the continued existence of a species of special concern. Therefore, oil and gas operations would not be permitted to occur in areas or during specified times if there is a potential to adversely affect species of special concern. When species of special concern and their habitat are identified to be within the project area, sufficient distance offsets and/or seasonal/timing restrictions would result in avoiding impacts. Therefore, there should be no adverse impacts on species of special concern. Protection of species of special concern and improvement of habitat would be more readily attainable in Protected Areas where geophysical exploration, and drilling or production operations would not be permitted year-round under Current Legal and Policy Requirements on approximately 7,500 acres, or within 500 feet of waterways.

There is a remote possibility of the incidental take of an individual from a species of special concern as a result of any oil and gas operations or activity. During the course of oil and gas operations, it is possible that mortality to an individual of a species of special concern could result from vehicles, construction activities, seismic operations, or releases of oil or other contaminating and hazardous substances. Identification of the potential for a take would be performed during consultation with FWS and issuance of an incidental take permit would be required.

Indirect impacts on species of special concern and their habitats in the Preserve from directionally drilling wells from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in impacts ranging from no impact to localized to widespread, short- to long-term, moderate adverse impacts from drilling and production; and localized, short- to long-term, minor adverse impacts from plugging/abandonment/reclamation activities.

Cumulative Impacts: Over time, protection provided to species of special concern under Current Legal and Policy Requirements would result in maintaining and improving habitat for species of special concern in the Preserve, with cumulative beneficial impacts on species of special concern in the Preserve. The expectation that adjacent lands would continue to be developed with incremental loss

of wildlife habitat over the long-term, could result in cumulative, minor to moderate, adverse impacts on species of special concern in the region.

Impairment Analysis: Because there would be no major adverse impacts to species of special concern or their habitat whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve species of special concern or their habitat.

Impacts on Species of Special Concern under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current Legal and Policy Requirements, including NPS Management Policies, 36 CFR 9B regulations, and particularly the Endangered Species Act, which have been discussed in Chapter 2, Parts II and III, and under Alternative A, impacts on species of special concern should be substantially reduced throughout the Preserve.

Geophysical Exploration: Similar to Alternative A, where geophysical exploration could be permitted in other areas of the Preserve, these activities and their effects are expected to avoid impacting species of special concern and their habitat. Through the well defined regulatory process under the Endangered Species Act, required biological surveys and consultations with FWS and TPWD would result in identification of potential impacts on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern.

Drilling and Production: Similar to Alternative A, where drilling and production operations could be permitted in other areas of the Preserve, potential adverse impacts on species of special concern could occur from the construction and maintenance of roads, wellpads, flowlines and pipelines. Drilling and production operations could range in duration from short-term (weeks or months for construction of roads, wellpads, flowlines and pipelines; and well drilling) to long-term lasting 20 years or longer (roads, flowlines, pipelines, wells and production operations). Through the regulatory process under the Endangered Species Act, required biological surveys and consultations with FWS and TPWD would result in identification of potential impacts on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern.

In SMAs that are geographically small, the added protection would primarily be provided for small mammals and invertebrates that occupy these areas. In larger SMAs, such as rare vegetation communities and rare forested wetland communities, protection from additional habitat fragmentation would benefit all fish and wildlife species. The increased offset from visitor use and administrative areas, from a 500-foot offset to a 1,500-foot offset, would further reduce the potential impacts of oil and gas operations and activities in these areas. The 1,500-foot offset from birding hot spots would reduce the possibility of impacts on birds and other wildlife using these areas during nesting, breeding, and migration.

While SMAs receive specific protection from new drilling and production operations, existing (24.2 acres) and abandoned (unreclaimed operations on 376 acres), and transpark pipelines (589 acres) could continue to adversely impact habitat for species of special concern in the Preserve. Some of these sites are located within SMAs.

Specific protection provided to species of special concern habitat under Alternative B is described below:

Designation of SMAs that Would Improve Habitat for Red-cockaded Woodpeckers. Because of their importance as red-cockaded woodpecker habitat, old-growth pinelands are well protected on lands in southeast Texas. Continued implementation of the 1985 U.S. Fish and Wildlife Service Red-Cockaded Woodpecker Recovery Plan in the Pineywoods Region of East Texas (which includes the Preserve) from federal and State agencies, The Woodlands Corporation, Louisiana-Pacific, Temple-Inland, and Champion International, is expected to improve the potential habitat and viability of this species (pers. comm., Jeffrey Reid, 1999). Under Alternative B, the Preferred Alternative, the NPS would formally designate old growth trees (located both in wetlands and uplands), upland pine forests, and wetland pine savannas as SMAs in which the No Surface Use stipulation would apply to drilling and production operations; however, geophysical exploration (3-D seismic surveys) and nonmanipulative data-collection activities could be permitted. As a result, the NPS would protect old-growth pines that are potential nesting habitat for the red-cockaded woodpecker. Also, the NPS anticipates that in the long-term, 20 – 30 years or more from now, the younger pinelands would reach maturity, thereby increasing potential habitat for red-cockaded woodpeckers. It is possible that some immature pinelands located outside these SMAs could be lost to oil and gas development, but the small reduction in potential habitat in comparison to the SMA-designated pinelands would be unlikely to influence future woodpecker populations.

Designation of SMAs that Would Improve Habitat for Fish, Reptiles, Aquatic Invertebrates, Migratory and Marine Birds. The increase of the standard 500-foot offset under § 9.41(a), unless specifically authorized in an approved plan of operations, to a 1,500-foot offset where no oil and gas operations may occur for visitor use, administrative and other use areas, including canoe routes and water-oriented visitor use areas, in addition to the designation of Rare Forested Wetlands Communities SMA (includes wetland baygall shrub thickets, wetland pine savannas, cypress-tupelo swamp forests, and old growth trees), and the Riparian Corridors SMA, would increase protection and improve habitat for the Bachman's Sparrow and other migratory/marine birds, fish and water-dependant species of special concern that utilize these riparian areas. While influences from oil and gas activities would be substantially reduced by the increased offsets and SMA designations, productivity of wetlands and floodplain values in the riparian corridors would still be strongly affected by influences external to the Preserve which could contribute to degradation of water quality and quantity.

Designation of SMAs that Would Improve Habitat for Uplands-Reliant Species. The NPS would formally designate the Rare Vegetation Communities SMA, including upland pine forests, sandhill pine forests, American Beech-Southern Magnolia-Loblolly Pine Forests, and old growth trees that are generally mid-slope to uplands vegetation communities. These vegetation communities would receive specific protection under a No Surface Use stipulation in which no oil and gas operations may occur, with the exception of geophysical exploration (3-D seismic surveys) and non-manipulative data collection activities. This added protection would increase protection and improve habitat for species of special concern that prefer these communities as habitat, including Bachman's sparrow, Rafinesque's Big-eared and Southeastern Myotis bats, Slender gay feather, Navasota Ladies'-Tresses, Texas trailing phlox, and White Firewheel, Louisiana pine and Smooth green snakes.

It is possible that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. Similar to Alternative A, indirect impacts on species of special concern and their habitats in the Preserve from directionally drilling and producing wells from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in impacts ranging from no impact to localized to widespread, short- to long-term, moderate adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in

upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including Riparian Corridors SMA) unless there is no practicable alternative.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill species of special concern of plants, fish and wildlife. Through the well defined regulatory process under the Endangered Species Act, required biological surveys and consultations with FWS and TPWD would result in identification of potential impacts on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern.

Similar to Alternative A, indirect impacts on species of special concern and their habitats in the Preserve from plugging/abandonment/reclamation of wells directionally drilled from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in impacts ranging from no impact to indirect, localized, short- to long-term, minor adverse impacts.

Cumulative Impacts: Cumulative impacts are similar to Alternative A; however, designation of SMAs under Alternative B would minimize cumulative impacts on species of special concern and would result in beneficial impacts for several species dependent on wetlands and old growth areas.

Despite the protection afforded the red-cockaded woodpecker under the proposed action, the long-term viability of the species in the region is uncertain. The threat stems from the bird's total dependence on mature pine stands for its habitat. Pinelands have been heavily exploited throughout southeast Texas for the production of pulp and wood products, which require relatively short rotations between harvests. Most mature stands (that is, those over 60 years old) were previously cut, and those that remain are isolated, relict stands. Such isolation can lead to a loss of genetic viability and to reproduction failure.

The U.S. Fish and Wildlife Service currently is researching methods to improve genetic diversity in the species (for example, translocating breeding birds). It is hoped that practical solutions to the genetic isolation problem will be found in the near future. In the meantime, remaining habitat and colonies become increasingly important as a source of genetic stock and as locations for future colony expansion. Therefore, the Alternative B would assist in the overall recovery by maintaining existing red-cockaded woodpecker habitat and colonies. Moreover, the proposed action promotes protection of young pineland communities in the effort to improve the rangewide survival of the species.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration, Drilling and Production, and Plugging/Abandonment/Reclamation: Impacts would be similar to Alternative A, resulting in no adverse impacts on species of special concern.

Protection of species of special concern and improvement of habitat would be more readily attainable in SMAs with the No Surface Use stipulation, or within 500 feet of waterways. Due to the designation of SMAs, well defined regulatory process under the ESA to protect species of special concern, and the application of mitigation measures, no adverse impacts on species of special concern are anticipated.

Similar to Alternative A, indirect impacts on species of special concern and their habitats in the Preserve from directionally drilling wells from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in impacts ranging from no impact to localized to

widespread, short- to long-term, moderate adverse impacts from drilling and production; and localized, short- to long-term, minor adverse impacts from plugging/abandonment/reclamation activities.

Cumulative Impacts: Similar to Alternative A, with cumulative, minor to moderate, adverse impacts on species of special concern in the region, however, protection of species of special concern and improvement of habitat in the Preserve would be more readily attainable in SMAs where the No Surface Use stipulation would be applied.

Impairment Analysis: Because there would be no major adverse impacts to species of special concern or their habitat whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve species of special concern.

Impacts on Species of Special Concern under Alternative C (Maximum Resource Protection)

SMAs would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to geophysical exploration in all SMAs, except for the Hunting Areas and Birding Hot Spots SMAs that would have timing restrictions. The No Surface Use stipulation would be applied to drilling and production operations in all SMAs, except for the Hunting Areas SMA. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations and the NPS's wetlands protection guidelines (Director's Order 77-1), which have been described in Chapter 2, Parts II and III, and under Alternative A, should substantially reduce impacts on species of special concern throughout the Preserve.

Geophysical Exploration: Similar to Alternatives A and B, geophysical exploration could be permitted in other areas of the Preserve. The No Surface Use stipulation year-round in SMAs covering 39,657 acres may result in the modification of project designs for 3-D seismic surveys. As a result, it may be necessary to increase the density of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines. These adverse impacts could occur inside or outside the Preserve, and are dependant upon the layout of the seismic grid.

Despite the greater number of vehicles and equipment for concentrated operations, impacts would be similar to Alternatives A and B; where geophysical exploration could be permitted in other areas of the Preserve, these operations and their effects are expected to avoid impacting species of special concern and their habitat. Through the regulatory process under the Endangered Species Act, required biological surveys and consultations with FWS and TPWD would result in identification of potential impacts on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern.

Drilling and Production: Similar to Alternatives A and B, where drilling and production operations could be permitted in other areas of the Preserve, potential adverse impacts on species of special concern could occur from the construction and maintenance of roads, wellpads, flowlines and pipelines. Through the regulatory process under the Endangered Species Act, required biological surveys and consultations with the FWS and TPWD would result in identification of potential impacts

on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern.

In SMAs that are geographically small, the added protection would primarily be provided for small mammals and invertebrates that occupy these areas. In larger SMAs, such as rare vegetation communities, rare forested wetland communities, and the riparian corridors, protection from additional fragmentation would benefit all fish and wildlife. The increased offset from visitor use and administrative areas, from a 500-foot offset to a 1,500-foot offset, would reduce the potential impacts of oil and gas operations and activities on riparian areas, providing added protection to species of special concern that rely on water and riparian areas for part or all of their life cycles. The 1,500-foot offset from birding hot spots would reduce the possibility of impacts on birds and other wildlife using these areas during sensitive seasons.

While SMAs receive specific protection from new drilling and production operations, existing (24.2 acres) and abandoned (unreclaimed operations on 376 acres), and transpark pipelines (589 acres) could continue to adversely impact habitat for species of special concern in the Preserve. Some of these sites are located within SMAs.

Specific protection provided to species of special concern habitat under Alternative B is described below:

Designation of SMAs that Would Improve Habitat for Red-Cockaded Woodpeckers. Because of their importance as red-cockaded woodpecker habitat, old-growth pinelands are well protected on lands in Southeast Texas. Continued implementation of the 1985 U.S. Fish and Wildlife Service Red-Cockaded Woodpecker Recovery Plan in the Pineywoods Region of East Texas (which includes the Preserve) from federal and State agencies, the Woodlands Corporation, Louisiana-Pacific, Temple-Inland, and Champion International, is expected to improve the potential habitat and viability of this species (pers. comm., Jeffrey Reid, 1999). Similar to Alternative B, the NPS would formally designate old growth trees (located both in wetlands and uplands), upland pine forests, wetland pine savannas, and expansive riparian corridors as SMAs in which the No Surface Use stipulation would apply to all oil and gas operations (including exploration, drilling and production operations), except that nonmanipulative research and data-collection activities may be permitted. As a result, the NPS would protect old-growth pines that are potential nesting habitat for the red-cockaded woodpecker. Also, the NPS anticipates that in the long-term, 20 – 30 years or more from now, the younger pinelands would reach maturity, thereby increasing potential habitat for red-cockaded woodpeckers. It is possible that some immature pinelands located outside these SMAs could be lost to oil and gas development, but the small reduction in potential habitat in comparison to the SMA-designated pinelands would be unlikely to influence future woodpecker populations.

Designation of SMAs that Would Improve Habitat for Fish, Reptiles, Aquatic Invertebrates, Migratory and Marine Birds. The increase of the standard 500-foot offset to a 1,500-foot offset where no oil and gas operations may occur near visitor use, administrative and other use areas, including canoe routes and water-oriented visitor use areas, in addition to the designation of the Rare Forested Wetlands Communities SMA (includes wetland baygall shrub thickets, wetland pine savannas, cypress-tupelo swamp forests, and old growth trees), and expansive Riparian Corridors SMA would increase protection and improve habitat for the Bachman's Sparrow and other migratory/marine birds, fish and water-dependant species of special concern that utilize these areas. While influences from oil and gas operations would be substantially reduced by the increased offsets and SMA designations, productivity of wetlands and floodplain values in the riparian corridors would still be strongly affected by influences external to the Preserve which could contribute to degradation of water quality and quantity.

Designation of SMAs that Would Improve Habitat for Uplands-Reliant Species.

The NPS would formally designate rare vegetation communities, including upland pine forests, sandhill pine forests, American Beech-Southern Magnolia-Loblolly Pine Forests, and old growth trees that are generally mid-slope to uplands vegetation communities. These vegetation communities would receive specific protection under a No Surface Use stipulation in which no oil and gas operations may occur (including exploration, drilling and production operations), with the exception of non-manipulative research and data collection activities. This added protection would increase protection and improve habitat for species of special concern that prefer these communities as habitat, including Bachman's sparrow, Rafinesque's Big-eared and Southeastern Myotis bats, Slender gay feather, Navasota Ladies'-Tresses, Texas trailing phlox, and White Firewheel, Louisiana pine and Smooth green snakes.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on species of special concern is dependant upon where the operation is located with respect to species of special concern, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed.

Similar to Alternatives A and B, indirect impacts on species of special concern and their habitats in the Preserve from directionally drilling and producing wells from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in adverse impacts. Impacts could range from no impact to indirect, localized to widespread, short- to long-term, moderate adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including the Riparian Corridors SMA) unless there is no practicable alternative.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles to reclaim sites could have the potential for release of oil, and other contaminating and hazardous substances, which could harm or kill plants, fish and wildlife. Through the well defined regulatory process under the Endangered Species Act, required biological surveys and consultations with the U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department would result in identification of potential impacts on species of special concern and their habitat, and the application of mitigation measures that should result in no adverse impacts on species of special concern

Similar to Alternatives A and B, indirect impacts on species of special concern and their habitats in the Preserve from plugging/abandonment/reclamation of wells directionally drilled from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in impacts ranging from no impact to indirect, localized, short- to long-term, minor adverse impacts.

Cumulative Impacts: Cumulative impacts are similar to Alternatives A and B; however, designation of SMAs where the No Surface Use stipulation would apply to all oil and gas operations would serve to keep cumulative adverse impacts on species of special concern to a minimum and would result in beneficial impacts in the Preserve for several species of special concern dependent on wetlands and old growth areas.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration, Drilling and Production, and Plugging/Abandonment/Reclamation: Impacts would be similar to Alternatives A and B, resulting in no adverse impacts on species of special concern.

Protection of species of special concern and improvement of habitat would be more readily attainable in SMAs where the No Surface Use stipulation would not permit geophysical exploration (39,657 acres), or drilling and production operations (46,273 acres), or within 500 feet of waterways. Due to the designation of SMAs, well defined regulatory process under the ESA to protect species of special concern, and the application of mitigation measures, no adverse impacts on species of special concern are anticipated.

Similar to Alternatives A and B, indirect impacts on species of special concern and their habitats in the Preserve from directionally drilling wells from surface locations outside the Preserve to reach bottomholes beneath the Preserve could result in impacts ranging from no impact to localized to widespread, short- to long-term, moderate adverse impacts from drilling and production; and localized, short- to long-term, minor adverse impacts from plugging/abandonment/reclamation activities.

Cumulative Impacts: Similar to Alternatives A and B, with cumulative, minor to moderate, adverse impacts on species of special concern in the region; however, protection of species of special concern and improvement of habitat in the Preserve would be more readily attainable in the larger acreage of SMAs where the No Surface Use stipulation would be applied.

Impairment Analysis: Because there would be no major adverse impacts to species of special concern or their habitat whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve species of special concern.

IMPACTS ON CULTURAL RESOURCES

Introduction

Cultural resources are an important component of Big Thicket's value as a National Preserve. Only a small area of the Preserve has been formally inventoried for cultural resources, resulting in the discovery of approximately 30 archeological sites. However, none of these has been evaluated for eligibility to the National Register of Historic Places (NRHP). The Brammer House is the only historic structure eligible for listing on the NRHP. Ethnographic consultations were initiated as part of this planning process, but, at this time, specific ethnographic resources that might be affected by oil and gas developments have not been confirmed. Consultation with the Alabama and Coushatta Tribes and other park-affiliated communities described in Chapter 3 will be undertaken as project-specific Plans of Operations are developed, in the effort to identify and ensure that ethnographic resources and associated community concerns are not adversely impacted by proposed oil and gas operations. Likewise, cultural landscapes are not fully understood because of the lack of information about cultural resources in the Preserve.

Oil and gas operations can adversely impact cultural resources if proper surveys and protection measures are not implemented. Federal laws and regulations and NPS policies provide management tools for protection and management of cultural resources. These are described in Chapter 2, Parts II and III, and in Appendix C.

Methodology for Assessing Impacts

The NPS categorizes cultural resources by the following categories: archeological resources, cultural landscapes, historic structures, museum objects, and ethnographic resources. A review of reference materials regarding cultural resources within the Preserve, as well as communications with NPS staff, was completed to identify and evaluate potential impacts to cultural resources.

The NPS has developed the following threshold definitions under the NEPA guidelines. Each definition corresponds to the NHPA definitions used to assess impacts to cultural resources.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are defined as follows:

- Negligible:** Impact is at the lowest levels of detection with neither adverse nor beneficial consequences. The determination of effect for Section 106 would be *no adverse effect*.
- Minor:** **Adverse:** disturbance of the site(s) results in little, if any, loss of integrity. The determination of effect for Section 106 would be *no adverse effect*.
 Beneficial: maintenance and preservation of the site(s). The determination of effect for Section 106 would be *no adverse effect*.
- Moderate:** **Adverse:** disturbance of the site(s) results in loss of integrity. The determination of effect for Section 106 would be *adverse effect*. A Memorandum of Agreement is executed among the NPS and applicable SHPO or tribal historic preservation officer, and if necessary, the ACHP in accordance with 36 CFR 800.6(b). Measures identified in the Memorandum of Agreement to minimize or mitigate adverse impacts reduce the intensity of impact under NEPA from major to moderate.
 Beneficial: stabilization of the site(s). The determination of effect for Section 106 would be *no adverse effect*.
- Major:** **Adverse:** disturbance of the site(s) results in loss of most or all of the site(s) integrity. The determination of effect for Section 106 would be *adverse effect*. Measures to minimize or mitigate adverse impacts cannot be agreed upon and the NPS and applicable SHPO or tribal historic preservation officer and/or ACHP are unable to negotiate and execute a Memorandum of Agreement in accordance with 36 CFR 800.6(b).
 Beneficial: active intervention to preserve the site(s). The determination of effect for Section 106 would be *no adverse effect*.

Impacts on Cultural Resources under Alternative A (No Action/Current Management)

Under Alternative A, nonfederal oil and gas Plans of Operations would continue to be evaluated on a project-by-project basis, and the integrity of physical remains and the context therein of listed or potentially eligible historic properties would be protected. Under applicable Current Legal and Policy Requirements, including 36 CFR 9B regulations, and particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer, which have been described in Chapter 2, Parts II and III, there should be no adverse impacts on cultural resources in the Preserve. However, the application of Current Legal and Policy Requirements, and project-specific operating stipulations, could result in variations in how, where, and to what extent resource protection is applied. Further, because of the limited scope of the NPS's directional drilling provision under 36 CFR § 9.32(e), the NPS has no regulatory authority to require applicants to perform cultural resource surveys on lands outside the Preserve where directional wells would be located, nor to require applicants to perform cultural resource surveys within the Preserve should the area of potential effect extend into the Preserve.

Because only a very small percentage of the Preserve has been surveyed for archeological resources, it is possible that cultural resource surveys performed in and adjacent to the proposed operations area could lead to the discovery of previously unknown archeological sites and other cultural resources. When the Preserve was established, access and surface uses were permitted under Special Use Permits. Beginning in 1979, permits were authorized under the NPS's Nonfederal Oil and Gas Rights Regulations, 36 CFR 9B. Since that time, all new surface uses permitted under Plans of Operations, pursuant to the 36 CFR 9B regulations, have required cultural resource surveys. See the Nonfederal Oil and Gas Exploration and Production section in the Affected Environment Chapter for a description of existing and abandoned nonfederal oil and gas operations. To date, archeological surveys conducted during the development of plans of operations for nonfederal oil and gas operations have resulted in many new archeological discoveries.

Geophysical Exploration: Exploration operations (3-D seismic surveys) could have both beneficial and adverse impacts concerning unknown archeological sites. Because the seismic lines would run in a dense grid pattern over the entire Preserve, with shotholes drilled along lines in one direction and geophone lines (receiver lines) are placed at an angle to the source lines, there is potential for discovering previously unknown archeological sites, thereby increasing the NPS's knowledge of the cultural resources in the Preserve. Each shothole would be approximately 3 to 4 inches in diameter, which is smaller than the area typically disrupted by a professional archeologist performing a shovel test; therefore drilling the shotholes should result in no adverse effect.

However, detonation of explosive charges associated with seismic exploration may have an effect on the distribution and condition of surface and subsurface artifact scatters or the condition of surface features. Explosive charges could be too large for the depth of shothole drilled, resulting in a blowout or cratering and the potential loss of archeological material/information. This unlikely, but unacceptable, impact would be halted immediately by the NPS until the operator relocates shotholes with the guidance of a qualified archeologist and approval of an NPS archeologist. These effects can be mitigated, however, by required cultural resource surveys and placing shotholes to avoid identified cultural sites. Alternatively, the operator could also redesign shotholes to adjust the size of explosive for a given shothole depth, given the nature of the soils and other physical conditions so blowouts and cratering would not occur. Redesign to avoid impacting archeological resources would require the technical involvement of a qualified archeologist.

If noise and its effects on traditional cultural sites is an issue, use of avoidance screening or scheduling operations to avoid persons visiting these sites would help to minimize impacts.

Potential adverse impacts on cultural resources and traditional cultural practices from exploration operations would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer. As a result, exploration operations that could occur on up to 465 acres of the Preserve should result in no adverse impacts on cultural resources.

Drilling and Production: By applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and consultation with the State Historic Preservation Officer, no adverse impacts should occur.

Potential adverse impacts on cultural resources and traditional cultural practices from the construction and maintenance of access roads, wellpads, flowlines, and pipelines would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act and consultation with the State Historic Preservation Office. This would result in no adverse impacts from drilling and production operations that could occur on up to 241 acres of the Preserve. If buried cultural resources cannot be avoided, impacts would be mitigated by recovery of data (excavation) and preservation of recovered materials and associated records, an irreversible adverse impact. Illegal collection or damage to previously-unidentified cultural resources listed or eligible for listing on the National Register of Historic Places (NRHP) would be an adverse impact.

Ground disturbance associated with construction and maintenance of access roads, wellpads, flowlines and pipelines, has the potential to impact prehistoric, historic, and traditional cultural resources. Any ground disturbing activity could potentially damage site integrity. Specific actions could include: removing vegetation for constructing access roads and well/production pads, earthmoving, compaction, rutting, survey marking, foot and vehicle traffic, drilling, spill response, fire management, flowline and pipeline construction, and installation of fences.

An indirect impact on cultural sites could result from increased erosion and increased soil deposition from construction activities associated with oil and gas development. Cultural resources could be exposed or buried.

It is possible that important cultural sites may not be visible from the surface and could be damaged by construction activities associated with drilling and production. These potential impacts would be mitigated as much as possible by requiring a qualified archeologist to monitor all ground-disturbing activities. Operations would be stopped in the area where archeological resources are uncovered and an NPS archeologist would evaluate the significance of the discovery and to determine how the project in the area of discovery shall be conducted to avoid adversely impacting the site.

Known archeological sites are relatively small, so direct impacts by road construction and well drilling and production could be easily achieved by avoidance. When significant sites cannot be avoided, impacts could be avoided or mitigated by excavating the site, using methodologies defined in a reviewed and approved research design (described under Current Legal and Policy Requirements in Chapter 2, Part II, and in Appendix C). In these rare instances, while information is retrieved from the site, the impacts on the site would be an irreversible adverse impact. Certain sites are considered significant for reasons other than their scientific value. Sites associated with significant events (criterion "a") or persons (criterion "b") or which embody distinctive characteristics (criterion "c") cannot have direct impacts mitigated merely through data collection, and often memoranda of agreement stipulating other types of mitigation measures must be developed and signed before a proposed action can proceed. Indirect impacts must also be considered at these sites and some standing structures may require that a sensory offset be defined in which visual, audible or atmospheric elements do not alter the setting.

Sights, sounds, and odors from drilling and production operations could have an effect on traditional cultural practices. Solitude is often an important aspect of many traditional cultural practices; and

the introduction of distractive elements could diminish the experience of the practitioner. While avoidance may be acceptable mitigation for geographically isolated areas (i.e., plant gathering locations), avoidance is not acceptable for sites significant for setting or associations (i.e., vision quest sites); other measures such as scheduling of activities, screening, or noise abatement may be employed to mitigate anticipated effects. While mitigation in traditional cultural sites is possible, it is often difficult or impossible to attain due to the cultural perspective of those persons utilizing the site. Similar actions may be necessary for non-Native American traditional users of the Preserve.

Indirect impacts on cultural resources would occur by increased access into areas that could increase the visibility of cultural resources and result in vandalism, illegal artifact collecting, or illegal excavation. While such activities could be minor and occur sporadically, over a period of time the impacts could be considered cumulatively major and adverse, if proper protective measures are not taken. Conversely, increased access can often increase the recreational or educational value of such sites.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact cultural resources in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions, such as steepness of slope and direction, and surface hydrology, and mitigation measures being employed. Based on these factors, indirect impacts on cultural resources in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Well plugging, shutting down, abandoning and removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could disturb and compact soil, increase soil erosion, release oil and other contaminating and hazardous substances. Potential adverse impacts on cultural resources and traditional cultural practices from plugging, abandonment and reclamation operations would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer. As a result, plugging, abandonment, and reclamation operations would result in no adverse impacts on cultural resources at sites throughout the Preserve.

Reclamation of sites and replanting with native vegetation would restore the natural character of the area, and may lessen any impacts related to disturbance in cultural setting or landscape.

Indirect impacts on cultural resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: The cumulative impact analysis area for cultural resources includes the seven-county area encompassing the Preserve. Impacts on undiscovered cultural resources could occur at oil and gas operations sites including existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) operations, and 71 transpark oil and gas pipelines (589 acres). Future oil and gas operations including RFD-projected Preservewide geophysical exploration on up to 465 acres, and drilling of an estimated 40 wells with production of an estimated 27 wells from locations within or outside the Preserve, and ancillary facilities such as access roads and flowlines, could adversely impact cultural resources and traditional cultural practices if proper surveys and protection measures are not implemented. As some operations are being developed, others would be plugged, abandoned, and reclaimed; therefore, potential for impacts would be distributed over time.

Other Preserve activities that could contribute to adverse impacts on cultural resources and traditional cultural practices include conducting prescribed fires; and performing routine maintenance of Preserve roads, visitor day use areas, trails, picnic areas, and boat launches. The information provided by cultural resource surveys required of the NPS prior to carrying out Preserve activities, or permitting oil and gas operations, would increase the NPS's knowledge of the resources in the Preserve, and would be used to preserve cultural resources, a cumulative, negligible beneficial impact. Over the long-term, protection provided to cultural resources in the Preserve under Current Legal and Policy Requirements, particularly the well-defined regulatory process under the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer, would result in the preservation of important cultural resources and traditional cultural practices, a cumulative beneficial impact on cultural resources in the Preserve.

The cultural resources and traditional cultural practices in the Preserve would become increasingly important as such resources outside the Preserve are lost to development. Because there are no requirements for developers on private property to survey their lands for archeological and other cultural resources before construction (such as for directional drilling exemptions under § 9.32(e)), no provisions exist for notifying professional archeologists and other cultural resource specialists of such finds, and there is no funding for mitigation on private lands, federal and State lands would increasingly become the places where such resources would be preserved. Without adequate mitigation, such sites could be lost, thus increasing the educational and scientific importance of those remaining inside the Preserve. Over the long-term, increasing population growth and development outside the Preserve could result in incremental losses of cultural resources, with cumulative, minor to moderate, adverse impacts on cultural resources and traditional cultural practices in the seven-county region.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Where exploration operations could be permitted, drilling shotholes would result in no adverse impact. Detonation of explosives in shotholes could effect the distribution and condition of artifact scatters (surface/subsurface) or the condition of surface features. These potential effects would be mitigated by required cultural resource surveys and siting 3-D seismic source lines, including shotholes to avoid identified cultural sites, resulting in no adverse impacts on cultural resources in the Preserve.

Drilling and Production: Where drilling and production operations could be permitted, potential adverse impacts on cultural resources and traditional cultural practices from the construction and maintenance of access roads, wellpads, flowlines, and pipelines would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act and consultation with the State Historic Preservation Officer, resulting in no adverse impacts from drilling and production operations that could occur on up to 241 acres of the Preserve.

If buried cultural resources cannot be avoided, impacts would be mitigated by recovery of data (excavation) and preservation of recovered materials and associated records, an irreversible adverse impact. Illegal collection or damage to previously-unidentified cultural resources listed or eligible for listing on the National Register of Historic Places (NRHP) would be an adverse impact.

Indirect impacts on cultural resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: By applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, there should be no adverse impacts on cultural resources and traditional cultural practices from plugging, abandonment, and reclamation operations. Indirect impacts on cultural resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: The information provided in cultural resource surveys required by the NPS for proposed operations would be used to preserve cultural resources. Over time, protection provided to cultural resources in the Preserve under Current Legal and Policy Requirements would result in the preservation of important cultural resources, resulting in cumulative beneficial impacts on cultural resources and traditional cultural practices in the Preserve; while resources outside the Preserve could be incrementally lost over the long-term, with cumulative, minor to moderate, adverse impacts on cultural resources and traditional cultural practices in the region.

Impairment Analysis: Because there would be no major adverse impacts to cultural resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative A would not result in an impairment of Preserve cultural resources or values.

Impacts on Cultural Resources under Alternative B (Preferred Alternative)

Special Management Areas would be formally designated under Alternative B with surface use and timing stipulations protecting up to 75,293 acres. By applying applicable Current Legal and Policy Requirements, including 36 CFR 9B regulations, and particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer, which have been described in Chapter 2, Parts II and III, and under Alternative A, there should be no adverse impacts on known cultural resources and traditional cultural practices in the Preserve.

Geophysical Exploration: Similar to Alternative A, where geophysical exploration could be permitted in other areas of the Preserve, drilling shotholes would result in no adverse impact. Detonation of explosives in shotholes could effect the distribution and condition of artifact scatters (surface/subsurface) or the condition of surface features. Potential adverse impacts on cultural resources and traditional cultural practices from exploration operations would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the well defined regulatory process under the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer. As a result, exploration operations that could occur on up to 465 acres of the Preserve would result in no adverse impacts on known cultural resources and traditional cultural practices.

Drilling and Production: Similar to Alternative A, where drilling and production operations could be permitted in other areas of the Preserve, potential adverse impacts on cultural resources and traditional cultural practices from the construction and maintenance of access roads, wellpads, flowlines, and pipelines would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act and consultation with the State Historic Preservation Officer, resulting in no adverse impacts from drilling and production operations that could occur on up to 241 acres of the Preserve. If buried cultural resources cannot be avoided, impacts would be mitigated by recovery of data (excavation) and preservation of recovered materials and associated records, an irreversible adverse impact. Illegal collection or damage to previously-

unidentified cultural resources listed or eligible for listing on the National Register of Historic Places would be an adverse impact.

It is possible under Alternative B that some wells may be directionally drilled from outside the Special Management Areas to develop hydrocarbons underlying the SMAs. The intensity of impacts on cultural resources is dependant upon where the operation is located with respect to cultural resources, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Similar to Alternative A, indirect impacts on cultural resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts. If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including Riparian Corridors SMA) unless there is no practicable alternative. Uplands, or areas of higher topographic relief, are expected to have a greater concentration of cultural sites.

Plugging/Abandonment/Reclamation: Similar to Alternative A, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could disturb and compact soil, increase soil erosion, release oil and other contaminating and hazardous substances. Potential adverse impacts on cultural resources and traditional cultural practices from plugging, abandonment and reclamation operations would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer. As a result, plugging/abandonment/reclamation operations would result in no adverse impacts on cultural resources at sites throughout the Preserve.

Reclamation of sites and replanting with native vegetation would restore the natural character of the area, and may lessen any impacts related to disturbance in cultural setting or landscape.

Similar to Alternative A indirect impacts on cultural resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts would be similar to Alternative A, with cumulative, minor to moderate, adverse impacts on cultural resources and traditional cultural practices in the region. However, as a result of formal designation of SMAs in the Preserve where the No Surface Use stipulation would be applied, there would be a lower probability of inadvertent harm to previously unidentified cultural resources in SMAs from ground disturbing activities that would be prohibited in SMAs.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: Similar to Alternative A, geophysical exploration could be permitted in other areas of the Preserve (on up to 465 acres); however, the potential adverse impacts on cultural resources would be avoided or mitigated, resulting in no adverse impacts on cultural resources.

Drilling and Production: Similar to Alternative A, drilling and production could be permitted in other areas of the Preserve on up to 241 acres; however, by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and consultation with the State Historic Preservation Officer, no adverse impacts should occur.

Adverse impacts on cultural resources could occur if a site cannot be avoided and is excavated.

Similar to Alternative A, indirect impacts on cultural resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Same as Alternative A, plugging, abandonment and reclamation operations in the Preserve would result in no adverse impacts. Indirect impacts on cultural resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Same as Alternative A. The information provided in cultural resource surveys required by the NPS would be used to preserve cultural resources. Over time, protection provided to cultural resources in the Preserve under Current Legal and Policy Requirements would result in the preservation of important cultural resources, resulting in cumulative beneficial impacts on cultural resources and traditional cultural practices in the Preserve; while resources outside the Preserve could be incrementally lost over the long-term, with cumulative, minor to moderate, adverse impacts on cultural resources and traditional cultural practices in the region.

Impairment Analysis: Because there would be no major adverse impacts to cultural resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative B would not result in an impairment of Preserve cultural resources or values.

Impacts on Cultural Resources under Alternative C (Maximum Resource Protection)

SMAs would be formally designated under Alternatives B and C; however, under Alternative C, the No Surface Use stipulation would be applied to geophysical exploration in all SMAs, except for the Hunting Areas and Birding Hot Spots SMAs that would have timing restrictions. The No Surface Use stipulation would be applied to drilling and production operations in all SMAs, except for the Hunting Areas SMA. In the remaining areas of the Preserve where operations could be permitted, the application of Current Legal and Policy Requirements, including the NPS's 36 CFR 9B regulations and the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer, which have been described in Chapter 2, Parts II and III, and under Alternative A, should substantially reduce impacts on cultural resources throughout the Preserve.

Geophysical Exploration: Similar to Alternatives A and B, geophysical exploration could be permitted in other areas of the Preserve on up to 465 acres. The No Surface Use stipulation year-round in SMAs covering 39,657 acres may result in the modification of project designs for 3-D seismic surveys. As a result, it may be necessary to increase the density or intensity of seismic shotholes outside the SMAs to adequately image the subsurface under the SMAs. This can be done by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and

receiver lines. These adverse impacts could occur inside or outside the Preserve, and are dependant upon the location and layout of the seismic grid.

Since fewer areas would be open for seismic exploration under this alternative, it is possible that seismic shotholes would be concentrated at the periphery of SMAs or deeper shotholes would be drilled. Truck-mounted drilling equipment would be required to drill deeper shotholes. The need to use vehicles to access and drill shotholes, and the greater concentration of shotholes in areas could result in increased ground disturbance (particularly if access is required through areas having hydrologic classes C and D soils) and a greater potential for impacting surface and subsurface artifact scatters. As a result, under Alternative C, cultural resource surveys would be required over a larger area where ground-disturbance could be anticipated. However, with cultural resource surveys and careful siting of operations, cultural resources are expected to be avoided. Therefore, impacts would be similar to Alternatives A and B. Drilling shotholes would result in no adverse impact. Detonation of explosives in shotholes could effect the distribution and condition of artifact scatters (surface/subsurface) or the condition of surface features. Potential adverse impacts on cultural resources and traditional cultural practices from exploration operations would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer. As a result, exploration operations would result in no adverse impacts on cultural resources.

Drilling and Production: Similar to Alternatives A and B, where drilling and production operations could be permitted in other areas of the Preserve, potential adverse impacts on cultural resources and traditional cultural practices from the construction and maintenance of access roads, wellpads, flowlines, and pipelines would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act and consultation with the State Historic Preservation Officer, resulting in no adverse impacts from drilling and production operations on up to 241 acres of the Preserve. If buried cultural resources cannot be avoided, impacts would be mitigated by recovery of data (excavation) and preservation of recovered materials and associated records, an irreversible adverse impact. Illegal collection or damage to previously-identified cultural resources listed or eligible for listing on the National Register of Historic Places would be an adverse impact.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The intensity of impacts on cultural resources and traditional cultural practices is dependant upon where the operation is located with respect to cultural sites, whether the operation is sited inside or outside the Preserve, and on the resource protection measures that are employed. Similar to Alternatives A and B, indirect impacts on cultural resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

If the operations are conducted inside the Preserve, they are likely to occur in upland areas since drilling and production operations would not be permitted within wetlands or the 500-year floodplain (including Riparian Corridors SMA) unless there is no practicable alternative. Uplands, or areas of higher topographic relief, are expected to have a greater concentration of cultural sites.

Plugging/Abandonment/Reclamation: Similar to Alternatives A and B, well plugging, shutting down and abandoning/removing flowlines and pipelines, and use of heavy equipment and vehicles during reclamation activities could disturb and compact soil, increase soil erosion, release oil and other contaminating and hazardous substances. Potential adverse impacts on cultural resources and traditional cultural practices from plugging, abandonment and reclamation operations would be avoided or mitigated by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and through consultation with the State Historic Preservation Officer. As a

result, plugging/abandonment/reclamation operations would result in no adverse impacts on cultural resources at sites throughout the Preserve.

Reclamation of sites and replanting with native vegetation would restore the natural character of the area, and may lessen any impacts related to disturbance in cultural setting or landscape.

Similar to Alternatives A and B, indirect impacts on cultural resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Cumulative impacts would be similar to Alternatives A and B, with cumulative, minor to moderate, adverse impacts on cultural resources in the region. However, as a result of formal designation of SMAs in the Preserve where the No Surface Use stipulation would be applied, there would be a lower probability of harm to previously unidentified cultural resources in SMAs from ground disturbing activities.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: Similar to Alternatives A and B, exploration operations could be permitted in other areas of the Preserve (on up to 465 acres); however, the potential adverse impacts on cultural resources would be avoided or mitigated, resulting in no adverse impacts on cultural resources.

Drilling and Production: Where drilling and production would not be permitted in SMAs with the No Surface Use stipulation, the modification of project designs could concentrate operations outside of the SMAs, and due to the large riparian corridor SMA, could concentrate operations onto uplands locations where there is increased potential for archeological resources.

Similar to Alternatives A and B, drilling and production could be permitted in other areas of the Preserve on up to 241 acres; however, by applying Current Legal and Policy Requirements, particularly the National Historic Preservation Act, and consultation with the State Historic Preservation Officer, no adverse impacts should occur.

Adverse impacts on cultural resources could occur if a site cannot be avoided and is excavated, or if cultural resources are lost or damaged.

Similar to Alternatives A and B, indirect impacts on cultural resources in the Preserve from drilling and production of directional wells drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging/Abandonment/Reclamation: Same as Alternatives A and B, plugging, abandonment and reclamation operations in the Preserve would result in no adverse impacts. Indirect impacts on cultural resources in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, minor, adverse impacts.

Cumulative Impacts: Same as Alternatives A and B. The information provided in cultural resource surveys required by the NPS would be used to preserve cultural resources. Over time, protection provided to cultural resources in the Preserve under Current Legal and Policy

Requirements would result in the preservation of important cultural resources, resulting in cumulative beneficial impacts on cultural resources in the Preserve; while resources outside the Preserve could be incrementally lost over the long-term, with cumulative, minor to moderate, adverse impacts on cultural resources in the region.

Impairment Analysis: Because there would be no major adverse impacts to cultural resources whose conservation is: (1) necessary to fulfill specific purposes identified in the establishing legislation of Big Thicket National Preserve; (2) key to the natural or cultural integrity of the Preserve; or (3) identified as a goal in the Preserve's general management plan or other relevant National Park Service planning documents, selection of Alternative C would not result in an impairment of Preserve cultural resources or values.

IMPACTS ON VISITOR USE AND EXPERIENCE

Introduction

Visitor use and experience was analyzed in this Plan/EIS, because oil and gas operations could potentially conflict with visitor experiences in the Preserve, and pose threats to human health and safety. An average of 87,000 people have visited Big Thicket National Preserve every year since 1990 to fish, boat, hike, camp in the backcountry, view wildlife and vegetation, and spend time in a natural setting. Surface disturbances, restrictions on visitor access, increased noise, dust, and odors, and releases of oil or hazardous chemicals from oil and gas operations could cause direct and indirect adverse impacts on visitor uses, experiences, and human health and safety in the Preserve.

As described in Chapter 3, Big Thicket National Preserve offers the visitor many different options, ranging from very active recreational pursuits (e.g., motorized boating, mountain biking, hunting) to more passive enjoyment of nature. The visitor's perception of oil and gas operations depends greatly on their previous experiences with these types of activities, the purpose of their visit, and the expectations of what the Preserve has to offer the visitor. Some visitors are interested primarily in a nature experience, with minimal noise and visual disturbance. Others use Big Thicket National Preserve for active recreation such as motor boating and hunting, and may perceive fewer impacts from oil and gas operations than other visitors. Overall, Preserve staff has received few complaints about oil and gas operations.

Several areas in the Preserve are particularly important visitor use areas, are heavily used, are highly susceptible to adverse impacts from oil and gas operations, and/or there would be a high probability of conflict with oil and gas operations. These visitor use areas are designated as Protected Areas under Alternative A and Special Management Areas under Alternatives B and C.

- Visitor Use Areas
 - Day Use Areas, including boat ramps, picnic areas, parking lots (26 areas)
 - Hiking Trails (9 trails)
 - Canoe Routes (4 routes)
- Administrative Areas
 - Big Thicket Visitor Information Station
 - Big Thicket Visitor Center
 - Maintenance and Meeting Facility
 - Turkey Creek Ranch House

- Other Use Areas
 - Cemeteries (3 sites)
 - Private Residences (2 sites)
- Birding Hot Spots
- Hunting Areas (in 5 units)

Methodology for Assessing Impacts

Potential impacts on visitor use and experience were considered for all phases of oil and gas development. Several topics are described in this section in order to focus on those attributes that contribute to a positive visitor experience at Big Thicket National Preserve: public access, visual quality, sounds, odors, and human health and safety. The assessment of impacts is based on personal observations during site visits, and discussions with Preserve staff and EIS team members. Oil and gas operations that are anticipated under the Reasonably Foreseeable Development Scenario (RFD) that could impact different visitor uses and experiences at Big Thicket National Preserve are analyzed in this section. In addition, the impacts of Current and Legal Policy Requirements, including regulatory requirements, operating stipulations, and mitigation measures relevant to visitor use and experience are described in the following section.

Impact Intensity Thresholds. The thresholds of change for the intensity of an impact are defined as follows:

- Negligible:** Impacts would be barely detectable and/or will impact few visitors.
- Minor:** Impacts would be slightly detectable and/or will impact few visitors.
- Moderate:** Impacts would be measurable and/or will impact some visitors.
- Major:** Impacts would be severely adverse or exceptionally beneficial and/or will impact many visitors.

Impacts on Visitor Use and Experience under Alternative A (No Action/Current Management)

Under this alternative, continued implementation of Current Legal and Policy Requirements would result in protecting visitor use areas and visitor enjoyment on a case-by-case basis. Specific measures currently in-place to protect visitor uses or visitor use areas from oil and gas development include the requirement that surface operations cannot be conducted within 500 feet of waterways, or visitor use, administrative and other use areas, unless specifically authorized by an approved plan of operations (36 CFR § 9.41(a)). This stipulation would separate the visitor from most oil and gas operations in the Preserve.

Developed recreation sites, such as day-use areas, may not receive adequate protection if an oil and gas operation is conducted near these sites. Noise, dust, odors, increased traffic, and visual impacts from wellpads could significantly reduce the quality of the visitor experience if wellpads are sited too close to visitor use areas. It is expected that the measures provided for in the Current Legal and Policy Requirements would considerably lessen impacts on visitor use and experience.

Oil and gas operations would have the most adverse impact on visitors who come to Big Thicket National Preserve to seek solitude or a quiet nature experience. Mitigation measures such as siting drilling and production operations near roads and away from large tracts of forest and wetlands and non-motorized trails would decrease the likelihood of disturbance to the wilderness character. Noise from helicopters used during 3-D seismic surveys probably constitutes one of the most severe yet short-term impacts on those seeking solitude in the Preserve. This impact could be partially mitigated by restricting helicopter access during certain times (e.g., in birding hot spots during peak nesting or migration periods) and to limit the use of helicopters during peak visitor use periods (e.g., holidays, high-use weekends).

The following sections provide more detailed descriptions of the types of impacts that could occur relating to access, visual quality, noise, odors, wilderness experience, and health and safety from the implementation of Alternative A.

Visitor Use and Experience: Given the geographic extent, the minimal amount of disturbance, and the limited duration (weeks to months) associated with 3-D seismic surveys, it is not expected that the operations would cause major adverse impacts on visitor access. Seismic operations could preclude short-term use of the survey areas by boaters, fishermen, hikers, and other Preserve visitors. Mitigation measures provided for in Plans of Operations such as scheduling operations outside of peak visitation periods would minimize impacts on visitor access. Therefore, it is expected that access limitations associated with geophysical exploration would result in localized, negligible to minor, adverse impacts on Preserve visitors.

For geophysical operations, the loss or modification of vegetation, the flagging used to mark trees, and the presence of oil and gas personnel could cause adverse visual impacts for the visitor. Mitigation that would minimize visual impacts include a 500-foot offset from waterways, visitor use, administrative and other use areas, use of Geographic Positioning Systems (GPS) to minimize vegetation trimming, removing trash and debris, replacing cuttings and covering shotholes, avoiding permanent marking of trees, and removing flagging after surveys are completed. Also, siting the data recording station and helicopter landing pad in areas that cannot be easily seen by the visitor would reduce visual impacts. With mitigation, geophysical exploration operations would result in localized, short-term, minor adverse impacts on visitors.

There would be noise associated with 3-D seismic surveys from the use of vehicles and drilling equipment (drills and support vehicles), personnel working in the area, detonation of explosive charges in shotholes, and other equipment used such as chain saws and helicopters. Noise generated by the detonation of explosives is equivalent to a shotgun blast and lasts for a fraction of a second. Helicopter noise can be quite loud and intrusive, especially to users in quiet, undeveloped and backcountry settings. However, helicopter use is relatively short-term and, most importantly, it avoids many adverse impacts on soil, water resources, vegetation, and wildlife by eliminating the need for extensive use of vehicles. With the implementation of operating stipulations and mitigation measures, noises associated with geophysical exploration operations (detonation of explosives in shotholes and helicopter use) would result in localized, short-term, negligible to minor adverse impacts.

Seismic surveys would not be expected to contribute many offensive odors or smells, unless spills of fuels or other hazardous chemicals would occur or exhaust fumes were particularly offensive.

Drilling and production operations (surface uses for drilling and production operations, including the placement of flowlines) would not directly impact visitor use and experience in Protected Areas where operations would not be permitted under Current Legal and Policy Requirements on 7,493 acres (includes the fire and long-term monitoring plots; Royal Fern Bog Research Plot; and within 500 feet of visitor use, administrative and other use areas or birding hot spots); or within 500 feet of waterways. However, operations on 989 acres including existing (24.2 acres) and abandoned

(unreclaimed sites comprising 376 acres) operations, and transpark pipelines (589 acres) could continue to adversely impact visitor use and experience in the Preserve.

Where drilling and production operations would be permitted in the Preserve, the areas (access roads and wellpads) would be closed to visitor access. Under the RFD scenario, drilling and production operations could restrict visitation on up to 241 acres in the Preserve. Due to safety concerns, there may be additional stipulations on visitor access adjacent to these sites. Indirect impacts such as increased noise, dust, odors, night lighting, and human activity would not necessarily preclude recreational access, but would decrease the quality of the visitor experience in the vicinity of the operation, especially in less developed areas of the Preserve.

Visual impacts from drilling and production operations would be more substantial, especially if wellpads are placed in relatively undisturbed settings where visitors would be able to readily see the operation and all associated equipment and tanks. Exploratory drill rigs can reach heights of 180 feet, which would be visible through lower-growing trees and shrubs. Site clearing would remove up to 2.4 acres of vegetation for each wellpad, and access road construction would result in visible cuts through Preserve vegetation. Lighting of the drilling rig could interfere with views of night sky. The operations, especially drilling, would increase the presence of work crews and equipment. Since drilling is a 24-hour, 7-day a week operation, these impacts would be continuous for several months. Production operations, although having a less intrusive human presence, would be visible for 20 years or longer. The visual presence of oil and gas operations in a natural setting would adversely impact the areas by displacing the visitor or lessening the quality of the visitor experience.

Mitigation measures that would reduce visual impacts during drilling and production operations include a 500-foot offset for visitor use areas, and siting the wellpads so they are screened from view with vegetation and topography. Flowlines would be sited along the shoulders of roads to avoid additional land disturbances. Drilling and production equipment could be painted to blend in with the surrounding environment. Low profile structures could be used for all permanent production facilities. Sites should be kept clean and orderly, and any spills, waste, or trash must be promptly cleaned up and removed from the operations site. To minimize effects on night sky, lighting should be kept to the minimum necessary for safe operation, lights should be shielded or designed to prevent offsite glare, and the use of low pressure sodium lights should be considered. With the implementation of these measures, impacts on visitor use and experience would be considerably reduced and could range from minor to moderate adverse impacts.

The intensity of adverse impacts from drilling would be greater than for seismic exploration, since drilling and production operations are conducted continuously until drilling is completed. There would be increased noise from construction activities (vehicles, saws, earth-moving equipment), drilling rigs, and the drilling crew. As noted in Chapter 3, background noise levels at many visitor use areas in the Preserve have been recorded, with most falling at or just below 40 dBA. Figure 3.6 shows that a drill rig at a distance of 1,500 feet is associated with a noise level of about 40 dBA, while near the drill rig, sound levels are approximately 80 dBA. The 500-foot offset required for visitor use and administrative areas under NPS's 36 CFR 9B regulations would result in reducing the adverse impacts from a drilling rig, but would not reduce sounds to background levels. Localized, moderate, adverse impacts could result if drilling or other loud noises occur close enough to a visitor use area to cause interference with the enjoyment or use of the area.

Production operations could also cause localized, moderate adverse impacts, since there periodically could be loud machinery and workover rigs operating on-site. However, most noise levels associated with production would be substantially less than those generated from a drilling operation. Impacts would be long-term, lasting up to 20 years or more.

The primary source of odors would be from drilling or production operations, especially if spill or leaks occurred and oil or other chemicals were not quickly cleaned up and removed from the site.

Mitigation measures to reduce adverse impacts from odors are provided by the offsets required under Current Legal and Policy Requirements, since odors will dissipate with increasing distance from the source. Also, proper handling of hazardous or contaminating substances would be required; including keeping lids on containers, cleaning up spills, and preventing blowouts (for more information, see the Human Health and Safety discussion). With adequate offsets and implementation of these measures, there should be negligible to minor adverse impacts due to odors.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could indirectly impact visitor use and experience in the Preserve. The types of impacts are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations sited closer to the Preserve boundary. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as vegetation screening, topography, and mitigation measures being employed. Based on these factors, indirect impacts on visitor use and experience in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Plugging, abandonment and reclamation operations would have public access impacts similar to those described for drilling and production, but would be limited in duration to the time needed to plug, abandon and reclaim the operations site. Reclamation operations should not interfere substantially with visitor access, and, when completed, would restore access to areas previously off-limits to visitors.

Reclamation of the wellpads following plugging and abandonment of the wells would serve to reduce longer-term visual impacts and eliminate the unnatural views of the site. The actual time required to reclaim the site's visual quality will depend on many factors, including the erosion potential of the site, productivity of the vegetation, topography, and soil characteristics. The time needed for recovery could last from one to three years for grasses and shrubs, to decades for larger trees. The removal of the rig and associated structures and equipment, in conjunction with site reclamation, should eliminate any long-term or cumulative adverse visual impacts from the site operations.

The operations involved in site closure would cause temporary, minor adverse impacts on visitor experiences near the reclamation areas. Noises from earth moving and other equipment would be short duration, and mitigation measures could be used to reduce engine noise and to avoid peak visitor use periods. When closure and reclamation are completed, noise levels would return to background levels.

There could be odors during plugging, abandonment, and reclamation operations from exhaust from heavy equipment and from leaks and spills. Mitigation measures to reduce adverse impacts on visitor use and experience is provided by the offsets required under Current Legal and Policy Requirements, since odors will dissipate with increasing distance from the source. Also, proper handling of hazardous materials and contaminating materials would be required; including secondary containment, and promptly cleaning up spills.

Indirect impacts on visitor use and experience in the Preserve from reclamation of wells directionally drilled from outside the Preserve to bottomholes beneath the Preserve could result in impacts similar to those described above for operations inside the Preserve, but the intensity of impact would depend on proximity to the Preserve, site-specific environmental conditions, and mitigation measures employed; therefore, impacts could range from no impact to indirect, localized, short- to long-term, moderate, adverse and beneficial impacts.

Human Health and Safety: All oil and gas development operations under any of the alternatives could increase the potential for conflicts with visitors using the Preserve and could jeopardize their health and safety.

Seismic exploration could expose Preserve visitors to hazards associated with coming into contact with explosives stored for the seismic survey and explosives that are placed in seismic shotholes, as well as hazards associated with increased vehicular traffic. During 3-D seismic surveys, operators would be required to safely store explosives and fuels away from the public. All shotholes would be plugged with bentonite, and where possible, all undetonated explosives would be removed. Only certified explosive handlers would handle explosives, and security guards may be employed as needed. Offsets required under 36 CFR § 9.41(a) from visitor use and administrative areas would help separate visitors from the oil and gas operations. Warning signs would be posted and notices placed in the park and the local newspaper about the operations. All generated wastes would be cleaned up and disposed of promptly. The seismic survey would need to have health and safety and spill prevention plans in place, in order for their Plan of Operations to be approved.

Drilling and production, and subsequent plugging, abandonment, and reclamation operations have the potential for releases of hydrocarbons or other hazardous substances and/or well blowouts, which could release hydrocarbons, drilling muds, and gases such as hydrogen sulfide (H₂S). Visitors could also be drawn to wellpads and sites out of curiosity, with potential exposure to dangerous equipment or stored chemicals. Hunters, in particular, would need to keep a safe distance from oil and gas operations and avoid shooting near drilling rigs and production facilities (i.e., storage tanks, wellheads, and pumpjacks). There is the possibility of storm or hurricane damage to drilling and production operations, which could spread hazardous and contaminating substances. Perforating or rupturing a storage tank at a production facility containing oil, produced water, or treatment chemicals would increase the threat of spills and subsequent harm to the public.

One of the biggest concerns for human health and safety is the potential exposure to hazardous and contaminating materials. During drilling and production operations, all potentially hazardous materials would be kept in completely enclosed storage containers. Drilling and production sites would not be permitted in floodplains unless there is no practicable alternative. Spill prevention and control measures and other contingency plans included in the Plan of Operations should assure that, in the event of storms, equipment failure, or operator error, accidental discharges of hydrocarbons and produced water would be minimal and would be contained within the operations area. The Preserve staff would be guaranteed access to the site to verify that operations are conducted in a manner which minimizes the potential for spills and provides for rapid spill response and clean up. Operations would also be inspected to ensure that they are conducted in accordance with other applicable regulations, including those enforced by the Railroad Commission of Texas, Texas Commission on Environmental Quality, Texas General Land Office, United States Fish and Wildlife Service, and the United States Environmental Protection Agency (for more information, see Chapter 2 Parts II and III).

In general, the required offsets between oil and gas sites and visitor use areas would help to limit visitors from seeing and going near these facilities. Other mitigation measures include the use of warning signs and notices, security guards (during active drilling), secondary containment (liners and berms), and fencing around the pad and all associated tanks and equipment. In some situations, the Superintendent can restrict public access on roads constructed and used exclusively for access oil and gas operations to safeguard human health and safety, and as may be necessary to protect Preserve resources.

Precautions should also be taken to prevent well blowouts and the sudden accidental release of H₂S during drilling operations. A well blowout could cause unpredictable damage near the well site. A blowout could release H₂S, and other gases, drilling fluids, formation waters, oil, or natural gas under pressure, which could spread some distance from the well site. If fires occurred, sulfur dioxide could be produced.

Preventing blowouts during drilling operations can be accomplished by use of experienced drilling personnel and by implementing mitigation measures that address high pressure precautions (see Table 2.21). These include proper designs and use of drilling muds; constant monitoring of the characteristics and volume of drilling mud to manage drilling conditions; and proper casing and cementing. Wells must be equipped with blowout preventers, which are tested periodically and can be used to shut-in the well if needed. Plans of Operations would also include an emergency response plan that would address H₂S. For those wells that may encounter H₂S, a radius of exposure analysis should be performed prior to site selection.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could pose human health and safety concerns for Preserve visitors. Because the Preserve is comprised of 12 distinct units, and boundaries are not well defined, visitors may not be aware when they are leaving the Preserve. The types of health and safety concerns are expected to be similar to those described above for operations inside the Preserve, but the intensity of impacts could increase for operations located close to but outside the Preserve boundary. Directional wells exempted from the NPS's 36 CFR 9B regulations under § 9.32(e) may not be fenced or signed as operations are required inside the Preserve. Impacts would depend on proximity to the Preserve, site-specific environmental conditions such as accessibility and slope towards visitor use areas in the Preserve; and mitigation measures being employed. Based on these factors, indirect impacts on human health and safety in the Preserve could range from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Oil and Gas operations on 989 acres (including transpark pipeline corridors, and existing and abandoned operations) would continue to adversely impact visitor use and experience in certain areas of the Preserve. Reclamation of these sites (covering 989 acres) would result in a localized, moderate, beneficial impact on visitor use and experience.

Cumulative Impacts: The cumulative impact analysis area for visitor use and experience includes the seven county area encompassing the Preserve (includes Hardin, Jasper, Jefferson, Liberty, Orange, Polk and Tyler Counties). This analysis area was selected because it represents an area within a few hours drive of the Preserve. Except for visitors who travel considerable distances to visit the Preserve, the majority of the visitation (58 percent) is from persons living within a 2-1/2 hour drive of the Visitor Information Station in the Turkey Creek Unit (Gully 1999). Big Thicket National Preserve has received an annual average of over 87,000 visitors over the past ten years. The Preserve attracts visitors that typically live within a few hours drive of the Preserve, primarily from the Houston, Beaumont, Galveston, Conroe, Spring, Austin, and San Antonio areas. Visitors primary reasons for coming to the Preserve are to enjoy nature, see wildlife, escape the crowds and noise, study nature, to see or support nature conservation, and to be with friends and family (Gully 1999).

Over the next several decades, visitation in the Preserve is expected to increase. The increase in visitation is attributed to increased tourism in the region as well as a growth in population. The population in the seven county analysis area is projected to increase an average of 12 percent over the next twenty years while the population in Texas is expected to increase 29 percent (Texas State Data Center 1999). As population increases, the demand for recreation areas and facilities will also increase. Increases in population can have cumulative, adverse impacts on visitor use and experience. As more visitors go to a limited number of recreational areas, there could be increased pressure on the recreational areas and facilities, and there could be conflicts with other users. Increased visitation could also result in resource degradation that could diminish the quality of the visitor experience. Population increases could indirectly impact recreational opportunities if wildlife habitat or populations decrease (i.e., loss in wildlife viewing opportunities and decreases in fish and wildlife populations), or if water quality is degraded (effects on fish populations).

In addition to the Preserve, there are a variety of areas available for recreational activities in the region. Several state parks (Sabine Pass Battleground State Historic Park, Sea Rim State Park, Village Creek State Park, John H. Kirby State Forest, and Martin Dies, Jr., State Park) are located within a few hours drive of the Preserve. Additional undeveloped areas include: Roy E. Larson Sandyland Sanctuary, and various National Forests to the north and west of the Preserve (San Jacinto, Davey Crockett, Sam Houston, San Augustine and Sabine National Forests). The Sam Rayburn and Steinhagen Reservoirs provide recreational opportunities for persons desiring water-related activities. With the increases in population, there is the possibility that additional lands may be set aside (both public and private) for a variety of recreational opportunities, a beneficial impact on visitor use and experience.

Abandoned, ongoing and future oil and gas operations within and outside of the Preserve could adversely impact the quality of the visitor experience if resources are degraded from oil and gas operations. The visitor's experience could also be adversely impacted by restricted access, the views, sounds, and odors associated with these operations. Existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) nonfederal oil and gas operations, and transpark pipelines (589 acres) in the Preserve totaling 989 acres continue to adversely impact soils, water resources, wetlands, fish and wildlife within and possibly outside of the Preserve. Future oil and gas operations that are projected to occur on up to 465 acres for exploration operations and on up to 241 acres for drilling and production operations may directly impact visitor uses on Preserve lands or on adjacent lands if the operations are sited outside the Preserve. The total acreage that would be directly impacted by from oil and gas operations could be as high as 1,695 acres in the Preserve, but it is expected that as some operations are being developed, others would be reclaimed to pre-disturbance conditions. Oil and gas operations outside the Preserve that have not been inventoried may also be adversely impacting visitor use and experience in areas outside of the Preserve. Reclamation of existing oil and gas operations, including access roads and wellpads within and outside the Preserve would be a beneficial impact on visitor use and experience because additional lands would be available for recreational pursuits.

Human health and safety could be threatened if there were an accidental leak or spill of hazardous or contaminating substances (oil, drilling mud, produced water, treatment chemicals), from a well blow-out, from production operations, including associated flowlines or pipelines. Mitigation measures and rapid response in the event of a spill should reduce the human health and safety threat to negligible. The use of heavy machinery is also a safety hazard if visitors come in contact with the equipment used to conduct operations. However, the requirement in the Preserve to site operations more than 500 feet from waterways, visitor use and administrative areas would greatly reduce the health and safety hazards from oil and gas operations. Mitigation measures for oil and gas operations that are in-place on other public lands are also expected to ensure visitor safety.

In summary, oil and gas operations within and outside the Preserve, in conjunction with population growth in the region and its associated impacts (i.e., increased pressure on recreational areas and facilities, visitor use conflicts with other users, degradation of fish and wildlife habitat) could result in cumulative, negligible adverse impacts on visitor use and experience and human health and safety. Required offsets from oil and gas operations and mitigation measures required under Current Legal and Policy Requirements would protect visitors and staff in the Preserve and on other public lands in the area.

Conclusions under Alternative A (No Action/Current Management)

Visitor Use and Experience: Exploration, drilling and production operations would not be permitted within 500 feet visitor use and administrative areas covering 7,469 acres, or within 500

feet of waterways under Current Legal and Policy Requirements (unless specifically authorized in an approved plan of operations), or during specified times for exploration operations covering 52,307 acres would separate the visitor from most oil and gas operations.

In areas where nonfederal oil and gas operations would be permitted in the Preserve, the loss or modification of vegetation, construction and maintenance of drilling and production operations, flowlines and pipelines, presence of oil and gas personnel, increased traffic and noise, odors that are incongruent with the natural setting, and views of oil and gas operations would adversely impact visitor use and experience (including access, visual quality, noise and odors), but with mitigation could result in localized, negligible to moderate, adverse impacts on visitor use and experience where oil and gas operations would be conducted in the Preserve (on up to 465 acres for exploration operations and on up to 241 acres for drilling and production operations). Drilling muds, hydrocarbons, produced waters, or treatment chemicals could be released during drilling, production, or transport, with adverse impacts on visitor use and experience but with mitigation, and prompt response in the event of a spill, adverse impacts would be negligible to moderate. Operations on 989 acres (including transpark pipeline corridors, and existing and abandoned operations) would continue to adversely impact visitor use and experience in certain areas of the Preserve. Reclamation of these sites (covering 989 acres) would result in a localized, moderate, beneficial impact on visitor use and experience.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve, and their reclamation, could indirectly impact visitor use and experience in the Preserve, resulting in impacts ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse and beneficial impacts.

Human Health and Safety: Increased traffic, use of explosives (for 3-D seismic operations), use of large equipment, and accidental releases of oil or other hazardous and contaminating substances (during drilling and production operations, the transport of hydrocarbons, or site reclamation) could result in injury to visitors and Preserve staff, with major, adverse impacts. Required operating stipulations, mitigation measures to ensure human safety, and prompt response in the event of a spill should reduce the intensity of the impact to negligible.

Wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could pose human health and safety concerns for Preserve visitors ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: Oil and gas operations within and outside the Preserve, in conjunction with population growth in the region and its associated impacts (i.e., increased pressure on recreational areas and facilities, visitor use conflicts with other users, degradation of fish and wildlife habitat) could result in cumulative, negligible adverse impacts on visitor use and experience and human health and safety.

Impacts on Visitor Use and Experience under Alternative B (Preferred Alternative)

Visitor Use and Experience: Drilling and production operations (surface uses for drilling and production operations, including the placement of flowlines) would not directly impact visitor use and experience in designated SMAs where the No Surface Use stipulation is applied on up to 46,273 acres (includes riparian corridors, fire and long-term monitoring plots with a 150-foot offset; rare vegetation communities, rare forested wetland communities, Royal Fern Bog with a 150-foot offset; visitor use, administrative and other use areas with a 1,500-foot offset; and birding hot spots with a 1,500-foot offset), or within 500 feet of waterways. Drilling and production operations may be permitted in the Hunting Areas SMA (52,172 acres). However, operations on 989 acres including existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) operations, and transpark pipelines (589 acres) could continue to adversely impact visitor use and experience in the Preserve.

Overall, the designation of SMAs where offsets and timing stipulations would be applied, and the implementation of mitigation measures for lighting, siting of operations, health and safety precautions, security, spill prevention, and clean-up would result in localized, minor adverse impacts on visitor use and experience under Alternative B.

In areas of the Preserve where nonfederal oil and gas operations would be permitted, the types of impacts would be the same as described under Alternative A. The same mitigation measures would also be applied to protect visitor uses and experiences from oil and gas operations. Oil and gas operations could be conducted in the Preserve on up to 465 acres for geophysical exploration and on up to 241 acres for drilling and production operations. The loss or modification of vegetation, ground disturbances, construction and maintenance of drilling and production operations, flowlines and pipelines, presence of oil and gas personnel, increased traffic and noise, odors that are incongruent with the natural setting, and views of oil and gas operations could adversely impact visitor use and experience (including access, visual quality, noise and odors, and backcountry experiences). The presence of leaks and spills could have an adverse impact on visitor experience as well as posing a threat to the health and safety of the visitor (see section on Impacts on Human Health and Safety).

Noise generated during detonation of explosives in shotholes and helicopter use could adversely impact the quality of the visitor experience in the Preserve. Noise generated by the detonation of explosives is equivalent to a shotgun blast and lasts for a fraction of a second. Helicopter noise can be quite loud and intrusive, especially to users in quiet, undeveloped and backcountry settings. The use of helicopters for geophysical exploration is relatively short-term and, most importantly, it avoids many adverse impacts on soil, water resources, vegetation, and wildlife by eliminating the need for extensive use of overland vehicles. With the implementation of operating stipulations and mitigation measures, such as flight elevation, flight path, and timing stipulations, especially during peak visitor use periods, noises associated with geophysical exploration operations (detonation of explosives in shotholes and helicopter use) there should be localized, short-term, minor adverse impacts on visitor use and experience.

Operations on 989 acres (including transpark pipeline corridors, and existing and abandoned operations) would continue to adversely impact visitor use and experience in certain areas of the Preserve. Reclamation of these sites would result in a localized, moderate, beneficial impact on visitor use and experience.

Similar to Alternative A, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve, and their reclamation, could indirectly impact visitor use and

experience in the Preserve, resulting in impacts ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse and beneficial impacts.

Human Health and Safety: The No Surface Use stipulation (covering 11,512 acres for exploration and up to 46,273 acres for drilling and production) and the timing stipulation (covering 52,272 acres for geophysical exploration) would increase the likelihood that more oil and gas operations would occur outside the Preserve rather than inside its boundaries. Where operations do occur, increased traffic, use of explosives (for geophysical exploration), use of large equipment, and accidental releases of hazardous or contaminating substances (during drilling and production operations, the transport of hydrocarbons, or site reclamation) could result in injury to visitors and Preserve staff, with major, adverse impacts. Required operating stipulations, mitigation measures to ensure human safety (described under Alternative A), and prompt response in the event of a spill should reduce the intensity of the impact to negligible.

One of the biggest concerns for human health and safety is the potential exposure to hazardous and contaminating materials during drilling and production operations. During drilling operations, blowouts could occur and release hydrocarbons, water, and drilling mud, but the use of blow-out preventers should prevent an uncontrolled contaminant release during drilling operations. There could also be accidental spills of drilling mud, diesel fuel, and other chemicals during drilling operations. There is the potential for leaks and spills of hazardous and contaminating substances from production operations (including flowlines and pipelines). Accidental leaks and spills of drilling fluids during workovers, hazardous waste spills including diesel fuel, well blowouts, rupture of flowlines and pipelines, and spills from tanker trucks could also occur. Mitigation measures required under Current Legal and Policy Requirements (described under Alternative A) would protect human health and safety under all alternatives and should reduce the intensity of impacts on human health and safety to negligible.

Similar to Alternative A, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could pose human health and safety concerns for Preserve visitors ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative B would be the same as described for Alternative A except that the No Surface Use stipulation on up to 75,293 acres for oil and gas development and the application of Current Legal and Policy Requirements including the required 500 foot offset from waterways, and increased offsets (1,500 feet for drilling and production operations) from visitor use and administrative areas would reduce adverse impacts on visitor use and experience and would ensure human health and safety in the Preserve. Oil and gas operations within and outside the Preserve, in conjunction with population growth in the region and its associated impacts (i.e., increased pressure on recreational areas and facilities, visitor use conflicts with other users, degradation of fish and wildlife habitat) could result in cumulative, negligible adverse impacts on visitor use and experience and human health and safety.

Conclusions under Alternative B (Preferred Alternative)

Visitor Use and Experience: The No Surface Use stipulation covering 11,512 acres for exploration operations (includes 500-foot offset near visitor use areas), on up to 46,273 acres for drilling and production operations (includes a 1,500-foot offset near visitor use areas), within 500 feet of waterways, and the timing stipulation for exploration operations in the Hunting Areas and Birding Hot Spots SMAs on 52,272 acres during designated times would separate the visitor from most oil and gas operations and may reduce the level of oil and gas activity in the Preserve.

The designation of SMAs may result in more drilling and production operations being conducted on lands adjacent to the Preserve. Increased offsets (1,500 feet) from visitor use areas would minimize the potential for conflicts with visitor uses and experiences in the Preserve. Similar to Alternative A, operating stipulations in conjunction with mitigation measures should result in localized, negligible to moderate adverse impacts on visitor use and experience in the Preserve.

Similar to Alternative A, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve, and their reclamation, could indirectly impact visitor use and experience in the Preserve, resulting in impacts ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse and beneficial impacts.

Human Health and Safety: The No Surface Use stipulation (covering 11,512 acres for exploration and up to 46,273 acres for drilling and production) and the timing stipulation (covering 52,272 acres for exploration operations) would increase the likelihood that more oil and gas operations would occur outside the Preserve rather than inside its boundaries, reducing the likelihood of human health and safety impacts from these operations, resulting in negligible, adverse impacts on human health and safety in the Preserve. Accidental leaks and spills of hazardous or other contaminating substances could result in injury to visitors and Preserve staff, with major, adverse impacts. Required operating stipulations, mitigation measures to ensure human safety, and prompt response in the event of a spill should reduce the intensity of the impact to negligible.

Similar to Alternative A, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could pose human health and safety concerns for Preserve visitors ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The cumulative impacts would be the same as Alternative A, except that formal designation of SMAs, and application of specific protection measures, would further protect visitor uses and experiences and human health and safety in designated areas of the Preserve. Oil and gas operations within and outside the Preserve, in conjunction with population growth in the region and its associated impacts (i.e., increased pressure on recreational areas and facilities, visitor use conflicts with other users, degradation of fish and wildlife habitat) could result in cumulative, negligible adverse impacts on visitor use and experience and human health and safety.

Impacts on Visitor Use and Experience under Alternative C (Maximum Resource Protection)

Visitor Use and Experience: Due to the designation of SMAs covering 46,273 acres where drilling and production would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. The increased area of the Preserve designated as SMAs, in conjunction with required mitigation should result in negligible adverse impacts on visitor use and experience.

In areas of the Preserve where nonfederal oil and gas operations could be permitted, the types of impacts would be the same as described under Alternatives A and B. The same mitigation measures would also be applied to protect visitor uses and experiences from oil and gas operations. Oil and gas operations could be conducted in the Preserve on up to 465 acres for geophysical exploration and on up to 241 acres for drilling and production operations. The loss or modification of vegetation, ground disturbances, construction and maintenance of drilling and production operations, flowlines and pipelines, presence of oil and gas personnel, increased traffic and noise, odors that are incongruent with the natural setting, and views of oil and gas operations would adversely impact visitor use and experience (including access, visual quality, noise and odors, and

wilderness experiences). Under Alternative C, there could be additional adverse impacts on visitor uses and experiences resulting from geophysical exploration operations conducted outside of the SMAs. Where the No Surface Use stipulation would apply in SMAs, it may be necessary to concentrate operations (increase the density of source and receiver lines or increase the depth of shotholes) to image the subsurface underlying the SMAs. Also, noise from helicopter use, shothole drilling and detonation of explosives in shotholes, and well drilling, and production operations; and leaks and spills could have indirect, adverse impacts on visitor use and experience.

Operations on 989 acres (including transpark pipeline corridors, and existing and abandoned operations) would continue to adversely impact visitor use and experience in certain areas of the Preserve. Reclamation of these sites (covering 989 acres) would result in a localized, moderate, beneficial impact on visitor use and experience.

Similar to Alternatives A and B, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve, and their reclamation, could indirectly impact visitor use and experience in the Preserve, resulting in impacts ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse and beneficial impacts.

Human Health and Safety: The No Surface Use stipulation (covering 39,657 acres for exploration and 46,273 acres for drilling and production) and the timing stipulation (covering 52,272 acres for geophysical exploration) would increase the likelihood that more oil and gas operations would occur outside the Preserve rather than inside its boundaries. Increased traffic, use of explosives (for geophysical exploration), use of large equipment, and accidental releases of oil or other hazardous and contaminating substances (during drilling and production operations, the transport of hydrocarbons, or site reclamation) could result in injury to visitors and Preserve staff, with major, adverse impacts. Required operating stipulations, including increasing the required offset from visitor use areas to 1,500 feet, mitigation measures to ensure human safety (described under Alternative A), and prompt response in the event of a spill should reduce the intensity of the adverse impact to negligible.

Similar to Alternatives A and B, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could pose human health and safety concerns for Preserve visitors ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: Cumulative impacts under Alternative C would be the same as described for Alternatives A and B except that the No Surface Use stipulation on 75,293 acres would be applied in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development in the Preserve. The designation of SMAs in the Preserve, the application of Current Legal and Policy Requirements (500' offset from waterways), and SMA stipulations including the 1,500 feet offset from visitor use and administrative areas for drilling and productions operations would reduce adverse impacts on visitor use and experience and would ensure human health and safety. Oil and gas operations, in conjunction with population growth in the region and its associated impacts (i.e., increased pressure on recreational areas and facilities, visitor use conflicts with other users, degradation of fish and wildlife habitat) could result in cumulative, negligible adverse impacts on visitor use and experience and human health and safety.

Conclusions under Alternative C (Maximum Resource Protection)

Visitor Use and Experience: The No Surface Use stipulation covering 39,657 acres for exploration (includes a 500-foot offset near visitor use areas), on 46,273 acres for drilling and

production (includes a 1,500-foot offset near visitor use areas), within 500 feet of waterways, and the timing stipulation for exploration operations in the Hunting Areas SMA on 52,172 acres during designated times would separate the visitor from most oil and gas operations and is likely to reduce the level of oil and gas activity in the Preserve.

Due to the designation of SMAs covering 46,273 acres where drilling and production operations would not be permitted, it is likely that most wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. Increased offsets (1,500 feet) from visitor use areas would minimize the potential for conflicts with visitor uses and experiences in the Preserve. The designation of SMAs in conjunction with mitigation measures should result in negligible to minor adverse impacts on visitor use and experience in the Preserve.

Similar to Alternatives A and B, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve, and their reclamation, could indirectly impact visitor use and experience in the Preserve, resulting in impacts ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse and beneficial impacts.

Human Health and Safety: The No Surface Use stipulation (covering 39,657 acres for exploration and 46,273 acres for drilling and production) and the timing stipulation (covering 52,272 acres for exploration operations) would increase the likelihood that more oil and gas operations would occur outside the Preserve rather than inside its boundaries, reducing the likelihood of human and health and safety impacts from these operations, resulting in negligible, adverse impacts on human health and safety in the Preserve. Accidental leaks and spills of hazardous or other contaminating substances could result in injury to visitors and Preserve staff, with major, adverse impacts. Required operating stipulations, mitigation measures to ensure human safety, and prompt response in the event of a spill should reduce the intensity of the impact to negligible.

Similar to Alternatives A and B, wells directionally drilled and produced from outside the Preserve to bottomholes beneath the Preserve could pose human health and safety concerns for Preserve visitors ranging from no impact to indirect, localized to widespread, short- to long-term, moderate, adverse impacts.

Cumulative Impacts: The impacts would be the same as Alternatives A and B, except that the No Surface Use stipulation in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development would further protect visitor uses and experiences and human health and safety in designated areas of the Preserve. Oil and gas operations within and outside the Preserve, in conjunction with population growth in the region and its associated impacts (i.e., increased pressure on recreational areas and facilities, visitor use conflicts with other users, degradation of fish and wildlife habitat) could result in cumulative, negligible adverse impacts on visitor use and experience and human health and safety.

IMPACTS ON ADJACENT LAND USES AND RESOURCES

Introduction

The emphasis of this impact topic is on the effect that nonfederal oil and gas operations could have on adjacent land uses and resources. The types of impacts on specific resources are similar to those that are presented throughout this chapter, and include Impacts on Air Quality, Geologic Resources, Water Resources, Floodplains, Wetlands, Vegetation, and Fish and Wildlife. For the most part, the NPS cannot mandate specific operating stipulations outside of the Preserve and the magnitude (intensity) of impacts may be greater than is characterized for operations occurring wholly inside of the Preserve. The reader is referred to these sections of Chapter 4 for a more detailed

description of the activities and their associated impacts. Table 2.17, Summary of Impacts Chart, provides an overview of the range of impacts that could occur to resources within and adjacent to the Preserve.

The National Park Service encourages directionally drilling wells from previously disturbed areas or from surface locations outside the Preserve to protect Preserve resources and values. If nonfederal oil and gas operations that are accessed from outside the Preserve do not pose a significant threat to resources and values in the Preserve (36 CFR § 9.32(e)), the Regional Director of the NPS may grant an exemption from the NPS Nonfederal Oil and Gas Regulations (36 CFR 9B). In most cases, the operator would prepare what is called a § 9.32(e) Application rather than a Plan of Operations to directionally drill a well from outside the boundaries of the Preserve. The content of an Application is similar to a Plan of Operation except that specific project layout and resource information is less detailed because the NPS does not have the regulatory authority to require these data. The NPS may only require a prospective operator of a directional drilling operation to conduct resource surveys inside a park when there is a correlation between downhole operations within the park and potential impacts on park resources and values. In contrast, the NPS may request, but cannot require operators to conduct resource surveys inside a park associated with operations outside of the park but connected to the downhole activities in the park or to conduct resource surveys outside of the park.

Where operations are located near the boundary of the Preserve, the NPS and operator would collaboratively develop mitigation for the proposed oil and gas operation to protect resources both inside and outside of the Preserve. Resource protection (mitigation) measures that are encouraged by the NPS include: (1) using containerized mud systems, (2) constructing berms around drilling and production sites, and (3) lining drillpads and storage facilities with impermeable liners. In addition, operators would be required to comply with all federal, state, and local legal requirements (see chapter 2 Parts II and III for more information).

The operator would decide whether to directionally drill a well on lands outside the Preserve. This decision may depend on a variety of factors, including operational costs, access to a site suitable for drilling the well, logistical constraints of drilling wells in flood-prone areas of the Preserve, and the reduced regulatory requirements outside of the Preserve. Nonfederal oil and gas operations can only be conducted on lands adjacent to the Preserve with prior landowner approval. Surface use agreements, operating stipulations, and reclamation requirements can be specified by regulating authorities and private landowners.

The degree of the impact on adjacent land uses and resources is dependent upon the type of oil and gas operation, mitigation measures, and adjacent land use. Nonfederal oil and gas operations that may occur on adjacent lands include geophysical exploration, construction of access roads, drilling exploratory and production wells, constructing and operating production facilities, and constructing and operating flowlines and pipelines to transport oil and gas. Bordering the Preserve there are individual homesites, residential subdivisions (i.e., Wildwood, Bevil Oaks), tribal lands (Alabama-Coushatta Indian Reservation), agricultural lands, industrial areas (Saratoga, refineries south of Beaumont Unit), commercial areas (i.e., Evadale, Beaumont), recreational areas (county park near Neches Bottom and Jack Gore Baygall Units), and commercial and private timber lands that could be impacted by oil and gas operations.

Methodology for Assessing Impacts

The assessment of potential impacts on adjacent land uses and resources is based on best professional judgment and has been developed through discussions with staff from the National Park Service and through review of relevant literature.

Impact Intensity Thresholds. Thresholds of change of the intensity of an impact are defined as follows:

- Negligible:** Adjacent land uses and resources would not be impacted, or changes in land use would be so slight, local, and likely short-term as a result of nonfederal oil and gas operations occurring outside the Preserve, that they would not be of any measurable or perceptible consequence.
- Minor:** Adjacent land uses and resources would result in a change, but the change would be small and of little consequence, short-term, and localized. Mitigation measures, if needed to offset adverse effects of nonfederal oil and gas operations occurring outside the Preserve, would be simple and successful.
- Moderate:** Adjacent land uses and resources would have measurable impacts that would be long-term, and of consequence, but would be relatively local. Mitigation measures, to offset adverse effects of nonfederal oil and gas operations occurring outside the Preserve, would likely succeed.
- Major:** Adjacent land uses and resources would have readily measurable impacts, with substantial consequences, and be noticed on a regional scale. Mitigation measures would be necessary to offset the adverse effects of nonfederal oil and gas operations occurring outside the Preserve, and their success would not be guaranteed.

Impacts on Adjacent Land Uses and Resources under Alternative A (No Action/Current Management)

Nonfederal oil and gas operations on lands adjacent to the Preserve could be permitted under the NPS's 36 CFR 9B regulations under an approved plan of operations, or exempted under 36 CFR § 9.32(e) (see Chapter 2, Part II). Oil and gas development may result in beneficial economic impacts because landowners could be compensated for allowing exploratory, drilling, or production operations on their lands. Surface use agreements, loss-of-use payments, and reclamation payments would be negotiated between the landowner and the operator. Resource impacts on lands outside of the Preserve may be greater than described in this chapter for operations inside the Preserve because the NPS does not have regulatory authority to require specific mitigation unless it can be demonstrated that the downhole operations have the potential to harm resources in the Preserve (§ 9.32(e)).

Geophysical Exploration: Under all alternatives, 3-D seismic surveys may be conducted on lands adjacent to the Preserve. Shotpoints and receivers may be placed on these lands to image the subsurface geology adjacent to and within the Preserve. These exploration operations may result in the development of drilling prospects within and adjacent to the Preserve. Impacts may include increased noise levels, unpleasant odors, minor clearing and removal of vegetation, soil compaction and rutting, localized increases in turbidity and sedimentation in water bodies, and water and soil contamination. These operations could adversely impact the rural quality of life, short-term uses of the land, and fish and wildlife species and their habitat.

Overall, geophysical operations could result in localized, short-term, negligible to moderate adverse impacts on adjacent land uses and resources. The resource impacts could be similar to those inside the Preserve, but the intensity of the impact may be different because operating requirements may not be the same on adjacent lands as are required by the NPS inside the Preserve. NPS operating stipulations within the Preserve may include limiting overland vehicles in certain areas,

using helicopters to move personnel and equipment, reducing the size of dynamite charges (using mini-shotholes vs. larger deep holes), consolidating staging areas, and instituting timing stipulations to protect fish and wildlife species, to reduce conflicts with visitor use, and to protect human health and safety.

Drilling and Production: There could be adverse impacts on adjacent landowners and resources if an operator directionally drills a well next to the Preserve to develop oil and gas underlying the Preserve. Under Alternative A, oil and gas operations could be allowed throughout the Preserve, based on Current Legal and Policy Requirements. Operations would not be permitted in Protected Areas on approximately 7,500 acres, or within 500 feet of waterways. Surface uses for geophysical exploration operations would not be permitted in hunting areas from October 1st through January 15th or in the designated birding hot spots from March 1st through May 30th and from September 1st through November 30th.

Without the formal designation of SMAs in this alternative, it is less likely (but still probable) than under Alternatives B and C that oil and gas operators would site their wells outside the Preserve to develop hydrocarbons underlying the Preserve. Directional wells are encouraged by the NPS. Surface use agreements and loss of use payments could result in a minor to moderate, economic benefit on adjacent landowners if oil and gas drilling and production operations occur outside the Preserve.

Drilling and production operations may remove lands (such as residential, tribal, ranching, recreational, or commercial) from established uses for the short-term (several months for a dry hole) to long-term (up to 20 years or more for a productive well). Adverse environmental impacts could occur to air quality, soils, water, vegetation, wildlife species and habitat, species of special concern, cultural resources, rural character/quality of life, and recreational uses (see summary under these topics in Table 2.17). During operations, adjacent landowners may experience increased noise levels, odors, road surface degradation, and increased traffic. Overall, there could be minor to major adverse impacts on adjacent land uses and resources. The duration of impacts would range from short-term for construction activities and drilling operations and long-term, extending up to 20 years or more for roads, production operations, and flowlines and pipelines. If there is an accidental leak or spill of hazardous or other contaminating substances, there could be widespread, minor to major adverse impacts on soils, water resources, vegetation, fish and wildlife until the spill is remediated. The intensity of the impact from drilling and production operations would be dependent upon the land uses and resources that are impacted, the tolerances of the landowner, and the resource protection measures implemented by the operator. Generally, Current Legal and Policy Requirements and mitigation measures are more stringent on federal lands than on private lands, so it is possible that there could be more adverse impacts outside the Preserve than if the operations were conducted within the Preserve.

Plugging/Abandonment/Reclamation: The extent of site reclamation is dependent upon the requirements imposed by the landowner. It is possible that reclamation of oil and gas operation sites on adjacent lands may not be as extensive as would be required in the Preserve. Depending on the amount of reclamation, there could be localized, negligible to major adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources).

Cumulative Impacts: The cumulative impact analysis area for adjacent landowners covers the Lower Neches River Watershed which extends from the B. A. Steinhagen Reservoir on the north, southward to Beaumont, and from the watershed divide east of the Neches River westward to the Trinity River. The analysis area has been selected because it includes the major rivers and tributaries that flow through the Preserve, and activities that disrupt surface and subsurface water flow, or degrade water quality could potentially impact land uses, resources and values on adjacent lands.

The Preserve is bordered by commercial and private timber lands, individual homesites, residential subdivisions, tribal lands, agricultural lands, commercial, industrial, and recreational areas that could be impacted by a variety of activities that are anticipated in the reasonably foreseeable future. Activities with potential adverse effects on adjacent land uses and resources include residential and urban development, commercial and private forestry, oil and gas operations, agricultural activities, and operation of publicly-owned facilities (e.g., water diversion and sewage treatment facilities). The reader is referred to previous cumulative impact sections in Chapter 4 for more detailed descriptions of the impacts from these various land uses. The degree of the impact on adjacent land uses and resources is dependent upon the adjacent land use, the type and level of activity, and the mitigation measures employed to protect the resources, land uses, and landowner's quality of life.

Over the next 15 to 20 years the population growth in east Texas is anticipated to increase. The population in the seven county area encompassing the Preserve is projected to increase an average of 12 percent over the next twenty years while the population in Texas is expected to increase 29 percent (Texas State Data Center 1999). With the increase in population, there would be construction activities associated with road building, and urban and residential developments. Adverse impacts on natural resources resulting from construction activities could include vegetation removal, increased erosion and sedimentation in waterways, water quality degradation, loss of wetlands, and wildlife habitat and habitat fragmentation. Land uses may change as a result of these developments, but would be up to the discretion of the landowner. The quality of life could also be adversely impacted by population growth, with increased noise, traffic, air quality degradation, and loss of natural areas. A beneficial impact of population growth would be the construction of infrastructure, facilities and other amenities (i.e., parks) that would serve the local population.

Private and commercial forestry activities could adversely impact land uses, resources, and values on adjacent lands. Immediately adjacent to the Preserve, commercial and private forestry accounts for approximately 95 percent of the land area (Harcombe and Callaway, 1997). Since the majority of adjacent land uses are ongoing private and commercial logging activities, it is likely that impacts associated with these activities would continue over the foreseeable future. Potential impacts of forestry activities on natural resources include exposing soils to erosion, increased sedimentation and turbidity in surface waters, water quality degradation, loss of wildlife habitat and biodiversity, and habitat fragmentation.

Abandoned, current and future oil and gas operations within and outside of the Preserve could adversely impact resources, land uses and quality of life on adjacent lands. Existing (24.2 acres) and abandoned (unreclaimed sites comprising 376 acres) operations, and transpark pipelines (589 acres) in the Preserve totaling 989 acres continue to adversely impact soils, water resources, wetlands, fish and wildlife within and possibly outside of the Preserve. Future oil and gas operations that are projected to occur on up to 465 acres for exploration operations and on up to 241 acres for drilling and production operations may directly impact resources on adjacent lands if they occur outside of the Preserve and could indirectly impact non-Preserve lands if they occur within the Preserve. Oil and gas operations outside the Preserve that have not been inventoried or may be drilled in the future to develop private minerals outside of the Preserve may adversely impact adjacent lands. Cumulative, adverse impacts may include increased turbidity and sedimentation in waterways, and surface and groundwater contamination from accidental leaks and spills of hazardous or contaminating substances (oil, drilling mud, produced water, and treatment chemicals). Reclamation of existing oil and gas operations, including access roads and wellpads within and outside the Preserve would be a beneficial impact on natural resources in the analysis area.

Agricultural activities in the area could have cumulative adverse impacts on natural and cultural resources. Vegetation removal could expose soils to erosion and increase sedimentation in surface waters. Ground disturbance (i.e., plowing) could expose cultural artifacts. Alteration of vegetation composition could also reduce wildlife habitat and biodiversity. Run-off of fertilizers can cause

nutrient and organic enrichment that increases organic matter and subsequently reduces dissolved oxygen in sediments and surface waters.

The operation of publicly-owned facilities (e.g., water impoundments and water diversion structures) may adversely impact soils, vegetation, wetlands, fish and wildlife habitat, water quality, and floodplain resources in the area. The Sam Rayburn and Steinhagen Reservoirs have reduced the frequency and duration of both high and low flows on the Neches River. Changes in the overall amount and timing of stream flows may directly impact stream channel morphology, rate of river migration, sedimentation, water quality, soil chemistry, and the amount and type of aquatic habitat downstream from the reservoirs. Indirectly, these changes could impact the growth, mortality, and regeneration of vegetation along riparian corridors. A number of water diversions exist in the southern portion of the Neches River Basin such as the Lower Neches River Valley Authority Canal. In addition, the transfer of water from the Sabine River Basin to the San Jacinto River Basin is being considered to accommodate increased water needs in southeast Texas. Water diversion structures can impact flooding frequency and duration by reducing (or increasing) the amount of water flowing through stream channels.

In summary, the use and development of non-Preserve lands could result in cumulative, minor to major, adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources). The intensity of the impact depends upon the adjacent land use, the type and level of activity, and the mitigation measures employed to protect these resources.

Conclusions under Alternative A (No Action/Current Management)

Geophysical Exploration: Depending on the methods employed and types of equipment used, there could be localized, short-term, negligible to moderate, adverse impacts on adjacent land uses and resources from geophysical exploration operations where shotholes and receivers are placed outside the boundaries of the Preserve.

Drilling and Production: There is the potential for wells to be directionally drilled from outside the Preserve since drilling and production would not be permitted under Current Legal and Policy Requirements on 7,469 acres, or within 500 feet of waterways within the Preserve. Nonfederal oil and gas operations on private lands outside the Preserve would be allowed based on Current Legal and Policy Requirements.

Surface use agreements and loss-of-use payments may result in minor to moderate, beneficial economic impacts on adjacent landowners. The overall impact on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources) from drilling and production operations would range from short-term (construction activities and drilling operations) to long-term (roads, production operations, and flowlines and pipelines), minor to major, adverse impacts, depending on the resource protection measures employed.

Plugging/Abandonment/Reclamation: Depending on the amount of reclamation on adjacent lands, there could be localized, negligible to major, adverse impacts on land uses, resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources), and values.

Cumulative Impacts: The use and development of non-Preservelands, including ground-disturbing activities within and outside of the Preserve such as residential and urban development,

road building, commercial and private forestry, oil and gas operations, agricultural activities, and operation of publicly-owned facilities (e.g., water diversion and sewage treatment facilities) could result in cumulative, minor to major, adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources). The intensity of the impact depends upon the adjacent land use, the type and level of activity, and the mitigation measures employed.

Impacts on Adjacent Land Uses and Resources under Alternative B (Preferred Alternative)

Geophysical Exploration: Under Alternative B, impacts from geophysical exploration would be similar to those described for Alternative A, except that with the designation of SMAs where the No Surface stipulation would be applied on 11,512 acres, there could be more widespread adverse impacts on adjacent land uses and resources if shotholes and receivers are placed outside the boundaries of the Preserve to image the subsurface adjacent to and within the Preserve. These exploration operations may result in the development of drilling prospects within and adjacent to the Preserve. Adverse impacts may include increased noise levels, unpleasant odors, minor clearing and removal of vegetation, soil compaction and rutting, localized increases in turbidity and sedimentation in water bodies, and water contamination. These operations would indirectly adversely impact the rural quality of life, short-term uses of the land, and fish and wildlife species and their habitat.

Overall, the impacts from geophysical operations on adjacent land uses and resources are anticipated to be localized, short-term, minor to major, adverse impacts. Impacts could be similar to those inside the Preserve, but the intensity of the impacts may be different because operating requirements may not be the same on adjacent lands as are required inside the Preserve.

Drilling and Production: Due to the designation of SMAs covering up to 46,273 acres where the No Surface Use stipulation would be applied, and the logistical constraints of drilling in flood-prone areas of the Preserve, there is a greater potential that wells would be directionally drilled from outside the Preserve than under Alternative A. Surface use agreements and loss-of-use payments may result in minor to moderate, beneficial economic impacts on adjacent landowners. The overall impact on land uses, resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources), and values from drilling and production operations may range from short- to long-term, minor to major, adverse impacts on adjacent land uses and resources, depending on the resource protection measures employed. If there is an accidental leak or spill of hazardous or other contaminating substances, there could be widespread, minor to major adverse impacts on soils, water resources, vegetation, fish and wildlife until the spill is remediated. The intensity of the impact from drilling and production operations would be dependent upon the land uses and resources that are affected, the tolerances of the landowner, and the resource protection measures implemented by the operator. Since more wells may be drilled from outside the Preserve, it is possible that the adverse impacts on adjacent landowners could be more widespread than under Alternative A.

Drilling and production operations may remove lands (such as residential, tribal, ranching, recreational, or commercial) from established uses for the short-term (several months for a dry hole) to long-term (up to 20 years or more for a productive well). Adverse environmental impacts could occur to air quality, soils, water, vegetation, wildlife species and habitat, cultural resources, rural character, species of special concern, and recreational uses. During operations, adjacent landowners may experience increased noise levels, odors, road surface degradation, and increased traffic.

Plugging/Abandonment/Reclamation: There are more lands designated with the No Surface Use stipulation than under Alternative A which increases the likelihood that oil and gas operations would be sited outside the Preserve, and upon completion of the operations, would be reclaimed. The extent of site reclamation is dependent upon the requirements imposed by the landowner. It is possible that reclamation of oil and gas operation sites on adjacent lands may not be as extensive as would be required in the Preserve. Depending on the amount of reclamation, there could be negligible to major adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources).

Cumulative Impacts: Cumulative impacts under Alternative B would be the same as described for Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of natural and cultural resources within the Preserve, and may indirectly protect resources in some areas outside of the Preserve. However, the designation of SMAs could result in more nonfederal oil and gas activity (and associated impacts) outside of the Preserve. The use and development of non-Preserve lands in conjunction with oil and gas operations, including ground-disturbing activities within and outside of the Preserve such as residential and urban development, road building, commercial and private forestry, oil and gas operations, agricultural activities, and operation of publicly-owned facilities (i.e., water impoundments, water diversion and sewage treatment facilities) could result in cumulative, minor to major, adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources). The intensity of the impact depends upon the adjacent land use, the type and level of activity, and the mitigation measures employed.

Conclusions under Alternative B (Preferred Alternative)

Geophysical Exploration: The impacts would be the same as Alternative A, except that with the designation of SMAs where the No Surface stipulation would be applied on 11,512 acres, there could be more widespread adverse impacts on adjacent land uses and resources if shotholes and receivers are placed outside the boundaries of the Preserve to image the subsurface adjacent to and within the Preserve, with localized, short-term, minor to major, adverse impacts

Drilling and Production: Due to the designation of SMAs on up to 46,273 acres where the No Surface Use stipulation would be applied, there is a greater potential that wells would be directionally drilled from outside the Preserve than under Alternative A.

Surface use agreements and loss-of-use payments may result in minor to moderate, beneficial economic impacts on adjacent landowners. The overall impact on land uses, resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources), and values from drilling and production operations may range from short-term to long-term, minor to major, adverse impacts, depending on the resource protection measures employed. Since more wells may be drilled from outside the Preserve, it is possible that the adverse impacts on adjacent landowners could be more widespread than under Alternative A.

Plugging/Abandonment/Reclamation: There are more lands designated with the No Surface Use stipulation than under Alternative A which increases the likelihood that oil and gas operations would be sited outside the Preserve, and upon completion of the operations, would be reclaimed. The impacts would be similar to Alternative A, ranging from negligible to major, adverse impacts, but could be more widespread than under Alternative A.

Cumulative Impacts: The impacts would be the same as described for Alternative A, except that formal designation of SMAs, and application of specific protection measures, would provide consistent protection of resources in the SMAs and may indirectly protect resources adjacent to these areas. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, minor to major, adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources). The intensity of the impact depends upon the adjacent land use, the type and level of activity, and the mitigation measures employed.

Impacts on Adjacent Land Uses and Resources under Alternative C (Maximum Resource Protection)

Alternative C has 75,293 acres (85 percent of the Preserve) designated as SMAs where either the No Surface Use or timing stipulations would be applied to geophysical exploration, drilling or production operations. Geophysical Exploration could occur during designated times in the Hunting Areas SMA (52,172 acres). Where surface use would not be permitted in SMAs that are adjacent to unit boundaries, geophysical exploration, and drilling and production operations could increase outside the Preserve. The intensity of the impacts on adjacent landowners could possibly be greater than under the other alternatives presented in this Plan/EIS because more nonfederal oil and gas operations may occur outside of the Preserve. Overall, the impacts from geophysical operations on adjacent land uses and resources are anticipated to be localized, short-term, minor to major, adverse impacts. Impacts could be similar to those inside the Preserve, but the intensity of the impacts may be different because operating requirements may not be the same on adjacent lands as are required inside the Preserve.

Geophysical Exploration: Geophysical exploration would not be permitted in any of the designated Special Management Areas in the Preserve, except with timing Stipulations in the Hunting Areas SMA. Due to the designation of 39,657 acres as SMAs under Alternative C, seismic shotholes and receivers may be placed outside the Preserve to image the subsurface adjacent to and within the Preserve. The 3-D seismic surveys may be modified by placing larger charges in deeper shotholes or by designing a denser seismic grid of source and receiver lines outside of the Preserve. These exploration operations may result in the development of drilling prospects within and adjacent to the Preserve. Impacts from geophysical exploration may include increased noise levels, unpleasant odors, minor clearing and removal of vegetation, soil compaction and rutting, localized increases in turbidity and sedimentation in water bodies, and water contamination, resulting in localized, short-term, minor to major adverse impacts. These operations would indirectly adversely affect the rural quality of life, short-term uses of the land, and fish and wildlife species and their habitat.

Drilling and Production: Due to the designation of SMAs covering 46,273 acres where the No Surface Use stipulation would be applied, there is a greater potential for wells to be directionally drilled from outside the Preserve than under Alternatives A and B. Surface use agreements and loss-of-use payments may result in minor to moderate, beneficial economic impacts on adjacent landowners. The overall impact on land uses, resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources), and values from drilling and production operations may range from short- to long-term, negligible to major, adverse impacts, depending on the resource protection measures employed. If there is an accidental leak or spill of hazardous or other contaminating substances, there could be widespread, minor to major adverse impacts on soils, water resources, vegetation, fish and wildlife until the spill is remediated. The intensity of the impact from drilling and production operations would

be dependent upon the land uses and resources that are affected, the tolerances of the landowner, and the resource protection measures implemented by the operator. Since more wells may be drilled from outside the Preserve, it is possible that the adverse impacts on adjacent landowners could be more widespread than under Alternatives A and B.

Drilling and production operations may remove lands (such as residential, tribal, ranching, recreational, or commercial) from established uses for the short-term (several months for a dry hole) to long-term (up to 20 years or more for a productive well). Adverse environmental impacts could occur to air quality, soils, water, vegetation, wildlife species and habitat, cultural resources, rural character, species of special concern, and recreational uses. During operations, adjacent landowners may experience increased noise levels, odors, road surface degradation, and increased traffic.

Plugging/Abandonment/Reclamation: There are more lands designated with the No Surface Use stipulation than under Alternatives A and B which increases the likelihood that oil and gas operations would be sited outside the Preserve, and upon completion of the operations, would be reclaimed. The extent of site reclamation is dependent upon the requirements imposed by the landowner. It is possible that reclamation of oil and gas operation sites on adjacent lands may not be as extensive as would be required in the Preserve. Depending on the amount of reclamation, there could be negligible to major adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources).

Cumulative Impacts: Cumulative impacts under Alternative C would be the same as described for Alternatives A and B except that the No Surface Use stipulation for SMAs on 39,657 acres for geophysical exploration and for SMAs on 46,273 acres for drilling and production operations would ensure widespread protection of natural and cultural resources in the Preserve, and would indirectly protect resources outside of the Preserve. However, the designation of SMAs could result in more nonfederal oil and gas activity (and associated impacts) outside of the Preserve. The use and development of non-Preserve lands, including ground-disturbing activities within and outside of the Preserve such as residential and urban development, road building, commercial and private forestry, oil and gas operations, agricultural activities, and operation of publicly-owned facilities (e.g., water impoundments, water diversion and sewage treatment facilities) could result in cumulative, minor to major, adverse impacts on adjacent land uses and resources (including air quality, geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources). The intensity of the impact depends upon the adjacent land use, the type and level of activity, and the mitigation measures employed.

Conclusions under Alternative C (Maximum Resource Protection)

Geophysical Exploration: The impacts would be the same as Alternatives A and B, except that with the designation of SMAs where the No Surface stipulation would be applied on 39,657 acres, there could be more widespread adverse impacts on adjacent land uses and resources if shotholes and receivers are placed outside the boundaries of the Preserve to image the subsurface adjacent to and within the Preserve, with localized, short-term, minor to major, adverse impacts.

Drilling and Production: Due to the designation of SMAs covering 46,273 acres where the No Surface Use stipulation would be applied, there is a greater potential for wells to be directionally drilled from outside the Preserve than under Alternatives A and B.

Surface use agreements and loss-of-use payments may result in minor to moderate, beneficial economic impacts on adjacent landowners. The overall impact on land uses, resources (air quality,

including geologic resources, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources), and values from drilling and production operations may range from short- to long-term, minor to major, adverse impacts, depending on the resource protection measures employed. Since more wells may be drilled from outside the Preserve, it is possible that the adverse impacts on adjacent landowners could be more widespread than under Alternatives A and B.

Plugging/Abandonment/Reclamation: There are more lands designated with the No Surface Use stipulation than under Alternatives A and B which increases the likelihood that oil and gas operations would be sited outside the Preserve, and upon completion of the operations, would be reclaimed. The impacts would be similar to Alternative A, ranging from negligible to major, adverse impacts, but could be more widespread than under Alternatives A and B.

Cumulative Impacts: The impacts would be the same as Alternatives A and B, except that the No Surface Use stipulation in all SMAs (except the Hunting Areas SMA), for all phases of oil and gas development would ensure widespread protection of resources in the Preserve, which would indirectly protect resources adjacent to these areas. Past, present, and future oil and gas development, along with other types of ground disturbing activities within and outside the Preserve, should have cumulative, minor to major, adverse impacts on adjacent land uses and resources (including geologic resources, air quality, water resources, vegetation, wetlands, fish and wildlife, species of special concern, and cultural resources). The intensity of the impact depends upon the adjacent land use, the type and level of activity, and the mitigation measures employed.

COMPARATIVE ANALYSIS OF THE PROPOSED ACTION AND ALTERNATIVES

Impairment

Alternatives B and C in this Plan were developed to better ensure the prevention of impairment of Preserve resources and values. The impairment analyses in this Plan/EIS were done programmatically for all resources and values that could be impacted from oil and gas development within and adjacent to the Preserve. During the impact analyses for this Plan/EIS, Special Management Areas and operating stipulations were modified or added to the alternatives to reduce the level of potential impact on park resources and values.

In addition, a site-specific analysis of the potential for impairment of Preserve resources and values will be required on all proposed oil and gas projects in the Preserve. The analysis must be included in the NEPA document on the Plan of Operations for all oil and gas projects.

Under all alternatives, if mitigation measures are not adequately applied during the conduct of nonfederal oil and gas operations, there could be impacts on Preserve resources and values. If this were to occur, the NPS would be required to suspend the operation until appropriate mitigation is applied. If mitigation is not technically feasible to avoid the impairment, the oil and gas operation would not be allowed to continue.

If an accidental spill of hydrocarbons or other contaminating substance were to occur in the Preserve, there could be major adverse impacts particularly to water, vegetation, wetlands, soils, fish and wildlife resources. Even if there were a catastrophic spill, the site would be remediated and would not likely result in an impairment of Preserve resources and values.

Alternative A. Current law, regulation, and policy preclude Preserve resource managers from authorizing nonfederal oil and gas operations that would impair Preserve resources and values.

Under Alternative A (the status quo), Preserve managers must carry out this responsibility on a case-by-case basis without the direction provided in a comprehensive oil and gas plan that provides upfront identification of resources that are most susceptible to adverse impacts from oil and gas operations and state-of-the-art mitigation measures. As a result, Preserve managers evaluate individual proposals with little guidance beyond the text of the 9B regulations and associated NEPA environmental analysis. Relative to Alternatives B and C, this increases the likelihood that the location of certain resources and available mitigation measures could be overlooked on any given proposed operation, placing Preserve resources and values at risk of impairment.

Alternatives B and C. The implementation of a comprehensive oil and gas management plan and the designation of Special Management Areas to further protect park resources and values would provide more certainty to oil and gas operators and consistent application of Current Legal and Policy Requirements that would protect Preserve resources and values from potential impairment from nonfederal oil and gas operations.

Special Management Areas have been designated in Alternatives B and C that would protect resources and values particularly susceptible to adverse impacts from oil and gas operations. Geologic resources, water resources, floodplains, wetlands, rare vegetation communities, and specific visitor use areas would be provided specific protection. Operating stipulations in SMAs, including setbacks and a No Surface Use stipulation would be required to avoid or minimize adverse impacts and would further reduce the likelihood of impairment of resources and values in the Preserve.

Due to the designation of Special Management Areas under Alternatives B and C, it is probable that more wells would be directionally drilled from outside the Preserve to develop hydrocarbons underlying the Preserve. While indirect impacts on Preserve resources and values could be greater from directional wells drilled from outside the Preserve compared to operations inside the Preserve, it is unlikely that Preserve resources and values would be impaired by directional drilling and production. In some cases, directional drilling proposals would involve other federal agencies applying other permitting requirements (i.e., Clean Water Act Section 404 permitting). The NPS would participate with the other federal entity through its permitting process to request any necessary mitigation measures be applied to reduce the potential for major adverse impacts on Preserve resources and values. If NPS is the only federal entity involved, and a directional drilling and production proposal could pose major adverse impacts on Preserve resources and values, the NPS would need to base its § 9.32(e) exemption on the findings of an environmental impact statement (EIS). In most cases, operators would preclude the need to prepare an EIS by locating directional wells a sufficient distance from the Preserve, and applying other necessary mitigation measures to reduce impacts.

Enhancement of Long-term Relationship between Local Short-term Uses of the Environment and Maintenance and Productivity

For all alternatives in this Plan/EIS, most impacts would be relatively short-term and would be mitigated to avoid impairment of Preserve resources and values; however, continuation of the existing management program as discussed above under Alternative A could lead to impairment of these resources. Land disturbed during oil and gas operations would be reclaimed, all equipment and contamination or wastes removed, and the ground restored to its natural contours. However, some surface disturbances resulting from oil and gas development may cause long-term effects, if the areas are not totally reclaimed or are reclaimed after a very long period of time. For example, access roads may be used for more than one wellpad or for other multiple uses. In such cases, long-term productivity would likely decrease and possibly be lost in the areas used for access roads. Also, if wetlands cannot be avoided and the mitigation required is not successful in compensating for

the original productivity of areas lost, there could be a loss in long-term productivity in these areas. This would be the case if certain out-of-kind wetland mitigation would be approved for replacement of productive wetland acreage.

Irreversible or Irretrievable Commitments of Resources

Irreversible impacts are those effects that cannot be changed over the long term or are permanent. An effect to a resource is irreversible if it (the resource) cannot be reclaimed, restored, or otherwise returned to its pre-disturbance condition.

For all the alternatives, there would be an irreversible commitment of the hydrocarbon resources underlying the Preserve, since oil and gas is being depleted at a much faster rate than it is being formed in the subsurface. The region is a mature hydrocarbon basin where exploratory and production drilling has occurred for the past 100 years and through time, oil and gas production is expected to decline in the Preserve and surrounding area. Even though 3-D seismic technology would contribute to new discoveries in the Preserve, production should continue to decline from current levels. This irreversible commitment of resources is not considered an impairment to Preserve resources because Congress did not establish the Preserve to specifically provide for oil and gas development. Rather, Congress recognized the Preserve for its outstanding natural, scenic, and recreational values while providing for the private property right to develop these resources.

Another irreversible commitment of resources would occur if any significant cultural resources were destroyed during any phase of oil and gas development. However, given the size of the shotholes during 3-D seismic operations and wellbores for drilling wells, this would be relatively minor. If buried cultural resources cannot be avoided, impacts would be mitigated by the recovery of data (excavation) and preservation of recovered materials and associated records, an irreversible adverse impact.

For all alternatives, there would be an irretrievable loss of undeveloped areas for visitor use and experience where the ground is cleared and disturbed for oil and gas exploration and development, including access roads and wellpads. This involves approximately up to 241 acres or 0.2 percent of the Preserve (based on the area being analyzed in this Plan/EIS). The potential for these lands to produce vegetation or be viewed in an undisturbed state would be irretrievably committed for the duration of the oil and gas development operations, and until the site(s) have been reclaimed.

Unavoidable Adverse Impacts that Cannot be Avoided Should the Action be Implemented

Unavoidable adverse impacts are adverse impacts that cannot be avoided and cannot be mitigated, and, therefore, would remain throughout the duration of the oil and gas operation. Under Alternatives B and C, the implementation of this oil and gas management plan would provide more direction to the oil and gas operator and greater protection to Preserve resources and values and hence avoid and mitigate potential damage to Preserve resources and values. If an operator's proposal could potentially lead to an impairment of Preserve resources, the NPS would not approve the proposed operation until adequate resource protection (mitigation measures) is integrated into the operation.

For any of the alternatives, there may be unavoidable adverse impacts if the mitigation proposed for any impacted wetlands is not successful and/or does not compensate for the original wetland functions and values. All alternatives would require avoidance of wetlands as the first mitigation

measure. However, if avoidance is not possible, it may be difficult to ensure that either the restoration of wetlands required through compensation for a specific operation, or the reclamation of the wetlands after operations have been completed, would have similar functions, or the necessary hydrologic regime and other environmental conditions, especially if they are replacing forested wetlands.

There may also be unavoidable adverse impacts on visitor uses and experiences if the setback (500-foot to 1,500-foot distance) and other mitigation measures do not provide enough of a restricted area between oil and gas operations and visitor use areas. There is a distinct possibility that the noise from drilling rigs, compressors, and other oil and gas operations could adversely impact the visitor experience. This would depend on the specific location, intervening topography and vegetation, noise mitigation techniques utilized, and the existing background noise levels in the vicinity of the operation.