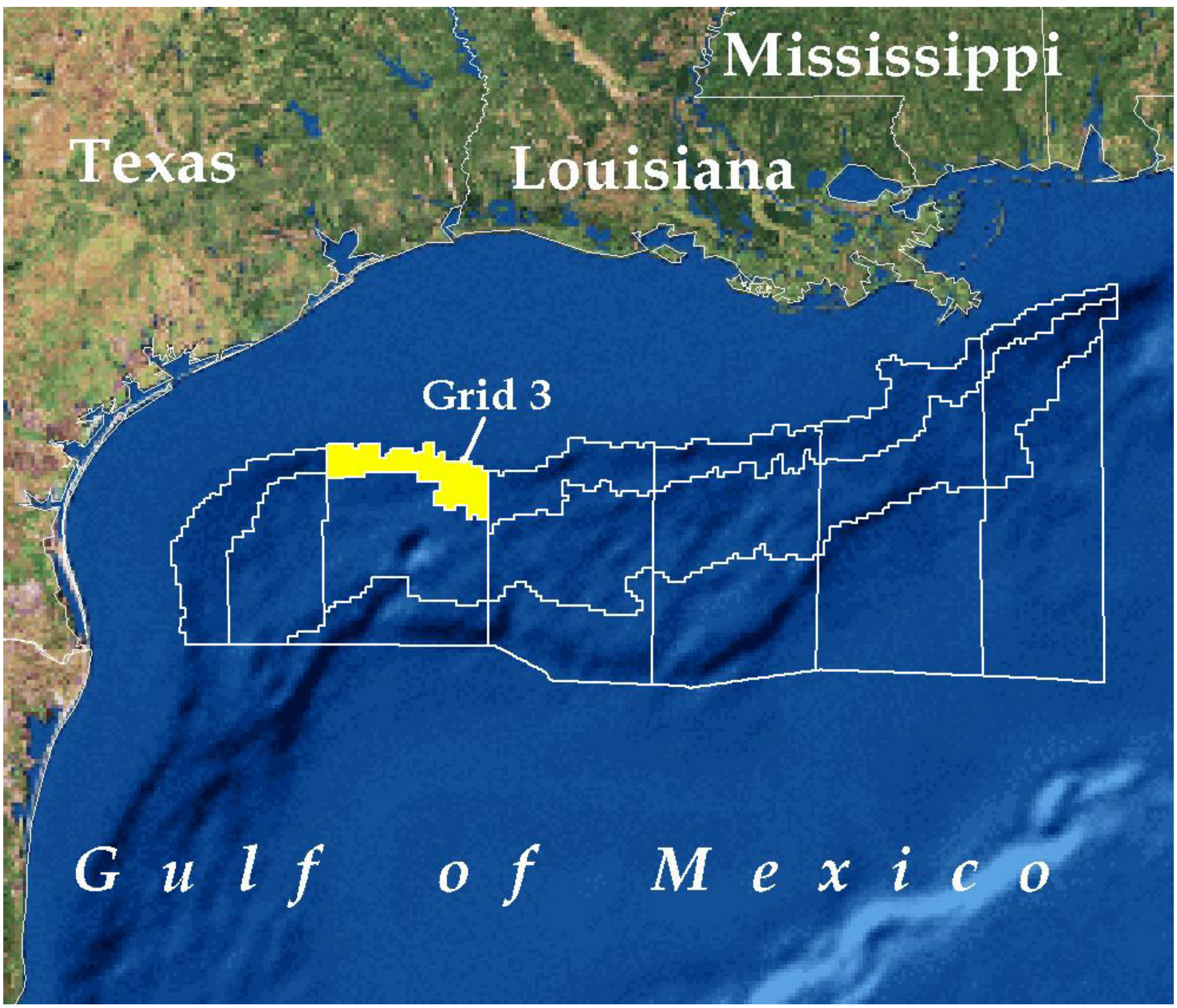
OCS EIS/EA
MMS 2003-021

Programmatic Environmental Assessment for Grid 3

Evaluation of Kerr-McGee Oil and Gas Corporation's Development Operations Coordination Document, N-7625

Gunnison Project
Garden Banks Blocks 667, 668, and 669



U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

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MMS 2003-021

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Gunnison Project
Garden Banks Blocks 667, 668, and 669

Prepared by

Minerals Management Service
Gulf of Mexico OCS Region

Published by

U.S. Department of the Interior
Minerals Management Service
Gulf of Mexico OCS Region

New Orleans
April 2003

PROGRAMMATIC ENVIRONMENTAL ASSESSMENT FOR GRID 3 DETERMINATION/ FINDING OF NO SIGNIFICANT IMPACT

Kerr-McGee Oil and Gas Corporation's Initial Development Operations Coordination Document (DOCD) and its amendments proposing to install a truss spar and to develop and produce 10 wells (3 of which are subsea wells) in Garden Banks Blocks 667, 668, and 669, have been reviewed. The application to install lease-term pipeline segments in Garden Blocks 667 and 668 has also been reviewed. Our programmatic environmental assessment (PEA) on the subject actions (N-7625) and (P-14109) is complete and results in a Finding of No Significant Impact (FONSI). Our PEA has also addressed categorical exclusion criterion C.(10)(1) by summarizing information to characterize the environment of Grid 3. Based on the conclusions of this PEA, there is no evidence that the proposed action will significantly (40 CFR 1508.27) affect the marine and human environments. Preparation of an environmental impact statement is not required. The following mitigations will be required and included in the operator's approval letter to ensure environmental protection, consistent environmental policy, and safety as required by the National Environmental Policy Act (NEPA) of 1969, as amended; or as needed for compliance with 40 CFR 1500.2(f) regarding the requirement for Federal agencies to avoid or minimize any possible adverse effects of their actions upon the quality of the human environment.

1. In response to the request accompanying your plan for a hydrogen sulfide (H_2S) classification, the area in which the proposed drilling operations are to be conducted is hereby classified, in accordance with 30 CFR 250.417(c), as "H_2S absent." (8.03)

2. Within 60 days of commencing production, you must provide this office with the following information regarding your liquid hydrocarbon production: ^{o}API gravity, pour point (^{o}C), and viscosity (Centipoise at 25 ^{o}C). (13.07)

3. Our review indicates that there are pipelines in the vicinity of Platform A that may pose a hazard to your proposed operations. Therefore, please be advised that you will take precautions in accordance with Notice to Lessees and Operators No. 98-20, Section IV.B, prior to performing operations. (15.01)

4. In accordance with NTL No. 2001-G04, the MMS has determined that you will not need to conduct the two ROV surveys you proposed in your plan. (19.03)

Robert M Rogers, Acting — 4/1/03

Mary Boatman
Supervisor, Studies/Plan Coordination Unit
Leasing and Environment, GOM OCS Region

Date

Dennis Chew — 4/1/03

Dennis Chew
Supervisor, NEPA/CZM Coordination Unit
Leasing and Environment, GOM OCS Region

Date

Pat Roscigno
Chief, Environmental Sciences Section
Leasing and Environment, GOM OCS Region

4-1-2003
Date

J. Hammond Eve
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4/2/03
Date

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ABBREVIATIONS AND ACRONYMS

AC	Alaminos Canyon
ASI	Airborne Support Inc.
BOD	biochemical oxygen demand
B.P.	before present
CEI	Coastal Environments, Inc.
CFR	*Code of Federal Regulations*
CPA	Central Planning Area
CSA	Continental Shelf Associates
DDT	Dichlorodiphenyltrichloroethane
DGoMB	Deepwater Program: Northern Gulf of Mexico Continental Slope Habitats and Benthic Ecology
DOCD	Development Operations Coordination Document
DO	dissolved oxygen
DOI	Department of the Interior (U.S.) (also: USDOI)
EB	East Breaks
E&D	Exploration and Development
EA	environmental assessment
EEZ	Exclusive Economic Zone
EFH	essential fish habitat
EIS	environmental impact statement
EP	Exploration Plan
EPA	Eastern Planning Area
et al.	and others
et seq.	and the following
FMC	Fishery Management Council
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
FR	*Federal Register*
FWS	Fish and Wildlife Service
GB	Garden Banks
GERG	Geochemical and Environmental Research Group
GIS	geographical information system
GMFMC	Gulf of Mexico Fishery Management Council
GOM	Gulf of Mexico
H_2S	hydrogen sulfide
HMS	highly migratory species
HMWHC	high molecular weight hydrocarbons
ITC	Intertribal Council
MARPOL	International Convention for the Prevention of Pollution from Ships
MBO	million barrels of oil
MMS	Minerals Management Service
MSA	Metropolitan Statistical Area
MWA	military warning area
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act, as amended
NGMCS	Northern Gulf of Mexico Continental Slope Study
NMFS	National Marine Fisheries Service
NOEC	No observable effect concentration
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant and Discharge Elimination System
NRC	National Response Corporation
NS&T	National Status & Trends Program (NOAA)
NTL	Notice to Lessees and Operators
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act, as amended
OSRA	Oil Spill Risk Analysis
OSRO	Oil Spill Removal Organizations
P&A	plugged and abandoned
PAH	polynuclear aromatic hydrocarbon
PEA	Programmatic Environmental Assessment
P.L.	Public Law
PCB	polychlorinated biphenyl
PLEM	pipeline end manifold
ppb	parts per billion
ppt	parts per thousand
ROSRP	Regional Oil Spill Response Plan
SIC	Standard Industrial Classification
SOP	suspension of production
SUTA	Subsea Umbilical Termination Assembly
TA	temporarily abandoned
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOI	U.S. Department of the Interior (also: DOI)
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
WPA	Western Planning Area

INTRODUCTION

The Minerals Management Service (MMS) developed a comprehensive strategy for postlease National Environmental Policy Act (NEPA) compliance in deepwater areas (water depths of greater than 400 m) of the Central and Western Planning Areas (CPA and WPA) of the Gulf of Mexico (GOM). You can find an in-depth discussion of this strategy on our Internet site at the following address:

www.gomr.mms.gov/homepg/regulate/environ/strategy/strategy.html.

The MMS's strategy led to the development of a biologically based grid system to ensure broad and systematic analysis of the GOM's deepwater region. The grid system divided the Gulf into 17 areas or "grids" of biological similarity. Under this strategy, MMS will prepare a programmatic environmental assessment (PEA) to address a proposed development project within each of the 17 grids. These Grid PEA's will be comprehensive in terms of the impact-producing factors and environmental and socioeconomic resources described and analyzed.

Once a PEA for a grid has been completed, it will serve as a reference document to implement the "tiering" (40 CFR 1502.20) concept detailed in NEPA's implementing regulations. Future environmental evaluations may reference appropriate sections from the PEA to reduce reiteration of issues and effects previously addressed in the "grid" document. This will allow the subsequent environmental analyses to focus on specific issues and effects related to the proposals.

This PEA will characterize the environment of Grid 3 and examine the effects that may result from Kerr-McGee Oil and Gas Corporation's Initial Development Operations Coordination Document (DOCD) for the Gunnison Project (N-7625).

Figure 1 shows the relationship of Grid 3 to the Gulf's coastline and to the other 16 grids. Garden Banks Block 668 is highlighted to show the proposed spar location.

Figure 2 depicts the protraction diagrams and blocks that are contained in Grid 3. The highlighted block (Garden Banks Block 668) is the proposed location for the Gunnison spar.

CURRENT STATUS OF GRID 3

The purpose of this section is to provide the reader with a "state of the grid." Information in this section is based on current MMS data and publicly announced prospects that are projected for Grid 3.

Grid 3 includes portions of two Outer Continental Shelf (OCS) protraction diagrams. Table 1 provides information on the protraction diagrams, blocks, and leases in Grid 3.

Table 1

Protraction Diagrams, Blocks, and Leases in Grid 3

Protraction Diagrams	No. of Grid Blocks	No. of Grid Blocks Leased	Percentage of Grid Blocks Leased
Garden Bank	82	31	38
East Breaks	138	32	23
Total	220	63	61

Figure 3 depicts the bathymetry of Grid 3 in 500-m contour intervals.

Military Warning Areas (MWA's) are located within Grid 3—W-602 and W-147E. See Figure 4 for the boundaries of the MWA's. All leased blocks within the Grid and that are contained within the MWA's will have stipulations in their lease regarding specific Department of Defense mitigative measures, i.e., hold and save harmless, electromagnetic emissions, and operational considerations. For additional information regarding these stipulations, see the Final Environmental Impact Statement (EIS) for Central GOM Lease Sales 185, 190, 194, 198, and 201, and Western GOM Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002a). Figure 4 also shows that an ordnance disposal area is located in the East Breaks ares of Grid 3.

Grid 3 contains a total of 220 blocks. Of these blocks, 61 (27%) are leased.

At present, there are 15 operators with leases in Grid 3. These operators include

Amerada Hess	McMoRan Oil	Samedan Oil
Devon Energy	Murphy	Shell Offshore
El Paso	Nippon Oil	Shell Gulf
Kerr-McGee	Ocean Energy	Spinnaker
Maxus (US)	Panaco	Union Oil

Figure 5 geographically depicts the leasehold position of these operators within Grid 3.

The Grid's active lease status and plans submitted data are portrayed in Figure 6. A total of 17 (10%) of the leased blocks have Exploration Plans (EP's) approved by MMS. Six (35%) of the 17 leases with EP's also have DOCD's approved or under evaluation. Five leases are currently producing within the Grid (East Breaks Blocks 158, 159, 160, 161, and 209).

Gunnison is the only publicly announced prospect contained within Grid 3. Drilled well locations within the Grid and its surrounding area are shown on Figure 7.

There are active and proposed right-of-way pipeline routes contained within the Grid. Figure 8 shows these routes in relationship to the Grid.

There are numerous onshore support bases that are available along the Gulf Coast and that could serve as logistical infrastructure for Grid 3. In the current proposal, Kerr-McGee has chosen Sabine Pass and Galveston as their onshore bases to support the proposed operations. Figure 9 shows the relationship of Grid 3 to these shore bases. The distance in miles from the Grid to each of Kerr-McGee's selected bases is also depicted on Figure 9.

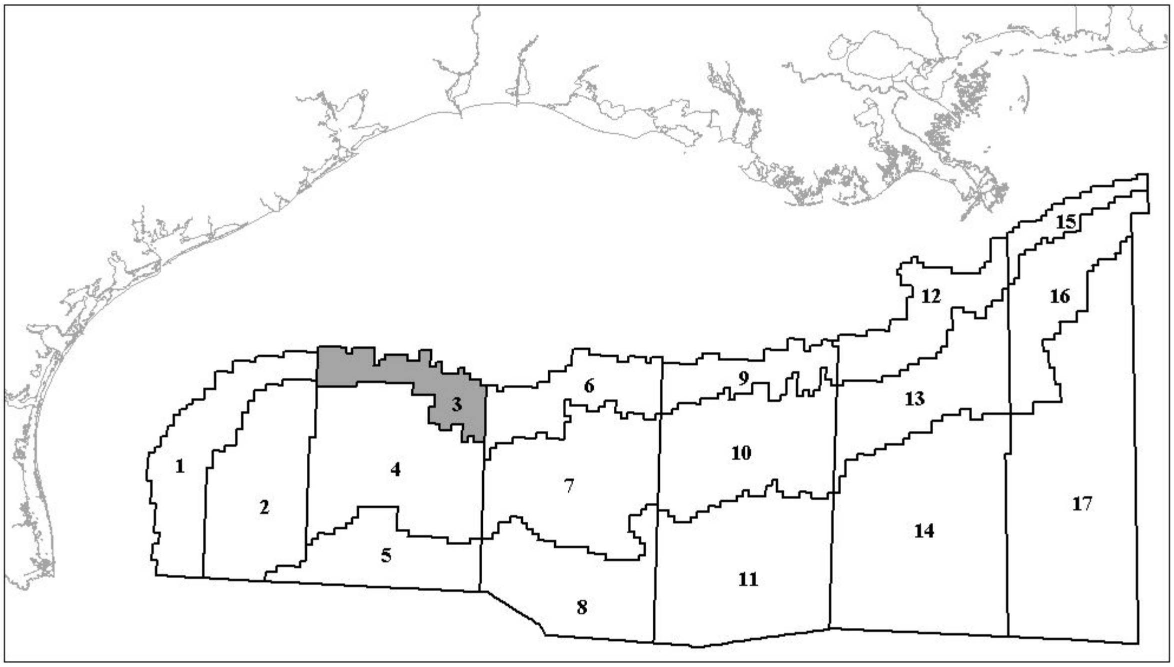

Figure 1. Grid 3 in Relationship to the Gulf Coastline and to Other Grids.

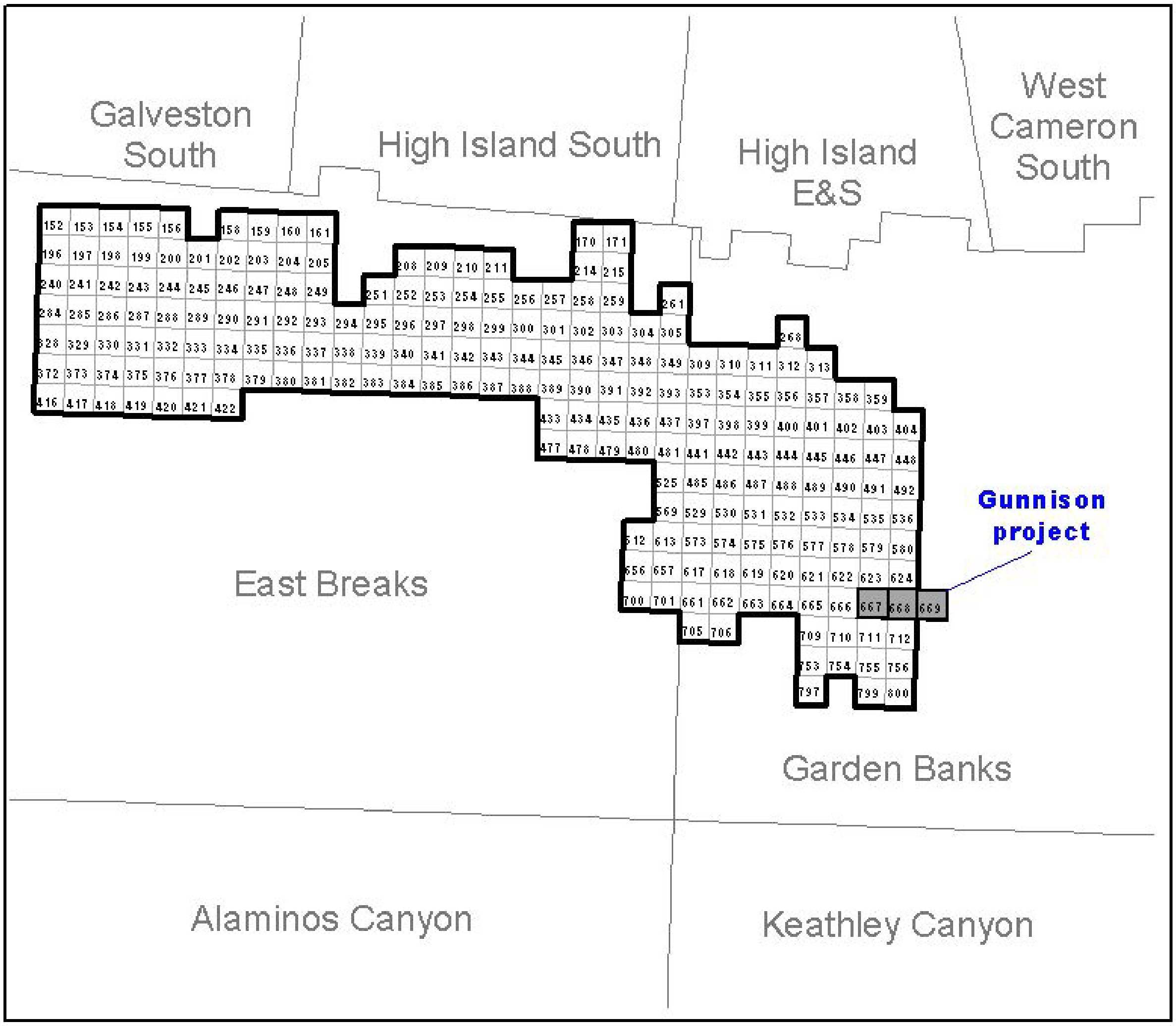

Figure 2. Protraction Diagrams and Blocks in Grid 3.

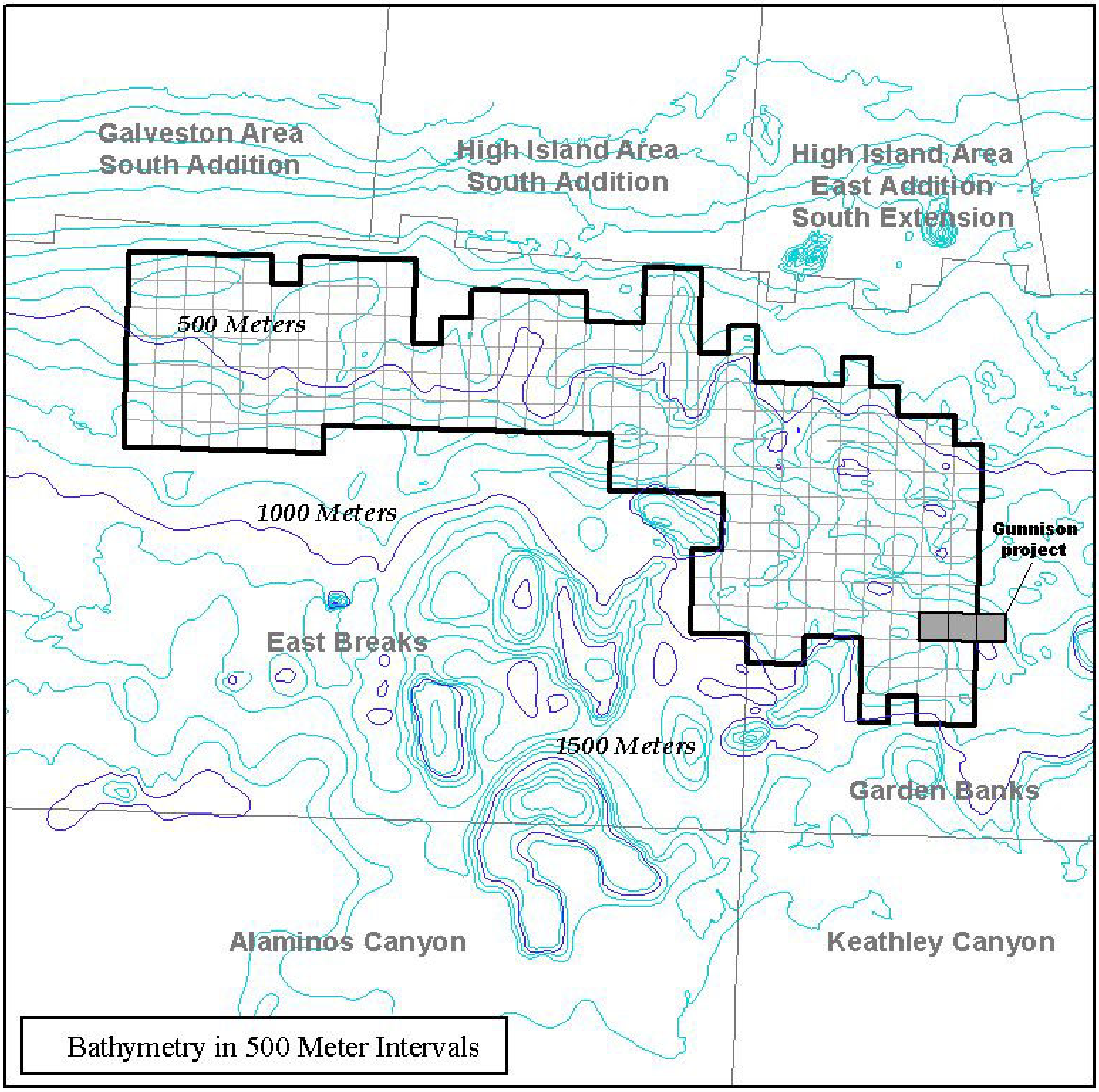

Figure 3. Bathymetry of Grid 3.

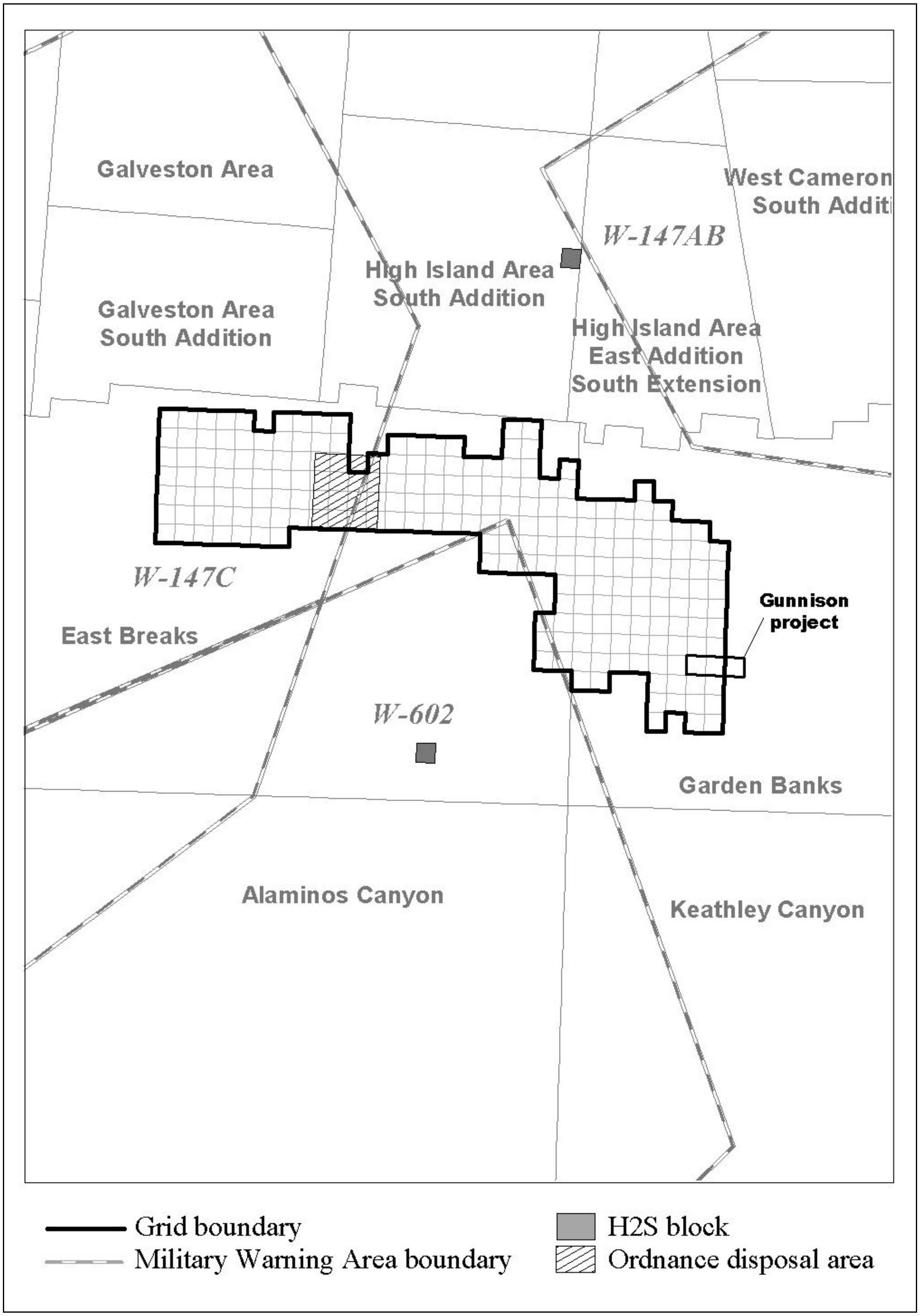

Figure 4. Military Warning Areas and Ordnance Disposal Area.

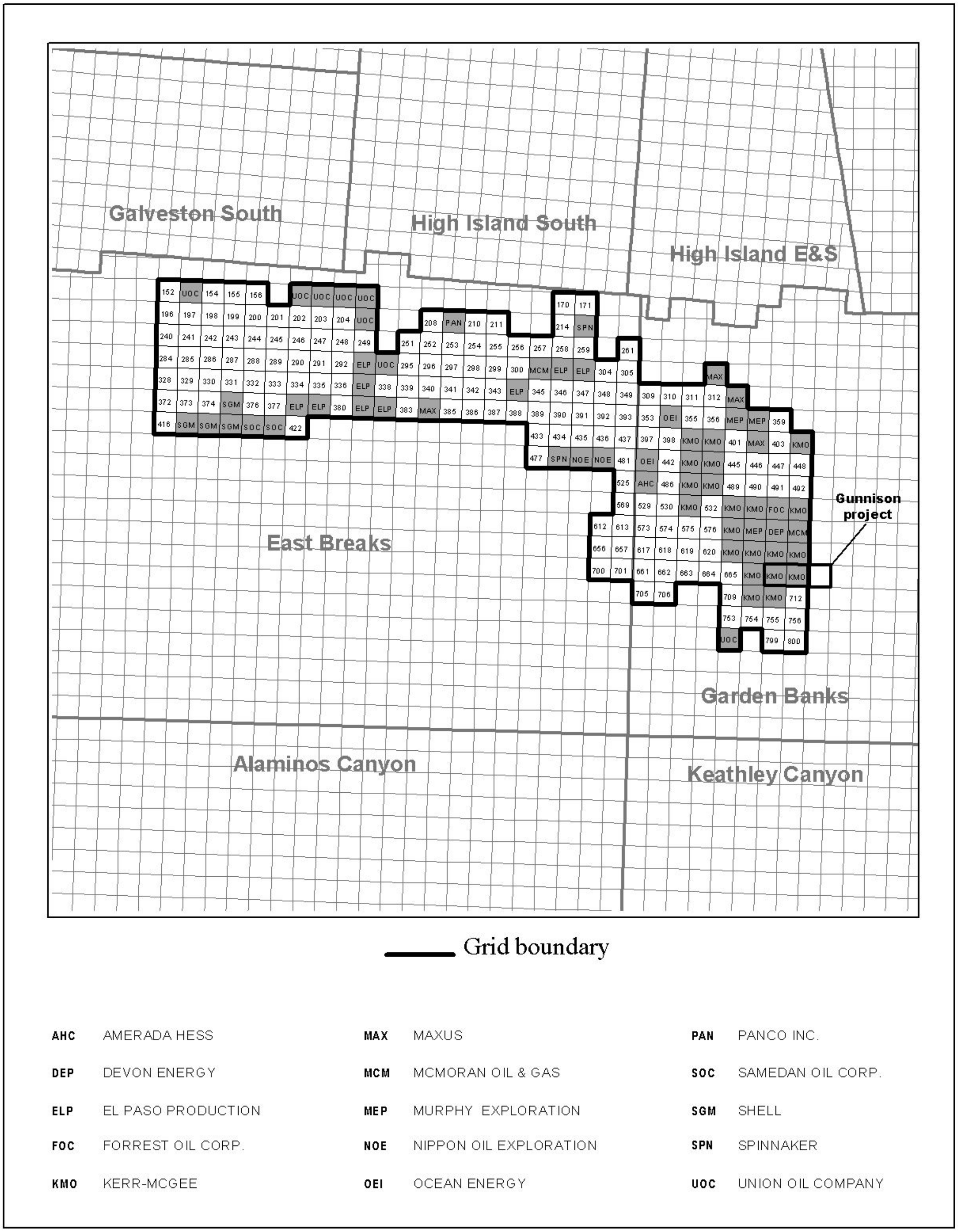

Figure 5. Leasehold Position of Operators within the Grid 3.

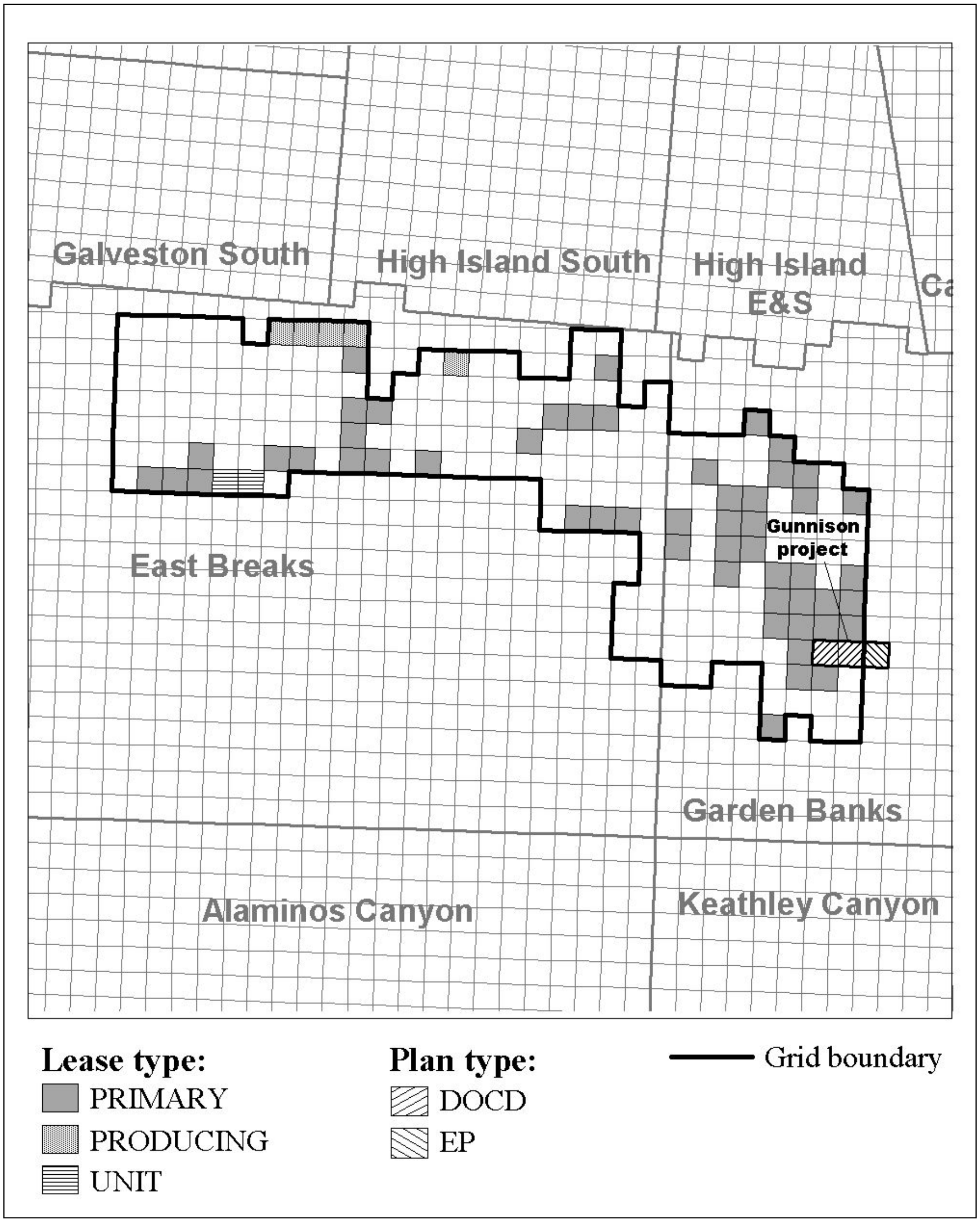

Figure 6. Active Lease Status and Plans Submitted.

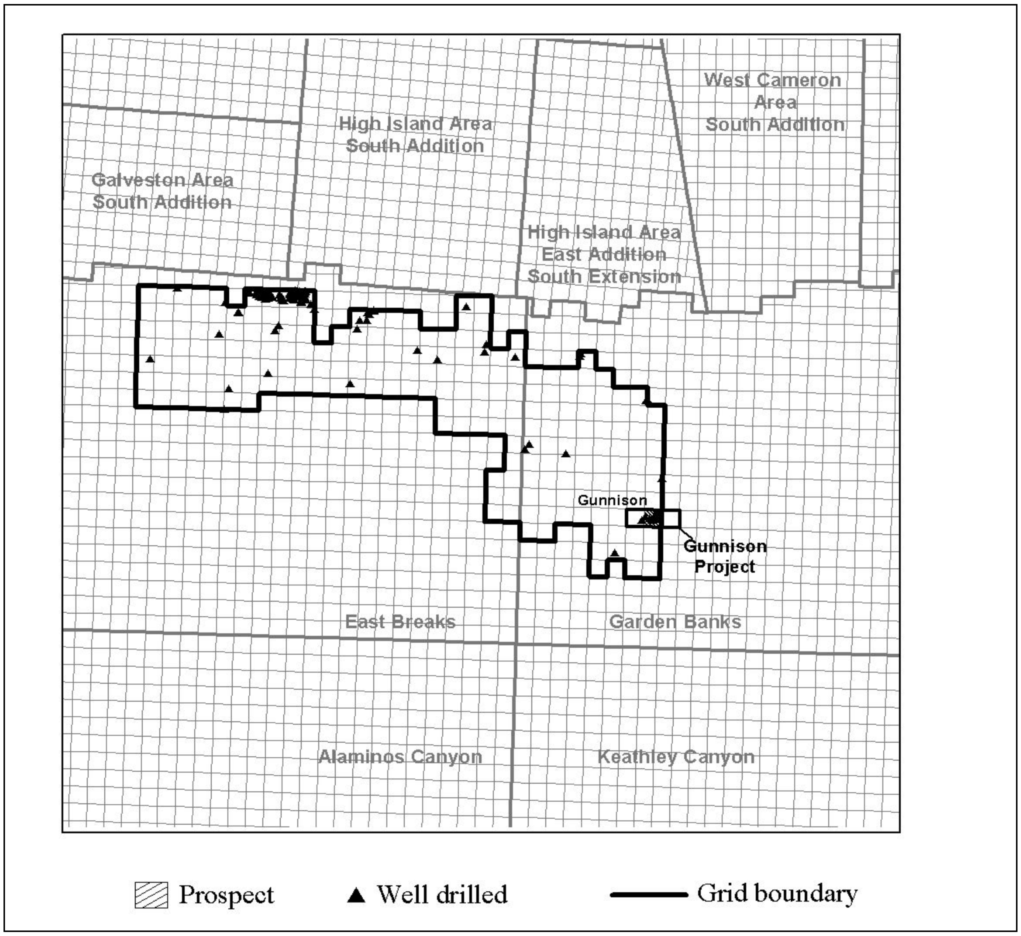

Figure 7. Publicly Announced Prospect and Wells Drilled in Grid 3.

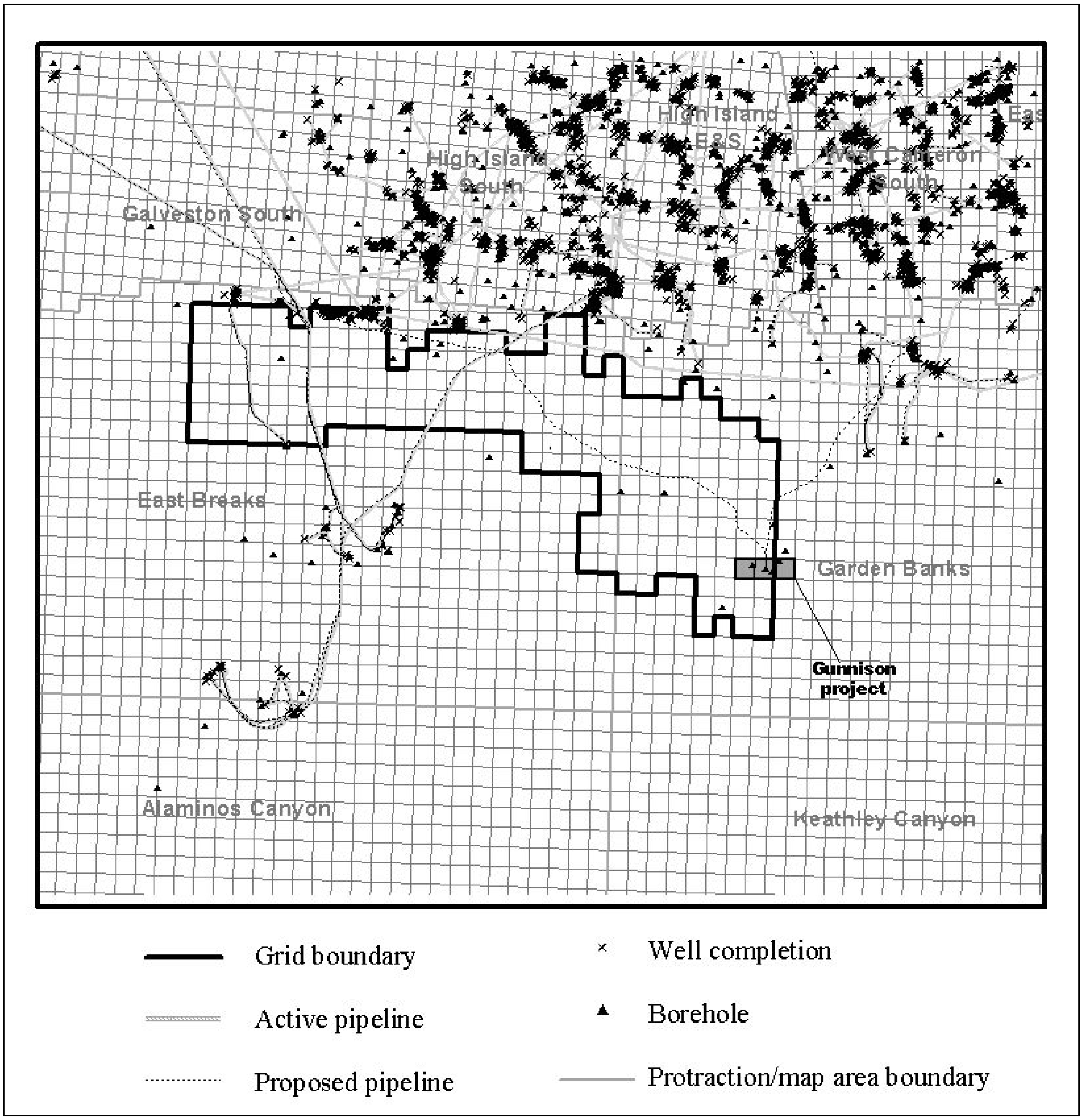

Figure 8. Existing and Proposed Pipeline Rights-of-Way within Grid 3.

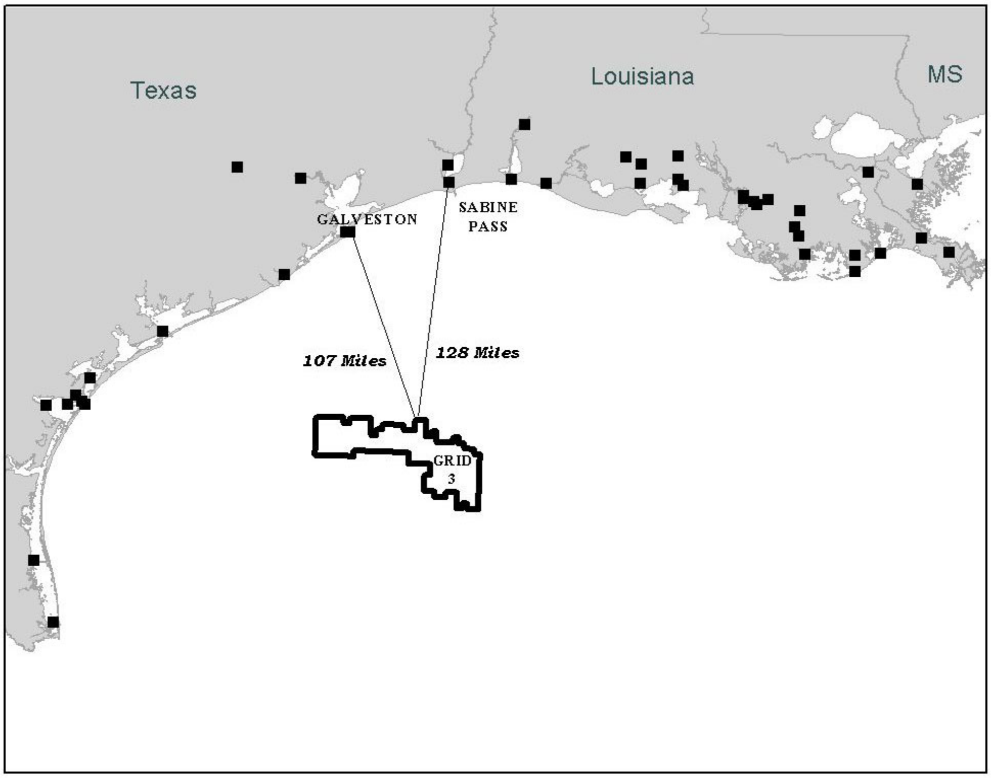

Figure 9. Distance from Grid 3 to Kerr-McGee's Selected Shore Bases.

1. THE PROPOSED ACTION

1.1. Purpose and Need for the Proposed Action

Under the Outer Continental Shelf Lands Act (OCSLA), as amended, the U.S. Department of the Interior (DOI) is required to manage the leasing, exploration, development, and production of oil and gas resources on the Federal OCS. The Secretary of the Interior oversees the OCS oil and gas program and is required to balance orderly resource development with protection of the human, marine, and coastal environments while simultaneously ensuring that the public receives an equitable return for these resources and that free-market competition is maintained.

Kerr-McGee Oil and Gas Corporation's (Kerr-McGee) Initial Development Operations Coordination Document (DOCD) represents an action that cannot be categorically excluded because it represents activities in relatively untested deep water [516 DM Chapter 6, Appendix 10, C.(10)(1)].

This programmatic environmental assessment (PEA) of the Grid implements the "tiering" process outlined in 40 CFR 1502.20, which encourages agencies to tier environmental documents, eliminating repetitive discussions of the same issue. By use of tiering from the most recent Final Environmental Impact Statement (EIS) for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002a) (and by referencing related environmental documents), this PEA concentrates on environmental effects and issues specific to the proposed action and proposed activities within the Grid.

Purpose

The purpose of this PEA is two-fold. It assesses the specific and cumulative impacts associated with Kerr-McGee's proposed action and also provides information on the deepwater area within Grid 3. The document can be used as a basis to allow most subsequent activities proposed in the Grid to be processed via a categorical exclusion review. However, if it is determined that a subsequent proposal will require preparation of a site-specific environmental assessment (SEA), the PEA provides information that can be referenced in the SEA. The SEA would then focus on selected key issues. The grid area was determined by the MMS's implementing regulations for the National Environmental Policy Act (NEPA) to be an area of "relatively untested deep water" [516 DM Chapter 6, Appendix 10, C.(10)(1)]. To properly characterize the grid, the PEA captures all of the available environmental and operational information for the area. Chapter 3 describes the environment at the specific site of the proposed activities and in the broader grid area. Analyses within Chapter 4 examine the potential effects of the proposed action and other reasonably foreseeable activities within the grid on the environment in the vicinity of the proposal and on the broader grid area.

Need for the Proposed Action

Consistent with its obligation to the Federal Government, Kerr-Mcgee filed a DOCD. Listed below are some of the reasons Kerr-Mcgee submitted this proposal to MMS:

- Commercial quantities of hydrocarbons have been encountered;
- Leaseholders have a legal right to secure development of the resources;
- Leaseholders are obligated by lease terms to diligently develop the resources; and
- Limited lease terms and failure to develop the resources could lead to loss of lease.

1.2. Description of the Proposed Action

The MMS, Gulf of Mexico (GOM) OCS Region, Office of Field Operations, received an Initial DOCD from Kerr-McGee that proposes to install a truss spar, develop and produce hydrocarbon reserves located in Garden Banks Blocks 667 (OCS-G 17406), 668 (OCS-G 17407), and 696 (OCS-G 17406). Kerr-McGee will complete and produce a total of 10 wells that were drilled under previously approved Exploration Plans. In addition, Kerr-McGee proposed to install lease term gas pipelines in Garden Banks Blocks 667 and 668 (P-14109). No new drilling operations are proposed as a part of this Initial DOCD; only development and production are proposed. All of the wells, except the three subsea wells, will share a common surface location (a truss spar floating production system) in Garden Banks Block 668. Table 1-1 depicts the spar's proposed location. For the initial development, three subsea gas wells are planned to be tied back to the spar and produced. One of these wells is located east of the proposed spar at a surface location in Garden Banks Block 668 (East Gunnison). The other two wells are located at a common surface location west of the proposed spar in Garden Banks Block 667 (West Gunnison). Table 1-3 and 1-4 describe the proposed pipline segment for East and West Gunnison.

Table 1-1

Proposed Location of the Gunnison Truss Spar

Surface Location	Distance from Lease Lines	Lambert X-Y Coordinates	Latitude/Longitude
Gunnison Truss Spar	FNL – 7,608.00 ft FEL – 7,458.00 ft	X = 1,465,662.00 Y = 9,908,232.60	Lat. 27° 18′ 13.825" N. Long. 93° 32′ 17.900" W.

Note: FNL is from the north line of the lease
FEL is from the east line of the lease

The Gunnison truss spar is a manned, floating production facility that will be permanently anchored with a nine-leg, taut catenary mooring system composed of conventional wire, chain, and anchor piles. The hull portion of the spar measures approximately 29.8 m (98 ft) in diameter and has an overall length of 167.3 m (549 ft). The spar is designed to accommodate 9 top-tensioned, dry tree risers; 10 risers; 5 umbilicals; and 2 export pipeline risers. No hydrocarbons will be stored in the hull of the spar; however, methanol will be stored in an in-hull tank. The spar is not drilling rig capable; however, a 1,500-hp completion/workover platform rig will be installed. The spar will have a 20-person permanent accommodation unit installed. Temporary, portable quarters for up to 48 people may be provided if it is needed on the spar.

Table 1-2 shows the activity schedule proposed by Kerr-McGee for their Gunnison Project.

Table 1-2

Proposed Activity Schedule for the Gunnison Project

Activity	Start Date	End Date
Install anchor piles	April 2003	April 2003
Install hull and moorings	June 2003	August 2003
Install topsides	August 2003	August 2003
Install subsea lease-term pipelines, jumpers, and umbilicals	September 2003	October 2003
First production from subsea wells	November 2003	N/A
Complete 7 dry tree wells	November 2003	July 2004
Produce subsea and dry tree wells	November 2003	November 2017

The water depth at the truss spar location is approximately 1,120 m (3,675 ft). The deepwater development is located approximately 155 km (117.5 mi) from shore. The project will use an existing onshore support base in Sabine Pass, Texas, to support the production activities. During completion or workover operations, either the onshore base in Sabine Pass, Texas, or an existing onshore base in Galveston, Texas, will be used to support these activities.

The East Gunnison subsea development in Garden Banks Block 669 consists of the tie back of the existing subsea well #1 to the east side of the Gunnison spar using a system of a flexible flowline, flexible riser, pipeline end manifold (PLEM), and a rigid well jumper. Garden Banks Block 669, Well #1 will be controlled by an electro/hydraulic umbilical from the Gunnison spar to the subsea umbilical termination assembly (SUTA) also located in Garden Banks Block 668.

The West Gunnison subsea development consists of the tie back of the existing subsea wells—Garden Banks Blockl 668, Well #9 and Garden Banks Block 667, Well #1 (referred to as Durango) will be tied back to the west side of the Gunnison spar using two parallel rigid flowlines, flexible risers, two PLEM's, two rigid well jumpers, and a flexible pigging loop. Garden Banks Block 668, Well #9 and Garden Banks

Block 667, Well #1 will be controlled by an electro/hydraulic umbilical from the Gunnison Spar to the SUTA located in Garden Banks Block 667.

Crude oil and natural gas produced at the Gunnison Project will be transported off lease by third-party owned and operated right-of-way pipelines.

Table 1-3

Description of Proposed Pipeline Sections (East Gunnison)

Pipeline Section	Length (ft)	Material	Grade	O.D. (in)	I.D. (in)	W.T. (in)
Tree jumper	75 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
Connectors and hubs on jumper/PLEM #1/tree	2 @ X ft	Steel forging	10,000 psi	N/A	N/A	N/A
5D induction bends on jumpers	6 @ 3 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
PLEM #1 piping	1 @ X ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
Tee on PLEM #1	1 @ X ft	Steel forging	10,000 psi	N/A	N/A	N/A
Gate valves on PLEM #1	3 @ X ft	Steel forging	10,000 psi	N/A	N/A	N/A
5D induction bends on PLEM #1	1 @ 3 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
On-bottom flowline; PLEM #1 to riser	5,800 ft	Unbonded flexible pipe	8,000 psi	8.236	5.375	1.430
Catenary flexible riser	4,290 ft	Unbonded flexible pipe	8,000 psi	8.612	5.375	1.618
Control umbilical	10,320 ft			4.134		

Notes: I.D. = inner diameter PLEM = Pipeline end manifold W.T. = wall thickness
O.D. = outer diameter SMLS = seamless

Table 1-4

Description of Proposed Pipeline Sections (West Gunnison)

Pipeline Section	Length (ft)	Material	Grade	O.D. (in)	I.D. (in)	W.T. (in)
Tree jumpers	2@75 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
Connectors and hubs on jumper/PLEM's	4 @ X ft	Steel forging	10,000 psi	N/A	N/A	N/A
5D induction bends on each jumpers	6 @ 3 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
PLEM piping	1 @ X ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
Tee on each PLEM	1 @ X ft	Steel forging	10,000 psi	N/A	N/A	N/A
Gate valves on each PLEM	3 @ X ft	Steel forging	10,000 psi	N/A	N/A	N/A
5D induction bends on each PLEM	1 @ 3 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
On-bottom flowline; PLEM to riser	2 @ 10,400 ft	Rigid steel pipe, SMLS	X-65	6.625	5.375	0.625
Catenary flexible riser	2 @ 4,290 ft	Unbonded flexible pipe	8,000 psi	8.612	5.375	1.618

Notes: I.D. = inner diameter PLEM = Pipeline end manifold W.T. = wall thickness
O.D. = outer diameter SMLS = seamless

2. ALTERNATIVES TO THE PROPOSED ACTION

2.1. NONAPPROVAL OF THE PROPOSAL

Kerr-McGee would not be allowed to complete and produce the 10 wells proposed in the Initial DOCD. This alternative would result in no impact from the proposed action but could discourage the development of much needed hydrocarbon resources, and thereby result in a loss of royalty income for the United States and energy for America. Considering these aspects and the fact that we anticipate very minor environmental and human effects resulting from the proposed action, this alternative was not selected for further analysis.

2.2. APPROVAL OF THE PROPOSAL WITH EXISTING MITIGATION

Measures that Kerr-McGee proposes to implement to limit potential environmental effects are discussed in the Initial DOCD. The MMS's lease stipulations, Outer Continental Shelf Operating Regulations, Notices to Lessees and Operators (NTL's), and other regulations and laws were identified throughout this environmental assessment as existing mitigation to minimize potential environmental effects associated with the proposed action. Additional information can be found in the Final EIS for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002a). Since additional mitigations were identified to avoid or mitigate potential impacts associated with the proposed action, this alternative was not selected.

2.3. APPROVAL OF THE PROPOSAL WITH EXISTING AND/OR ADDED MITIGATION

Measures that Kerr-McGee proposes to implement to limit potential environmental effects are discussed in the Initial DOCD. The MMS's lease stipulations, Outer Continental Shelf Operating Regulations, Notices to Lessees and Operators (NTL's), and other regulations and laws were identified throughout this environmental assessment as existing mitigation to minimize potential environmental effects associated with the proposed action. Additional information can be found in the Final EIS for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002a). Approval of the proposal with existing and additional mitigation is the selected alternative. The following additional mitigations have been identified.

Mitigation 8.03 (Advisory) — H_2S absent (plans)

In response to the request accompanying your plan for a hydrogen sulfide (H_2S) classification, the area in which the proposed drilling operations are to be conducted is hereby classified, in accordance with 30 CFR 250.417(c), as "H_2S absent."

Mitigation 13.07 (Advisory) — Liquid hydrocarbon production information

Within 60 days of commencing production, you must provide this office with the following information regarding your liquid hydrocarbon production: ^{o}API gravity, pour point (^{o}C), and viscosity (Centipoise at 25 ^{o}C).

Mitigation 15.01 (Advisory) — Multiple hazards (plans)

Our review indicates that there are pipelines in the vicinity of Platform A that may pose a hazard to your proposed operations. Therefore, please be advised that you will take precautions in accordance with Notice to Lessees and Operators No. 98-20, Section IV.B, prior to performing operations.

Mitigation 19.03 (Advisory) — ROV survey not required

In accordance with NTL No. 2001-G04, the MMS has determined that you will not need to conduct the two ROV surveys you proposed in your plan.

3. DESCRIPTION OF THE AFFECTED ENVIRONMENT

3.1. PHYSICAL ELEMENTS OF THE ENVIRONMENT

3.1.1. Water Quality

3.1.1.1. Coastal

The bays, estuaries, and nearshore coastal waters of the north-central Gulf provide important feeding, breeding, and/or nursery habitat for many commercially important invertebrates and fishes, as well as sea turtles, birds, and mammals. Water quality governs the suitability of these waters for animal as well as human use. Furthermore, the egg, larval, and juvenile stages of marine biota dependent upon these areas are typically more sensitive to water quality than the adult stages. The quality of coastal waters is, herefore, an important issue.

Nearshore water quality is addressed because the Gunnison Project is located offshore of the Louisiana and Texas coasts. The service bases for the development are located on or near the coast, and marine transportation to and from the site would traverse coastal waters. A comprehensive assessment of water quality in coastal and estuarine waters of the GOM is contained in USEPA (1999) and is not repeated here. The following material briefly highlights some of the key points concerning water quality in this region. Water quality in coastal waters of the northern GOM is highly influenced by season. For example, salinity in open water near the coast may vary between 29 and 32 parts per thousand (ppt) during fall and winter but decline to 20 ppt during spring and summer due to increased runoff (USDOI, MMS, 1998). Oxygen and nutrient concentrations also vary seasonally.

More than 30 percent of the estuaries along the north-central Gulf have impaired water quality to the point that they cannot support beneficial uses such as aquatic life support, and recreational and commercial fisheries (USEPA, 1999). Urban runoff is the leading source of impairment. Other sources, in their order of importance, include agriculture, municipal sources, land disposal, industrial sources, petroleum and hydromodification. Point-source discharges to the Gulf of Mexico include some 1,300 wastewater treatment plants and 2,000 industrial point sources (USEPA, 1999). Most of the industrial sources are in Texas and Louisiana.

Vessels from the shipping and fishing industries, as well as recreational boaters, add contaminants to coastal water through bilge water discharges, waste, spills, and leaching from antifouling paints. Many millions of cubic feet of sediments are moved each year in coastal areas due to channelization, dredging, dredged material disposal, and shoreline modification in support of shipping, oil and gas operations, and other activities. Water quality may be affected by these activities as they can facilitate saltwater intrusion, increase turbidity, and release contaminants.

Nonpoint sources of contamination, such as agriculture, and urban runoff are difficult to regulate and have the greatest impact on coastal water quality. About 80 percent of U.S. croplands are upstream of the northern Gulf coastal waters. Nutrient enrichment in runoff (nitrogen and phosphorus) is another major water quality problem that can lead to noxious algal blooms, reduced seagrasses, fish kills, and oxygen depletion. From 1980 to 1996, the annual average flux of nitrogen and phosphorus from the Mississippi/Atchafalaya River Basin to the Gulf was 1.6 million metric tons per year and 136,500 metric tons per year, respectively (Goolsby et al., 1999). The hypoxic zone located in shelf waters is discussed in the following section. The USEPA Gulf of Mexico Program works with Federal, State and local agencies, industry, and nongovernmental organizations to collect information and improve the environmental quality of the Gulf of Mexico.

Biological indicators demonstrate areas of poor coastal water quality. Fifty percent of the largest U.S. fish kills between 1980 and 1989 occurred in Texas. Shellfish harvest is limited in over 50 percent of the Gulf of Mexico beds. In Louisiana, the harvest of shellfish is prohibited in about 11 percent of shellfish beds because of contamination (USDOC, NOAA, 1998). On the other hand, Gulf States, although they had a number of "hot spots" for certain locations and contaminants, did not fare that badly in comparison to other U.S. coastal waters during the major NOAA National Status and Trends Mussel Watch Program (USDOI, MMS, 2001b).

Sediment contamination in U.S. coastal waters is highly related to proximity to large cities. High levels for certain contaminants have been reported for all Gulf States (O'Connor 1995). At least some contaminants are bioavailable, as evidenced by the 1986-1999 Mussel Watch Program (USDOI, MMS, 2001b). A more lengthy discussion of coastal sediment quality is presented in the Final EIS for GOM Oil and Gas Lease Sales: 2003-2007 (USDOI MMS, 2002).

3.1.1.2. Offshore

Offshore marine waters in the GOM are characterized by higher salinity (36.0-36.5 ppt) than inshore waters (USDOI, MMS, 1998). The five watermasses identified in Appendix D (Physical Oceanography) can be recognized by their chemical characteristics such as salinity, dissolved oxygen (DO), nitrate, phosphate, and silicate. The Mississippi River exerts considerable influence on the Gulf, including the offshore.

The depth distribution of nutrients and DO in the deep water of the Gulf is similar to that of the Atlantic Ocean. The DO is highest at the surface due to photosynthesis and exchange with the atmosphere, and it generally decreases with depth due to respiration by various organisms (including bacteria). Higher oxygen concentrations may be encountered in cold watermasses. Nutrient concentrations are lowest in the upper water layers where they are depleted by photosynthetic activity and are highest in deep water. Nutrient and oxygen concentrations in the open water of the deep Gulf are not usually measurably affected by anthropogenic inputs.

Two unusual water quality phenomena occur in the Gulf: (1) hypersaline basins (e.g., 250 ppt in Orca Basin) and (2) mid-shelf freshwater vents (e.g., southwestern Florida shelf springs). Another feature is the nepheloid layer, a thin, near-bottom, highly turbid layer that may play a role in transporting material, including contaminants, from nearshore to offshore waters. Hypoxic or oxygen-depleted bottom waters may be present in the northern Gulf off the mouth of the Mississippi River. This hypoxic area may be very large (16,500 km^2), extending from the Mississippi River delta to Freeport, Texas, and is probably exacerbated by human inputs (USDOI, MMS, 1998). Near-hypoxic conditions, unrelated to the river plume, may also be observed in the oceanic oxygen minimum at depths between 200 and 400 m; these conditions are low enough (2.5-3.0 mg/l) to affect the biota (USDOI, MMS, 2001b).

Offshore areas, particularly over deep water, could be considered almost pristine compared to the coastal waters, particularly the deep water off southern Texas and Florida (USDOI, MMS, 2001b). However, petroleum-related volatile organic carbons have been detected at offshore locations. Offshore Texas, Louisiana, and Alabama show detectable levels of petroleum hydrocarbons, likely from natural seeps (Kennicutt, 1988 in USDOI, MMS, 1998). Similarly, trace metal concentrations are low relative to coastal waters (Boyle et al., 1984, in USDOI, MMS, 2001b).

Sediment hydrocarbon concentrations, including biogenic hydrocarbons (e.g., from plankton and other biological sources), range from 5 to 86 ng/g in Gulf slope sediments (Kennicutt et al., 1987, in USDOI, MMS, 2001b). Petroleum hydrocarbons, including aromatic hydrocarbons (<5 ppb) were present at all sites sampled (Gallaway et al., 2002; USDOI, MMS, 2001b). Land-derived material is widespread in the Gulf due to large riverine inputs and transport across the shelf to the slope by slumping, slope failure (Gallaway et al., 2002), and other processes. Natural seepage is considered to be a major source of petroleum hydrocarbons in the Gulf slope area (Kennicutt et al., 1987; Gallaway et al., 2002; USDOI, MMS, 2001b). Deepwater sediments do not appear to contain elevated levels of metal contaminants (USDOI, MMS, 1998). Limited exception to this is the presence of barium-enriched sediments in the vicinity of previous drilling activity.

Recent research found that the concentration of hydrocarbons in slope sediments (except in seep areas) was lower than previous reports for shelf and coastal sediments. No consistent decrease with increasing water depth was apparent below 300 m (Gallaway et al., 2002). In general, the Central Gulf had higher levels of hydrocarbons, particularly those from terrestrial sources, than the Western and Eastern Gulf (Gallaway and Kennicutt, 1988). Total organic carbon was also highest in the Central Gulf. Hydrocarbons in sediments have been determined to influence biological communities of the Gulf slope, even when present in trace amount (Gallaway and Kennicutt, 1988).

3.1.2. Air Quality

These operations will occur west of 87.5 ^{o}W. longitude and hence falls under MMS's jurisdiction for enforcement of the Clean Air Act. The air over the OCS water is not classified, but it is presumed to be better than the National Ambient Air Quality Standards (NAAQS) for all criteria pollutants. The blocks involved—Garden Banks Blocks 667, 668, and 669—are offshore, south of Cameron Parish, Louisiana. Cameron Parish is in attainment of all of the NAAQS.

The influence to onshore air quality is dependent upon meteorological conditions and air pollution emitted from the proposed action. The primary meteorological conditions are the wind speed and direction, the atmospheric stability class, and the mixing height, which govern the dispersion and transport of emissions. The mixing heights offshore are quite low, generally 900 m (2,950 ft) or less where there are no influences from land. The general wind flow for this area is driven by the clockwise circulation around the Bermuda High, resulting in a prevailing southeasterly to southerly flow. Superimposed upon this circulation are smaller scale effects such as the sea breeze effect, tropical cyclones, and mid-latitude frontal systems. Because of the various factors, the winds blow from all directions in the area of concern.

Not all of the Pasquill-Gifford stability classes are routinely found offshore in the Gulf of Mexico. Specifically, the F stability class is rare. This is the extremely stable condition that usually develops at night over land with rapid radiative cooling. This large body of water is simply incapable of loosing enough heat overnight to set up a strong radiative inversion. Likewise, the A stability class is also rare. It is the extremely unstable condition that requires a very rapid warming of the lower layer of the atmosphere, along with cold air aloft. This is normally brought about when cold air is advected in aloft and strong insolation rapidly warms the earth's surface, which in turn warms the lowest layer of the atmosphere. Once again, the ocean surface is incapable of warming rapidly; therefore, you would not expect to find stability class A over the Gulf of Mexico. For the most part, the stability is slightly unstable to neutral.

The mixing heights offshore are quite shallow, generally 900 m (2,950 ft) or less. The exception to this is close to shore, where the influence of the land penetrates out over the water for a short distance. Transient cold fronts also have an impact on the mixing heights; some of the lowest heights can be expected to occur with frontal passages and on the cold air side of the fronts. This effect is caused by the frontal inversion.

Table 3-1 depicts Kerr-McGee's projected emissions for the Gunnison Project.

Table 3-1

Projected Emissions for the Gunnison Project

Date	TSP (tons)	SO_X (tons)	NO_X (tons)	VOC (tons)	CO (tons)
2001	19.20	84.43	785.89	71.79	172.09
2002	23.51	94.11	1,614.13	331.82	355.97
2003	6.19	14.64	101.66	313.95	226.05

Note: The MMS's exemption level for each of the above components is 3,929.40 tons.

3.2. Biological Resources

3.2.1. Sensitive Coastal Environments

3.2.1.1. Coastal Barrier Beaches and Associated Dunes

Coastal barriers of the Western GOM are generally divided into two physiographic areas: the Chenier Plain, of eastern Texas and western Louisiana, and the Texas barrier islands. These coastal barriers are relatively low landmasses that can be divided into several interrelated environments, including the unvegetated foreshore, the dune zone, and the backshore. When coastal storms occur, Gulf waters may become elevated enough to overwash a coastal barrier, leveling the areas of beach and dunes, creating overwash fans or terraces. Within a week, overwashed beaches will reestablish their typical structure. Over longer periods, terraces will become revegetated by opportunistic species, and the formation of dunes will begin again with the availability and nature of wind-blown sand at each terrace.

Landform changes can be seasonal and cyclical. Coastal barriers are dynamic habitats and provide a variety of niches that support many avian, terrestrial, aquatic, and amphibian species, some of which are endangered or threatened.

Accumulations and movements of sediments that make up barrier landforms are often described in terms of transgressive and regressive sequences. A transgressive sequence moves the shore landward allowing marine deposits to form on terrestrial sediments. A regressive sequence is one in which terrestrial sediments are deposited over marine deposits as land builds out, into the sea. Although transgressive landforms are dominant in the western and northern GOM, both transgressive and regressive barriers may occur in the region.

3.2.1.2. Wetlands

Wetland habitats of the Western Gulf Coast include fresh, brackish, and saline marshes; mud flats; and forested wetlands, including mangroves in the southernmost regions. They may occur as narrow bands around streams, lakes, bays, and sounds or as broad inshore expanses. The Chenier Plain, found in Texas and Louisiana, is the largest concentration of coastal wetlands in the region. Along the southern coast of Texas, the greatest wetland concentrations are associated with the Laguna Madre and other sounds behind barrier islands and with the tidal portions of rivers that flow into the various bays of the State.

Coastal wetlands are characterized by high organic productivity, high detritus production, and efficient nutrient recycling. Wetlands provide habitat for a great number and wide diversity of invertebrates, fish, reptiles, birds, and mammals, and are particularly important nursery grounds for many economically important fish and shellfish.

3.2.1.3. Seagrasses

Three million hectares of submerged seagrass beds are estimated to exist in protected, shallow coastal waters of the northern GOM and its higher salinity estuaries; however, Texas and Louisiana contain less than 0.5 percent of these seagrass beds. Seagrass beds grow best in shallow, relatively clear and protected waters with predominantly sand bottoms. Their distribution depends on an interrelationship among a number of environmental factors that include temperature, water depth, turbidity, salinity, turbulence, and substrate suitability.

Seagrass beds are important habitat for immature shrimp, black drum, spotted sea trout, and southern flounder. They are also are a food source for several species of wintering waterfowl.

The distribution of seagrass beds in the Western Gulf has diminished during recent decades. Primary factors believed to be responsible include dredging, dredged material disposal, trawling, water quality degradation, hurricanes, and a combination of flood protection, saltwater intrusion, and infrequent freshwater diversions from the Mississippi River into coastal areas during flood stage.

For additional information, see the Final EIS for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002a).

3.2.2. Deepwater Benthic Communities/Organisms

3.2.2.1. Chemosynthetic Communities

Chemosynthetic communities are defined as persistent, largely sessile assemblages of marine organisms dependent upon symbiotic chemosynthetic bacteria as their primary food source (MacDonald, 1992). Chemosynthetic clams, mussels, and tube worms, similar to (but not identical with) the hydrothermal vent communities of the eastern Pacific (Corliss et al., 1979), have been discovered in association with hydrocarbon seeps in the northern GOM. Bacteria live within specialized cells in these invertebrate organisms and are supplied with oxygen and chemosynthetic compounds by the host via specialized blood chemistry (Fisher, 1990). The host, in turn, lives off the organic products subsequently released by the chemosynthetic bacteria and may even feed on the bacteria themselves. Free-living chemosynthetic bacteria may also live in the substrate within the invertebrate communities and may compete with their symbionts for sulfide and methane energy sources. Initial discoveries of cold-water seep communities indicated that they are primarily associated with hydrocarbon and H_2S seep areas (Kennicutt et al., 1985; Brooks et al., 1986a). Since the initial discovery in 1984 of chemosynthetic communities dependent on hydrocarbon seepage in the GOM off the west coast of Florida, their geographic range has been found to include the Texas, Louisiana, and Alabama continental slope with a depth range varying from less than 500 m to 2,200 m (Rosman et al., 1987; MacDonald, 1992). Four general community types have been described by MacDonald et al. (1990). These are communities dominated by vestimentiferan tube worms, mytilid mussels, vesicomyid, and infaunal lucinid or thyasirid clams. These faunal groups tend to display distinctive characteristics in terms of how they aggregate, the size of aggregations, the geological and chemical properties of the habitats in which they occur and, to some degree, the heterotrophic fauna that occur with them.

The reliance of deep-sea chemosynthetic communities on nonphotosynthetic carbon sources limits their distribution in the Gulf to areas where hydrocarbon sources are available. Within the northern Gulf, chemosynthetic communities are generally associated with slow oil and gas seeps, rapid expulsion mud volcanoes, and mineral seeps (Roberts and Carney, 1997). The most common hydrocarbon source is associated with seeps. Oil reservoirs beneath the Gulf include faults within source rock that have allowed oil and gas to migrate upward to the seafloor over the past several million years (Sassen et al., 1993). Hydrocarbons seeping to the surface diffuse through overlying sediments where bacterial degradation creates the chemosynthetic substrate taken up by symbiotic invertebrates. Vestimentiferan tube worms and lucinid and vesicomyid clams rely on H_2S, whereas mytilid mussels used dissolved CH_4. Mud volcanoes and mineral seeps provide similar chemosynthetic source material, but their occurrence in the Gulf is far less extensive than oil and gas seeps.

Hydrocarbon seep communities in the Central Gulf have been reported to occur at water depths between 290 and 2,200 m (Roberts et al., 1990; MacDonald, 1992). To date, there are 45 sites (in 42 blocks) across the northern GOM continental slope where the presence of chemosynthetic metazoans (dependent on hydrocarbon seepage) has been definitively documented (MacDonald, 1992; Boland, personal observations, 2000). There are several known chemosynthetic communities located in Grid 3; the nearest to the Gunnison Project is a chemosynthetic clam community observed by submersible about 10 nmi to the north-northeast in Garden Banks Block 535. The northernmost anchor impact area comes within 7.5 nmi to the Garden Banks Block 535 community. The total number of chemosynthetic communities in the Gulf is now known to exceed 50 (Gallaway et al., 2000). Future identification of chemosynthetic communities will likely rely on a combination of broad-scale geophysical sensing surveys followed by more detailed site-specific protocols including visual surveys by submersibles or remotely-operated vehicles (ROV's). A review for the potential occurrence of chemosynthetic communities associated with the Gunnison Project was performed separately from this EA. The conclusion of this analysis, determined that all impacting factors related to the Gunnison development in Garden Banks Block 668 are well removed from any area with the potential for the existence of chemosynthetic communities pursuant to the requirements of NTL 2000-G20.

Figure 3-1 depicts the chemosynthetic communities and topographic features in or proximal to Grid 3.

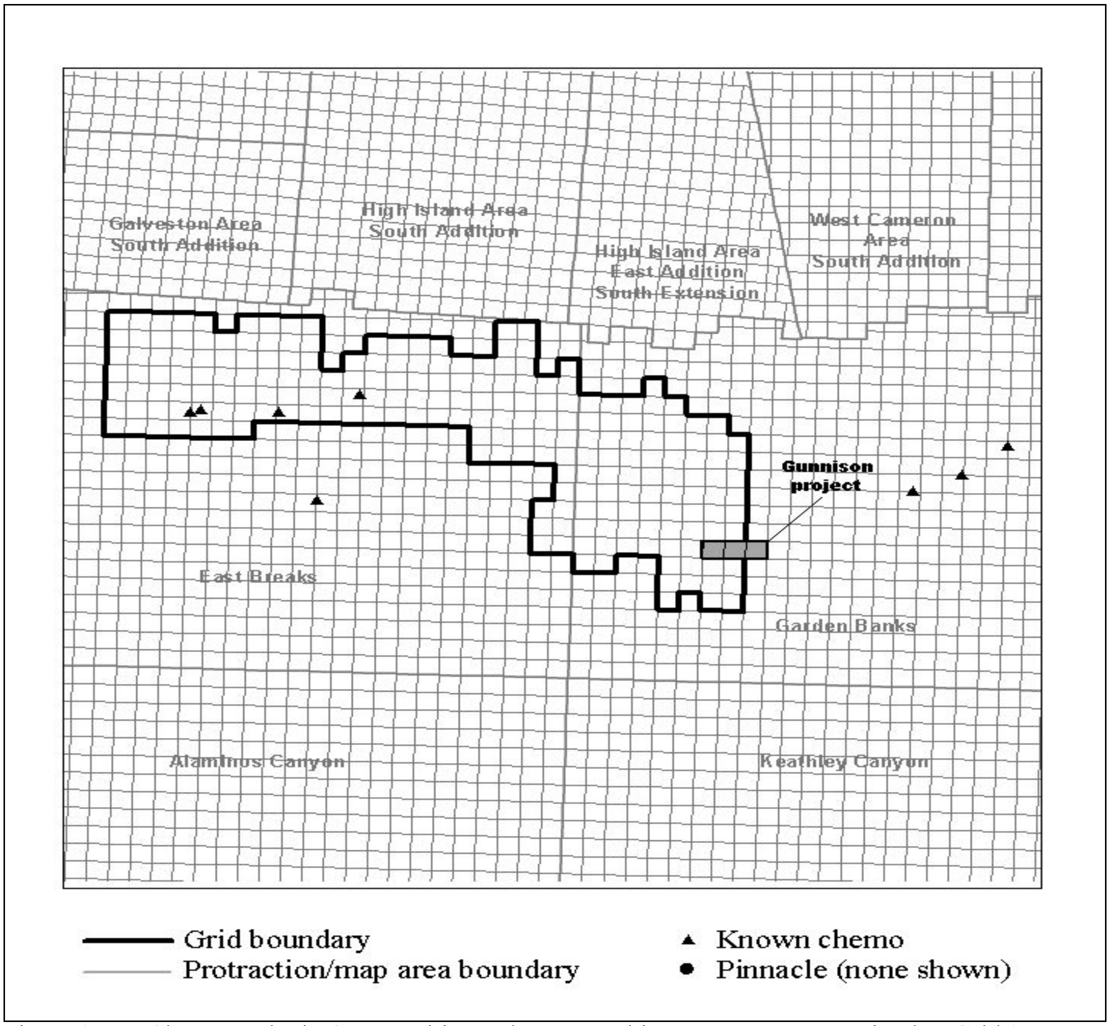

Figure 3-1. Chemosynthetic Communities and Topographic Features In or Proximal to Grid 3.

3.2.2.2. Deepwater Benthos

Marine benthic communities consist of a wide variety of single-celled organisms, plants, invertebrates, and fish. Their lifestyles are extremely varied as well and can include absorption of dissolved organic material, symbiosis (e.g., chemosynthetic communities), collection of food through filtering, mucous webs, seizing, or other mechanisms.

It is convention in the Gulf region to classify benthic animals according to size as megafauna (large usually mobile animals on the surface), macrofauna (retained on 0.25- to 0.50-mm mesh size sieve), meiofauna (0.063-mm screen; mostly nematode worms), and microfauna (protists and bacteria). The four types are discussed briefly below.

3.2.2.2.1. Megafauna

Megafaunal invertebrate and benthic fish densities appear to decline with depth between the upper slope and the abyssal plain (Pequegnat 1983; Pequegnat et al., 1990). This phenomenon is generally believed to be related to the low productivity in deep, offshore Gulf waters (USDOI, MMS, 2001a). Megafaunal communities in the offshore Gulf have historically been zoned by depth strata, which are typified by certain species assemblages (Menzies et al., 1973; Pequegnat, 1983; Gallaway et al., 1988; Gallaway, 1988a-c; Pequegnat et al., 1990; and USDOI, MMS, 2001a). These zones include the following:

- Shelf/Slope Transition Zone (100-500 m) — Echinoderms, crustaceans, and several species of abundant fish.
- Archibenthal Zone (Horizon A) (500-775 m) — Galatheid crabs, rat tail fishes, large sea cucumbers, and sea stars are abundant.
- Archibenthal Zone (Horizon B) (800-1,000 m) — Galatheid crabs and rat tail fishes are abundant; fishes, echinoderms, and crustaceans decline; characterized by the red crab, *Chaceon quinquedens*.
- Upper Abyssal Zone (1,000-2,000 m) — Number of fish species decline while the number of invertebrate species appear to increase; sea cucumbers, *Mesothuria lactea* and *Benthodytes sanguinolenta*, are common; galatheid crabs include 12 species of the deep-sea genera *Munida* and *Munidopsis,* while the shallow brachyuran crabs decline.
- Mesoabyssal Zone (2,300-3,000 m) — Fish species are few and echinoderms continue to dominate the megafauna.
- Lower Abyssal Zone (3,200-3,800 m) — Large asteroid, *Dytaster insignis,* is the most common megafaunal species.

Carney et al. (1983) postulated a simpler system of zonation having three zones: (1) a distinct shelf assemblage in the upper 1,000 m; (2) indistinct fauna between 1,000 and 2,000 m; and (3) a distinct slope fauna between 2,000 and 3,000 m.

The baseline Northern Gulf of Mexico Continental Slope (NGMCS) Study conducted in the mid- to late 1980's trawled 5,751 individual fish and 33,695 invertebrates, representing 153 and 538 taxa, respectively. That study also collected 56,052 photographic observations, which included 76 fish taxa and 193 non-fish taxa. Interestingly, the photographic observations were dominated by holothurians, bivalves, and sea pens, groups that were not sampled effectively (if at all) by trawling. Decapod crustaceans dominated the trawls and were fourth in the photos from an abundance perspective. Decapod density generally declined with depth but with peaks at 500 m and between 1,100 and 1,200 m, after which depth abundance was quite low. Fish density, while variable, was generally high at depths between 300 and 1,200 m; it then declined substantially.

Gallaway et al. (2002) concluded that megafaunal composition changes continually with depth such that a distinct upper slope fauna penetrates to about 1,200-m depths, and a distinct deep-slope fauna is present below 2,500 m. A broad transition zone characterized by low abundance and diversity occurs between depths of 1,200 and 2,500 m. The proposed Gunnison development, at a depth of 960 m, lies within the distinct upper slope zone described above.

3.2.2.2.2. Macrofauna

The benthic macrofaunal component of the NGMCS Study (Gallaway et al., 2002) included sampling in Grid 3 and in nearby grids (Grids 6 and 7). One transect (the western transect) of 5 baseline stations beginning in Grid 3 from 305 m to nearly the 3,000-m contour was sampled in this study. All of these data are relevant to the proposed Gunnison development because they were taken from the same geographic area and encompass the same depths and substrates.

The NGMCS Study examined 69,933 individual macrofauna from over 1,548 taxa; 1,107 species from 46 major groups were identified (Gallaway et al., 2002). Polychaetes (407 species), mostly deposit-feeding forms (196 taxa), dominated in terms of numbers. Carnivorous polychaetes were more diverse but less numerous than deposit-feeders, omnivores, or scavengers (Pequegnat et al., 1990; Gallaway et al., 2001). Polychaetes were followed in abundance by nematodes, ostracods, harpacticoid copepods, bivalves, tanaidacids, bryozoans, isopods, amphipods, and others. Overall abundance of macrofauna ranged from 518 to 5,369 individuals/m^2 (Gallaway et al., 1988). The central transect (4,938 individuals/m^2) had higher macrofaunal abundance than either the eastern or western Gulf transects (4,869 and 3,389 individuals/m^2, respectively) (Gallaway et al., 2002).

In the GOM, macrofaunal density and biomass declines with depth from approximately 5,000 individuals/m^2 on the lower shelf-upper slope to several hundred individuals/m^2 on the abyssal plain

(USDOI, MMS, 2001a). This decline in benthos has been attributed to the relatively low productivity of the Gulf offshore open waters (USDOI, MMS, 2001a). However, Pequegnat et al. (1990) reported mid-depth maxima of macrofauna in the upper slope at some locations of high organic particulate matter, and Gallaway et al. (2002) noted that the decline with depth is not clear cut and is somewhat obscured by sampling artifacts.

There is some suggestion that sizes of individual macrofauna decrease with depth (Gallaway et al., 2002) and that size of individuals are generally small. Macrofaunal abundance appears to be higher in spring than in fall (Gallaway et al., 2002).

Macrofauna in the Gulf appears to have lower densities but higher diversities than the Atlantic, especially above 1,000 m; whereas at deep depths, the fauna are less dissimilar in densities and very similar in diversities (Gallaway et al., 2002).

3.2.2.2.3. Meiofauna

Meiofauna (primarily composed of small nematode worms), as with megafauna and macrofauna, also decline in abundance with depth (Pequegnat et al., 1990; Gallaway et al., 2002; USDOI, MMS, 2001a). The overall density (mean of 707,000/m^2) of meiofauna is approximately two orders of magnitude greater than the macrofauna throughout the depth range of the slope (Gallaway et al., 1988). These authors reported 43 major groups of meiofauna with nematodes, harpacticoid copepods (adults and larvae), polychaetes, ostracods, and Kinorhyncha, accounting for 98 percent of the total numbers. Nematodes and harpacticoids were dominant in terms of numbers, but polychaetes and ostracods were dominant in terms of biomass, a feature that was remarkably consistent across all stations, regions, seasons, and years (Gallaway et al., 2002). Meiofaunal densities appeared to be somewhat higher in the spring than in the fall. Meiofaunal densities reported in the NGMCS Study are among the highest recorded worldwide (Gallaway et al., 2002). There is also evidence that the presence of chemosynthetic communities may enrich the density and diversity of meiofauna in the immediate surrounding area (Gallaway et al., 2002).

The above conclusions were partially based on the collections from the NGMCS Study stations in the Central Gulf transect. The Central Gulf transect appeared to contain a higher abundance of meiofauna than transects in the Eastern or Western Gulf, and in general, there was a trend of decreasing meiofauna numbers with depth (Gallaway et al., 2002).

3.2.2.2.4. Microbiota

Less is known about the microbiota than the other groups in the GOM, especially in deep water (USDOI, MMS, 2000). A recent MMS publication (USDOI, MMS, 2001b) provides information on this subject. An overview is provided below.

As reported by Rowe (CSA, 2000), the microbiota of the deep Gulf sediments is not well characterized. While direct counts have been coupled with some *in situ* and repressurized metabolic studies performed in other deep ocean sediments (Deming and Baross, 1993), none have been made in the deep GOM. Cruz-Kaegi (1998) made direct counts using a fluorescing nuclear stain at several depths down the slope, allowing bacterial biomass to be estimated from their densities and sizes. Mean biomass was estimated to be 2.37 g C·m^{-2} for the shelf and slope combined, and 0.37 g C·m^{-2} for the abyssal plain. In terms of biomass, data indicate that bacteria are the most important component of the functional infaunal biota. Cruz-Kaegi (1998) developed a carbon cycling budget based on estimates of biomass and metabolic rates in the literature. She discovered that, on the deep slope of the Gulf, the energy from organic carbon in the benthos is cycled through bacteria.

3.2.3. Marine Mammals

Twenty-nine species of marine mammals are known to occur in the GOM (Davis et al., 2000). The Gulf's marine mammals are represented by members of the taxonomic order Cetacea, which is divided into the suborders Mysticeti (i.e., baleen whales) and Odontoceti (i.e., toothed whales, dolphins, and their allies), as well as the order Sirenia, which is comprised of the manatee and the dugong. Within the GOM, there are 28 species of cetaceans (7 mysticete and 21 odontocete species) and 1 sirenian species, the manatee, which is further split into two subspecies (Jefferson et al., 1992).

3.2.3.1. Nonthreatened and Nonendangered Species

Two of the seven species of mysticetes known to occur in the Gulf are not currently listed as threatened or endangered. With the exception of the sperm whale, none of the odontocetes known to occur in the Gulf are currently listed as endangered or threatened.

Cetaceans – Mysticetes

The minke whale *(Balaenoptera acutorostrat*a) is widely distributed from tropical to polar seas. Minke whales may be found offshore but appear to prefer coastal and inshore waters. Their diet consists of invertebrates and fishes (Leatherwood and Reeves, 1983; Stewart and Leatherwood, 1985; Jefferson et al., 1993; Wursig et al., 2000). Sighting data suggest that minke whales either migrate into Gulf waters in small numbers during the winter or, more likely, that sighted individuals represent strays from low-latitude breeding grounds in the western North Atlantic (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The Bryde's whale *(Balaenoptera eden*i) is generally confined to tropical and subtropical waters (i.e., between latitude 40°N. and latitude 40°S.). Unlike a few other baleen whales, it does not have a well-defined breeding season in most areas; thus, calving may occur throughout the year. The Bryde's whale is represented by more sighting records than any other species of baleen whale in the Gulf. All Bryde's whale sightings made during the GulfCet I and II programs were from the continental shelf edge in the vicinity of DeSoto Canyon and along the 100-m (328-ft) isobath in the north-central Gulf. These data suggest that the Gulf may represent at least a portion of the range of a dispersed, resident population of Bryde's whale (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000). Bryde's whales feed on both fishes and invertebrates (Leatherwood and Reeves, 1983; Cummings, 1985; Jefferson et al., 1993).

Cetaceans – Odontocetes

Pygmy and Dwarf Sperm Whales

The pygmy sperm whale *(Kogia brevicep*s) and its congener, the dwarf sperm whale *(K. simu*s), are known from deep waters in tropical to warm temperate zones (Jefferson and Schiro, 1997). They appear to be most common on the continental slope and along the shelf edge, although field identification and differentiation of the two species is problematic. Little is known of their natural history. Data collected from stomach contents of stranded individuals suggest that these species feed on cephalopods, fishes, and crustaceans in deep water (Leatherwood and Reeves, 1983; Jefferson et al., 1993). *Kogia* has been sighted throughout the Gulf across a wide range of depths and bottom topographies, though they may be more commonly associated with watermass fronts along the continental shelf edge break and upper slope (Baumgartner, 1995).

Beaked Whales

Two genera and four species of beaked whales are known to occur in the GOM. These encompass (1) three species in the genus *Mesoplodon* (i.e., Sowerby's beaked whale [*M. biden*s], Blainville's beaked whale [*M. densirostri*s], and Gervais' beaked whale [*M. europaeu*s]), and (2) one species in the genus *Ziphiu*s, Cuvier's beaked whale *(Ziphius cavirostri*s). Generally, beaked whales appear to prefer deep water, though little is known of their respective life histories. Stomach content analyses suggest that these whales feed primarily on deepwater cephalopods, although they will also take fishes and some benthic invertebrates (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, beaked whales have been sighted at depths between approximately 700 m and 2,000 m (2,297 ft and 6,562 ft). Cuvier's beaked whale is probably the most common beaked whale in the Gulf (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

Delphinids

All remaining species of nonendangered and nonthreatened cetaceans found in the Gulf are members of the taxonomically diverse family Delphinidae. The pygmy killer whale *(Feresa attenuat*a) is apparently widely distributed in tropical waters, though little is known of its biology or life history. Its diet includes cephalopods and fishes, though reports of attacks on other delphinids have been reported (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pygmy killer whale does not appear to be commonly found in the GOM. Sightings of this species have been at depths of 500 m to 1,000 m (1,641 ft to 3,281 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The short-finned pilot whale *(Globicephala macrorhynchus*) is found in warm temperate to tropical waters of the world. Short-finned pilot whales feed primarily on cephalopods and fishes. In the Gulf, it is most commonly sighted along the continental slope at depths of 250 m to 2,000 m (820 ft to 6,562 ft) (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The Risso's dolphin *(Grampus griseus*) is a pantropical species that inhabits deep oceanic and continental slope waters. Risso's dolphins feed primarily on cephalopods and secondarily on fish and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Baumgartner, 1997; Wursig et al., 2000). In the Gulf, its distribution appears to be widespread at depths of 150 m to 2,000 m (492 ft to 6,562 ft), with aggregations sighted in areas along the upper continental slope with steep bottom topography (Baumgartner, 1995).

The Fraser's dolphin *(Lagenodelphis hosei*) has a pantropical distribution in oceanic waters and nearshore in areas where deep water approaches the coast. Fraser's dolphins feed on fishes, cephalopods, and crustaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Jefferson and Schiro, 1997). Fraser's dolphins have been sighted in the western and eastern Gulf at depths of around 1,000 m (3,281 ft) (Leatherwood et al., 1993; Jefferson and Schiro, 1997; Davis et al., 2000).

The killer whale *(Orcinus orca*) is one of the most cosmopolitan of all of the delphinids. Generally, they appear to prefer nearshore, cold temperate to subpolar zones. Killer whales feed on marine mammals, marine birds, fishes, sea turtles, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, most sightings of killer whales have been along the continental slope, within a broad area of the north-central Gulf (Jefferson and Schiro, 1997; O'Sullivan and Mullin, 1997).

The melon-headed whale *(Peponocephala electra*) is a deepwater, pantropical species. It is known to feed on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994a; Jefferson and Schiro, 1997). Sightings of this species in the Gulf have been primarily in continental slope waters west of the Mississippi River (Jefferson and Schiro, 1997; Davis et al., 1998 and 2000).

The false killer whale *(Pseudorca crassidens*) is found in tropical to warm temperate zones in deep offshore waters. It feeds on primarily fishes and cephalopods, although it has been known to also feed on cetaceans (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, most sightings of false killer whales have occurred along the continental slope, although some have been sighted in shallower shelf waters (Davis et al., 1998).

The pantropical spotted dolphin *(Stenella attenuata*) is a tropical species known from the Atlantic, Pacific, and Indian Oceans. It is known to feed on epipelagic fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The pantropical spotted dolphin is the most common and abundant cetacean on the slope, especially outer slope waters of the Gulf at depths greater than 1,200 m (3,937 ft) (Davis and Fargion, 1996; Jefferson and Schiro, 1997).

The rough-toothed dolphin *(Steno bredanensis*) is a circumtropical and subtropical species that feeds on cephalopods and fishes (Leatherwood and Reeves, 1983; Jefferson et al., 1993). In the Gulf, they are sighted almost exclusively west of the Mississippi River at depths of 900 m to 2,000 m (2,953 ft to 6,562 ft), and occur year-round (Davis et al., 1998; Jefferson and Schiro, 1997).

The Clymene dolphin *(Stenella clymene*) is endemic to the Atlantic and found only in tropical and subtropical waters. This species appears to feed on fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993; Mullin et al., 1994b). Data suggest that Clymene dolphins are widespread within deeper Gulf waters (i.e., shelf edge and slope) (Davis et al., 2000; Wursig et al., 2000).

The striped dolphin *(Stenella coeruleoalba*) is primarily a tropical species, though it may also range into temperate seas. Striped dolphins are known to feed on cephalopods and fishes. In the Gulf, they are found offshore of the shelf edge, at depths of less than 200 m (less than 656 ft) (Jefferson and Schiro, 1997; Davis et al., 2000; Wursig et al., 2000).

The Atlantic spotted dolphin *(Stenella frontalis*) is endemic to the Atlantic within tropical to temperate waters. They are known to feed on a wide variety of fishes and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). The Atlantic spotted dolphin is the only other species of cetacean (other than the bottlenose dolphin) that commonly occurs on the continental shelf of the GOM (Davis and Fargion, 1996; Jefferson and Schiro, 1997). Previous Gulf surveys sighted the Atlantic spotted dolphin primarily on the continental shelf and shelf edge at depths less than 250 m (820 ft), although some individuals were sighted along the slope at depths of up to approximately 600 m (1,969 ft) (Davis et al., 1998).

The spinner dolphin *(Stenella longirostri*s) is a pantropical species (Jefferson and Schiro, 1997). Spinner dolphins appear to feed on fishes and cephalopods (Wursig et al., 2000). In the Gulf, most sightings of spinner dolphins have been east of the Mississippi River at depths of 500 m to 1,800 m (1,641 ft to 5,906 ft) (Jefferson and Schiro, 1997; Davis et al., 2000).

The bottlenose dolphin *(Tursiops truncatu*s) is a common inhabitant of the continental shelf and upper slope waters of the Gulf. Sightings of this species in the Gulf are rare beyond approximately 1,200 m (3,937 ft) (Mullin et al., 1994c; Jefferson and Schiro, 1997; Davis et al., 2000). Opportunistic feeders, they prey on a wide variety of species (Davis and Fargion, 1996; Jefferson and Schiro, 1997). Current data suggest that there are genetically discrete inshore and offshore populations of bottlenose dolphins.

3.2.3.2. Threatened and Endangered Species

Five mysticete (or baleen) whales (the northern right, blue, fin, sei, and humpback), one odontocete (or toothed) whale (the sperm whale), and two subspecies of one sirenian (the West Indian manatee) occur or have been reported in the GOM and are currently listed as endangered species. No listed baleen whales normally occur in the Gulf (Jefferson and Schiro, 1997). Sperm whales are common and perhaps a resident species in certain deepwater areas of the Gulf. The West Indian manatee *(Trichechus manatu*s) inhabits only coastal marine, brackish, and freshwater habitats.

Cetaceans – Mysticetes

The northern right whale *(Eubalaena glaciali*s) inhabits primarily temperate and subpolar waters. The western North Atlantic population ranges between the Maritime Provinces of eastern Canada to northeastern Florida. Right whales forage primarily on subsurface and localized concentrations of zooplankton such as calanoid copepods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). Sparse, historical sightings and stranding records suggest that this species is not a normal inhabitant of the GOM. Records that do exist are considered to be those of extralimital strays from their wintering grounds off the southeastern United States (Jefferson and Schiro, 1997).

The sei whale *(Balaenoptera boreali*s) is an oceanic species that is not commonly sighted near the coast. They occur from the tropics to polar zones in both hemispheres, but appear to be more common in mid-latitude temperate zones. Sei whales feed on localized concentrations of zooplankton, small fishes, and cephalopods (Gambell, 1985; Jefferson et al., 1993). Sparse sighting data in the GOM suggest that their presence there is rare, or of accidental occurrence (Jefferson and Schiro, 1997).

The blue whale *(Balaenoptera musculu*s) is an oceanic species that moves into shallower habitats to feed. Blue whales are distributed from the equator to polar regions of both hemispheres. Blue whales feed almost exclusively on localized concentrations of zooplankton (Yochem and Leatherwood, 1985; Jefferson et al., 1993). Their presence in the GOM is considered to be very rare, as sighting records consist of two stranded individuals on the Texas coast and two nonconfirmed sightings (Jefferson and Schiro, 1997).

The fin whale *(Balaenoptera physalu*s) is also an oceanic species of both hemispheres and may be found from the tropics to polar zones. They are sighted near the coast in certain areas where deep water approaches the coast. Fin whales feed on localized concentrations of zooplankton, fishes, and cephalopods (Leatherwood and Reeves, 1983; Jefferson et al., 1993). Their presence in the GOM is considered to be uncommon to rare. Sparse sighting data on this species suggest that individuals in the Gulf may be extralimital strays from their western Atlantic population (Jefferson and Schiro, 1997; Wursig et al., 2000).

The humpback whale *(Megaptera novaeanglia*e) feeds and breeds in coastal waters and migrates from its tropical breeding areas to polar or subpolar regions. Humpback whales feed on localized concentrations of zooplankton and fishes (Winn and Reichley, 1985; Jefferson et al., 1993). Humpback whales sighted in the GOM may be extralimital strays during their breeding season or during their migrations (Wursig et al., 2000).

Cetaceans – Odontocetes

The sperm whale *(Physeter macrocephalus*) is the largest toothed whale and is distributed from the tropics to polar zones in both hemispheres. They are deep-diving mammals and inhabit oceanic waters, although they may come close to shore in certain areas where deep water approaches the coast. Sperm whales are known to feed on cephalopods, demersal fishes, and benthic invertebrates (Rice, 1989; Jefferson et al., 1993). The sperm whale is the only great whale that is considered to be common in the GOM (Jefferson and Schiro, 1997). Sighting data suggest a Gulfwide distribution on the slope. Congregations of sperm whales are commonly found in waters over the shelf edge in the vicinity of the Mississippi River delta in water depths of 500 m to 2,000 m (1,641 ft to 6,562 ft). From these consistent sightings, it is believed that there is a resident population of sperm whales in the Gulf consisting of adult females, calves, and immature individuals (Mullin et al., 1994a; Davis and Fargion, 1996; Sparks et al., 1996; Jefferson and Schiro, 1997; Davis et al., 2000). Recent minimum population estimates of sperm whales in the entire GOM totaled 411 individuals, as cited in the National Marine Fisheries Service's (NMFS) stock assessment report for 1996 (Waring et al., 1997). Subsequent abundance estimates of sperm whales in the "oceanic northern GOM" survey area totalled 387 individuals (Davis et al., 2000).

Sirenians

The West Indian manatee *(Trichechus manatus*) is the only sirenian found in tropical and subtropical coastal waters of the southeastern United States, GOM, Caribbean Sea, and Atlantic coast of northern and northeastern South America (Reeves et al., 1992; Jefferson et al., 1993; O'Shea et al., 1995). There are two subspecies of the West Indian manatee: the Florida manatee *(T. m. latirostris*), which ranges from the northern GOM to Virginia; and the Antillean manatee *(T. m. manatus*), which ranges from northern Mexico to eastern Brazil, including the islands of the Caribbean Sea. The West Indian manatee typically ranges no farther north than the Suwannee River in northwest Florida, though individuals are occasionally found as far west as Texas. West Indian manatees are herbivorous, feeding on aquatic plants.

Distributions of Cetaceans within Offshore Waters

Factors that may influence the spatial and temporal distribution and abundance of cetaceans may be environmental, biotic, or anthropogenic. Environmental factors encompass those that are physiochemical, climatological, or geomorphological. Biotic factors include the distribution and abundance of prey, inter- and intra-specific competition, reproduction, natural mortality, catastrophic events (e.g., die offs), and predation (Davis et al., 1998). Anthropogenic factors include such items as historical hunting pressure (in some species), pollution, habitat loss and degradation, shipping traffic, recreational and commercial fishing, oil and gas development and production, and seismic exploration.

Within the northern GOM, many of the aforementioned environmental and biotic factors are strongly influenced by various circulation patterns. These patterns are generally driven by river discharge, wind stress, and the Loop Current. The major river system in this area is the Mississippi-Atchafalaya. Most of the river discharge into the northern Gulf is transported to the west and along the coast. Circulation on the continental shelf is largely wind-driven, with localized effects from fresh water (i.e., riverine) discharge. Beyond the shelf, mesoscale circulation is largely driven by the Loop Current in the Eastern Gulf. Meanders of the Loop Current create warm-core anticyclonic eddies (anticyclones) once or twice annually that migrate westward. The anticyclones in turn spawn cold-core cyclonic eddies (cyclones). Together, anticyclones and cyclones govern the circulation of the continental slope in the Central and Western Gulf. The Loop Current and anticyclones are dynamic features that transport large quantities of high-salinity, nutrient-poor water across the near-surface waters of the northern Gulf. Cyclones, in contrast, contain high concentrations of nutrients and stimulate localized production. The combination of input of nutrients into the Gulf from river outflow and mesoscale circulation features enhances productivity, and thus the abundance of cetacean prey species such as fishes and cephalopods within the Gulf. The dynamics of these oceanographic features, in turn, affect the spatial and temporal distribution of prey species and ultimately influence cetacean diversity, abundance, and distribution (Mullin et al., 1994c; Davis et al., 2000).

Studies conducted during the GulfCet I program demonstrated correlation of cetacean distribution patterns with certain geomorphic features such as bottom depth or topographic relief. These studies suggested that bottom depth was the most important variable in habitat partitioning among cetacean species in the northern Gulf (Baumgartner, 1995; Davis et al., 1998). For example, GulfCet I surveys, along with other surveys (such as the subsequent GulfCet II program) and opportunistic sightings of cetaceans within the U.S. GOM, found that only the Atlantic spotted dolphin and the coastal form of the bottlenose dolphin were common inhabitants of the continental shelf. The remaining species of cetaceans known to regularly occur in the Gulf (with the possible exception of the Bryde's whale) were sighted on the continental slope (Mullin et al., 1994c; Jefferson, 1995; Davis et al., 1998 and 2000). During the GulfCet II program, the most commonly sighted cetaceans on the continental slope were bottlenose dolphins (pelagic form), pantropical spotted dolphins, Risso's dolphins, and dwarf/pygmy sperm whales. The most abundant species on the slope were pantropical spotted and spinner dolphins. Sperm whales sighted during GulfCet II surveys were found almost entirely in the north-central and northeastern Gulf, and near the 1,000-m (3,281-ft) isobath on the continental slope (Davis et al., 2000).

An objective of the GulfCet II program was to correlate a number of environmental parameters such as selected hydrographic features with cetacean sighting data in an effort to characterize cetacean habitats in the GOM (Davis et al., 2000). From GulfCet II surveys, sightings of cetaceans along the slope were concentrated in cyclones where production (in this case, measured chlorophyll concentration) was elevated; increased primary production within these cyclonic features enhances secondary production, including preferred prey items. Sightings of these deepwater species, however, were much less frequent in water depths greater than 2,000 m (6,562 ft) and in anticyclones. Sperm whales tended to occur along the mid-to-lower slope, near the mouth of the Mississippi River and, in some areas, in cyclones and zones of confluence between cyclones and anticyclones. From these data, it was suggested that the greater densities of cetaceans sighted along the continental slope, rather than abyssal areas, of the northern Gulf probably result from localized conditions of enhanced productivity, especially along the upper slope, and as a result of the collisions of mesoscale eddies with the continental margin (Davis et al., 2000).

In the north-central Gulf, the relatively narrow continental shelf south of the Mississippi River delta may be an additional factor affecting cetacean distribution, especially in the case of sperm whales (Davis et al., 2000). Outflow from the Mississippi River mouth transports large volumes of low salinity, nutrient-rich water southward across the continental shelf and over the slope. River outflow may also be entrained within the confluence of a cyclone-anticyclone eddy pair and transported beyond the continental slope. In either case, this input of nutrient-rich water leads to a localized deepwater environment with enhanced productivity and may explain the presence of a resident population of sperm whales within 50 km (31 mi) of the Mississippi River delta in the vicinity of the Mississippi Canyon.

Temporal variability in the distribution of cetaceans in the northern GOM may also be primarily dependent upon the extent of river discharge and the presence and dynamic nature of mesoscale hydrographic features such as cyclones. Consequently, the distribution of cetacean species will change in response to the movement of prey species associated with these hydrographic features. GulfCet I and II survey data determined that most of the cetacean species that were routinely or commonly sighted in the northern Gulf apparently occur in these waters throughout the year, although seasonal abundance of certain species or species assemblages in slope waters may vary at least regionally (Baumgartner, 1995; Davis et al., 1998 and 2000).

3.2.4. Sea Turtles

Of the seven or eight extant species of sea turtles, five are known to inhabit the waters of the GOM (Pritchard, 1997): the green turtle, the loggerhead, the hawksbill, the Kemp's ridley, and the leatherback.

As a group, sea turtles possess elongated, paddlelike forelimbs that are substantially modified for swimming and shells that are depressed and streamlined (Marquez, 1990; Ernst et al., 1994; Pritchard, 1997). They depend on land only during the reproduction period, when females emerge to nest on sandy beaches. They are long-lived and slow-maturing. Generally, their distributions are primarily circumtropical, although the various species differ widely in their seasonal cycles, geographical ranges, and behavior. There are also considerable differences in behavior among populations of the same species (Marquez, 1990).

Most sea turtles (except perhaps the leatherback) exhibit differential distributions among their various life stages: hatchling, juvenile, and adult (Marquez, 1990; Musick and Limpus, 1997; Hirth, 1997). After reaching the sea, hatchling turtles actively swim directly away from the nesting beach until they encounter zones of watermass convergence and/or sargassum rafts that are rich in prey and provide shelter (USDOC, NMFS and USDOI, FWS, 1991a and b; USDOC, NMFS and USDOI, FWS, 1992a; Hirth, 1997). Most then undergo a passive migration, drifting pelagically within prevailing current systems such as oceanic gyres. After a period of years (the number varies among species), the juveniles actively move into neritic developmental habitats. When approaching maturity, subadult juvenile turtles move into adult foraging habitats, which in some populations are geographically distinct from their juvenile developmental habitats (Musick and Limpus, 1997).

All sea turtle species that inhabit the Gulf are listed as either endangered or threatened under the authority of the Endangered Species Act of 1973 (Pritchard, 1997). It is believed that human activities are the causes of the collapse of sea turtle numbers. These activities impact every stage of their life cycle and encompass (1) the loss of nesting beach and foraging habitats; (2) the harvesting of eggs and adults for consumption; (3) incidental mortalities at sea through pelagic and ground fishing practices; and (4) harm or mortality from increasing loads of nonbiodegradable waste and pollutants (Lutcavage et al., 1997).

The loggerhead *(Caretta carett*a) is a large sea turtle that inhabits the continental shelves and estuaries of temperate and tropical environments of the Atlantic, Pacific, and Indian Oceans. This species typically wanders widely throughout the marine waters of its range and is capable of living in varied environments for a relatively long time (Marquez, 1990; USDOC, NMFS and USDOI, FWS, 1991b; Ernst et al., 1994). They may remain dormant during winter months, buried in moderately deep, muddy bottoms (Marquez, 1990). Loggerheads are carnivorous and, though considered primarily predators of benthic invertebrates, are facultative feeders over a wide range of food items (Ernst et al., 1994). Loggerheads are considered to be the most abundant sea turtle in the GOM (Dodd, 1988). Loggerhead nesting along the Gulf Coast occurs primarily along the Florida panhandle, although some nesting also has been reported from Texas through Alabama (USDOC, NMFS and USDOI, FWS, 1991b). The loggerhead is currently listed as a threatened species.

The green turtle *(Chelonia myda*s) is the largest hardshell turtle and considered to be a circumglobal species. They are commonly found throughout the tropics and as stragglers in a far more extensive area, generally between latitude 40° N. and latitude 40° S. (USDOC, NMFS and USDOI, FWS, 1991a; Hirth, 1997). In the continental U.S., they are found from Texas to Massachusetts. Green turtles are omnivorous; adults prefer feeding on plants, but juveniles and hatchlings are more carnivorous (Ernst et al., 1994; Hirth, 1997). The adult feeding habitats are beds or pastures of seagrasses and algae in relatively shallow, protected waters; juveniles may forage in areas such as coral reefs, emergent rocky bottom, sargassum mats, and in lagoons and bays. Movements between principal foraging areas and nesting beaches can be extensive, with some populations regularly carrying out transoceanic migrations (USDOC, NMFS and USDOI, FWS, 1991a; Ernst et al., 1994; Hirth, 1997). Green turtles occur in some numbers over grass beds along the south Texas coast and the Florida Gulf Coast. Reports of nesting along the Gulf Coast are infrequent, and the closest important nesting aggregations are along the east coast of Florida and the Yucatan Peninsula (USDOC, NMFS and USDOI, FWS, 1991a). The green turtle is currently listed internationally as a threatened species and as an endangered species in the State of Florida.

The hawksbill *(Eretmochelys imbricat*a) is a small to medium-sized sea turtle that occurs in tropical to subtropical seas of the Atlantic, Pacific, and Indian Oceans. In the continental U.S., the hawksbill has been recorded in all the Gulf States and along the Atlantic Coast from Florida to Massachusetts, although sightings north of Florida are rare. They are considered to be the most tropical of all sea turtles and the least commonly reported sea turtle in the GOM (Marquez, 1990; Hildebrand, 1995). Coral reefs are generally recognized as the resident foraging habitat for juveniles and adults. Adult hawksbills feed primarily on sponges and demonstrate a high degree of selectivity, feeding on a relatively limited number of sponge species, primarily demosponges (Ernst et al., 1994). Nesting within the continental U.S. is limited to southeastern Florida and the Florida Keys. Juvenile hawksbills show evidence of residency on specific foraging grounds, although some migrations may occur (USDOC, NMFS and USDOI, FWS, 1993). Some populations of adult hawksbills undertake reproductive migrations between foraging grounds and nesting beaches (Marquez, 1990; Ernst et al., 1994). The hawksbill is presently listed as an endangered species.

The Kemp's ridley *(Lepidochelys kemp*i) is the smallest sea turtle. This species occurs mainly in the GOM and along the northwestern Atlantic coast as far north as Newfoundland. Juveniles and adults are typically found in shallow areas with sandy or muddy bottoms, especially in areas of seagrass habitat. Kemp's ridleys are carnivorous and feed primarily on crabs, though they also feed on a wide variety of other prey items as well (Marquez, 1990; USDOC, NMFS and USDOI, FWS, 1992a; Ernst et al., 1994).

The major Kemp's ridley nesting area is near Rancho Nuevo, along the northeastern coast of Mexico (Tamaulipas), although scattered nests have also been reported in other areas of Mexico and in Texas (e.g., within the Padre Island National Seashore), Colombia, Florida, and South Carolina (USDOC, NMFS and USDOI, FWS, 1992a; Ernst et al., 1994). Adult Kemp's ridleys exhibit extensive internesting movements but appear to travel near the coast, especially within shallow waters along the Louisiana coast. The Kemp's ridley is currently regarded as the most endangered of all sea turtle species.

The leatherback *(Dermochelys coriace*a) is the largest and most distinctive living sea turtle. This species possesses a unique skeletal morphology, most evident in its flexible, ridged carapace, and in cold water maintains a core body temperature several degrees above ambient. They also have unique deep-diving abilities. This species is also the most pelagic and most wide-ranging sea turtle, undertaking extensive migrations from the tropics to boreal waters. Though considered pelagic, leatherbacks will occasionally enter the shallow waters of bays and estuaries. Leatherbacks feed primarily on gelatinous zooplankton such as jellyfish, siphonophores, and salps, though they may, perhaps secondarily, ingest some algae and vertebrates (Ernst et al., 1994). Data from analyses of leatherback stomach contents suggest that they may feed at the surface, nocturnally at depth within deep scattering layers, or in benthic habitats. Florida is the only site in the continental U.S. where the leatherback regularly nests (USDOC, NMFS and USDOI, FWS, 1992b; Ernst et al., 1994; Meylan et al., 1995). The leatherback is currently listed as an endangered species.

Distributions of Sea Turtles in the Offshore Waters of the Northern GOM

Surveys conducted during the GulfCet I and II programs represent the most recent assessments of sea turtle distribution and abundance within the oceanic northern GOM (Davis et al., 1998 and 2000). During these surveys, only three species of sea turtles were sighted: loggerheads, Kemp's ridleys, and leatherbacks.

GulfCet I and II surveys found the abundance of sea turtles in the GOM to be considerable higher on the continental shelf and within the eastern Gulf, east of Mobile Bay (Lohoefener et al., 1990; Davis et al., 2000). Kemp's ridleys were sighted only along the shelf. The number of sightings of loggerheads were also found to be considerably higher on the continental shelf than the slope. There were also sightings of individual loggerheads over very deep waters (>1,000 m). The importance of the oceanic Gulf to loggerheads was not clear from these surveys, though it was suggested that they may transit through these waters to distant foraging sites or while seeking warmer waters during winter (Davis et al., 2000). From historic sighting data, leatherbacks appear to spatially utilize both shelf and slope habitats in the GOM (Fritts et al., 1983a and b; Collard, 1990; Davis et al., 1998). GulfCet I and II surveys suggested that the region from Mississippi Canyon to DeSoto Canyon, especially near the shelf edge, appears to be an important habitat for leatherbacks (Davis et al., 2000).

Seasonally, loggerheads were widely distributed across the shelf during both summer and winter, though their abundance on the slope was considerably higher during winter surveys than summer (Davis et al., 2000). Temporally, variability in leatherback distribution and abundance suggest that specific areas may be important to this species, either seasonally or for short periods of time. Overall, leatherbacks occurred in substantial numbers during both summer and winter surveys, and the high variability in the relative numbers of individual leatherbacks sighted within specific areas suggest that their distribution patterns were irruptive in nature (Davis et al., 2000).

3.2.5. Birds

Nonendangered and Nonthreatened Species

The offshore waters, coastal beaches, and contiguous wetlands of the northern GOM are populated by both resident and migratory species of coastal and marine birds. They are separated into five major groups: seabirds, shorebirds, marsh birds, wading birds, and waterfowl. Recent surveys indicate that Louisiana and Texas are among the primary states in the southern and southeastern U.S. for nesting colony sites and total number of nesting coastal and marine birds (Martin and Lester, 1991; Martin, 1991). Seabirds are a diverse group of birds that spend much of their lives on or over saltwater; they live far from land most of the year, except at breeding time when they return to nesting areas along coastlines (Terres, 1991). Shorebirds are generally restricted to coastline margins (beaches, mudflats, etc.). An important characteristic of almost all shorebird species is their strongly developed migratory behavior.

The Central and Western GOM coastline serves as the southern terminus of the Mississippi Flyway (Alabama, Mississippi, and Louisiana) and the Central Flyway (Texas). The two flyways overlap on coastal Texas.

The term “marsh bird” is a general term for birds that have adapted to living in marshes. Little blue herons, snowy egrets, and tricolored herons constitute the greatest number of coastal nesting pairs on the Western Gulf Coast (Texas Parks and Wildlife Department, 1990). Waterfowl include swans, geese, and ducks. A total of 36 species are regularly reported along the north-central and western Gulf Coast. Waterfowl are highly social and possess a diverse array of feeding adaptations related to their habitat (Johnsgard, 1975).

Endangered and Threatened Species

The following coastal and marine bird species that inhabit or frequent the north-central and western GOM coastal areas are recognized by the U.S. Fish and Wildlife Service (FWS) as either endangered or threatened: piping plover, whooping crane, bald eagle, brown pelican, and least tern.

The piping plover, a migratory shorebird, is endemic to North America. Along the U.S. Gulf Coast, the highest number of wintering plovers occurs along the Texas coast (Haig and Plissner, 1993). The whooping crane is an omnivorous, wading bird. Whooping cranes currently exist in three wild populations and at five captive locations (USDOI, FWS, 1994). These birds winter in coastal marshes and estuarine habitats along the Gulf Coast at Aransas National Wildlife Refuge, Texas, and represent the majority of the world’s population of free-ranging whooping cranes. The bald eagle is the only species of sea eagle that regularly occurs on the North American continent (USDOI, FWS, 1984). Most breeding pairs occur in Florida and Louisiana, and some in South Carolina, Alabama, and east Texas. The bald eagle was listed as endangered in 1967 in response to the declines due to DDT and other organochlorines that affected the species’ reproduction (USDOI, FWS, 1984). In July 1995, the FWS reclassified the bald eagle from endangered to threatened in the lower 48 states (*Federal Register*, 1995).

The brown pelican is one of two pelican species in North America. Organochlorine pesticide pollution apparently contributed to the endangerment of the brown pelican. In recent years, there has been a marked increase in brown pelican populations along its entire former range. However, within the remainder of the range, which includes coastal areas of Texas, Louisiana, and Mississippi, where populations are not secure, the brown pelican remains listed as endangered (*Federal Register*, 1985). The least tern is the smallest North American tern. They prefer inshore habitats. Least terns are listed as endangered, except within approximately 80 km (50 mi) of the coast. Least terns are not expected to be affected by the proposed action.

3.2.6. Essential Fish Habitat and Fish Resources

3.2.6.1. Essential Fish Habitat

The Fishery Conservation and Management Act of 1976 (Magnuson Act) established national standards for the conservation and management of exploited fish and shellfish stocks in U.S. Federal waters. The Fishery Conservation and Management Act was superceded by the Magnuson-Stevens Fishery Conservation and Management Act of 1996, which required that FMP’s further include the identification and description of Essential Fish Habitat (EFH). Essential fish habitat includes those waters and substrate necessary for the successful spawning, breeding, feeding, or growth to maturity of targeted species. The Act also requires that management councils consult with Federal agencies regarding any activities that may adversely affect EFH designated in specific FMP’s. An adverse effect is any activity that reduces the quality of EFH whether it is direct (physical disruption) or indirect (loss of prey). Federal agencies are also required to assess actions that could conserve and enhance essential fish habitat.

In the Central and Western Gulf, EFH has been identified for 32 managed species of fish and shellfish (Gulf of Mexico Fisheries Management Council, 1998; USDOC, NMFS, 1999a and b). Of these, 21 species inhabit nearshore waters less than 200 m (656 ft) in depth. (See USDOI, MMS, 2001a, for further information on the distribution and habitat of these species.) The remaining 11 "offshore" species include the silky shark, longfin mako shark, dolphin, swordfish, skipjack tuna, yellowfin tuna, bluefin tuna, greater amberjack, king mackerel, tilefish, and red snapper. Although these species spawn in deepwater areas of the GOM, little is known about the life history and fate of pelagic larvae and fry. Bluefin larvae have been found associated with the Loop Current boundary and the Mississippi River plume (Richards et al., 1989). Juvenile and adult red snapper aggregate around hard-bottom relief but seldom occur at depths >300 m (985 ft).

3.2.6.2. Description of Fish Resources

The GOM supports a great diversity of fish resources. The distribution and abundance of these resources are not random and are governed by a variety of ecological factors such as temperature, salinity, primary productivity, bottom types, and many other physical and biological factors. There are considerable inshore and offshore differences in fish resources. The majority of the GOM fisheries are dependent upon wetland, estuarine, and nearshore habitats (USDOI, MMS, 2001b).

Fish can be classified as demersal (bottom-dwelling), oceanic pelagic, or mesopelagic (midwater). Demersal (or benthic) fish have been addressed above under the megafauna descriptions (Chapter 3.2.2.3.1). There are no commercial fisheries directed at demersal species in the vicinity of the Gunnison Project. Oceanic pelagic and mesopelagic fishes are discussed briefly below. Additional life history information on important commercial invertebrate fish resources of the GOM is contained in USDOI, MMS (2001a and 2002).

3.2.6.2.1. Oceanic Pelagics (including highly migratory species)

Common oceanic pelagic species include the large predatory tunas, marlins, sailfish, swordfish, dolphins, wahoo, and mako sharks. Other pelagics include halfbeaks, flyingfishes, and driftfishes (Stromateidae). Lesser known oceanic pelagics include opah, snake mackerels (Gempylidae), ribbonfishes (Trachipteridae), and escolar.

Oceanic pelagic species occur throughout the GOM, especially at or beyond the shelf edge. Oceanic pelagics are reportedly associated with mesoscale hydrographic features such as fronts, eddies, and discontinuities. Fishermen contend that yellowfin tuna aggregate near sea-surface temperature boundaries or frontal zones; however, Power and May (1991) found no correlation between longline catches of yellowfin tuna and sea-surface temperature (defined from satellite imagery) in the GOM. Many of the oceanic fishes associate with drifting *Sargassum* seaweed, which provides feeding and/or nursery habitat.

3.2.6.2.2. Mesopelagics (midwater fishes)

Mesopelagic fish assemblages in GOM collections are numerically dominated by myctophids (lanternfishes), with gonostomatids (bristlemouths) and sternoptychids (hatchet fishes) common but less abundant. These fishes make extensive vertical migrations during the night from mesopelagic depths (200-1,000 m; 656-3,280 ft) to feed in upper, more productive layers of the water column (Hopkins and Baird, 1985). Mesopelagic fishes are important ecologically because they transfer substantial amounts of energy between mesopelagic and epipelagic zones.

The GOM appears to be a distinct zoogeographic province based upon analysis of lanternfish distribution (Bakus et al., 1977). The GOM lanternfish assemblage was characterized by species with tropical and subtropical affinities. This was particularly true for the eastern GOM where Loop Current effects on species distributions were most pronounced. Gartner et al. (1987) collected 17 genera and 49 species of lanternfish in trawls fished at discrete depths from stations in the Western, Central, and Eastern Gulf. The most abundant species in decreasing order of importance were *Ceratoscopleus warmingii*, *Notolychus valdiviae*, *Lepidophanes guentheri*, *Lampanyctus alatus*, *Daiphus dumerili*, *Benthosema suborbitale*, and *Myctophum affine*. Ichthyoplankton collections from oceanic waters yielded high numbers of mesopelagic larvae as compared with larvae of other groups (Richards et al., 1989). Lanternfishes generally spawn year-round, with peak activity in spring and summer (Gartner, 1993).

3.2.7. Socioeconomic Conditions and Other Concerns

3.2.7.1. Economic and Demographic Conditions

3.2.7.1.1. Socioeconomic Impact Area

The MMS defines the GOM impact area for population, labor, and employment as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. For this analysis, the coastal impact area consists of 80 counties and parishes along the U.S. portion of the GOM. This area includes 24 counties in Texas, 26 parishes in Louisiana, 4 counties in Mississippi, 2 counties in Alabama, and 24 counties in the Panhandle of Florida. Inland counties and parishes are included where offshore oil and gas activities are known to exist, where offshore-related petroleum industries are established, and where one or more counties or parishes within a Metropolitan Statistical Area (MSA) are on the coast; all counties and parishes within the MSA are included.

For analysis purposes, MMS has divided the impact area into the 10 subareas listed below. This impact area is based on the results of a recent MMS socioeconomic study, "Cost Profiles and Cost Functions for Gulf of Mexico Oil and Gas Development Phases for Input-Output Modeling." One of the objectives of this study was to allocate expenditures from the offshore oil and gas industry to the representative onshore subarea where the dollars were spent. Table E-1 (Appendix E) presents these findings in percentage terms. In the table, the IMPLAN number is the code given to the industry (sector) by the input-output software (IMPLAN) used to calculate impacts in Chapter 4. It is analogous to the standardized industry code (SIC). As shown in the table, very little has been spent in the Florida subareas. This is to be expected given the lack of offshore leasing in this area and Florida's attitude towards oil and gas development off their beaches. The table also makes clear the reason for including all of the GOM subareas in the economic impact area. Expenditures in Texas to several sectors are either exclusively found there or make up a very large percentage of the total. In addition, a significant percentage of total sector expenditures is allocated to each Louisiana subarea. The following subareas (which include the counties/parishes as listed below) are considered as the economic impact area for the proposed activity:

LA-1	LA-2	LA-3	MA-1
Acadia, LA Calcasieu, LA Cameron, LA Iberia, LA Lafayette, LA St. Landry, LA St. Martin, LA Vermilion, LA	Ascension, LA Assumption, LA East Baton Rouge, LA Iberville, LA Lafourche, LA Livingston, LA St. Mary, LA Tangipahoa, LA Terrebonne, LA West Baton Rouge, LA	Jefferson, LA Orleans, LA Plaquemines, LA St. Bernard, LA St. Charles, LA St. James, LA St. John the Baptist, LA St. Tammany, LA	Baldwin, AL Hancock, MS Harrison, MS Jackson, MS Mobile, AL Stone, MS
TX-1	**TX-2**	**FL-1**	**FL-3**
Aransas, TX Calhoun, TX Cameron, TX Jackson, TX Kenedy, TX Kleberg, TX Nueces, TX Refugio, TX San Patricio, TX Victoria, TX Willacy, TX	Brazoria, TX Chambers, TX Fort Bend, TX Galveston, TX Hardin, TX Harris, TX Jefferson, TX Liberty, TX Matagorda, TX Montgomery, TX Orange, TX Waller, TX Wharton, TX	Bay, FL Escambia, FL Okaloosa, FL Santa Rosa, FL Walton, FL **FL-2** Dixie, FL Franklin, FL Gulf, FL Jefferson, FL Levy, FL Taylor, FL Wakulla, FL	Charlotte, FL Citrus, FL Collier, FL Hernando, FL Hillsborough, FL Lee, FL Manatee, FL Pasco, FL Pinellas, FL Sarasota, FL **FL-4** Miami-Dade, FL Monroe, FL

The proposed activity in Grid 3 is expected to have negligible economic consequences throughout all 10 of the coastal subareas as well as minute global impacts. Most of the probable changes in population, labor, and employment resulting from the proposed activity would likely occur in the 24 counties in Texas and the 26 parishes in Louisiana because the oil and gas industry is best established in this region. Some of the likely changes in population, labor, and employment resulting from the proposed activity would also occur in the six Alabama and Mississippi counties due to their established oil and gas industry and proximity to the offshore location. Changes in economic factors (in minor service and support industries) from the proposed activity would occur, to a much lesser extent, in the 24 counties of the Florida Panhandle because their economy only marginally includes primary and support industries for oil and gas development.

3.2.7.1.2. Population and Education

Table E-2 (Appendix E) depicts baseline population projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activity. The analysis area consists of highly populated metropolitan areas (such as the Houston MSA, which predominates Subarea TX-2) and sparsely populated rural areas (as is much of Subarea TX-1). Some communities in the analysis area experienced extensive growth during the late 1970's and early 1980's when OCS activity was booming. Following the drop in oil prices, many of these same areas experienced a loss in population (Gramling, 1984; Laska et al., 1993). All subarea populations are expected to grow at a higher rate than the United States' average annual population growth rate over the life of the proposed actions, reflecting the region migration pattern of favoring the south and west over the northeast and Midwest (USDOC, Bureau of the Census, 2001). This is a continuation of historic trends. Average annual population growth projected over the life of the proposed actions range from a low of 0.45 percent for Subarea LA-3 (dominated by the Orleans MSA) to a high of 3.27 percent for Subarea FL-3 in the lower panhandle of Florida. Over the same time period, the population for the United States is expected to grow at about 1.36 percent per year.

This analysis uses the 2000 U.S. Census Supplementary Survey Profile educational attainment data for States. For people 25 years and over, 75.2 percent of the population in the U.S. has graduated from high school, while 20.3 percent has received a bachelor's degree. Texas' educational attainment percentages are higher than the national average for both categories: 76.8 and 23.5 percent, respectively. Louisiana, while higher than the national average for high school graduates, 76.7 percent, is lower for college degrees, 19.5 percent. Mississippi's educational attainments are lower than the Nation's for both categories—74.3 and 18.6 percent, respectively. Alabama, like Louisiana, has a higher than national high school graduation rate (76.0%), but a lower rate for bachelor's degree (20.2%). Florida mirrors Texas; its educational attainments are higher than the national rates—81.9 and 23.2 percent, respectively.

3.2.7.1.3. Infrastructure and Land Use

The Gulf of Mexico OCS Region has one of the highest concentrations of oil and gas activity in the world. The offshore oil and gas industry has experienced dramatic changes over recent years, particularly since 1981. Historically, most of the activity has been concentrated on the continental shelf off the coasts of Texas and Louisiana. Future activity is expected to extend into progressively deeper waters and into the Eastern Planning Area (EPA). To date, only exploration activities have taken place off the shores of the State of Florida. The high level of offshore oil and gas activity in the GOM is accompanied by an extensive development of onshore service and support facilities. The major types of onshore infrastructure include gas processing plants, navigation channels, oil refineries, pipelines and pipeline landfalls, pipecoating and storage yards, platform fabrication yards, separation facilities, service bases, terminals, and other industry-related installations such as landfills and disposal sites for drilling and production wastes.

Land use in the impact area varies from state to state. The coasts of Florida and Texas are a mixture of urban, industrial, recreational beaches, wetlands, forests, and agricultural areas. Alabama's coastal impact area is predominantly recreational beaches, and small residential and fishing communities. Mississippi's coast consists of barrier islands, some wetlands, recreational beaches, and urban areas. Louisiana's coast impact area is mostly vast areas of wetlands; some small communities and industrial areas extend inward from the wetlands.

3.2.7.1.4. Navigation and Port Usage

A service base is a community of businesses that load, store, and supply equipment, supplies, and personnel needed at offshore work sites. Although a service base may primarily serve the OCS planning area and subarea in which it is located, it may also provide significant services for the other OCS planning areas and subareas. As OCS operations have progressively moved into deeper waters, larger vessels with deeper drafts have been phased into service, mainly for their greater range of travel, greater speed of travel, and larger carrying capacity. Service bases with the greatest appeal for deepwater activity have several common characteristics: strong and reliable transportation system; adequate depth and width of navigation channels; adequate port facilities; existing petroleum industry support infrastructure; location central to OCS deepwater activities; adequate worker population within commuting distance; and insightful strong leadership. Typically, deeper draft service vessels require channels with depths of 6-8 m. The proposed activity is expected to impact Sabine Pass and Galveston, Texas, the designated service bases for the proposed action. The OCS service sector at the Port of Galveston has expanded its capacity curing the last decade and is poised to serve the increasing demand for services in the Western OCS sector.

3.2.7.1.5. Employment

Table E-3 (Appendix E) depicts baseline employment projections for the potential impact area. Baseline projections are for the impact area in the absence of the proposed activity. Average annual employment growth projected over the life of the proposed actions range from a low of 1.19 percent for Subarea LA-3 (predominated by the Orleans MSA) to a high of 5.43 percent for Subarea FL-3 in the lower panhandle of Florida. Over the same time period, employment for the United States is expected to grow at about 2.25 percent per year, while the GOM analysis area is expected to grow at about 2.06 percent per year. As stated above, this represents growth in general employment for the subareas. Continuation of existing trends, both in OCS activity and other industries in the area, are included in the projections.

The industrial composition for the subareas in the WPA and that in the CPA are similar. With the exception of Subareas LA-2, LA-3, and FL-4, the top four ranking sectors in terms of employment in the analysis area are the service, manufacturing, retail trade, and State and local government sectors. In Subareas LA-2 and LA-3, construction replaces manufacturing as one of the top four industries on the basis of employment, In Subarea FL-4, transportation, communication, and public utilities replaces manufacturing as one of the top four industries on the basis of employment. The service industry employs more people in all subareas. The service industry is also the fastest growing industry.

3.2.7.1.6. Current Economic Baseline Data

Oil and natural gas prices are used to evaluate the oil and gas industry’s ability to economically develop resources. As of February 11, 2003, Henry Hub Natural Gas closed at $6.175 per million BTU (Oilnergy, 2003). The price of natural gas to be delivered in March settled at $5.785 per 1,000 cubic feet on the New York Mercantile Exchange (NYMEX). As of January 31, 2003, there were 728 rigs drilling for natural gas in North America, compared with 709 a year ago, an increase of 2.7 percent. Rigs drilling for gas in the Gulf increased from 94 to 95 over the same period.

The threat of possible disruptions to Middle East oil flows and the cut in Venezuelan crude exports have driven oil prices up more than 30 percent since the end of November 2002 to reach a new two-year high. The NYMEX West Texas Intermediate for April delivery closed at $35.23 per barrel on February 11, 2003. Venezuela’s output, crippled by months of political strife, has recovered but it is still less than half of its previous production levels. Crude prices have been high since early 2002. The rally in crude oil futures has been spurred by high declines in U.S. crude inventories, which have fallen to the lowest level since 1975. Exploration expenditures are another indicator of the energy industry’s strength. Lehman Brothers released the final results of its Original E&P Spending Survey of 231 companies, indicating that U.S. E&P expenditures in 2003 are expected to decline 0.7 percent from $30.5 billion in 2002 to $30.3 billion. Independents’ spending is forecast to decline a modest 0.4 percent, while the majors are expected to reduce expenditures by 1.1 percent. Lehman Brothers’ analysts found that more companies spent an increased percentage of their budget offshore in 2002 (almost a 2:1 ratio) and that an even greater percentage of companies plan to spend an increased percentage of their budgets offshore in 2003.

In addition to E&P spending, drilling rig use is employed by the industry as a barometer of economic activity. As of February 7, 2003, the fleet utilization rate for all marketed mobile rigs in the GOM was 62.0 percent, compared to 72.0 percent two and one-half months ago (OneOffshore, 2003). This breaks down as a 61.8 percent fleet utilization rate for jackups (average day rates of $17,500-$45,000); 63.2

percent for semisubmersibles (average day rates of $33,500-$150,000); 87.5 percent for drillships (average day rates are about $180,000); and 28.6 percent for submersibles (average day rates are about $19,500). Platform rigs in the Gulf recorded a 37.7 percent fleet utilization rate, while inland barges had a 37.5 percent utilization rate. The first week of February 2003 marked a significant low point for the GOM offshore rig count. The GOM offshore rig demand has not been this low since May 1999, with the situation particularly bleak for jackup rigs. However, a new research study by ODS-Petrodata, "The Worldwide Jack-up Market: Scenarios for Newbuilding and Attrition to 2015," examines the trends that are likely to impact the retirement of jackups in the medium and long term. According to Stewart Wiseman, author of the report, the useful life of a typical jackup is about 25 years without major upgrades. At present, only 17 percent are this old; however, by 2012, 90 percent of the current fleet will be at least 26 years old. Thus, the industry will soon face a significant challenge in replenishing its aging equipment (OneOffshore, 2003).

The still depressed GOM rig market continues to hit offshore service vessel (OSV) operators hard, with the smaller vessel owners hit the hardest. The most significant barometer of rig activity is what the energy companies are thinking, even if commodity prices are high enough to make money. The December 2002 average day rates for supply boats and crewboats used by the offshore oil and gas industry decreased from the December 2001 figures and, for the most part, utilization rates for these vessels followed suit. However, anchor-handling tug/supply vessels' (AHTS) average day rates increased over the same time period and maintained a 100 percent utilization rate. Average day rates for AHTS vessels ranged from $12,000 for under 6,000-hp vessels (up $1,500 from last year's rate) to $15,000 for over 6,000-hp vessels (up $1,500 from last year's rate); utilization rates were 100 percent for both. Supply boat average day rates ranged from $4,741 for boats up to 200 ft (down $1,239 from a year ago) and $9,240 for boats 200 ft and over (down $750 from a year ago); utilization was 81 percent and 97 percent, respectively. Crewboat average day rates ranged from $2,135 for boats under 125 ft (down $302 from a year ago) to $2,700 for boats 125 ft and over (down $612 from last year's average rates); utilization was 79 percent and 89 percent, respectively (Greenberg, 2003).

Commencing with Central Gulf Lease Sale 178 Part 1 in March 2001, new royalty relief provisions for both oil and gas production in the GOM's deep and shallow waters were enacted. These rules will govern the next three years of lease sales. Central Gulf Lease Sale 178 Part 1 resulted in 534 leases (an increase of 59.88% or 200 blocks from Central Gulf Lease Sale 175 in March 2000). Of these 534 leases, 348 were in shallow water (0-400 m). This increase of 67.30 percent from the last Central Gulf lease sale largely reflects the intensified interest in natural gas due to higher prices over the last year and the new royalty relief provisions. The 186 blocks receiving bids in deep water (>400 m) reflect an increase of 47.62 percent or 60 blocks. Again, this dramatic increase in leasing could be a result of the recently issued royalty relief provisions. Western Gulf Lease Sale 180 and Central Gulf Lease Sale 178 Part 2, offering the newly available United States' blocks beyond the U.S. Exclusive Economic Zone, were held on August 22, 2001. No bids were received for blocks offered in Central Gulf Lease Sale 178 Part 2. Of the 4,114 blocks offered in Western Gulf Lease Sale 180, 320 received bids. About 55 percent of blocks receiving bids (177 blocks) in Western Gulf Lease Sale 180 are in deep water, and 175 of these deepwater blocks were leased. In Eastern Gulf Lease Sale 181, held on December 5, 2001, all 95 deepwater blocks receiving bids were leased. New royalty relief provisions for both oil and gas production in the GOM's 400- to 799-m range were offered beginning with Central Gulf Lease Sale 182. In Sale 182, held March 20, 2002, 307 shallow-water blocks and 199 deepwater blocks received bids. In Western Gulf Lease Sale 184, held August 21, 2002, 164 shallow-water blocks and 159 deepwater blocks received bids.

3.2.7.1.7. How OCS Development Has Affected the Impact Area

The topic of how OCS development has affected the WPA is discussed in the latest environmental assessment for this portion of the Gulf (USDOI, MMS, 2001a). The analysis describes the effects in multiyear segments, i.e., 1980-1989, 1990-1997, and 1998-present. The discussion explains the expansion and contraction of oil and gas activities in the GOM during these intervals.

3.2.7.1.8. Environmental Justice

On February 11, 1994, President Clinton issued an executive order to address questions of equity in the environmental and health conditions of impoverished communities. The most effective way of assuring that environmental endangerment is not concentrated in minority or low-income neighborhoods is to locate and identify them from the outset of a proposed project. Low incomes also coincided with concentrations of minority populations: black, Hispanic, and/or Native American. Minority populations within the impact region include African-Americans living in all of the Gulf Coast States and Asian-Americans in Alabama. Few Native Americans live in coastal counties. The Intertribal Council (ITC) was established in the early 1970's by five tribes—the Chitimacha, Tunica-Biloxi, Coushatta, Houma, and Jena Band of Choctaws. At that time, only the Coushatta tribe was federally recognized. Today, four Louisiana tribes are federally recognized. The first of these to be recognized was the Coushatta in 1973, and the last was the Jena Band of Choctaw in 1995. The United Houma Nation is still awaiting a finding on its petition. Because its citizens live principally in Lafourche Parish and close to Port Fourchon, they could be directly affected by increases in oil and gas activity from the proposed action. Low-income populations living in the impact area include fishermen and timber harvesters.

3.2.8. Commercial Fisheries

More than 26 percent (40% excluding Alaska) of commercial fish landings in the continental U.S. occur in the GOM. In 1999, the GOM placed second in total landed weight (almost 1 million tons) and third in value ($776 million) considering all U.S. regions (USDOC, NMFS, 2001). The most important species, such as menhaden, shrimps, oyster, crabs, and drums, are all species that depend heavily on estuarine habitats and the fisheries are restricted to the continental shelf. Menhaden was the most valuable finfish landed in 1999, accounting for $78.5 million in total value. The GOM shrimp fishery, however, is the most valuable fishery in the U.S., and the Gulf fishery accounts for 71.5 percent of total domestic production.

Commercial fishing in deeper waters (i.e., >200 m [656 ft]) of the GOM is characterized by fewer species, and lower landed weights and values than the inshore fisheries. Historically, the deepwater offshore fishery contributes less than 1 percent to the regional total weight and value (USDOI, MMS, 2001a). Target species can be classified into three groups: (1) epipelagic fishes, (2) reef fishes, and (3) invertebrates. In general, the Gunnison development is beyond the normal depth range of commercial reef fishes and invertebrates. While it is possible that new species of demersal fish or invertebrates may be pursued in the future if other fisheries fail, it appears unlikely at present because of the high cost and risk of fishing at extreme water depths. In addition, considerable time, effort and finances would have to be expended to develop new markets for new species. Epipelagic commercial fishes include dolphin, sharks (spinner, silky, and sandbar), snake mackerels (escolar and oilfish), swordfish, tunas (bigeye, blackfin, bluefin, and yellowfin), and wahoo (USDOI, MMS, 2001a). These species are widespread in the Gulf and probably occur in Grid 3. The distribution and abundance of epipelagic species is influenced by several interrelated variables: water temperature, thickness of water layers of the same temperature, circulation patterns, and biological productivity. Pelagic longlining is likely occurring throughout the Grid 3 area and near the Gunnison Project area.

3.2.9. Recreational Resources and Beach Use

The northern GOM coastal zone is one of the major recreational regions of the United States, particularly for marine fishing and beach activities. Gulf Coast shorelines offer a diversity of natural and developed landscapes and seascapes. Major recreational resources include coastal beaches, barrier islands, estuarine bays and sounds, river deltas, and tidal marshes. Other resources include publicly owned and administered areas, such as national seashores, parks, beaches, and wildlife lands, as well as designated preservation areas, such as historic and natural sites and landmarks, wilderness areas, wildlife sanctuaries, and scenic rivers.

Beach use is a major economic component of many of the Gulf's coastal communities, especially during the peak-use seasons (spring and summer). According to USDOI, MMS (1997a), recreational resources, activities, and expenditures are not uniformly distributed along the Gulf but are focused where public beaches are close to major urban centers. Beach activities and the aesthetic value of the shoreline are important economic factors in the coastal zone. The scenic and aesthetic value of Gulf Coast beaches plays an important role in attracting both residents and tourists to the coastal zone. One of the major recreational activities occurring on the OCS is offshore marine recreational fishing and diving. A substantial recreational fishery, including scuba diving, is directly associated with oil and gas production platforms and stems from the fact that platforms beneficially function as high-profile, artificial reefs that attract fishes.

Commercial and private recreational facilities and establishments, such as resorts, marinas, amusement parks, and ornamental gardens, also serve as primary-interest areas. According to the Texas Department of Commerce's Tourism Division, the number of person-trips to the Gulf Coast Region was estimated at 57 million for the two-year period 2000-2001, and the volume of person-days was approximately 130 million. The average total expenditure (per person per day) was $108 (Texas Department of Economic Development, 2003). The two major recreational areas most directly associated with and potentially affected by offshore leasing are the offshore marine environment and the coastal shorefront of the adjoining states. The major recreational activity occurring on the OCS is recreational fishing and diving. Interest remains high throughout the GOM region to acquire, relocate, and retain selected oil and gas structures in the marine environment to be used as dedicated artificial reefs to enhance marine fisheries when the structures are no longer useful for oil and gas production (Reggio, 1989). Other prominent natural features (e.g., Flower Garden Banks) also serve as primary diving destinations for sport divers.

3.2.10. Archaeological Resources

Archaeological resources are any material remains of human life or activities that are at least 50 years of age and that are of archaeological interest (30 CFR 250.2). The Archaeological Resources Regulation (30 CFR 250.26) provides specific authority to each MMS Regional Director to require archaeological resource surveys, analyses, and reports. Surveys are required prior to any exploration or development activities on leases within the high probability areas (NTL 2002-G01).

3.2.10.1. Prehistoric

Available evidence suggests that sea level in the northern GOM was at least 90 m (295 ft), and possibly as much as 130 m (427 ft), lower than present sea level, and that the low sea-stand occurred during the period 20,000-17,000 years Before Present (B.P.) (Nelson and Bray, 1970). Sea level in the northern Gulf reached its present stand around 3,500 years B.P. (Coastal Environments, Inc., 1986).

The area was open to habitation by prehistoric peoples during periods that the continental shelf was exposed above sea level. The advent of early man into the GOM region is currently accepted to be around 12,000 years B.P. (Aten, 1983). According to the sea-level curve for the northern GOM proposed by Coastal Environments, Inc. (CEI) sea level at 12,000 B.P. would have been approximately 45 m (148 ft) below the present still stand (CEI, 1977 and 1982). On this basis, the continental shelf shoreward of the 45-m to 60-m (148-ft to 197-ft) bathymetric contours has potential for prehistoric sites dating after 12,000 B.P. Because of inherent uncertainties in both the depth of sea level and the entry date of prehistoric man into North America, MMS adopted the 12,000 years B.P. and the 60-m (197-ft) water depth as the seaward extant of the prehistoric, archaeological high-probability area. The MMS recognizes both the 12,000 B.P. and 60-m (197-ft) water depth as the seaward extent of prehistoric archaeological site potential on the OCS. The water depth of the Grid 3 area exceeds 200 m. The water depth of lease blocks in this area precludes the possibility that any of the seafloor in the Grid 3 area was subaerially exposed during the Paleoindian Period in the Gulf Region. As a result, the proposed action will have no effect on potentially significant prehistoric archaeological properties.

3.2.10.2. Historic

With the exception of the Ship Shoal Lighthouse structure, historic archaeological resources on the OCS consist of historic shipwrecks. A historic shipwreck is defined as a submerged or buried vessel, at least 50 years old, that has foundered, stranded, or wrecked and is presently lying on or is embedded in the seafloor. This includes vessels (except hulks) that exist intact or as scattered components on or in the seafloor. A 1977 MMS archaeological resources baseline study for the northern GOM concluded that two-thirds of the total number of shipwrecks in the northern Gulf lie within 1.5 km (0.9 mi) of shore. Most of the remaining wrecks lie between 1.5 km and 10 km (0.9 mi and 6.2 mi) of the coast (CEI, 1977). A subsequent MMS study published in 1989 found that changes in the late 19th and early 20th century sailing routes increased the frequency of shipwrecks in the open sea in the Eastern Gulf to nearly double that of the Western and Central Gulf (Garrison et al., 1989). The highest observed frequency of shipwrecks occurred within areas of intense marine traffic, such as the approaches and entrances to seaports and the mouths of navigable rivers and straits.

Review of the Garrison et al. (1989) shipwreck database lists no historic shipwrecks within the Grid 3 area. The MMS shipwreck database should not be considered an exhaustive lists of shipwrecks. Regular reporting of shipwrecks did not occur until late in the 19th century, and losses of several classes of vessels, such as small coastal fishing boats, were largely unreported in official records.

Wrecks occurring in deeper water would have a moderate to high preservation potential. In the deep water, temperature at the seafloor is extremely cold, which slows the oxidation of ferrous metals. The cold water would also eliminate the wood eating shipworm *Terredo navalis* (Anuskiewicz, 1989; page 90).

Aside from acts of war, hurricanes cause the greatest number of wrecks in the Gulf. The wreckage of the 19^{th}-century steamer, *New York*, which was destroyed in a hurricane in 1846, lies in 16 m (52 ft) of water and has been documented by MMS (Irion and Anuskiewicz, 1999) as scattered over the ocean floor in a swath over 457 m (1,500 ft) long. Shipwrecks occurring in shallow water nearer to shore are more likely to have been reworked and scattered by subsequent storms than those wrecks occurring at greater depths on the OCS. Historic research indicates that shipwrecks occur less frequently in Federal waters. However, these wrecks are likely to be better preserved, less disturbed, and, therefore, more likely to be eligible for nomination to the National Register of Historic Places than are wrecks in shallower State waters.

4. POTENTIAL ENVIRONMENTAL EFFECTS

4.1. PHYSICAL ELEMENTS OF THE ENVIRONMENT

4.1.1. Impacts on Water Quality

The proposed Gunnison Project in Garden Banks Blocks 667, 668, and 669 is located approximately 155 mi (249 km) from the nearest coastline. All discharges to water are regulated by the USEPA. Kerr-McGee would obtain permit coverage under USEPA's NPDES General Permit No. GMG290000.

Kerr-McGee proposes to install a spar floating production platform and associated anchor pilings and moorings, install subsea lease-term pipelines, jumpers, and umbilicals. They would complete seven wells and commence production through three subsea tie backs. Water quality could be affected by sediment disturbance during installation activities and by operational routine discharges of wastewater during completion and production activities. Accidental spills could also alter water quality.

The only drilling fluids to be discharged are residuals, which remain in the temporarily abandoned wells. Resuspended solids and discharged drilling fluids are not expected to impact coastal water quality. They would settle through the water column onto the seafloor. Produced-water discharges, the primary wastewater to be discharged, and other operational routine discharges are expected to be diluted to background levels prior to reaching coastal waters (Avanti Corporation, 1998). Accidental spills are addressed in Appendix A.

4.1.1.1. Coastal

Coastal waters could be degraded by onshore support operations such as use of onshore support bases and associated navigation channels, dredging and sediment disturbance associated with construction or modification of onshore bases, and pipeline emplacement to bring oil and gas to shore. Kerr-McGee plans to use existing onshore support bases at Sabine Pass and Galveston, Texas. No expansion of these onshore facilities is expected to result from the proposed activities. No increase in maintenance dredging of access canals is expected.

No new nearshore or onshore pipelines are proposed for the project. No sediment disturbance from pipeline emplacement in coastal waters would occur.

Waste waters would be discharged from the onshore bases as well as support vessels. State regulations are in place to control contaminants associated with these waste discharges. Minor, transient changes in localized water quality would be intermittent, resulting from such waste discharges.

Conclusion

The proposed action would use existing onshore support facilities. These facilities are not expected to expand their operations to support the proposed activity and no new coastal pipeline or channels are proposed. As a result, only discharges from the support facilities and vessel traffic associated with the proposed action would result in a negative impact to coastal waters. The level of this impact is expected to be very minor and transient, negligibly affecting water quality. Offshore activities associated with the project are not expected to adversely affect coastal water quality because of the water depth and the 155-mi distance of the project from the coast.

4.1.1.2. Offshore

Offshore activities that have the potential to change water quality include sediment disturbance and discharge of wastes. Sediment disturbance would occur during emplacement of the mooring system for the proposed spar. The installation of anchor systems, pipelines, and other subsea infrastructure during emplacement operations would also result in some sediment disturbances.

Discharged wastes include residual drilling fluids, discharges of well treatment, completion fluids or workover fluids, operational routine discharges of wastewater during drilling, completion and production activities, and sanitary and domestic waste discharges. Accidental spills could also occur. Decommissioning effects would presumably be similar in scope and magnitude with offshore construction and installation operations. All discharges would adhere to existing regulatory discharge standards designed to mitigate environmental effects.

Sediment disturbance and increased turbidity would create little impact on the water quality because the inputs would be limited in amount and would occur over a 3-month time period. Light limitation, one of the effects of high turbidity, is not an issue in deepwater areas. Surface sediments in the deepwater GOM are relatively pristine so that any turbidity created by bottom disturbances would not decrease water quality other than for the expected temporary and localized total suspended solids (TSS) increase. In conclusion, any effects from elevated turbidity would be short term, localized, and reversible.

Table 4-1 provides an estimate of discharges to surrounding water by discharge type and volume or rate. Table 4-2 provides an estimate of waste types and volumes that will be transported to the shore base for disposal. Well treatment, completion, or workover fluids are primarily salt or acid solutions (Boehm, 2001). Some inert particulate materials may also be used. The NPDES permit requirements restrict the discharge of priority pollutants and oil. Spent fluids would be discharged intermittently at a rate of 300 bbl/day. Treatment, completion, or workover fluids could alter the pH or dissolved solids in the receiving water. Negligible impacts to water quality would result because of the limitations imposed by the NPDES requirements and the volume and rate of discharge.

Table 4-1

Estimates of Discharges to Surrounding Water

Waste Type	Amount to be Discharged	Maximum Discharge Rate	Treatment and/or Storage, Discharge Location, and Discharge Method
Water-based drilling fluids	1,000 bbl/well	Bulk discharge of mud in casing following temporary abandonment	GB 668—Discharge overboard
Produced water	40,000 bbl/day (maximum)	40,000 bbl/day	GB 668—Remove oil and grease and discharge overboard
Sanitary waste	20 gallon/ person/day	NA	GB 668—Chlorinate and discharge overboard
Domestic waste	30 gallon/ person/day	NA	GB 668—Remove floating solids and discharge overboard
Deck drainage	0-4,000 bbl/day (dependent upon rainfall)	NA	GB 668—Remove oil and grease and discharge overboard
Well treatment, workover, or completion fluids	300 bbl/day	300 bbl/day during this type of operation	GB 668—Remove oil and grease and discharge overboard
Uncontaminated fresh or seawater	Varied	NA	GB 668—Discharge overboard
Desalinization unit water	700 bbl/day	NA	GB 668—Discharge overboard
Uncontaminated ballast water	10,000 bbl	400 gal/min (pump capacity)	GB 668—Discharge overboard
Miscellaneous discharges to which treatment chemicals have been added	Varied	NA	GB 668—Discharge overboard
Other miscellaneous discharges	Varied	NA	GB 668—Discharge overboard

GB – Garden Banks.
NA – not applicable.

Table 4-2

Estimates of Waste Types and Volumes

Type of Waste	Amount	Rate per Day	Name/Location of Disposal Facility	Treatment and/or Storage, Transport, and Disposal Method
Produced sand	200 lb/year	0.6 bbl/day	Newpark	Store in cuttings box and transport by boat to shore base
Waste oil	200 bbl/yr	0.5 bbl	Aaron Oil or Omega Waste Management	Pack in drums and transport by boat to shore base
NORM-contaminated waste	1 ton	NA	Newpark	Transport to a transfer station via dedicated barge
Trash and debris	1,000 ft^3	3 ft^3	Omega Waste Management	Transport in storage bins on boats to shore base
Chemical product wastes	100 bbl	2 bbl/day	Vendor or Omega Waste Management	Transport in barrels on boat to shore base
Workover fluids- (not discharged)	150 bbl	2 bbl/day	Newpark	Transport in barrels on boats or barge to shore base

Note: 1. Newpark Transfer Stations are located in Galveston and Port Arthur, Texas.
2. Aaron Oil is located in Mobile, Alabama.
3. Omega Waste Management is located in Patterson, Louisiana.
4. Waste for land disposal or recycling is normally brought to the shore base by workboat. From the shore base, it is usually transported to the disposal or recycling site by truck.

A maximum of 40,000 bbl of produced water per day would be discharged over the life of the project. In the early years of production, the project would generate smaller volumes of produced water. Contaminants in the produced-water discharge stream may contain elevated levels of hydrocarbons and metals, and produced water would be discharged more or less continuously from a surface outlet throughout the production phase (Neff et al., 1997). Any produced water that has been treated and discharged is expected to disperse rapidly into the open oceanic environment. Because of the water depth, elevated concentrations of hydrocarbons or metals are not expected in bottom sediments. Produced-water discharges in Grid 3 would disperse in the water column before they reach the bottom and, thus, are not expected to concentrate in the benthic environment.

Sanitary and domestic waste discharges from personnel on-site (50 gal/day/person) are expected to increase nutrient input and biological oxygen demand (BOD) slightly, but this is not normally a concern in open oceanic waters. Other minor discharges from development activities such as deck drainage, other well fluids, and cooling water would affect water quality (e.g., TSS, nutrients, chlorine, BOD) within tens of meters of the discharge.

Accidental spills are examined in Appendix A. Oil from a spill would weather dependent upon a number of factors, particularly the characteristics of the released oil and oceanographic conditions. In a subsurface release, some of the subsurface oil may disperse within the water column, as in the case of the *Ixtoc I* seafloor blowout. Evidence from a recent experiment in the North Sea indicated that oil released during a deepwater blowout (844-m water depth) would quickly rise to the surface and form a slick (Johansen et al., 2001). Once the oil enters the ocean, a variety of physical, chemical, and biological processes act to disperse the oil slick. These processes include spreading, evaporation of the more volatile constituents, dissolution into the water column, emulsification of small droplets, agglomeration sinking, microbial modification, photochemical modification, and biological ingestion and excretion. Some oil from the slick would be mixed into the water and dispersed by wind and waves. The quality of marine waters would be temporarily affected by the dissolved components and by the small, dispersed oil droplets that do not rise to the surface but are mixed down by surface turbulence. Dispersion by currents and microbial degradation remove the oil from the water column and dilute the constituents to background levels.

Conclusion

Near-bottom water quality would be affected by sediment disturbance during the period of installation of subsea infrastructure, including the anchor piles, moorings, and pipelines. Any effects from the elevated turbidity would be short term, localized, and reversible. All produced water, well treatment, completion, or workover fluids that have been treated and discharged are expected to affect a relatively small area of oceanic water, would be rapidly diluted, and would disperse into the open oceanic environment. Produced-water discharges would disperse in the water column before they reach the bottom and thus would not influence sediments or interact with the benthic environment. Routine operational wastes and other minor discharges that have been treated and discharged are expected to affect only the immediate area, would be diluted, and would disperse rapidly into the open ocean.

Offshore effects from an accidental spill of oil would affect water quality immediately under the slick (top few meters of the water column). Operator-initiated activities to contain and clean up an oil spill would begin as soon as possible after an event. However, the remaining portion of the discharged oil would weather, disperse, and biodegrade within a short period of time so that no significant long-term effects to offshore water quality are expected to occur.

4.1.2. Impacts on Air Quality

The oil and gas activities proposed for the Gunnison Project would generate air pollutants due to emissions from operations of diesel and turbine equipment such as generators, compressors, crew and supply vessels, barges, tugs, and drilling rigs. These emissions would only affect the immediate vicinity of the proposed actions. Air pollutant emissions are readily dispersed by typical over-water atmospheric turbulence; therefore, onshore impacts are expected to be insignificant. Impacts from oxides of nitrogen (NO_x) would be highest during the third year when drilling and construction are taking place. SO_x emissions will be highest during the days when flaring occurs.

Under normal operations, a minor amount of volatile organic compounds (VOC's) would be emitted directly into the atmosphere from various facilities and equipment, such as pipe-fittings, storage tanks, pumps, glycol dehydrators, and turbines. Highly volatile, low molecular weight hydrocarbons would be released to the atmosphere from the formation. The VOC's in the released hydrocarbons are precursors to photochemically produced ozone. A spike in VOC's could contribute to a corresponding spike in ozone, especially if the release was to occur on a hot sunny day in a NO_2-rich environment. The nearby onshore areas are all currently in attainment for ozone. Methane, the primary component of the gas stream, is a greenhouse gas. If a fire occurs, particulate and combustible emissions will be released in addition to the VOC's.

Conclusion

The proposed action is not expected to result in any significant impacts to air quality.

4.2. Biological Resources

4.2.1. Impacts on Sensitive Coastal Environments

4.2.1.1. Coastal Barrier Beaches and Associated Dunes

The following chapter describes potential impacts to coastal barrier beaches and associated dunes from oil spills that might occur as a result of proposed activities in Grid 3. The proposal for completion and production of seven wells from the surface location of the Gunnison spar in Garden Banks Block 668 and the tie back and production of an additional three wells that were previously completed subsea involves minimal risks of an oil spill. Table A-5 in Appendix A indicates less than a 0.5 percent probability of a spill occurring and contacting identified environmental features. Recent EIS's prepared by MMS provide additional information on oil spill risks and potential impacts (USDOI, MMS, 2002a and b).

In the unlikely event that a spill associated with the proposal occurs, the level of impacts will depend on many factors, including the type, rate, and volume of oil spilled and the weather and oceanographic conditions at the time of the spill. These parameters would determine the quantity of oil that is dispersed into the water column; the degree of weathering, evaporation, and dispersion of the oil before it contacts a shoreline; the actual amount, concentration, and composition of the oil at the time of shoreline or habitat contact; and a measure of the toxicity of the oil. The possible range for dispersal patterns of contacting oil ranges from small, diffusely scattered specks to heavy concentrations spread over the beach.

Severe adverse impacts to dunes contacted by a spill are very unlikely. For storm tides to carry oil from a spill across and over the dunes, strong southerly or easterly winds must persist for an extended time, prior to or immediately after the spill. Strong winds required to raise water levels adequately to contact dunes would also accelerate oil slick dispersal, thereby reducing impact severity at a landfall site. In addition, a study in Texas showed that oil disposal on vegetated sand dunes had no deleterious effects on the existing vegetation or on the recolonization of the oiled sand by plants (Webb, 1988).

Cleanup operations associated with large oil spills can affect the stability of barrier beaches more than the spill itself. If large quantities of sand were removed during spill cleanup operations, a new beach profile and sand configuration would be established in response to the reduced sand supply and volume. The net result of these changes would be accelerated rates of shoreline erosion at the contact site and down drift of that site. This situation would be accentuated in sand-starved or eroding barrier beaches, such as those found on Galveston Island and the Louisiana coast. State governments around the Gulf have recognized these problems and have established policies to limit sand removal by cleanup operations.

Conclusion

The proposed action is not projected to adversely alter barrier beach or dune configurations significantly as a result of a related oil spill, should one occur.

4.2.1.2. Wetlands

The following chapter describes potential impacts to wetlands and subtidal seagrass habitats from oil spills that might occur as a result of proposed activities in Grid 3. The proposal for completion and production of seven wells from the surface location of the Gunnison spar in Garden Banks Block 668 and the tie back and production of an additional three wells that were previously completed subsea, involves minimal risks of an oil spill. Table A-5 in Appendix A indicates less than a 0.5 percent probability of a spill occurring and contacting identified environmental features. Recent EIS's prepared by MMS provide additional information on oil spill risks and potential impacts (USDOI, MMS, 2002a and b). As discussed in USDOI, MMS (1998), distant offshore spills have a further diminished probability of impacting inland wetland shorelines and seagrasses, largely due to their sheltered locations.

In the unlikely event that a spill associated with the proposal occurs, the level of impacts will depend on many factors, including the type, rate, and volume of oil spilled and the weather and oceanographic conditions at the time of the spill. These parameters would determine the quantity of oil that is dispersed into the water column; the degree of weathering, evaporation, and dispersion of the oil before it contacts a shoreline; the actual amount, concentration, and composition of the oil at the time of shoreline or habitat contact; and a measure of the toxicity of the oil. The possible range for dispersal patterns of contacting oil ranges from small, diffusely scattered specks to heavy concentrations spread over the beach.

An inland fuel-oil spill may occur at a shore base or as a result of a vessel collision. The probability of an inland, fuel-oil spill occurring in association with the proposed action is also very small. Should a spill occur inshore or in nearshore waters, it presents a much greater potential for adversely impacting wetlands and seagrasses, due to their proximity to the spill. Oil could accumulate in sheens and thick layers in the marsh and in protected pools and embayments.

The works of several investigators (Webb et al., 1981 and 1985; Alexander and Webb, 1983, 1985, and 1987; Lytle, 1975; Delaune et al., 1979; and Fischel et al., 1989) were used to evaluate impacts of potential spills to wetlands. For wetlands along more stable coasts, such as in Texas, the critical oil concentration is assumed to be 1.0 l/m^2 of marsh. Concentrations above this will result in longer-term impacts to wetland vegetation, including some plant mortality and landloss. Concentrations less than this may cause die-backs for one growing season or less, depending upon the concentration and the season during which contact occurs.

4.2.1.3. Seagrasses

Seagrasses have generally experienced minor or no damage from oil spills (Zieman et al., 1984; Chan, 1977). The relative insusceptibility of seagrasses in the WPA to oil-spill impacts is partly the result of their location, which is subtidal, generally landward of barrier islands and in a region with a micro-tidal range. The lack of low-tide exposure protects seagrasses from direct contact with oil. The degree of impact depends on water depth, the nature of the oil, and the tidal and weather events in the affected area during the presence of the floating oil. Another reason for seagrass insusceptibility to oil spills is that a large percentage of their biomass is found in the buried root and rhizome, from which the leaves generate. An oil spill that moves over a seagrass area in the WPA would not be expected to directly cause anything but slight damage to the vegetation. Some seagrass die-back for one growing season might occur, largely depending upon water currents and weather. No permanent loss of seagrass habitat is expected to result from such spills.

Only during extremely low water, wind-driven tidal events might seagrass beds be exposed to the air such that they might be directly impacted by an oil slick. Even then, their roots and rhizomes remain buried in the water bottom. Given the geography of the coastal area discussed, a strong wind that could lower the water that much generally would be a northerly or westerly wind, which would push water out of bays and sounds and drive a slick away from the coast. In this situation, oil that was already in the bay or sound would be driven against the southern or eastern shores. Any seagrass beds that may be exposed there may be contacted.

The greatest oil-spill effect to seagrass communities has been to the diversity and populations of the epifaunal community found in the grass bed. Should water turbulence and turbidity increase sufficiently, some oil on the water surface may be emulsified. Suspended particles in the water column will adsorb oil from a sheen as well as from emulsified droplets, causing some particulates to clump together and decrease their suspendability. Typically, submerged vegetation reduces water velocity among the vegetation as well as for a short distance above it. Reduced flow velocity or turbulence further enhances sedimentation.

Minute oil droplets, whether emulsified or bound to suspended particulates, may adhere to the vegetation or other marine life; they may be ingested by animals, particularly by filter and sedimentation feeders; or they may settle onto bottom sediments in or around a bed. In these situations, oil has a limited life since it will be degraded chemically and biologically (Zieman et al., 1984). Because estuaries have a greater suspended particulate load and greater microbial populations, oil degrades more rapidly there (Lee, 1977). In an accident where high concentrations of hydrocarbons are mixed in to the water column, the diversity or population of epifauna and benthic fauna found in seagrass beds could be impacted. Seagrass epiphytes are sessile plants and animals that grow attached to their seagrass host. They play an important role in the highly productive seagrass ecosystem. The small animals, such as amphipods, limpets, and snails would likely show more lethal effects than the epiphytic plant species. The lack of grazers could lead to a short-term (up to 2 years) imbalance in the seagrass epifaunal community and cause stress to the seagrass due to epiphyte overgrowth.

A more damaging scenario would involve the secondary impacts of a slick that remains, for a period of time, over a submerged bed of vegetation in a protected embayment during typical fair-weather conditions. This would reduce light levels in the bed. If light reduction continues for several days, chlorophyll content in the leaves will be reduced (Wolfe et al., 1988), causing the grasses to yellow, reducing their productivity. By itself, shading from an oil slick should not last long enough to cause mortality. This depends upon the slick thickness, currents, weather, efforts to clean up the slick, and the nature of the embayment.

Also, a slick that remains over a submerged vegetation bed in an embayment will reduce or eliminate oxygen exchange between the air and the water of the embayment. Currents may not flush adequate oxygenated water from the larger waterbody to the shallow embayment. Seagrasses and related epifauna might be stressed and perhaps suffocated if the biochemical oxygen demand is high, as would be expected for a shallow waterbody that contains submerged vegetation, with its usual detritus load, and an additional burden of spilled oil (Wolfe et al., 1988).

The cleanup of slicks that come to rest in shallow or protected waters [0 to 1.5 m (0 to 5 ft) deep] may be performed using "john" boats, booms, anchors, and skimmers mounted on boats or shore vehicles. Personnel assisting in oil-spill cleanup in water shallower than about 1 m (3-4 ft) may readily wade through the water to complete their tasks. Foot traffic and equipment can easily damage the seagrass beds. Oil can also be worked more deeply into their sediments by these activities.

As described for wetlands, oil that penetrates or is buried into the water bottom is less available for dissolution, oxidation, or microbial degradation. Oil may then be detectable in the sediments for five years or more, depending upon circumstances.

Navigational vessels that vary their route from established navigational channels can directly scar shallow beds of submerged vegetation with their props, keels (or flat bottoms), and anchors (Durako, et.al., 1992).

Conclusion

Adverse impacts to wetlands resulting from a proposed project-related spill are highly unlikely to occur. If a spill occurs at the project site, oceanographic and meteorological conditions are very unlikely to move oil far enough in a short enough time to cause oil contacts with wetlands or seagrasses. If an unlikely, related fuel-oil spill occurs inshore, some wetlands in the spill vicinity may be adversely impacted; seagrasses are unlikely to be impacted directly. A spill's secondary impacts, including shading, suffocation, and cleanup activities, present a greater impact potential. Due to their low frequency of occurrence in the region in which project-related impacts are likely to occur, protection for seagrass beds should be promoted.

4.2.2. Impacts on Deepwater Benthic Communities/Organisms

4.2.2.1. Chemosynthetic Communities

A biological review for the potential occurrence of chemosynthetic communities was performed. No areas for potential chemosynthetic communities were identified in the area, including the 457-m (1500-ft) avoidance distance from the discharging structure, which is required by NTL 2000-G20. No other potential chemosynthetic community areas were identified within 152 m (500 ft) of all anchor locations or anchor chain/cable impacting areas. The closest known chemosynthetic community is located in Garden Banks Block 535, more than 10 nmi to the north-northeast.

Conclusion

The proposed Gunnison Project would not have an impact on known chemosynthetic communities, and no potential communities are located in the vicinity of the impacting activities, as indicated by geophysical characteristics.

4.2.2.2. Deepwater Benthos and Sediment Communities

The deepwater benthos in the immediate vicinity of the proposed project would be impacted by the discharge of limited quantity of water-based drilling mud, placement of mooring lines, and anchor palcement. The most common adverse impact would be physical smothering by sediments. Invertebrates, many with some degree of mobility, typically dominate the megafaunal benthic communities at the project depth of 960 m. The macrofauna is dominated by deposit-feeding polychaete worms with varying degrees of mobility and tolerance to disturbance. The meiofauna, primarily composed of small nematode worms, is more abundant than macrofauna, and their numbers decline with depth. Little is known of the microbiota in deep water, but it probably includes hydrocarbon-degrading forms. None of the benthic communities found in Garden Banks Block 668 are unique to the area and appear to be widespread throughout the Gulf, where depths, substrates, and other environmental factors are similar.

The effects of drilling muds will be very limited as the wells have been previously drilled. Only a limited amount of water-based drilling mud will be discharged. No synthetic-based fluids or drill cuttings will be discharged as part of this DOCD.

The anchor system for the truss spar and the mooring lines should have minimal effects on the benthos. Installation of the anchors and activities at the proposed well sites would physically disturb the benthos in the immediate area. The benthos would also be affected in the unlikely event of a subsea blowout that caused disturbance and slumping of the surrounding seabed.

Conclusion

Structure emplacement (including anchor installations and moorings) and well completion operations would disturb benthic communities by smothering and displacing them from patches within limited distances of the well site locations and within a small area of the anchors and chains or cables that contact the bottom. Partial recovery of the community would occur within weeks or months of the disturbance, probably followed by a more or less full recovery within 1-2 years. This would not result in a significant impact on the benthic communities because the duration and area extent of the proposed activities would be limited.

Routine production activities would not significantly impact the benthos. A subsea blowout would physically disturb the benthos within a small radius of the blowout, but most of the released fluids are expected to go to the surface and not interact with deepwater benthos.

4.2.3. Impacts on Marine Mammals

Factors that could adversely affect cetaceans include increased vessel traffic, degradation of water quality from operational discharges, helicopter and vessel traffic noise, platform and drillship noise, structure removals, seismic surveys, oil spills, oil-spill-response activities, loss of debris from service vessels and OCS structures, commercial fishing, capture and removal, and pathogens. The cumulative impact on cetaceans is expected to result in a number of chronic and sporadic sublethal effects that may serve to stress and/or weaken individuals of a local group or population and make them more susceptible to infection from natural or anthropogenic sources. Few lethal effects are expected from oil spills, chance collisions with service vessels, ingestion of plastic material, fishing, and pathogens. Oil spills of any size are estimated to be aperiodic events that may contact cetaceans. Deaths as a result of structure removals are not expected to occur because of anticipated mitigation measures required by NMFS. Disturbance (e.g., noise) and/or exposure to sublethal levels of biotoxins and anthropogenic contaminants may stress animals, weaken their immune systems, and make them more vulnerable to parasites and diseases that normally would not be fatal.

Another factor of concern is the ability that cetaceans (more specifically, sperm whales) possess for detecting and avoiding the various flowlines, risers, umbilicals, and mooring lines associated with the Gunnison spar. Sperm whales are known to get entangled in deep-sea cables (Heezen, 1957). The net result of any disturbance would depend on the size and percentage of the population affected, ecological importance of the disturbed area, environmental and biological parameters that influence an animal's sensitivity to disturbance and stress, and the accommodation time in response to prolonged disturbance (Geraci and St. Aubin, 1980). Collisions between cetaceans and ships could cause serious injury or death (Laist et al., 2001). Sperm whales are one of 11 whale species that are hit commonly by ships (Laist et al., 2001). Collisions between OCS vessels and cetaceans in the grid area are expected to be unusual events.

Conclusion

The proposed action is unlikely to have significant long-term adverse impacts on the size and productivity of any marine mammal species or population stock in the northern GOM.

4.2.4. Impacts on Sea Turtles

Factors that have the potential to impact sea turtles include structure installation, dredging, water quality and habitat degradation, OCS-related trash and debris, vessel traffic, structure removals, oil spills, oil-spill-response activities, natural catastrophes (e.g., hurricanes), pollution, dredging operation, vessel traffic, commercial and recreational fishing, consumption by humans, beach lighting, and entrainment in power plants. Small numbers of turtles could be killed or injured by chance collision with service vessels or by eating indigestible trash, particularly plastic items, accidentally lost from drill rigs, production facilities, and service vessels. Deaths due to structure removals are not expected due to anticipated mitigation measures that are required by NMFS. The presence of service vessels and the noise they produce could disrupt normal behavior patterns and physiologically stress the turtles, making them more susceptible to disease. Contaminants in waste discharges and drilling muds could indirectly affect turtles through food-chain biomagnification; there is uncertainty concerning the possible effect. Oil spills and oil-spill-response activities are potential threats that may be expected to cause turtle deaths, but the risks are greatly reduced by spill contingency planning and the habitat protection requirements of the Oil Pollution Act of 1990. Contact with oil and consumption of oil and oil-contaminated prey may seriously impact turtles.

Conclusion

Most OCS-related impacts are estimated to be sublethal. Chronic sublethal effects (e.g., stress) resulting in persistent physiological or behavioral changes and/or avoidance of impacted areas could cause declines in survival or productivity, resulting in either acute or gradual population declines. The proposed action is unlikely to have significant long-term adverse effects on the size and productivity of any sea turtles species or population stock in the northern GOM.

4.2.5. Impacts on Coastal and Marine Birds

This chapter discusses the possible effects of the proposed action on coastal and marine birds of the Gulf of Mexico and its contiguous waters and wetlands. Air emissions, water quality degradation resulting from discharges, helicopter and service-vessel traffic and noise, discarded trash and debris from service vessels and the drilling rig, a 5,700-bbl per day blowout at the proposed spar site, and spill-response activities are sources of potential adverse impacts. Any effects would be especially critical for intensively managed populations, such as endangered and threatened species, that need to maintain a viable reproductive population size or that depend upon a few key habitat factors. Species of special concern are often populations at the edge of their range. These populations may be more vulnerable to impacts than populations of the same species living near the center of their range.

Emissions of pollutants into the atmosphere from the activities associated with the proposed action are projected to have minimum effects on offshore air quality because of the prevailing atmospheric conditions, emission heights, and pollutant concentrations. Such emissions are projected to have negligible effects on onshore air quality because of the atmospheric regime, emission rates, and distance of these emissions from the coastline. These judgements are based on average steady state conditions; however, there will be days of low mixing heights and low wind speeds that could further decrease air quality. These conditions are characterized by fog formation, which in the Gulf occurs about 35 days a year, mostly during winter. Impacts from offshore sources are reduced in winter because the frequency of significant onshore winds decreases (37%) and the removal of pollutants by rain increases. The summer is more conducive to air quality effects as onshore winds occur more frequently, approximately 61 percent of the time.

Helicopter and service-vessel traffic related to the proposed action could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. These impact-producing factors could contribute to indirect population loss through reproductive failure resulting from nest abandonment. The FAA (Advisory Circular 91-36C) and corporate helicopter policy state that, when flying over land, the specified minimum altitude is 610 m (2,000 ft) over populated areas and biologically sensitive areas such as wildlife refuges and national parks. However, pilots traditionally have taken great pride in not disturbing birds. It is expected that approximately 10 percent of helicopter trips would occur at altitudes somewhat below the minimums listed above as a result of inclement weather. Although these incidents are very short term in duration and sporadic in frequency, they can disrupt coastal bird behavior and, at worst, possibly result in habitat or nest abandonment.

Service vessels would use selected nearshore and coastal (inland) navigation waterways or corridors, and adhere to protocol set forth by the USCG for reduced vessel speeds within these inland areas. Routine presence and low speeds of service vessels within these waterways would diminish the effects of disturbance from service vessels on nearshore and inland populations of coastal and marine birds. The effects of service-vessel traffic on birds offshore would be negligible.

Seabirds (e.g., laughing gulls) that remain and feed in the vicinity of the spar structure could be affected by operational discharges or runoff in the offshore environment. These impacts could also be both direct and indirect.

Coastal and marine birds are commonly entangled and snared in discarded trash and debris. In addition, many species will readily ingest small plastic debris, either intentionally or incidentally. Interaction with plastic materials is therefore very serious and can lead to permanent injuries and death. It is expected that coastal and marine birds would seldom become entangled in or ingest OCS-related trash and debris as a result of MMS's prohibitions on the disposal of equipment, containers, and other materials into offshore waters by lessees (30 CFR 250.40). In addition, 33 U.S.C. §§ 1901 et seq., which prohibits the disposal of any plastics at sea or in coastal waters, is enforced by the Coast Guard. However, generally violations of the law are not reported to the Coast Guard. Nevertheless, it is expected that plastic debris would seldom interact with coastal and marine birds; therefore, the effect would be negligible.

Various birds along shoreline contacted by spilled oil could experience mortality and reproductive losses. Recovery would depend on later influxes of birds from nearby feeding, roosting, and nesting habitat. Spill risk estimates are available for the shoreline potentially contacted by an oil spill (Cameron County, Texas, to Monroe County, Florida). In all cases, spill risk within 30 days was negligible (<0.5%) (Appendix A).

An oil spill of 5,700 bbl per day for three days from a blowout at the well site is the operator's assumed oil-spill scenario (Appendix A). Various birds along contacted shoreline could experience mortality and reproductive losses. Recovery would depend on later influxes of birds from nearby feeding, roosting, and nesting habitat.

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersant and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, will also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat similar to that of oil in its effects to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone; however, successful dispersal of a spill will generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in the size of an established breeding population may also be a result of disturbance in the form of increased human activity for cleanup and monitoring efforts or to the intensified research activity after the oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, have extremely limited applicability (Clark, 1984).

Federally Endangered and Threatened Birds

Piping Plover

The impacts on shorebirds not listed as endangered or threatened discussed above also apply to the piping plover. The amount of shoreline affected by spilled oil would be small compared to the extensive shoreline habitat available. Spill risk estimates are available for the shoreline potentially contacted by an oil spill (Cameron County, Texas, to Monroe County, Florida). In all cases, the spill risk within 30 days was negligible (<0.5%) (Appendix A).

Bald Eagle

The bald eagle feeds on fish, waterfowl, shorebirds, and carrion near water. The bald eagle may eat dead or dying contaminated fish and birds because it consumes carrion. This bird may come in contact with an oil spill by eating contaminated dead and dying prey. Bald eagles have narrow preferences for nesting habitat. Any oiling of aquatic feeding habitat resulting in nest site abandonment could lead to relocation of a nest to less preferred habitat. This event in turn would reduce population growth for this already threatened species. However, the bald eagle has high mobility and, when an oil slick enters the feeding habitat, may relocate feeding to unpolluted parts of the waterbodies. When relocating feeding far from the nest, the eagle would successfully home to its nest after feeding because it prefers to build its nest in a highly visible place over the forest canopy with a clear short path from the water. After the *Exxon Valdez* spill in Prince William Sound (PWS) on March 24, 1989, the PWS bald eagle population returned to its estimated pre-spill size by 1995. The population increased at an average annual rate of 3.7 percent from 1982 to 1995 (Bowman et al., 1997). Spill risk estimates for the shoreline potentially contacted by an oil spill (Cameron County, Texas, to Monroe County, Florida). In all cases, the spill risk within 30 days is negligible (<0.5%) (Appendix A).

Brown Pelican

The brown pelican is a species of special concern in Louisiana and Mississippi, and it is no longer listed as endangered or threatened in Florida or Alabama (USDOI, FWS, 1998). This bird has no nesting reported in Mississippi. The bird nests on Guillard Island, Mobile Bay, which is a dredge spoil island in Alabama. Impacts on brown pelicans would be the same as for other nonendangered and nonthreatened seabirds, as analyzed above in this chapter.

It is expected that the majority of effects from the major impact-producing factors on coastal and marine birds would be sublethal (behavioral effects and nonfatal intake of discarded debris), causing temporary disturbances and displacement of localized groups inshore. Chronic stress, such as digestive upset, partial digestive occlusion, sublethal poisoning, or behavior changes, however, is often undetectable in birds. It could serve to weaken individuals, and expose them to infection and disease. Migratory species would be especially vulnerable. Death could result primarily from spilled oil and associated spill-response activities, and this could be especially serious for the brown pelican. Any reductions in population size represent a threat to the bird's existence. Spill risk estimates are available for the shoreline potentially contacted by an oil spill (Cameron County, TX, to Monroe County, FL). In all cases spill risk within 30 days was negligible (< 0.5 percent) (Appendix A).

Oil-spill cleanup methods often require heavy trafficking of beaches and wetland areas, application of oil dispersants and bioremediation chemicals, and the distribution and collection of oil containment booms and absorbent material. The presence of humans, along with boats, aircraft, and other technological creations, would also disturb coastal birds after a spill. Investigations have shown that oil-dispersant mixtures pose a threat like that of oil to successful reproduction in birds (Albers, 1979; Albers and Gay, 1982). The external exposure of adult birds to oil/dispersant emulsions may reduce chick survival more than exposure to oil alone would; however, successful dispersal of a spill would generally reduce the probability of exposure of coastal and marine birds to oil (Butler et al., 1988). It is possible that changes in size of an established breeding population may also be a result of disturbance in the form of personnel for shoreline cleanup, monitoring efforts, or the intensified research activity after oil spills (Maccarone and Brzorad, 1994). Studies are indicating that rescue and cleaning of oiled birds makes no effective contribution to conservation, except conceivably for species with a small world population (Clark, 1978 and 1984). A growing number of studies indicate that current rehabilitation techniques are not effective in returning healthy birds to the wild (Anderson et al., 1996; Boersma, 1995; Sharp, 1995 and 1996). Preventative methods, such as scaring birds from the path of an approaching oil slick or the use of booms to protect sensitive colonies in an emergency, are also not effective (Clark, 1984).

Conclusion

Oil spills from a proposed action pose the greatest potential direct and indirect impacts to coastal and marine birds. Birds that are heavily oiled are usually killed. If physical oiling of individuals or local groups of birds occurs, some degree of both acute and chronic physiological stress associated with direct and secondary uptake of oil would be expected. Small coastal spills could contact and affect the different groups of coastal and marine birds, most commonly marsh birds, waders, waterfowl, and certain shorebirds. Lightly oiled birds can sustain tissue and organ damage from oil ingested during feeding and grooming or from oil that is inhaled. Stress and shock enhance the effects of exposure and poisoning. Low levels of oil could stress birds by interfering with food detection, feeding impulses, predator avoidance, territory definition, homing of migratory species, susceptibility to physiological disorders, disease resistance, growth rates, reproduction, and respiration. The toxins in oil can affect reproductive success. Indirect effects occur by fouling of nesting habitat, and displacement of individuals, breeding pairs, or populations to less favorable habitats.

Dispersants used in spill cleanup activity can have toxic effects similar to oil on the reproductive success of coastal and marine birds. The, air, vehicle, and foot traffic that takes place during shoreline clean up activity can disturb nesting populations and degrade or destroy habitat.

4.2.6. Impacts on Fish Resources

Minor sources of discharges associated with the proposed action to marine waters are muds and cuttings resulting from completion activities. A limited amount of mud discharge is expected from the completion operations. However, drilling muds contain materials, such as lead and cadmium, that in high concentrations are toxic to fishery resources (detailed in Section IV.A.3.b. of USDOI, MMS, 2001); the plume is expected to disperse rapidly, is very near background levels at a distance of 1,000 m (3,281 ft), and is usually undetectable at distances greater than 3,000 m (9,843 ft). In this specific action, discharges will be far less than during the drilling of the wells themselves.

Based on historical data, MMS estimates the rate at which spills $\geq$1,000 bbl occur from platforms is 0.13 spills per billion barrels produced. See Appendix A for an in-depth evaluation of potential spill events.

The probability that a hypothetical oil spill $\geq$1,000 bbl from the proposed facilities contacting a land segment within 3-10 days is less than 0.5 percent (Price et al., 1999). Only after 30 days do the probabilities increase and range from 1 to 6 percent for a spill event to contact a land segment. Although not a significant concern at the distance from shore for this action, discussion of impacts of oil spills to coastal and estuary environments and fisheries are detailed in Sections IV.D.1.a.(1) and (8) in the Final EIS for Western GOM Lease Sales 171, 174, 177, and 180 (USDOI, MMS, 1998), Discussions of impacts to essential fish habitat are detailed in Section IV.D.1.a.(10) of the Final EIS for Eastern GOM Lease Sale 181 (USDOI, MMS, 2001b).

If a blowout or a spill from any source was abated early, the impact on fisheries and commercial populations would likely be small.

There is no evidence at this time that commercial fisheries in the Gulf have been adversely affected on a regional population level by oil spills. However, the worst case blowout scenario could introduce a moderate amount of oil to surface waters over a short period of time. Adult fish would likely avoid the area of a spill, but fish eggs and larvae within the relatively small spill area of the northern Gulf of Mexico could be killed.

4.2.6.1. Adults

Regardless of spill size, adult fish are likely to actively avoid an oil spill, thereby limiting the effects and lessening the extent of damage (Baker et al., 1991; Malins et al., 1982). This behavior explains why there has never been a commercially important fish-kill on record following an oil spill. Observations at oil spills around the world, including the *Exxon Valdez* spill in Prince William Sound, consistently indicate that free-swimming fish are rarely at risk from oil spills (NRC, 1985). Some recent work has demonstrated avoidance of extremely small concentrations of hydrocarbons. Farr et al. (1995) reported the behavioral avoidance of dissolved concentrations of a PAH as low as 14.7 μg/l by a species of minnow.

Adult fish must experience continual exposure to relatively high levels of hydrocarbons over several months before secondary toxicological compounds that represent biological harm are detected in the liver (Payne et al., 1988). The direct effects of spilled oil on fish occur through the ingestion of oil or oiled prey and through the uptake of dissolved petroleum products through the gills and epithelium by adults and juveniles (NRC, 1985). Upon exposure to spilled oil, liver enzymes of fish oxidize soluble hydrocarbons into compounds that are easily excreted in the urine (Spies et al., 1982). Ordinary environmental stresses may increase the sensitivity of fish to oil toxicity. These stresses may include changes in salinity, temperature, and food abundance (Evans and Rice, 1974; NRC, 1985). Migratory species, such as mackerel, cobia, and crevalle jack, could be impacted if oil spills covered large areas of nearshore open waters.

The only adult fish-kill on record following an oil spill was on the French coast in 1978 when several tons of small rock-clinging fish (not commercially harvested) were killed at the site of the *Amoco Cadiz* wreck (volume of oil spilled was approximately six times that of the *Exxon Valdez*).

4.2.6.2. Eggs and Larvae

For OCS-related oil spills to have a substantial effect on a commercial fishery resource, whether estuary dependent or not, eggs and larvae would have to be concentrated in the immediate spill area. This area could be very large considering the maximum blowout discharge volume. Oil components also would have to be present in highly toxic concentrations when both eggs and larvae are in the pelagic stage (Longwell, 1977). When contacted by spilled oil, floating eggs and larvae (with their limited mobility and physiology), and most juvenile fish are killed (Linden et al., 1979; Longwell, 1977). However, fish overproduce eggs on an enormous scale, and the overwhelming majority of them die at an early stage, generally as food for predators. It is likely that even a heavy death toll from a single large oil spill would not have a detectable effect on the adult populations that are exploited by commercial fisheries. This has been confirmed during and after the *Torrey Canyon* spill off southwest England and the *Argo Merchant* spill off Nantucket. In both cases, a 90 percent death of fish eggs and larvae, pilchard and pollack, respectively, was observed in the affected area, but this had no impact on the regional commercial fishery (Baker et al., 1991).

Oil spills that contact coastal bays, estuaries, and waters of the Gulf when pelagic eggs and larvae are present have the greatest potential to affect commercial fishery resources. An oil spill contacting a low-energy inshore area would affect localized populations of commercial fishery resources, such as menhaden, shrimp, and blue crabs.

In the event that oil spills should occur in coastal bays, estuaries, or waters of the OCS proximate to mobile adult finfish or shellfish, the effects are expected to be nonfatal and the extent of damages are expected to be limited and lessened due to the capability of adult fish and shellfish to avoid an oil spill, to metabolize hydrocarbons, and to excrete both metabolites and parent compounds. For floating eggs and larvae contacted by spilled oil, the effect is expected to be lethal.

The incremental contribution of the proposed action to the cumulative impacts would be small. The proposed action would add slightly to the overall offshore water quality degradation through the disposal of offshore operational wastes. Other activities of the proposed action potentially contributing to regional impacts would be the effects of potential petroleum spills. Impact-producing factors of the cumulative scenario in the area of the proposed action that are expected to substantially affect fish resources and EFH include overfishing. The incremental contribution of the proposed action to the cumulative impact is negligible.

Conclusion

It is expected that marine environmental degradation from the proposed action would have little effect on fish resources or EFH. The impact of marine environmental degradation is expected to cause an undetectable decrease in fish populations or EFH. It is expected that subsurface blowouts that may occur as a result of the proposed action would have a negligible effect on Gulf fish resources.

4.3. Impacts on Socioeconomic Conditions and Other Concerns

4.3.1. Effects on Economic and Demographic Conditions

In Chapter 3.2.7.1.1, the MMS defined the potential impact region as that portion of the GOM coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. In this chapter, MMS projects how and where future changes will occur and whether they correlate with the proposed action.

4.3.1.1. Population and Education

The impact region's population will continue to grow, but at a slower rate. Minimal effects on population are projected from activities associated with the proposed action. While some of the labor force is expected to be local to the Galveston/Sabine Pass areas, most of the additional employees associated with the proposed action are not expected to require local housing. Activities related to the proposed activity are not expected to significantly affect the region's educational level.

Conclusion

Activities related to the proposed activity are not expected to significantly affect the region's population and educational level.

4.3.1.2. Infrastructure and Land Use

While OCS-related servicing should increase in Galveston, Texas, no expansion of these physical facilities is expected to result from the proposed activity. The existing onshore base located in Sabine Pass, Texas, while not adding a C-port as is Galveston, is also likely to benefit from OCS-related servicing. However, no expansion of Sabine Pass's physical facilities is expected to result from the Gunnison proposal. Changes in land use throughout the region as a result of the proposed activity are expected to be contained and minimal. While land use in the impact area will change over time, the majority of this change is estimated as general regional growth. Increased OCS deepwater activity is expected to impact Galveston, Texas, and other OCS ports with deepwater capability. The proposed activity is not expected to cause expansion to the Galveston and Sabine Pass support bases that Kerr-McGee plans to use.

Conclusion

The proposed action is not expected to significantly affect the region's infrastructure and land use.

4.3.1.3. Navigation and Port Usage

The proposed action would use the existing onshore support bases located in Sabine Pass, Texas, to support production activities and possibly completion activities or workovers. Kerr-McGee may also use onshore facilities located in Galveston, Texas, as a port of debarkation for completions and workovers. Both Sabine Pass and Galveston are capable of providing the services necessary for the proposed activities; therefore, no onshore expansion or construction is anticipated with respect to the proposed action.

During production operations, two round-trip vessel trips a week are anticipated. The vessels to be used will be workboats. During completion activities or workovers, three round-trip vessel trips are planned. These vessels will also be workboats.

Conclusion

No impacts to navigation and port usage are expected as result of this proposed action.

4.3.1.4. Employment

The importance of the oil and gas industry to the coastal communities of the GOM is significant, particularly in Louisiana, eastern Texas, and coastal Alabama. Dramatic changes in the level of OCS oil and gas activity over recent years have resulted in similar fluctuations in population, labor, and employment in the GOM region. This economic analysis focuses on the potential direct, indirect, and induced impacts of the OCS oil and gas industry on the population and employment of the counties and parishes in the impact region.

To improve regional economic impact assessments and to make them more consistent with each other, MMS recently developed a methodology for estimating changes to employment and other economic factors. The methodology developed to quantify these impacts on population and employment takes into account changes in OCS-related employment, along with population impacts resulting from these employment changes within each individual coastal subarea.

The model for the GOM region has two steps. Because there are no publicly available models that estimate the expenditures resulting from offshore oil and gas activities, the first step in the model estimates the expenditures resulting from the drilling of four exploratory wells and assigns these expenditures to industrial sectors in the 10 MMS coastal subareas defined in Chapter 3.2.7. A contracted effort "Modeling the Economic Impacts of Offshore Oil and Gas Activities in the Gulf of Mexico: Methods and Applications" was used for this. The second step in the model uses multipliers from the commercial input-output model IMPLAN (using 2000 data, the latest available data) to translate these expenditures into direct, indirect, and induced employment and other economic factors. Direct employment results from the first round of industry spending. It is the employment that results from the initial dollars spent by Kerr-McGee on the Gunnison proposal. Indirect employment results as the initial spending reverberates through the economy. First, the suppliers of the goods and services for the platform and wells spend the initial direct dollars from the industry. Then, these dollars are re-spent by other suppliers until the initial dollars have trickled throughout the economy. Labor income produces induced spending by the households receiving that income.

Both the level (the amount spent) and the sectoral (the industry in which it is spent) allocation of expenditures can vary considerably. Because local economies vary, a separate set of IMPLAN multipliers is used for each MMS coastal subarea to which expenditures are assigned. Each set of multipliers is based on the actual historical patterns of economic transactions in the area. Model results for employment are presented in number of jobs per year, where one job is defined as a year of employment. This does not necessarily mean only one person occupies the position throughout the year. One job may be equal to two part-time positions occupied over the year or one person occupying a position for 6 months, while another person occupies it for the other 6 months.

Total peak-year employment (direct, indirect, and induced) projections for the completion of the wells and the installation of the spar in 2003 is expected to be minimal at about 1,900 jobs throughout the Gulf of Mexico impact area. This is no more than 0.1 percent for any given subarea's baseline employment. Because these baseline projections assume the continuation of existing social, economic, and technological trends, they also include employment resulting from the continuation of current patterns in OCS Program activities. Based on model results, direct employment associated with the proposed action is estimated at about 900 jobs. Indirect employment for the peak year is projected at about 450 jobs, while induced employment is calculated to be about 520 jobs. Although the majority of employment is expected to occur in coastal Subarea TX-2, employment is not expected to exceed 0.1 percent of the total employment in any given subarea. Also, 60-75 jobs per year associated with production and workover activities are projected throughout the productive life of the proposal. This employment is expected to negligibly impact the impact area.

The resource costs of cleaning up an oil spill, both onshore and offshore, were not included in the above analysis for two reasons. First, oil-spill cleanup activities reflect the spill's opportunity cost. In other words, some of the resources involved in the cleanup of an oil spill, in the absence of that spill, would have produced other goods and services (e.g., tourism activities). Secondly, the occurrence of a spill is not a certainty. Spills are random accidental events. Given that the exploratory wells are drilled as described in the proposal, the timing, numbers, sizes, offshore locations of occurrence, and onshore locations of contact of potential spills occurring over the drilling life of the plan are all unknown variables. Appendix A discusses oil spills in general, and the expected sizes, number, and probability of a spill from the proposed action. Additionally, the cost involved in any given cleanup effort is influenced by a variety of factors: whether or not the oil comes ashore; the type of coastal environment contacted by the spill; weather conditions at the time of the incident; the type and quantity of oil spilled; and the extent and duration of the oiling. Nevertheless, the opportunity cost employment associated with cleaning up an oil spill is expected to run between $1.9 and $4.5 million per 1,000 bbl of oil spilled. Based on MMS model results, should a spill occur, it is projected to cost about 35-80 person-years of employment per 1,000 bbl spilled for cleanup and remediation, depending on whether some of the oil contacts land. The risk of an accident from the completion and installation activities is expected to be minimal. Employment associated with oil-spill cleanup is expected to be of short duration (less than 6 weeks), aside from employment associated with the legal aspects of a spill.

Conclusion

Negligible impacts to employment, including those that could result from a blowout and related spill cleanup scenario, are expected as a result of this proposed action.

4.3.1.5. Environmental Justice

Executive Order 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," directs Federal agencies to assess whether their actions have disproportionate environmental effects on people of ethnic or racial minorities or with low incomes. Those environmental effects encompass human health, social, and economic consequences.

The siting of onshore facilities related to OCS activities is usually based on economics, logistical considerations, zoning restrictions, and permitting requirements. Because of the need for contiguous land and the attraction of lower land values, such facilities, with their concomitant environmental implications, are often near low-income or minority populations. Within the impact region, the individuals potentially affected by the proposed action are African-Americans living in all of the Gulf Coastal States and low-income fishermen and timber harvesters in the coastal states. Native Americans are few and widely dispersed throughout the Gulf States. The impact region is not physically, culturally, or economically homogenous. Communities range in size from small municipalities to the urban. The racial and ethnic composition of the counties and parishes varies widely as does the distribution of income. While people of these minority groups are scattered throughout the impact region, there are concentrations.

The MMS does not anticipate any negative environmental effects on the minority or poor persons in the Gulf counties or parishes. In addition, disproportionate and negative effects should not occur because the facilities, land use, and jobs already exist. If these change, especially if they increase and cause disruptions of local neighborhoods, then the relevant regulatory agencies should pay particular attention to how these neighborhoods are affected.

Conclusion

Should Kerr-McGee complete the activities described in their Initial DOCD, there would be very little economic stimulus to the Gulf of Mexico coastal impact area. Minimal effects, if any, on population and education are projected from activities associated with the proposed action. While land use in the impact area will change over time, the majority of this change is estimated as general regional growth. Sabine Pass and Galveston, Texas, the designated service bases, are capable of providing the services necessary for the proposed activities; therefore, no onshore expansion or construction is anticipated with respect to the proposed action. Less than a 1 percent increase in employment in any impact subareas is expect as a result of the proposed action. The opportunity cost employment associated with oil-spill cleanup activities is expected to be temporary and of short duration.

4.3.2. Impacts on Commercial Fisheries

Commercial fishermen will actively avoid the area of a spill and the area where there are ongoing activities to control a blowout. Even if fish resources successfully avoid spills, tainting (oily-tasting fish), public perception of tainting, or the potential of tainting commercial catches from oil or dispersants will prevent fishermen (either voluntarily or imposed by regulation) from initiating activities in the spill area. This in turn could decrease landings and/or the value of catch for several months. However, Gulf of Mexico species can be found in many adjacent locations; Gulf commercial fishermen do not fish in one locale and have responded to past petroleum spills without discernible loss of catch or income by moving elsewhere for a few months.

Conclusion

There will be some unavoidable loss of space that could be utilized for pelagic fishing techniques such as long lines. Other unavoidable adverse impacts include loss of fishing space caused by the installation of pipelines, rigs, and platforms or by other OCS-related structures. These impacts are not considered to be significant. There are no commercially important species occurring at the water depth of this proposed action.

4.3.3. Impacts on Recreational Resources and Beach Use

The value of recreation and tourism in the Gulf of Mexico coastal zone from Texas through Florida has been estimated at almost $20 billion annually (USDOI, MMS, 1990). A significant portion of these expenditures is made in coastal counties, where major shoreline beaches are primary recreational attractions. In 1996, for example, well over 1 million people visited the beaches of Galveston Island and the Padre Island National Seashore, demonstrating the popularity of destination beach parks throughout the WPA as recreational resources.

The primary impact-producing factors associated with offshore oil and gas development, and most widely recognized as major threats to the enjoyment and use of recreational beaches, are oil spills (Appendix A) and trash and debris. Additional factors such as noise from aircraft can adversely affect a beach-related recreational experience. All these factors, either individually or collectively, may adversely affect the number and value of recreational beach visits. The major recreational activity occurring on the OCS is recreational fishing and diving. A substantial recreational fishery, including scuba diving, is directly associated with oil and gas production platforms and stems from the fact that platforms beneficially function as high-profile, artificial reefs that attract fish.

Conclusion

The risk of a large oil spill occurring due to the proposed development operations in Garden Banks Blocks 667, 668, and 669 is very small. In the event such a spill did occur, according to trajectory analysis from the OSRA model, there is a negligible chance that the spill would contact land within 30 days of a spill.

Kerr-McGee has an established waste management plan for all of their offshore operations. While some accidental loss of solid wastes may occur from time to time, it is expected to have a negligible impact on recreational resources.

4.3.4. Impacts on Archaeological Resources

4.3.4.1. Prehistoric

The Grid 3 area has no blocks specifically located within either of the MMS's designated high-probability areas for the occurrence of prehistoric or historic archaeological resources. Lease blocks with a high probability for prehistoric archaeological resources may only be found landward of a line that roughly follows the 60-m (200-ft) bathymetric contour. As stated in Section 3 of this document, MMS recognizes both the 12,000 B.P. date and 60-m water depth as the seaward extant of prehistoric archaeological potential on the OCS. The water depth of these lease areas is deeper than 200 m. Based on the extreme water depth of the Grid 3 area, there is no potential for prehistoric archaeological resources. Therefore, any oil or gas exploration or development cannot possibly impact prehistoric archaeological resources.

The proposed action includes the use of a derrick barge and its associated anchors, the emplacement of a truss spar production facility and its associated anchors, and the impacts of these anchors on the seafloor. The proposed offshore development as described in this plan cannot result in an impact to an inundated prehistoric archaeological site.

The MMS recognizes both the 12,000 B.P. date and 60-m (197 ft) water depth as the seaward extant of prehistoric potential on the OCS. The water depth of the Grid 3 is greater than 200 m (656 ft). The water depth at the proposed project site is approximately 900 m (2,952 ft) deeper than the earliest known prehistoric archaeological sites in the Gulf of Mexico.

Conclusion

Based on the extreme water depth of Grid 3, the proposed oil or gas exploration or development will not impact any prehistoric archaeological resources.

4.3.4.2. Historic

There are areas of the northern Gulf of Mexico that are considered to have a high probability for historic period shipwrecks, as defined by a MMS-funded study and shipwreck model (Garrison et al., 1989). The study expanded the shipwreck database in the Gulf of Mexico from 1,500 to more than 4,000 wrecks. Statistical analysis of shipwreck location data identified two specific types of high-probability areas--the first within 10 km of the shoreline, and the second proximal to historic ports, barrier islands, and other loss traps. High-probability search polygons associated with individual shipwrecks were created to afford protection to wrecks located outside of the two aforementioned high-probability areas.

An Archaeological Resources Stipulation was included in all Gulf of Mexico lease sales from 1974 through 1994. The stipulation was incorporated into operational regulations effective November 21, 1994. The language of the stipulation was incorporated into the operational regulations under 30 CFR 250.26 with few changes, and all protective measures offered in the stipulation have been adopted by the regulation.

NTL 2002-G01 effective March 15, 2002, supersedes all other archaeological NTL’s and LTL’s and makes minor technical amendments; updates cited regulatory authorities and continues to mandate a 50-m remote-sensing survey linespacing density for historic shipwreck surveys in water depth of 60 m or less. The NTL also requires submission of an increased amount of magnetometer data to facilitate MMS analysis. Survey and report requirements for prehistoric sites have not been changed.

Several OCS-related, impact-producing factors may cause adverse impacts to unknown historic archaeological resources. Offshore development could result in a drilling rig, platform, pipeline, or anchors associated with truss spar rigs and derrick barges impacting an historic shipwreck. Direct physical contact with a shipwreck site could destroy fragile ship remains, such as the hull and wooden or ceramic artifacts, and could disturb the site context. The result would be the loss of archaeological data on ship construction, cargo, and the social organization of the vessel's crew, and the concomitant loss of information on maritime culture for the time period from which the ship dates.

The emplacement of a derrick barge and associated anchors and a truss spar production facility has the potential to cause physical impact to historic archaeological resources on the seafloor. Based on the plan submitted by the applicant, the manned floating production facility, the Gunnison spar, will be permanently anchored with a 9-leg taut catenary system consisting of conventional wire and chain and anchor piles. The placing of these nine permanent piles in a three 3-pile patterns into the seafloor and allowing for wire rope and chain catenary to contact to the seafloor would directly disturb approximately an area of 2.1 ha per 3-pile pattern. The derrick barge with its six-point anchoring system would directly disturb approximately 1.9 ha of the seafloor at each anchor point. Pile driving associated with platform emplacement may also cause sediment liquefaction an unknown distance from the piling, disrupting stratigraphy in the area of liquefaction.

Pipeline installation has the potential to cause a physical impact to historic archaeological resources. In a recent pipeline installation in March 2001, an 8-in pipeline was laid across a historic shipwreck in a water depth of 800 m (2,650 ft).

Petroleum spills have the potential to affect historic archaeological resources. Impacts to historic resources would be limited to visual impacts and, possibly, physical impacts associated with spill cleanup operations. The OCS operations may also generate tons of ferromagnetic structures and debris, which will tend to mask magnetic signatures of significant historic archaeological resources during magnetometer surveys. The task of locating historic resources via an archaeological survey is, therefore, made more difficult as a result of leasing activity.

The specific locations of archaeological site area cannot be identified without first conducting a remote-sensing survey of the seabed and near-surface sediments. The MMS, by virtue of new operational regulations under 30 CFR 250.26, requires that an archaeological survey be conducted prior to development of leases within the high-probability zones for historic and prehistoric archaeological resources. None of the lease blocks within the Grid 3 area fall within the MMS high-probability zone.

The proposed action includes installation of subsea lease-term pipelines and umbilicals, Gunnison spar mooring installation, spar topside and buoyancy installation, pull in risers/umbilicals for subsea wells, first production from subsea wells, and hookup completion and production initiation from dry tree wells.

Ferromagnetic debris associated with exploration and production activities has the potential to mask the magnetic signatures of historic shipwrecks. It is expected that most ferromagnetic debris associated with the proposed action would be removed from the seafloor during required postlease site clearance. Site clearance, however, takes place after the useful life of the structure is complete. Also, site clearance is not required for pipeline abandonment. Therefore, there remains the potential for masking the signatures of historic shipwrecks as a result of ferromagnetic debris from OCS oil and natural gas activities.

Onshore historic properties include sites, structures, and objects such as historic buildings, forts, lighthouses, homesteads, cemeteries, and battlefields. Sites already listed on the National Register of Historic Places and those considered eligible for the Register have already been evaluated as being able to make a unique or significant contribution to science. At present, unidentified historic sites may contain unique historic information and would have to be assessed after discovery to determine the importance of the data.

Onshore development in support of the proposed action, such as construction of new onshore facilities or pipelines, could result in the direct physical impact to previously unidentified historic sites. This direct physical contact with a historic site could cause physical damage to, or complete destruction of, information on the history of the region and the Nation. Each facility constructed must receive approval from the pertinent Federal, State, county, and/or community involved. Protection of archaeological resources in these cases is expected to be achieved through the various approval processes involved. There is, therefore, no expected impact to onshore historic sites from any onshore development in support of the proposed action.

Should an oil spill contact a coastal historic site, such as a fort or a lighthouse, the major impact would be visual from petroleum contamination of the site and its environment. Impacts to coastal historic sites are expected to be temporary and reversible.

The greatest potential risk to a historic shipwreck from the proposed action is the placement of a derrick barge and its associated anchors and this vessel's support to the installation of a truss spar facility. This risk has been greatly reduced by performance of a high-resolution, remote-sensing survey over the affected area. A geohazard assessment was performed for the Gunnison Prospect by C&C Technologies, Inc. (C&C Technologies, Inc., 2002). A hazard assessment of the anchor pile locations was prepared separately (Fugro Geoservices, 2002). None of these surveys detected debris on the seafloor that could be associated with a potentially significant archaeological resource.

The Garrison et al. (1989) shipwreck database lists no historic shipwrecks within the Grid 3 Area. The Grid 3 area falls within the MMS GOM Region’s low-probability area for the occurrence of historic shipwrecks.

Most other activities associated with the proposed action are not expected to impact historic archaeological resources. Ferromagnetic debris has the potential to mask the magnetic signatures of historic shipwrecks. It is expected that onshore archaeological resources would be protected through the review and approval processes of the various Federal, State, and local agencies involved in permitting onshore activities. There is a small chance of contact from an oil spill associated with the proposed action. Furthermore, the major impact from a spill contact on an historic coastal site, such as a fort or lighthouse, would be visual contamination. These impacts would be temporary and reversible.

Conclusion

It is extremely unlikely that oil and gas activities associated with proposed development of the Gunnison Project could impact a shipwreck since high-resolution sonar imagery acquired over the project area does not show any indication of shipwreck remains on the seafloor. It is conceivable that such remains may be embedded in and buried under seafloor sediments and are not detectable by side-scan sonar. Although this occurrence is not probable, such an event would result in the disturbance or destruction of important historic archaeological information. Other factors associated with the proposed action are not expected to affect historic archaeological resources.

4.4. Cumulative Effects

The MMS addressed the cumulative effects of OCS- and non-OCS-related activities for the WPA and the Gulf Coast region for the years 1996 through 2036 as part of the NEPA documentation completed for proposed multisale lease activities. The latest publication applicable to Grid 3 is the Final EIS for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002a). Specific OCS-related effects from the proposed activities related to the Gunnison Project are addressed in Chapters 4.1-4.3.

The following provides a summary of cumulative effects for potentially affected resources in the Western Planning Area of the GOM. For all of the resources discussed below, the incremental contribution of the Gunnison Project to cumulative impacts would be negligible.

4.4.1. Water Quality

4.4.1.1. Coastal

The rivers that drain the U.S. interior and enter the Gulf are the predominant source of contaminant inputs to coastal waters bordering the GOM. Runoff from urban and agricultural areas drains into tributaries and rivers. Numerous industries and activities contribute to the contamination of Gulf coastal waters. These include industry, municipal sewerage, marinas, commercial fishing, maritime shipping, hydromodification activities, and recreational boating. Runoff, wastewater discharge, accidental spills, and atmospheric deposition from these sources will cause water quality changes that result in nonattainment of Federal water quality standards by a significant percentage of coastal waters.

Vessel traffic will degrade coastal water quality through routine releases of bilge and ballast waters, fuel and tank spills, trash, and domestic and sanitary discharges. The greatest impacts from vessel traffic will occur along navigation channels within highly populated, confined harbors and anchorages and boat yards due to increased BOD and pathogens from sanitary waste discharges and the presence of other compounds used in boat servicing, such as tributyltin in marine paints.

Dredging of coastal areas to support residential, commercial and industrial coastal development will continue to increase each yer. Increased turbidity from dredging operation and dumping of sediments into the coastal water would affect the water quality of the coastal area.

Degradation of water quality conditions due to these inputs is expected to continue. The Gulf Coast has been heavily used and signs of environmental stress are evident. Large areas experience nutrient overenrichment, oxygen depletion, shellfish ground closures, and wetland loss.

4.4.1.2. Offshore

Contaminant inputs to GOM marine waters include offshore, coastal, and land-based sources. Numerous studies have identified the Mississippi River, which drains two-thirds of the U.S., as the major source of contamination for Gulf waters (e.g., Bedinger, 1981; Brooks and Giammona, 1988). Other land-based sources include those industries and activities described in the preceding section on coastal waters. Contaminants released to coastal waters can be transported to offshore marine waters. Offshore sources of contaminants besides OCS oil and gas operations include marine transportation, commercial fishing, and natural hydrocarbon seeps.

Spills of oil and other substances may occur from vessels transporting crude oil and petroleum products, and other products through Gulf waters between U.S. ports, from OCS oil and gas production operations, and from vessels associated with other offshore activity (marine transportation, recreational ships, etc.). Bottom-area disturbances resulting from vessel anchoring, and facility and pipeline emplacement would increase water-column turbidity in the overlying offshore waters. The extent of anchoring by the maritime industry is not known, but in lightering areas, large supertankers daily anchor while offloading their cargo. Should operations occur frequently and in proximity of each other, there would be increased risk of water quality degradation. Individual operations would result in short-lived and local impacts on water quality. Blowouts can disturb bottom sediments and increase turbidity, but would not be of consequence to regional water quality.

Vessels moving through Gulf waters and most oil and gas operations discharge to offshore waters. Vessel traffic associated with the extensive maritime industry, the oil and gas support operations, and recreational and commercial fishing operations discharge domestic and sanitary wastes and bilge and ballast waters into offshore waters. The discharged bilge waters and ballast waters can contain petroleum and metallic compounds leaked from machinery. Diluted and discharged slowly over large areas, vessel wastes are assumed to contribute in a very small way to the long-term, regional degradation of water quality.

The discharge of drilling fluids and cuttings and produced waters accounts for the bulk of effluent discharge volumes from oil and gas development and production facilities. Oil-field waste characteristics can include high salinity, low pH, high BOD and chemical oxygen demand (COD), heavy metals, and radionuclides. The discharge of treated sanitary and domestic wastes from rigs and platforms may increase suspended solids concentrations, and add chlorine and nutrients that exert a high BOD in a small area near the point of discharge. Deck drainage from OCS structures and support vessels can be contaminated. Numerous studies have examined the water quality impacts of OCS discharges (Avanti Corporation, 1993; CSA, 1997a and b; Kennicutt et al., 1995; Neff, 1997). The studies concluded that contaminants in produced water and drilling discharges should be undetectable in the water column at a distance of 1,000 m from the discharge point.

Information is available on the volumes of petroleum hydrocarbon compounds entering Gulf waters from various sources (USDOI, MMS, 1998 and 2002). Based on the analysis of inputs from various sources, the OCS oil and gas industry contributes about 4 percent of the Gulf's regional, long-term contamination by petroleum hydrocarbons. Natural seepage accounts for 28 percent of the total input. Although the Gulf comprises one of the world's most prolific offshore oil-producing provinces, onshore sources of hydrocarbons to Gulf waters far outweigh the contributions from offshore domestic production of oil; coastal sources contribute an order of magnitude more petroleum hydrocarbons to Gulf waters than offshore anthropogenic sources.

4.4.2. Air Quality

Effects on air quality within the study area will come primarily from industrial, power generation, and urban emissions. The coastal areas nearest the study area are currently designated as "attainment" for all the National Ambient Air Quality Standards-regulated pollutants except ozone. The USEPA has designated several areas along the Gulf Coast as "nonattainment" for ground-level ozone—Houston-Galveston-Brazoria and Beaumont-Port Arthur areas in Texas and Lafouche Parish in Louisiana (USEPA, 2001).

4.4.3. Sensitive Coastal Environments

4.4.3.1. Coastal Barrier Beaches and Associated Dunes

Coastal barrier beaches of the Chenier Plain have experienced severe erosion and landward retreat because of human activities and natural processes. Over the last 50 years, most adverse effects to the Texas barrier islands have resulted from human activities. These adverse effects on barrier beaches and dunes have come from changes to the natural dynamics of water and sediment flow along the coast. Examples of these activities include pipeline canals, channel stabilization structures, beach stabilization structures, recreational use of vehicles on dunes and beaches, recreational and commercial development, and removal of coastal vegetation. Human activities cause direct impacts as well as accelerate natural process that deteriorate coastal barrier features. Natural processes that contribute to most effects include storms, subsidence, and sea-level rise acting upon shorelines with inadequate sand content and supply.

Deterioration of Gulf barrier beaches is expected to continue in the future. Federal, State, and county/parish governments have made efforts over the last 10 years to slow beach erosion.

4.4.3.2. Wetlands

In most areas that might be influenced by the proposed action, the conversion of wetlands to agricultural, residential, and commercial uses has generally been the major cause of wetland loss. Commercial uses including dredging for both waterfront developments and coastal oil and gas activities. In the Chenier Plain of Louisiana, natural and man-induced erosion and subsidence are also important causes of wetland loss. Wetland loss is projected to continue around the WPA and CPA of the Gulf.

4.4.3.3. Seagrasses

Seagrasses are adversely affected by several human activities. These impacts include changes to water quality resulting from riverine input, stream channelization, urban runoff, and industrial discharges; physical removal of plants by various forms of dredging, anchoring, and grounding of vessels; and severe storms. These impacts and the general decline of seagrasses are expected to continue into the near future. Various Federal, State, and local programs are focused upon reversing this trend.

4.4.4. Deepwater Benthic Communities/Organisms

4.4.4.1. Chemosynthetic Communities

No impacts to chemosynthetic communities from non-OCS-related activities are expected. Normal fishing practices should not disturb these areas. Other bottom-disturbing activities such as trawling and anchoring are virtually nonexistent at water depths of greater than 400 m.

4.4.4.2. Deepwater Benthos and Sediment Communities

The most serious impact-producing factor that may affect deepwater benthos and sediment communities is the physical disturbance of the sea bottom. Within anchoring depths, marine transportation vessels may affect localized areas. Hypoxic conditions at the seafloor may affect the deepwater benthos and associated communities.

4.4.5. Marine Mammals

Marine mammals could be adversely affected by vessel traffic, degradation of water quality, aircraft and vessel noise, loss of debris from vessels, commercial fishing (capture and removal), pathogens, and negative impacts to prey populations. The cumulative impacts to marine mammals are expected to result in a number of chronic and sporadic lethal and sublethal effects. Sublethal effects may stress and/or weaken individuals of a local group or population, thus making them more susceptible to infection from natural or anthropogenic sources.

4.4.6. Sea Turtles

Factors with the potential to effect sea turtles include dredging operations, water quality and habitat degradation, trash and debris, vessel traffic, natural catastrophes (e.g., hurricanes, unseasonably cold weather), commercial and recreational fishing, beach and other lighting, and entrainment in industrial intakes (e.g., electrical generation plants). Small numbers of turtles could be killed or injured from chance collisions with vessels or from eating indigestible trash or debris (particularly plastic items). Noise from vessels could disrupt normal behavioral patterns and physiologically stress turtles making them more susceptible to disease. Pollution could indirectly affect sea turtles through food-chain biomagnification.

4.4.7. Coastal and Marine Birds

Possible impacts to coastal and marine birds can come from air emissions, water quality degradation, habitat loss and modification resulting from coastal construction and development, collisions with aircraft or vessels, noise from aircraft and vessels, trash and debris, and lighting. Any effects could be especially critical to endangered or threatened species that must maintain a viable reproductive population size or that are dependent on a few key habitat factors. Aircraft or vessel traffic could sporadically disturb feeding, resting, or nesting behavior of birds or cause abandonment of preferred habitat. Birds could become entangled and snared in trash and debris. In addition, they may ingest small plastic debris that could lead to injury or death.

4.4.8. Fish Resources

Degradation of water quality, loss of essential habitat (including wetlands loss), pathogens, trash and debris, riverine influences, and overfishing could affect fish resources. Eggs and larvae are more susceptible than adults to environmental contaminants. Portions of the Gulf experience hypoxia during portions of the year (LATEX B; Murray, 1998). However, areas of hypoxia typically occur only on the continental shelf.

4.4.9. Economic and Demographic Conditions

The economic and demographic conditions evaluated in this PEA are limited to that portion of the GOM's coastal zone whose social and economic well-being (population, labor, and employment) is directly or indirectly affected by the OCS oil and gas industry. The energy industry has become increasingly more global. While the OCS Program, in general, has played a significant role in the GOM region's economy and demography, the activities in Grid 3 are expected to have minimal economic and demographic consequences to the region.

4.4.9.1. Population and Education

The impact area's population is expected to grow at an average annual rate of 1.5 to 1.0 percent over the next 40 years with that growth slowing over time. This population growth is based on the continuation of existing conditions including OCS energy development. Activities in Grid 3 are not expected to affect the population's growth rate. Education levels are expected to remain unchanged by activities within Grid 3.

4.4.9.2. Infrastructure and Land Use

Sufficient infrastructure is in place to support activities within Grid 3. Sufficient land is designated in commercial and industrial parks and adjacent to the existing ports to minimize potential disruption to current residential and business use patterns. Land use in the area will change over time; however, the majority of this change is expected to be general regional growth.

4.4.9.3. Navigation and Port Usage

There are approximately 50 shore bases that are traditionally used by the oil and gas industry to support activities on the Federal OCS. Certain companies favor some of these bases for their offshore operations. No new expansion or construction is expected at these existing shore bases to support offshore activities within Grid 3.

4.4.9.4. Employment

The oil and gas industry is very important to many of the coastal communities of the GOM, especially in Louisiana and eastern Texas. Changes in OCS oil and gas activities have significant employment implications to these communities, particularly in industries directly and indirectly related to oil and gas development. However, the energy industry has global markets (both for the supply of goods and services needed to produce energy and demand for energy products). While mergers, relocations, and consolidation of oil and gas companies' assets have affected employment in the GOM region in recent years, employment changes to the coastal communities as a result of activities in Grid 3 are expected to be negligible.

4.4.9.5. Environmental Justice

Federal agencies are directed by Executive Order 12898 to assess whether their actions will have a disproportionate environmental effect on people of ethnic or racial minorities or with low income. Since sufficient onshore facilities are available to support offshore activities in Grid 3, no effects to minorities or people with low incomes in the Gulf counties and parishes are expected.

4.4.10. Commercial Fisheries

Federal and State fishery management agencies will control the "take" of commercial fishes. The agencies' primary responsibility is to manage effectively the fishery stock to perpetuate commercially important species. Various management plans aimed at selected species have been and will continue to be prepared. The GOM will remain one of the Nation's most important commercial fisheries area.

4.4.11. Recreational Resources and Beach Use

Factors such as land development, civil works projects, and natural phenomena have affected, and will continue to affect, beach stabilization, which ultimately affects the recreational use of beaches. Many of the people in the adjacent coastal states live in the coastal zone. Pressure on the natural resources within the coastal zone is expected to continue or possibly increase.

Frequent impacts from man-induced debris and litter derived from both offshore and onshore sources are likely to diminish the tourist potential of beaches and to degrade the ambience of shoreline recreational beaches chronically, thereby affecting the enjoyment of recreational beaches throughout the planning area. A ton or more per mile of trash and debris has been removed from recreational beaches cleaned in the WPA each fall since 1986. MARPOL Annex V and the special efforts to generate cooperation and support for reducing marine debris through the Gulf of Mexico Program's Marine Debris Action Plan should lead to a decline in the level of human-generated trash adversely affecting recreational beaches throughout the Gulf.

Although trash from onshore sources will continue to adversely affect the ambience of recreational beaches, the level of chronic pollution should decline. Beach use at the regional level is unlikely to change.

4.4.12. Archaeological Resources

4.4.12.1. Prehistoric

Grid 3 is located in deep water (greater than 1,000 m or 3,281 ft). It is not located in one of MMS's designated high-probability areas. No potential exists to affect prehistoric archaeological resources.

4.4.12.2. Historic

No historic shipwrecks were identified in MMS's database in the Grid 3 area. It is possible that resources are present that do not appear in the database, which should not be considered exhaustive. Seafloor-disturbing activities do hold the potential to affect these resources if they are present. Conducting remote-sensing surveys prior to development would eliminate or minimize potential impacts to these resources. In water depths where anchoring is plausible, these activities may adversely affect historic archaeological resources.

5. CONSULTATION AND COORDINATION

A notice of preparation of an environmental assessment on the Gunnison Project was published in the Legal Notice section of the *Houston Chronicle*. The Notice provided the public with an opportunity to provide comments on issues that should be addressed in the PEA. No comments were received.

The State of Texas has an approved Coastal Zone Management (CZM) Program. Therefore, a Certificate of Coastal Zone Consistency was required for the proposed activities. The MMS mailed the plan and other required and necessary information to the State of Texas, Coastal Coordination Council in December 2002. It was received by the Council on January 7, 2003. The plan was assigned Project Number 02-0433-F4. On January 14, 2003, MMS received written notice from the Council stating that the plan was deemed to be consistent with the Texas CZM Program.

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8. APPENDICES

Appendix A. Accidental Hydrocarbon Discharge Analysis
Appendix B. Meteorological Conditions
Appendix C. Geology
Appendix D. Physical Oceanography
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APPENDIX A

Accidental Hydrocarbon Discharge Analysis

Analysis of the Potential for an Accidental Oil Spill and Potential for Impacts from Kerr-McGee Oil and Gas Corporation's Garden Banks Blocks 667, 668, and 669, Gunnison Project, Initial DOCD N-7625

Introduction

The National Environmental Policy Act (NEPA) requires Federal agencies to consider potential environmental impacts (direct, indirect, and cumulative) of a proposed action as part of agency planning and decisionmaking. The NEPA analyses address many issues relating to potential impacts, including issues that may have a very low-probability of occurrence, but which the public considers important or for which the environmental consequences could be significant.

The past several decades of spill data show that impacts from accidental oil spills ≥1,000 bbl associated with oil and gas exploration and development are low-probability events in Federal OCS waters of the Gulf of Mexico (GOM). This appendix summarizes key information about the probability of accidental spills from offshore oil and gas activities in the GOM.

Spill Prevention

The MMS has comprehensive pollution-prevention requirements that include numerous redundant levels of safety devices, as well as inspection and testing requirements to confirm that these devices work. Many of these requirements have been in place since about 1980. Spill trends analysis for the GOM OCS show that spills from facilities have decreased over time, indicating that MMS engineering and safety requirements have minimized the potential for spill occurrence and associated impacts. Details regarding MMS engineering and safety requirements can be found at 30 CFR 250.800 Subpart H.

OCS Spills in the Past

This summary of past OCS spills presents data for the period 1985-1999. The 1985-1999 time period was chosen to reflect more modern engineering and regulatory requirements and because OCS spill rates are available for this period. For the period 1985-1999, there were no spills ≥1,000 bbl from OCS platforms, eight spills ≥1,000 bbl from OCS pipelines, and no spills ≥1,000 bbl from OCS blowouts (Tables A-1 through A-3). It should be noted that past OCS spills (Tables A-1 through A-3), some of which are considerably ≥1,000 bbl, have not resulted in any documented significant impacts to shorelines or other resources. The Draft EIS for Eastern Gulf Lease Sales 189 and 197 (USDOI, MMS, 2002a) and the most recent Final EIS for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002b) provides additional information and discussion on past OCS spills.

Estimating Future Potential Spills

The MMS estimates the risk of future potential spills by multiplying variables to result in a numerical expression of risk. These variables include the potential of a spill occurring based on historical OCS spill rates and a variable for the potential for a spill to be transported to environmental resources based on trajectory modeling. The following sections describe the spill occurrence and transport variables used to estimate risk and the risk calculation for the proposed action.

Spill Occurrence Variable (SOV) —Representing the Potential for a Spill

The SOV is derived based on past OCS spill frequency; that is, data from past OCS spills are used to estimate future potential OCS spills. The MMS has estimated spill rates for spills from facilities, pipelines, and drilling.

Spill rates for facilities and pipelines have been developed for several time periods and an analysis of trends for spills is presented in Anderson and Labelle (2000). Spill rates for the most recent period analyzed, 1985-1999, are presented here. Data for this recent period should reflect more modern spill prevention requirements.

Spill rates for facilities and pipelines are based on the number of spills per volume of oil handled. Spill rates for drilling activity are based on the number of spills associated with activities during drilling. These rates include spills from blowouts, drill rigs, supply vessels, fuel storage, and other drilling activities. Spill rates for the period 1985-1999 are shown in Table A-4. It should be noted that there were no platform or drilling spills ≥1,000 bbl for the period 1985-1999. Use of "zero" spills would result in a zero spill rate. To provide a nonzero spill rate for conservative (bias toward overestimation) future predictions of spill occurrence, the spill period was expanded to include older spill data. The data period was expanded to 1980 to include a spill from facilities and to 1971 to include a spill from a well blowout. Spill rates are combined with site-specific data on production or pipeline volumes or number of wells being drilled to result in a site-specific SOV.

Transport Variable (TV)—Representing the Potential for a Spill to be Transported to Important Environmental Resources

The TV is derived using an oil-spill trajectory model. This model predicts the direction that winds and currents would transport spills. The model uses an extensive database of observed and theoretically computed ocean currents and fields that represent a statistical estimate of winds and currents that would occur over the life of an oil and gas project, which may span several decades. This model produces the TV that can be combined with other variables, such as the SOV, to estimate the risk of future potential spills and impacts.

Risk Calculation for the Proposed Action

The proposed action includes the completion and production of seven wells from the surface location of the Gunnison spar in Garden Banks Block 668 and the tie back and production of an additional three wells that were previously completed subsea. Table A-5 presents an estimate of spill risk to resources using two variables—the SOV and the TV. The SOV used is the risk of a spill during production. Table A-4 presents an estimate of spill risk from the facility to resources (0.13 per billion barrels of oil produced). The risk estimate for the facility was calculated using the spill rate of 0.13 per billion barrels of oil produced the estimated production for the proposed action and oil-spill trajectory calculations.

The environmental resources analyzed within this PEA are presented in Table A-5. The final column in Table A-5 presents the result of combining the SOV and the TV. The risk of a spill impact from the facility could be considered to be so low as to be near zero. The Draft EIS for Eastern Gulf Lease Sales 189 and 197 (USDOI, MMS, 2002a) and the most recent Final EIS for Central Gulf Lease Sales 185, 190, 194, 198, and 201, and Western Gulf Lease Sales 187, 192, 196, and 200 (USDOI, MMS, 2002b) provides additional information on spills and potential impacts.

Spill Response

The MMS has extensive requirements both for the prevention of spills and preparedness to respond to a spill in the event of an accidental spill. The MMS's spill-prevention requirements and the low incidence of past OCS spills were addressed earlier in this appendix. The following sections present information on MMS's requirements for spill-response preparedness.

MMS Spill-Response Program

The MMS's Oil Spill Program oversees the review of oil-spill-response plans, coordinates inspection of oil-spill-response equipment, and conducts unannounced oil-spill drills. This program also supports continuing research to foster improvements in spill prevention and response. Studies funded by MMS address issues such as spill prevention and response, *in-situ* burning, and dispersant use.

In addition, MMS works with the U.S. Coast Guard and other members of the multiagency National Response System to further improve spill-response capability in the GOM. The combined resources of these groups and the resources of commercially contracted oil-spill-response organizations result in extensive equipment and trained personnel for spill response in the GOM.

Spill Response for this Project

The subject operator has an oil-spill-response plan on file with MMS and has current contracts with offshore oil-spill-response organizations.

Potential spill sources for this project include an accidental blowout (5,700 bbl of 30 API crude oil per day, which represents the calculated uncontrolled flow), a spill of liquid oil stored on the drill rig (approximately 4,971-bbl worst case capacity), or a spill from the associated support vessel (largest vessel having a 37,000-bbl capacity). The operator has addressed spill sources in their oil spill response plan and has demonstrated spill response preparedness for accidental releases.

The MMS will continue to verify the operator's capability to respond to oil spills via the MMS Oil Spill Program. The operator is required to keep their oil-spill-response plan up to date in accordance with MMS regulations. The operator must also conduct an annual drill to demonstrate the adequacy of their spill preparedness. The MMS also conducts unannounced drills to further verify the adequacy of an operator's spill-response preparedness; such a drill could be conducted for the proposed action.

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Table A-1

Historical Record of OCS Spills ≥1,000 Barrels from OCS Facilities, 1985-1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (bbl)	Cause of Spill
None	None	0	*

*No OCS facility spills ≥1,000 bbl during the period 1985-1999.

Table A-2

Historical Record of OCS Spills ≥1,000 Barrels from OCS Pipelines, 1985-1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (bbl)	Cause of Spill
February 7, 1988	South Pass 60 (75 ft, 3.4 mi)	15,576	Service vessel’s anchor damaged pipeline
January 24, 1990	Ship Shoal 281 (197 ft, 60 mi)	14,423*	Anchor drag, flange and valve broke off
May 6, 1990	Eugene Island 314 (230 ft, 78 mi)	4,569	Trawl drag pulled off valve
August 31, 1992	South Pelto 8 (30 ft, 6 mi)	2,000	Hurricane Andrew, loose drilling rig’s anchor drag damaged pipeline
November 22, 1994	Ship Shoal 281 (197 ft, 60 mi)	4,533*	Trawl drag
January 26, 1998	East Cameron 334 (264 ft, 105 mi)	1,211*	Service vessel's anchor drag damaged pipeline during rescue operation
September 29, 1998	South Pass 38 (110 ft, 6 mi)	8,212	Hurricane Georges, mudslide parted pipeline
July 23, 1999	Ship Shoal 241 (133 ft, 50 mi)	3,200	Jack-up barge sat on pipeline

*condensate.

Table A-3

Historical Record of OCS Spills ≥1,000 Barrels from OCS Drilling, 1985-1999

Spill Date	Area and Block (water depth and distance from shore)	Volume Spilled (bbl)	Cause of Spill
None	None	0	*

*No OCS blowout spills ≥1,000 bbl during the period 1985-1999.

Table A-4

Spill Rates Used to Estimate the Future Potential for Spills

Spill Source	Volume of Oil Handled in Billions of Barrels	Number of Wells Drilled	No. of Spills ≥1,000 Barrels	Risk of Spill from Facilities or Pipelines per Billion Barrels	Risk of Spill from Drilling per Well
Facilities	7.41 [a]	Not Applicable	1[a]	>0 to <0.13[c]	Not Applicable
Pipelines	5.81	Not Applicable	8	1.38	Not Applicable
Drilling	Not Applicable	23,610	1[b]	Not Applicable	>0 to <0.00004[c]

[a] There were actually zero spills ≥1,000 bbl from facilities during the period 1985-1999. The data shown represent 1980-1999. The spill period for facility spills was expanded to 1980 to include a spill for facilities to result in a nonzero risk.

[b] There have been no spills ≥1,000 bbl from drilling activities during the period 1985-1999. Drilling activities include spills from blowouts, drill rigs, supply vessels, fuel storage, and other drilling activities. The data shown represent 1971-1999. One spill ≥1,000 bbl occurred in this period—a 1,500-bbl diesel spill from a drill rig damaged in a storm.

[c] There were no facility or drilling spills ≥1,000 bbl for the period 1985-1999; however, a nonzero spill rate was calculated by expanding the facility and drilling period to 1980 and 1971. Therefore, the spill rates for these categories are presented as greater than zero but below the rates calculated by expanding the data period.

Table A-5

Spill Risk Estimate

Environmental Resource	Spill Occurrence Variable[1] (%)	Transport Variable[2] within 30 Days (%)	Spill Risk[3] within 30 Days (%)
Counties			
Cameron, TX	0.464	1	<0.5
Willacy, TX	0.464	<0.5	<0.5
Kenedy, TX	0.464	2	<0.5
Kleberg, TX	0.464	2	<0.5
Nueces, TX	0.464	1	<0.5
Aransas, TX	0.464	2	<0.5
Calhoun, TX	0.464	3	<0.5
Matagorda, TX	0.464	6	<0.5
Brazoria, TX	0.464	2	<0.5
Galveston, TX	0.464	4	<0.5
Chambers, TX	0.464	<0.5	<0.5
Jefferson, TX	0.464	3	<0.5
Cameron, LA	0.464	5	<0.5
Vermilion, LA	0.464	2	<0.5
Iberia, LA	0.464	1	<0.5
St. Mary, LA	0.464	<0.5	<0.5
Terrebonne, LA	0.464	1	<0.5
Lafourche, La	0.464	<0.5	<0.5
Jefferson, LA	0.464	<0.5	<0.5
Plaquemines, LA	0.464	<0.5	<0.5
St. Bernard, LA	0.464	<0.5	<0.5
Harrison, MS	0.464	<0.5	<0.5
Jackson, MS	0.464	<0.5	<0.5
Baldwin, AL	0.464	<0.5	<0.5
Mobile, AL	0.464	1	<0.5
Escambia, FL	0.464	<0.5	<0.5
Santa Rosa, FL	0.464	<0.5	<0.5
Okaloosa, FL	0.464	<0.5	<0.5
Walton, FL	0.464	<0.5	<0.5
Bay, FL	0.464	<0.5	<0.5
Gulf, FL	0.464	<0.5	<0.5
Franklin, FL	0.464	<0.5	<0.5
Wakulla, FL	0.464	<0.5	<0.5
Jefferson, FL	0.464	<0.5	<0.5
Taylor, FL	0.464	<0.5	<0.5
Dixie, FL	0.464	<0.5	<0.5
Levy, FL	0.464	<0.5	<0.5
Citrus, FL	0.464	<0.5	<0.5
Hernando, FL	0.464	<0.5	<0.5
Pasco, Fla.	0.464	<0.5	<0.5
Pinellas, FL	0.464	<0.5	<0.5
Hillsborough, FL	0.464	<0.5	<0.5
Manatee, FL	0.464	<0.5	<0.5
Sarasota, FL	0.464	<0.5	<0.5
Lee, FL	0.464	<0.5	<0.5
Collier, FL	0.464	<0.5	<0.5
Monroe, FL	0.464	<0.5	<0.5
State Offshore Waters			
Texas State Offshore Waters	0.464	30	<0.5
Western Louisiana Offshore Waters	0.464	10	<0.5
Eastern Louisiana Offshore Waters	0.464	<0.5	<0.5
Mississippi Offshore Waters	0.464	<0.5	<0.5
Alabama Offshore Waters	0.464	<0.5	<0.5
Florida Panhandle Offshore Waters	0.464	<0.5	<0.5
Florida Peninsula Offshore Waters	0.464	<0.5	<0.5

Beaches			
Coastal Bend Area Beaches	0.464	5	<0.5
Matagorda Area Beaches	0.464	7	<0.5
Galveston Area Beaches	0.464	7	<0.5
Sea Rim State Park	0.464	2	<0.5
Louisiana Beaches	0.464	5	<0.5
Gulf Islands	0.464	<0.5	<0.5
Gulf Shores	0.464	<0.5	<0.5
Panhandle Beaches	0.464	<0.5	<0.5
Big Bend Beaches	0.464	<0.5	<0.5
Southwest beaches	0.464	<0.5	<0.5
Ten Thousand Islands	0.464	<0.5	<0.5

(1) The percent chance of a spill event occurring from the proposed action.

(2) The percent chance that winds and currents will move a point projected onto the surface of the Gulf beginning within the Garden Banks area (W4-3) and ending at specified shoreline segments or environmental resources within 30 days. These results are the results of a numerical model that calculates the trajectory of a drifting point projected onto the surface of the water using temporally and spatially varying winds and ocean current fields. These probabilities do not factor in the risk of spill occurrence, consideration of the spill size, any spill response or cleanup actions, or any dispersion and weathering of the slick with time.

(3) The probability of a spill occurring and contacting identified environmental features represents the weighted risk that accounts for both the risk that a large spill will occur and the risk that it will contact locations where the resources occur, given the assumptions already described in (1) and (2).

(4) <0.5 = less than 0.5%.

APPENDIX B

Meteorological Conditions

METEOROLOGICAL CONDITIONS

General Description

The Gulf of Mexico is influenced by a maritime subtropical climate controlled mainly by the clockwise circulation around the semipermanent area of high barometric pressure commonly known as the Bermuda High. The Bermuda High is a high-pressure cell. The center of the high is usually located at the Atlantic Ocean or sometimes near the Azores Islands off the coast of Spain (Henry et al., 1994). The Gulf of Mexico is located to the southwest of this center of circulation. This proximity to the high-pressure system results in a predominantly east to southeasterly flow in the Gulf of Mexico region. Two important classes of cyclonic storms are occasionally superimposed on this circulation pattern. During the winter months of December through March, cold fronts associated with cold continental air masses influence mainly the northern coastal areas of the Gulf of Mexico. Behind the fronts, strong north winds bring drier air into the region. During the summer and fall months of June through October, tropical cyclones may develop or migrate into the Gulf of Mexico. These storms may affect any area of the Gulf of Mexico and substantially alter the local wind circulation around them. In coastal areas, the sea breeze effect may become the primary circulation feature during the summer months of May through October. In general, however, the subtropical maritime climate is the dominant feature in driving all aspects of the weather in this region; as a result, the climate shows relatively small diurnal variation in summer.

The climatology of the Gulf of Mexico region is primarily governed by two types of air masses. One type of air mass is the warm and moist, maritime tropical air; the other type is very cold and dry, continental polar air. During summer months, the mid-latitude polar jet retreats northward, allowing maritime air to dominate through the Gulf of Mexico. In the southeastern region of the Gulf of Mexico, the climate is dominated by the warm and moist, maritime tropical air year round.

Pressure, Temperature, and Relative Humidity

The western extension of the Bermuda High into the Gulf of Mexico dominates the circulation throughout the year; the high-pressure center is weakening in winter and strengthening in summer. The average monthly pressure shows a west to east gradient during summer. In the winter, the monthly pressure is more uniform. The minimum average monthly pressure occurs during the summer. The maximum pressure occurs during the winter as a result of the pressure and influence of transitional continental cold air.

Average air temperature at coastal locations vary with latitude and exposure. Winter temperatures depend on the frequency and intensity of penetration by polar air masses from the north. Air temperature over the open Gulf exhibit much smaller variation on a daily and seasonal basis due to the moderating effect of the large body of water.

The relative humidity over the Gulf of Mexico region is high throughout the year. Minimum humidities occur during the late fall and winter when cold, continental air masses bring dry air into the northern Gulf. Maximum humidities occur during the spring and summer. Due to the presence of the warm, moist, maritime tropical air mass in the southern Gulf of Mexico, the relative humidity in this region is high for the whole year.

Surface Winds

Winds are more variable near the coast than over open waters because coastal winds are more directly influenced by the moving cyclonic storms that are characteristic of the continent and because of the land and sea breeze regime. During the relatively constant summer conditions, the southerly positions of the Bermuda High generates predominantly southeasterly winds in the northern Gulf and easterly winds in the southern parts of the Gulf. Winter winds usually blow from northeasterly directions and become more easterly in the southern parts of the Gulf.

Precipitation and Visibility

Precipitation is frequent and abundant throughout the year but does show distinct seasonal variation. The highest precipitation rates occur during the warmer months of the year. The warmer months usually have convective cloud systems that produce showers and thunderstorms; however, these thunderstorms rarely cause any damage or have attendant hail (USDOC, 1967; Brower et al., 1972). Hail can occur when water droplets freeze in the strong updraft of a convective cloud system. Winter rains are associated with the frequent passage of frontal systems through the area. Rainfalls are generally slow, steady, and relatively continuous, often lasting several days. In the northern parts of the Gulf, snowfalls are rare, and when frozen precipitation does occur, it usually melts upon contact with the ground. Incidence of frozen precipitation decreases with distance offshore and rapidly reaches zero. The annual average precipitation in Lake Charles, Louisiana, is 1.35 m. In the southern portions of the Gulf of Mexico, because of warm climate, the frozen precipitation is unlikely to occur.

Warm, moist Gulf air blowing slowly over chilled land or water surfaces brings about the formation of fog. Fog occurrence decreases seaward, but visibility has been less than 800 m (less than ½ mile) due to offshore fog in the coastal area. Coastal fogs generally last 3 or 4 hours, although particularly dense sea fogs may persist for several days. The poorest visibility conditions occur during winter and early spring. The period from November through April has the most days with low visibility. Industrial pollution and agricultural burning also impact visibility.

Atmospheric Stability and Mixing Height

Mixing height is very important because it determines the volume of air available for dispersing pollutants. Mixing height is directly related to vertical mixing in the atmosphere. A mixed layer is expected to occur under neutral and unstable atmospheric conditions. Vertical mixing is most vigorous during unstable conditions. Vertical motion is suppressed during stable conditions. The mixing height tends to be lower in winter and daily variations are smaller than in summer.

Not all of the Pasquill-Gifford stability classes are found offshore in the Gulf of Mexico. Specifically, the F stability class seldom occurs and the G stability is markedly absent; the G stability class is the extremely stable condition that only develops at night over land with rapid radiative cooling. This large body of water is simply incapable of losing enough heat overnight to set up a strong radiative inversion. Likewise, A stability class is rarely present but could be encountered during cold air outbreaks in the wintertime, particularly over warmer waters. Category A is the extremely unstable condition that requires a very rapid warming of the lower layer of the atmosphere, along with cold air aloft. This is normally brought about when cold air is advected aloft, and in strong insolation rapidly warms the earth's surface, which, in turn, warms the lowest layer of the atmosphere. Once again, the ocean surface is incapable of warming rapidly; therefore, you would not expect to find stability class A over the ocean. For the most part, the stability is neutral to slightly unstable.

In this area, the over-water stability is predominantly unstable, with neutral conditions making up the bulk of the remainder of the time (Hsu, 1996; Marks, written communication, 1996 and 1997; Nowlin et al., 1998). Stable conditions do occur, although infrequently.

The mixing heights offshore are quite shallow, 900 m or less (Hsu, 1996; Nowlin et al., 1998). The exception to this is close to shore, where the influence of the land penetrates out over the water for a short distance. Transient cold fronts also have an impact on the mixing heights; some of the lowest heights can be expected to occur with frontal passages and on the cold-air side of the fronts. This effect is caused by the frontal inversion.

Severe Storms

The Gulf of Mexico is part of the Atlantic tropical cyclone basin. Tropical cyclones generally occur in summer and fall seasons; however, the Gulf also experiences winter storms or extratropical storms. These winter storms generally originate in middle and high latitudes and have winds that can attain speeds of 15-26 m/sec (11.2-58.2 mph). The Gulf is an area of cyclone development during cooler months due to the contrast of the warm air over the Gulf and the cold continental air over North America.

Cyclogenesis, or the formation of extratropical cyclones, in the Gulf of Mexico is associated with frontal overrunning (Hsu, 1992). The most severe extratropical storms in the Gulf originate when a cold front encounters the subtropical jetstream over the warm waters of the Gulf. Statistics of 100-year data of extratropical cyclones reveal that most activity occurs above 25°N in the Western Gulf of Mexico. The mean number of these storms ranges from 0.9 storms per year near the southern tip of Florida to 4.2 over central Louisiana (Florida A&M University, 1988).

The frequency of cold fronts in the Gulf exhibits similar synoptic weather patterns during the four-month period of December through March. During this time the area of frontal influence reaches south to 10°N. Frontal frequency is about nine fronts per month in February (1 front every 3 days on the average) and about seven fronts per month in March (1 front every 4-5 days on the average). By May, the frequency decreases to about four fronts per month (1 front every 7-8 days), and the region of frontal influence retreats to about 15°N. During June-August frontal activity decreases to almost zero and fronts seldom reach below 25°N. (Florida A&M University, 1988).

Tropical cyclones affecting the Gulf originate over the equatorial portions of the Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Tropical cyclones occur most frequently between June and November. Based on 42 years of data, there are about 9.9 storms per year with about 5.5 of those becoming major hurricanes in the Atlantic Ocean (Gray, written communication, 1992). Data from 1886 to 1986 show that 44.5 percent of these storms, or 3.7 storms per year, will affect the Gulf of Mexico (Florida A&M University, 1988). The Yucatan Channel is the main entrance of Atlantic storms into the Gulf of Mexico, and a reduced translation speed over Gulf waters leads to longer residence times in this basin. The probability of occurrence for a tropical storm in Louisiana and Mississippi is on average about 15 percent.

There is a high probability that tropical storms will cause damage to physical, economic, biological, and social systems in the Gulf. Tropical storms also affect OCS operations and activities; platform design needs to consider the storm surge, waves, and currents generated by tropical storms. Most of the damage is caused by storm surge, waves, and high winds. Storm surge depends on local factors, such as bottom topography and coastline configuration, and storm intensity. Water depth and storm intensity control wave height during hurricane conditions. Sustained winds for major hurricanes (Saffir-Simpson Category 3 and above) are higher than 49 m/sec (109.6 mph).

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APPENDIX C

Geology

GEOLOGY

General Description

The present day Gulf of Mexico is a small ocean basin of more than 1.5 million km^2 with its greatest water depth reaching approximately 3,700 m. It is almost completely surrounded by land, opening to the Atlantic Ocean through the Straits of Florida and to the Caribbean Sea through the Yucatan Channel. Underlying the present Gulf of Mexico and the adjacent coast is the larger geologic basin that began forming in Triassic time. Over the last 20 million years, clastic sediments (sands and silts) have poured into the Gulf of Mexico Basin from the north and west. The centers of sediment deposition shifted progressively eastward and southward in response to changes in the source of sediment supply. Sediments more than 15 km in thickness have been deposited. Each sediment layer is different, reflecting the source of the material and the geologic processes occurring during deposition. In places where the Gulf was shallow and intermittently dry, evaporitic deposits such as salt were formed. Where there was gradual subsidence and shallow seas persisted overtime, marine plants and animals created reefs. Where marine life was abundant, the deposition of limestone was dominant.

The physiographic provinces in the Gulf of Mexico—shelf, slope, rise, and abyssal plain—reflect the underlying geology. In the Gulf, the continental shelf extends seaward from the shoreline to about the 200-m water depth and is characterized by a gentle slope of less than one degree. The shelf is wide off Texas, but it is narrower or absent where the Mississippi River delta has extended across the entire shelf. The continental slope extends from the shelf edge to the continental rise, usually at about the 2,000-m water depth. The topography of the slope in the Gulf is uneven and is broken by canyons, troughs, and escarpments. The gradient on the slope is characteristically 3-6 degrees, but may exceed 20 degrees in some places, particularly along escarpments. The continental rise is the apron of sediment accumulated at the base of the slope. It is a gentle incline, with slopes of less than one degree, to the abyssal plain. The abyssal plain is the flat region of the basin floor at the base of the continental rise.

The Western Gulf, which includes both the Western and Central Planning Areas, is a clastic province. Many wells have been drilled in the Western Gulf, and the geology has been studied in detail for the identification and development of natural gas and oil resources.

Sedimentary features, such as deltas, fans, canyons, and sediment flow forms, are formed by the erosion of land and deposition of sediments. Structural features, such as faults, folds, and ridges, are produced by displacement and deformation of rocks. The regional dip of sediments in the Gulf of Mexico is interrupted by salt diapirs, shale diapirs, and growth faults. Deformation has been primarily in response to heavy sediment loading.

The most significant factor controlling the hydrocarbon potential in the northern Gulf of Mexico is the environment of deposition. Sediments deposited on the outer shelf and upper slope have the greatest potential for hydrocarbon accumulation because it is the optimum zone for encountering the three factors necessary for the successful formation and accumulation of oil and gas: source material, reservoir space, and geologic traps. The massive shale beds with high organic content are excellent source beds. The thick sands and sandstones with good porosity (pore space between the sand grains where oil and gas can exist) and permeability (connections between the pore spaces through which oil and gas can flow) provide reservoir space. Impermeable shales, salt dome caprocks, and faults serve as seals, trapping oil and gas in the pore spaces of the reservoir rocks.

The geologic horizons with the greatest potential for hydrocarbon accumulation on the continental shelf of the northern Gulf are Miocene, Pliocene, and Pleistocene in age. Producing horizons become progressively younger in a seaward direction. Recent developments in high-energy, 3D seismic technology has allowed industry to "see" below the regional salt layers and identify potential "subsalt plays" or hydrocarbon traps. Exploration and development in the Gulf of Mexico have resulted in the identification of more than 1,000 fields.

The presence of hydrogen sulfide (H_2S) within formation fluids occurs sporadically throughout the Gulf of Mexico OCS. H_2S-rich oil and gas is called "sour." Approximately 65 operations have encountered H_2S-bearing zones on the Gulf of Mexico OCS to date. Occurrences of H_2S offshore Texas are in Miocene Age rocks and occur principally within a geographically narrow band. There is some debate as to the origin of H_2S in these wells offshore Texas as they were reported mostly from deep, high-temperature drilling wells using a ligno-sulfonate mud component, which is widely believed to break down under high wellbore temperature to generate H_2S. The occurrences of H_2S offshore Louisiana are mostly on or near piercement domes with caprock and are associated with salt and gypsum deposits. The H_2S from a caprock environment is generally thought to be a reaction product of sulfates and hydrocarbons in the presence of sulfate-reducing microbes. In some areas offshore Louisiana, H_2S-rich hydrocarbons are produced from lower Cretaceous Age limestone deposits not associated with piercement domes. Generally speaking, formations of Lower Cretaceous Age or older (which are deeply buried in the Gulf) are prone to contain H_2S in association with hydrocarbons (cf. Bryan and Lingamallu, 1990). There has also been some evidence that petroleum from deepwater plays contain significant amounts of sulfur (cf. Smith, written communication, 1996; Thorpe, 1996).

The concentrations of H_2S found in conjunction with hydrocarbons vary extensively. Examination of in-house data suggest that H_2S concentrations vary from as low as fractional ppm to as high as 650,000 ppm in one isolated case (the next highest concentrations of H_2S reported are about 55,000 and 19,000 ppm). The concentrations of H_2S found to date are generally greatest in the eastern portion of the CPA.

Geologic Hazards

The major geologic hazards that may affect oil and gas activities within the Gulf of Mexico north of 26°N. latitude can be generally grouped into the following categories: (a) slope instability and mass transport of sediments; (b) gas hydrates; (c) sediment types and characteristics; and (d) tectonics.

Geologic conditions that promote seafloor instability are variable sediment types, steep slopes, high-sedimentation rates, gas hydrates at or near the seafloor, interstitial gas, faulting, areas of lithified and mounded carbonates, salt and shale mobilization, and mudflows. Some features that may indicate a possible unstable condition include step faulting, deformed bedding, detached blocks, detached masses, displaced lithologies, acoustically transparent layers, anomalously thick accumulations of sediment, and shallow faulting and fissures. These features can be identified on seismic survey profiles or through coring samples.

Mass movement of sediments includes landslides, slumps, and creeps. Sediment types, accumulation rates, sediment accumulation over features with seafloor relief, and internal composition and structure of the sedimentary layers are all factors that affect seafloor stability. Rapidly accumulated sediments that have not had the opportunity to dewater properly are underconsolidated. These underconsolidated sediments can be interbedded with normal or overconsolidated sediments and may act as slide zones causing mass movement or collapse. A slope of less than one degree can be sufficient to cause sliding or slumping when high sedimentation rates have resulted in underconsolidation or high pore-pressure conditions in the sediments.

In the deepwater areas of the Gulf, slope stability and soil properties are of great concern in the design of oil and gas operations. Slopes steep enough to create conditions conducive to mass transport are found regionally on the continental slope. Steeper slopes are found locally along the walls of canyons and channels, adjacent to salt structures, and at fault scarps.

Gas hydrates occur in the upper sediments and are of biogenic in origin rather than petrogenic. Methane is the major and often the only component. Gas hydrates are more prevalent in deeper waters than on the shelf because of the lower temperature and high pressures at greater depths. The effect of gas pressure, distribution of gas in pores, solution-dissolution potential, and upward dispersal characteristics are factors considered in the engineering design of production facilities.

Overpressured salt, shale, and mud have a tendency to become plasticized and mobile. Movements of overpressured salts and shales could form mounds and diapirs. Large diapirs formed by the upward movement of shale or salt originates from a greater depth and do not form an environmental geologic hazard by itself. These features have associated faulting and sometimes collapse structures. Their upward movement causes slope steepening and consequently slumping. Movement of overpressured mud could form mud volcanoes. Soft mud diapirs resulting from delta front muds are excellent indicators of an unstable sediment at shallow depths.

Evidence of geologic hazards includes hydrocarbon seeps, deformed bedding, detached blocks or masses, anomalously thick accumulations of sediments, shallow faulting and fissures, diapirs, sediment dikes or mud lumps, displaced lithologies, internal chaotic masses, hummocky topography, en echelon faulting, and horst and graben blocks. Evidence of geologic hazards can be obtained or seen by using core sampling techniques, high-resolution seismic surveying, and side-scan sonar. Geologic hazards pose engineering, structural design, and operational constraints that can usually be effectively mitigated through existing or new technologies and designs.

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APPENDIX D

Physical Oceanography

PHYSICAL OCEANOGRAPHY

The Gulf of Mexico is a semienclosed, subtropical sea with an area of approximately 1.5 million km^2. The main physiographic regions of the Gulf Basin are the continental shelf (including the Campeche, Mexican, and U.S. shelves), continental slopes and associated canyons, abyssal plains, the Yucatan Channel, and Florida Straits.

The continental shelf width along the Gulf coastline varies from about 350 km offshore West Florida to 16 km off the Mississippi River, then to 156 km off Galveston, Texas, and finally decreasing to 88 km off Port Isabel near the Mexican border. The depth of the central abyss ranges to approximately 3,700 m. The water volume of the Gulf, assuming a mean water depth of 2 km, is 2 million km^3. The shelf's volume, assuming a mean water depth of 50 m, is 25,000 km^3. The Gulf is unique among the world's mediterranean seas, having two entrances: the Yucatan Channel and the Straits of Florida. Both straits restrain communication from the deep Atlantic waters because of the limited sill depths—1,600 m in the Yucatan Channel and about 1,000 m in the Straits of Florida. A portion of the Gulf Stream system, the parent Loop Current, whose presence and influence are described below, is present in the Gulf. Along the 24,800-km Gulf coastline, 21 major estuaries are found on the U.S. coast. The amount of freshwater input to the Gulf Basin from precipitation and a number of rivers—dominated by the Mississippi and Atchafalaya Rivers—is enough to influence the hydrography of most of its northern shelves. The basin's freshwater budget shows a net deficit, however, due to the high rate of evaporation.

Sea-surface temperatures in the Gulf range from nearly isothermal (29-30°C) in August to a sharp horizontal gradient in January, ranging from 25°C in the Loop core to 14-15°C along the shallow northern coastal estuaries. August temperatures at 150 m water depth show a warm Loop Current and an anticyclonic feature in the Western Gulf (both about 18-19°C) grading into surrounding waters of 15-16°C along the slope. The entire pattern is maintained during winter, but warmer by about 1°C. At 1,000 m water depth, the temperature remains close to 5°C year-round. Intimately related with the vertical distribution of temperature is the thermocline, defined as the depth at which the temperature gradient is at maximum. During January, the thermocline depth is about 91-107 m in the Western and Central Gulf and about 30-61 m in the Eastern Gulf. In May, the thermocline depth is about 46 m throughout the entire Gulf (Robinson, 1973). This depth is important because it demarcates the bottom of the mixed layer and acts as a barrier to the vertical transfer of materials and momentum.

Surface salinities along the northern Gulf display seasonal variations because of the seasonality of the freshwater input. During months of low freshwater input, deep Gulf water penetrates into the shelf, and salinities near the coastline range between 29 and 32 parts per thousand (ppt). High, freshwater-input conditions (spring-summer months) are characterized by strong horizontal gradients and inner-shelf salinity values of less than 20 ppt (Wallace, 1980; Cochrane and Kelly, 1986; Murray, 1998).

Sharp discontinuities of temperature and/or salinity at the sea surface, such as fronts associated with eddies or river plumes or the Loop Current front, are dynamic features that may act to concentrate buoyant material such as spilled oil, detritus, or plankton. These materials are not transported by the front's movements such as the slow westward drift of eddies or Loop Current incursion. The motion consists mainly of lateral movement along the front instead of motion across the front. In addition to open ocean fronts, a coastal front, which separates turbid, lower salinity water from the open-shelf regime, is probably a permanent feature of the northern Gulf shelf. This front lies about 30-50 km offshore. It is not known how strongly this front might affect buoyant material transport.

The Loop Current, a highly variable current feature, enters the Gulf through the Yucatan Channel and exits through the Straits of Florida (as the Gulf Stream) after tracing an arc that may intrude as far north as the Mississippi-Alabama shelf. The Loop consists of ascending and descending 30-km-wide bands of rapidly moving water enclosing a relatively quiescent inner region, and the entire feature may be clearly seen in hydrographic sections down to about 1,000 m. Below that level, there is evidence of a countercurrent. The volumetric flux of the Loop has been estimated at 30 million m^3/sec. This volume flow is enough to replace the water volume of the Gulf shelf in about 10 days.

Major Loop Current eddies move into the Western Gulf along various paths to a region between 25°-28°N and 93°-96°W. Recent analysis of frontal-positions data indicates that the eddy-shedding period varies between 6.5 and 9.5 months with an average of 7.5 months (Hamilton et al., 1989). Major eddies have diameters on the order of 300-400 km and may clearly be seen in hydrographic data to a depth of about 1,000 m. The eddies move at speeds ranging from 2 to 5 km/day, decreasing in size as they mix with resident waters. The life of an individual eddy to its eventual assimilation by regional circulation patterns in the Western Gulf is about 1 year.

Eddy-shedding from the Loop Current is the principal mechanism coupling the circulation patterns of the eastern and western parts of the basin. The heat and salt budgets of the Gulf are dependent on this importation, balanced by seasonal cooling and river input, and probably also by deep currents. Deep currents have been observed in the Gulf of Mexico which have low velocities that are fairly uniform in the vertical, although with bottom intensification, a characteristics of topographic Rossby waves (Hamilton, 1990). Indications of mean cyclonic drift in the deep waters of the western Gulf of Mexico have been observed in numerical modeling studies (Welsh and Inoue, 2002). The eddies are frequently observed to affect local current patterns along the Louisiana/Texas slope, hydrographic properties, and possibly the biota of fixed platforms or hard bottoms. There is some evidence that these large reservoirs of warm water play some role in strengthening tropical cyclones when their paths coincide.

Smaller anticyclonic eddies with diameters on the order of 100 km have been observed to be generated by the Loop Current. Their observed movements indicate a tendency to translate westward along the Louisiana/Texas slope. Similar in size, cyclonic eddies are observed in the Eastern Gulf, are associated with the eddy-shedding cycle, and occur along the Louisiana/Texas slope (Hamilton, 1992).

Aside from the wind-driven surface layer, current regimes on the outer shelf and slope are the result of balance between the influence of open Gulf circulation features and the shelf circulation proper, which is dominated by long-term wind forcing. A few mid-water brief high speed jet events have been documented on the Louisiana-Texas slope, but these have not been verified and data quality remains in doubt (Nowlin et al., 2001). High speed currents in water depths of 2,000 m. have been observed along the northern Gulf of Mexico slope (Hamilton and Lugo-Fernandez, 2001).

A strong east-northeasterly current prevails along the outer shelf and slope of northern and middle Texas and Louisiana (Nowlin et al., 1998). When the Loop Current impinges onto the Florida slope and shelf, it has been observed that the current structure acts to upwell nutrient-rich water from deeper zones (Collard and Lugo-Fernandez, 1999). This mechanism may also take place as eddies move along the Louisiana/Texas slope, accounting for the increased productivity recognized in these areas (Nowlin et al., 1998). West of approximately Cameron, Louisiana (93^{o}W.), current measurements clearly show a strong response of coastal current to the winds, setting up a large-scale, anticyclonic gyre. The inshore limb of the gyre is the westward or southwestward (downcoast) component that prevails along much of the coast, except in July-August. Because the coast is concave, the shoreward prevailing wind results in a convergence of coastal currents at a location where the winds are normal to the shore or at the downcoast extent of the gyre. A prevailing countercurrent toward the northeast along the shelf edge constitutes the outer limb of the gyre. The convergence at the southwestern end of the gyre migrates seasonally with the direction of the prevailing wind, ranging from a point south of the Rio Grande in the fall to the Cameron area by July. The gyre is normally absent in July but reappears in August-September when a downcoast wind component develops (Cochrane and Kelly, 1986). The Mississippi/Alabama shelf circulation is controlled by the Loop Current, winds, tides, and freshwater input. The West Florida shelf circulation is dominated by tides, winds, eddy-like perturbations, and the Loop Current.

Longshore currents, consisting of tidal, wind-driven, and density-gradient components, predominate over across-shelf components within a narrow band close to the coast (on the order of 10-20 km, referred to as the coastal boundary layer). Typical maximum tidal currents within this band would be about 15 cm/sec. These currents will cause a particle displacing, known as the tidal excursion, at 2-3 km. Currents, driven by synoptic-scale winds, range up to 25-50 cm/sec for conditions that are not extreme, with 10- to 100-km excursions expected for a typical 5-day “wind event.” Longshore currents due to winter northers, tropical storms, and hurricanes may range up to hundreds of cm/sec, depending on local topography, fetch, and duration. Should an oil spill occur, deviations from results predicted by open-ocean models could happen at coastal fronts, where concentration and lateral translation could occur, and within the longshore-current zone, where significant transport away from the “expected” point of contact could occur, as determined by local tidal phase and predominant winds.

Studies of surface drifters are useful and illustrative in the study of oil movement because, hopefully, surface slicks will respond to currents in a similar way. A summary of drifter studies across the Gulf (Parker et al., 1979) indicated that the Texas coastline and the southern and eastern Florida coastlines receive the most landings. Other coastlines along the Gulf received very small numbers of landings. Strangely, during summer and fall, the Louisiana and Texas coastlines received sizable fractions of the landings. However, these results contain some bias because populated or frequently visited areas would show more landings than desolated areas.

Summer waves in the Western Gulf tend to be smaller than those in the Eastern Gulf. Waves in both regions intensify in winter, with the Western Gulf showing a clear mode at 2-3.

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APPENDIX E

Socioeconomic Conditions

Table E-1

Listing of Counties and Parishes of the Coastal Impact Area

LA-1	LA-2	LA-3	MA-1
Acadia, LA Calcasieu, LA Cameron, LA Iberia, LA Lafayette, LA St. Landry, LA St. Martin, LA Vermilion, LA	Ascension, LA Assumption, LA East Baton Rouge, LA Iberville, LA Lafourche, LA Livingston, LA St. Mary, LA Tangipahoa, LA Terrebonne, LA West Baton Rouge, LA	Jefferson, LA Orleans, LA Plaquemines, LA St. Bernard, LA St. Charles, LA St. James, LA St. John the Baptist, LA St. Tammany, LA	Baldwin, AL Hancock, MS Harrison, MS Jackson, MS Mobile, AL Stone, MS
TX-1	TX-2	FL-1	FL-3
Aransas, TX Calhoun, TX Cameron, TX Jackson, TX Kenedy, TX Kleberg, TX Nueces, TX Refugio, TX San Patricio, TX Victoria, TX Willacy, TX	Brazoria, TX Chambers, TX Fort Bend, TX Galveston, TX Hardin, TX Harris, TX Jefferson, TX Liberty, TX Matagorda, TX Montgomery, TX Orange, TX Waller, TX Wharton, TX	Bay, FL Escambia, FL Okaloosa, FL Santa Rosa, FL Walton, FL FL-2 Dixie, FL Franklin, FL Gulf, FL Jefferson, FL Levy, FL Taylor, FL Wakulla, FL	Charlotte, FL Citrus, FL Collier, FL Hernando, FL Hillsborough, FL Lee, FL Manatee, FL Pasco, FL Pinellas, FL Sarasota, FL FL-4 Miami-Dade, FL Monroe, FL

Table E-2

Onshore Expenditure Allocation by Subarea
(in percentages)

Sector Description	Subarea							
	TX-1	TX-2	LA-1	LA-2	LA-3	MA-1	Gulf-Other	US Other
Oil and Gas Operations		0.34	0.09	0.06	0.15		0.25	0.12
New Gas Utility Facilities				0.06	0.62	0.11	0.13	0.07
Misc. Natural Resource Facility Construction	0.03	0.21	0.23	0.15	0.30	0.02	0.06	0.03
Maintenance and Repair, Other Facilities				0.05	0.52	0.09	0.22	0.11
Other Oil and Gas Field Services		0.30	0.26	0.12	0.16		0.11	0.05
Office Furniture and Equipment	0.15	0.54			0.08	0.23		
Maps and Charts (Misc. Publishing)	0.12	0.59	0.02	0.06	0.11	0.10		
Explosives	0.50	0.50						
Chemicals, NEC	0.03	0.64	0.04	0.10	0.04	0.04	0.08	0.04
Petroleum Fuels	0.11	0.50	0.09	0.16	0.09	0.05		
Hydraulic Cement		0.10				0.10	0.50	0.30
Steel Pipe and Tubes		0.50	0.31	0.05	0.07		0.08	0.04
Fabricated Plate Work	0.04	0.63	0.06	0.09	0.05	0.14		
Iron and Steel Forgings		0.81			0.05		0.14	
Turbines	0.05	0.65		0.10	0.20			
Construction Machinery & Equipment	0.06	0.42		0.06	0.19	0.11	0.11	0.06
Oil and Gas Field Machinery	0.03	0.18	0.27	0.18	0.22		0.08	0.04
Special Industrial Machinery				0.38	0.54		0.05	0.03
Pumps and Compressors	0.04	0.30	0.17	0.22	0.09		0.12	0.06
Industrial Machines, NEC	0.05	0.66	0.06	0.10	0.06	0.06		
Switchgear		0.63		0.07	0.11	0.07	0.11	
Communication Equipment, NEC	0.13	0.50			0.25		0.13	
Shipbuilding and Ship Repair	0.09	0.24	0.05	0.24	0.18	0.19		
Transportation Equipment, NEC		0.78	0.06	0.11		0.06		
Lab Equipment		1.00						
Instrumentation	0.01	0.13	0.39	0.27	0.08		0.08	0.04
Demurrage/Warehousing/Motor Freight				0.07	0.69	0.12	0.12	
Water Transport				0.07	0.72	0.13	0.08	
Air Transport				0.06	0.61	0.11	0.22	
Communications	0.09	0.51	0.07	0.11	0.11	0.11		
Electric Services	0.13	0.36	0.06	0.15	0.12	0.18		
Gas Production/Distribution	0.10	0.54	0.08	0.07	0.05	0.03	0.08	0.04
Water Supply	0.08	0.43	0.08	0.12	0.05	0.11	0.12	0.01
Waste Disposal		1.00						
Eating/Drinking			0.37	0.11	0.53			
Misc. Retail	0.09	0.48	0.06	0.10	0.15	0.11		
Insurance	0.04	0.47	0.07	0.12	0.09		0.18	0.03
Real Estate	0.09	0.47	0.04	0.08	0.11	0.08	0.12	0.01
Advertisement	0.06	0.45	0.06	0.08	0.15	0.08	0.12	0.01
Other Business Services		0.60	0.11	0.09	0.06		0.10	0.05
Misc. Equipment Rental and Leasing				0.06	0.59	0.11	0.20	0.03
Doctors and Veterinarian Services	0.09	0.53	0.06	0.09	0.14	0.08		
Legal Services	0.07	0.48	0.07	0.11	0.19	0.08		
Environmental/Engineering Services	0.06	0.38	0.11	0.08	0.08	0.03	0.21	0.01
Acct/Msc Business Services	0.06	0.46	0.05	0.09	0.13	0.07	0.12	0.01
Management/Consulting Services	0.04	0.54	0.04	0.09	0.11	0.05	0.12	0.01
Testing/Research Facilities		0.38	0.14	0.14	0.05		0.22	0.11

Source: U.S. Dept. of the Interior, Minerals Management Service, 2000. Cost Profiles and Cost Functions for Gulf of Mexico Oil and Gas Development Phases for Input-Output Modeling Study.

Table E-3

Population Projection for Socioeconomic Impact Area
(in thousands)

Onshore Subarea	2000	2001	2002	2005	2010	2015	2020	2025
LA-1	697.71	702.97	708.32	723.93	749.61	775.93	803.08	830.66
LA-2	1,054.55	1,068.40	1,082.27	1,123.38	1,191.06	1,259.65	1,329.20	1,399.61
LA-3	1,197.73	1,202.56	1,207.41	1,221.45	1,235.16	1,267.95	1,292.76	1,318.46
MA-1	912.11	922.24	932.40	962.52	1,011.98	1,062.37	1,113.54	1,165.51
CGOM	3,862.10	3,896.17	3,930.40	4,031.28	4,187.81	4,365.90	4,538.58	4,714.24
TX-1	923.09	933.22	943.46	973.95	1,024.54	1,076.45	1,129.68	1,183.81
TX-2	5,021.05	5,094.84	5,168.84	5,388.52	5,750.80	6,117.37	6,488.76	6,864.69
WGOM	5,944.14	6,028.06	6,112.30	6,362.47	6,775.34	7,193.82	7,618.44	8,048.50
FL-1	772.44	785.47	798.60	837.50	901.81	966.77	1,032.56	1,099.13
FL-2	122.07	124.05	125.98	131.81	141.53	151.29	161.18	171.18
EGOM	894.51	909.52	924.58	969.31	1,043.34	1,118.06	1,193.74	1,270.31
Total GOM	10,700.75	10,833.75	10,967.28	11,363.06	12,006.49	12,677.78	13,350.76	14,033.05
Average Annual Percentage Population Increase								
Onshore Subarea	2000	2001	2002	2005	2010	2015	2020	2025
LA-1	0.60%	0.75%	0.76%	0.73%	0.71%	0.70%	0.70%	0.69%
LA-2	1.02%	1.31%	1.30%	1.27%	1.20%	1.15%	1.10%	1.06%
LA-3	0.11%	0.40%	0.40%	0.39%	0.22%	0.53%	0.39%	0.40%
MA-1	1.06%	1.11%	1.10%	1.08%	1.03%	1.00%	0.96%	0.93%
CGOM	0.67%	0.88%	0.88%	0.85%	0.78%	0.85%	0.79%	0.77%
TX-1	0.87%	1.10%	1.10%	1.08%	1.04%	1.01%	0.99%	0.96%
TX-2	1.72%	1.47%	1.45%	1.42%	1.34%	1.27%	1.21%	1.16%
WGOM	1.58%	1.41%	1.40%	1.36%	1.30%	1.23%	1.18%	1.13%
FL-1	1.19%	1.69%	1.67%	1.62%	1.53%	1.44%	1.36%	1.29%
FL-2	1.35%	1.62%	1.56%	1.54%	1.47%	1.38%	1.31%	1.24%
EGOM	1.21%	1.68%	1.66%	1.61%	1.53%	1.43%	1.35%	1.28%
Total GOM	1.22%	1.24%	1.23%	1.20%	1.13%	1.12%	1.06%	1.02%

Table E-4

Employment Impacts Projected from Kerr-McGee's
Initial Development Operations Coordination Document
(peak employment is projected for the year 2001 as shown; an additional 40-50 person years of employment for operations and maintenance is required for each year over the life of the project)

Onshore Subarea	Direct Employment	Indirect Employment	Induced Employment	Total Employment	Baseline Employment	Marathon Plan as a % of Baseline
FL-1	1.5	1.2	0.8	3.5	436,890	0.00%
FL-2	0.2	0.1	0.0	0.3	45,320	0.00%
EGOM	1.6	1.3	0.8	3.8	482,210	0.00%
LA-1	188.5	48.7	71.8	309.0	394,330	0.08%
LA-2	138.9	47.1	54.9	240.9	613,040	0.04%
LA-3	309.6	118.3	124.0	551.8	741,380	0.07%
MA-1	21.4	9.8	9.0	40.3	521,070	0.01%
CGOM	658.5	223.8	259.7	1,142.0	2,269,820	0.05%
TX-1	24.3	8.0	9.0	41.3	465,640	0.01%
TX-2	313.5	172.7	180.6	666.8	3,119,840	0.02%
WGOM	337.8	180.7	189.7	708.2	3,585,480	0.02%
Total GOM	997.9	405.9	450.2	1,854	6,337,510	0.03%

Table E-5

Oil Spill Employment

Onshore Subarea	Direct Employment	Indirect Employment	Induced Employment	Total Employment
FL-1	0.34	0.21	0.16	0.16
FL-2	0.00	0.00	0.00	0.00
FL-3	39.31	27.02	19.88	19.88
FL-4	0.10	0.06	0.05	0.05
EGOM	39.75	27.29	20.09	20.09
LA-1	19.46	4.34	9.69	9.69
LA-2	24.39	4.73	11.45	11.45
LA-3	37.07	7.75	21.13	21.13
MA-1	15.90	3.10	8.48	8.48
CGOM	96.82	19.92	50.75	50.75
TX-1	17.48	4.05	8.90	8.90
TX-2	80.79	25.86	52.44	52.44
WGOM	98.27	29.91	61.34	61.34
Total GOM	234.84	77.13	132.18	132.18

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.