Moxa Arch Area Infill
Gas Development Project
DRAFT Environmental Impact Statement

Volume 1 of 2

BLM

Wyoming State Office - Kemmerer Field Office

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

October 2007

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United States Department of the Interior

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Dear Reader:

This Draft Environmental Impact Statement (DEIS) for the proposed Moxa Arch Infill Gas Development Project is submitted for your review and comment. The DEIS has been prepared in consultation with cooperating agencies to analyze the potential impacts of drilling and production operations of natural gas wells and associated access roads, pipeline, and infrastructure proposed by EOG Resources and other operators in the Project Area. The Project Area is located within Lincoln, Uinta, and Sweetwater Counties, Wyoming.

An Air Quality Technical Support Document (TSD) has also been prepared in conjunction with the DEIS. The Air Quality TSD, along with other appendices, is provided in Volume 2 of the DEIS. The DEIS, Air Quality TSD, and other appendices will be available for review at the Bureau of Land Management (BLM) offices below. All of these documents may be viewed or downloaded from the BLM website at: http://www.blm.gov/wy/st/en/info/NEPA/kfodocs/moxa_arch.html.

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The Moxa Arch Area (MAA) includes 475,808 acres with Federal surface ownership of approximately 260,284 acres, plus 5,216 acres of split-estate land. Currently there are approximately 1,400 wells completed within the MAA. Wells, roads, pipelines, compressors, treatment facilities, and other associated infrastructure have been constructed in the MAA.

The DEIS was prepared pursuant to the National Environmental Policy Act and other regulations and statutes to address the environmental and socio-economic impacts which could result from the project. The DEIS is not a decision document. Its purpose is to inform the public and interested parties of impacts associated with implementing the proponents' proposal, to evaluate alternatives to the proposal, and to solicit comments.

Four alternatives are analyzed in the DEIS. The Proposed Action is infill drilling of up to 1,861 new wells to the Dakota and Frontier formations, and installation and operation of additional ancillary facilities including roads, gas pipelines, and separation, dehydration, metering, and fluid storage facilities. Under the No Action alternative (Alternative A) the project as proposed would not be implemented and wells analyzed and approved in the 1996 EIS and 1997 Record of Decision (ROD) for the MAA would continue to be drilled and put into production. Alternative B evaluates full field development under a scenario with the same surface disturbance allowed for Alternative A. Alternative C evaluates the drilling of up to 16 well pads per square mile in the "core" of the MAA, and up to 4 well pads per square mile in the "flank."

The BLM has not selected a preferred alternative at this time. Information acquired during public comment periods and BLM internal review will result in the selection of an alternative, or combination of alternatives, to provide the best mix of operational requirements, mitigation measures, and best management practices to reduce environmental effects.

If you wish to submit comments on the DEIS, we request that you make them as specific as possible. Comments are more helpful if they include suggested changes, sources, or methodologies. Comments that contain only opinions or preferences will not receive a formal response from the BLM. However, they will be considered and included as part of the BLM decision-making process.

The BLM can best use your comments if they are submitted within 60 days after the Environmental Protection Agency (EPA) publishes its Notice of Availability in the Federal Register. Please submit written comments to:

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Michele_Easley@blm.gov
Fax: (307) 828-4539

The BLM will host a public meeting approximately 4 weeks following the publication of the EPA's Federal Register notice to receive comments on the DEIS. This meeting will be announced at least 14 calendar days in advance through public notices, media news releases, and/or mailings.

Comments submitted for the DEIS, including the names and street addresses of respondents, will be made available for review after the comment period closes at the Kemmerer Field Office during regular business hours (7:45 a.m. to 4:30 p.m.), Monday through Friday, except holidays. Public comments will be published as part of the final EIS. While you can ask us in your comment to withhold from public review your personal identifying information, we cannot guarantee that we will be able to do so. All submissions from organizations or businesses and from individuals identifying themselves as representatives or officials of organizations or businesses will be made available for public inspection in their entirety.

A copy of the DEIS has been sent to affected Federal, State, and local government agencies, and to those persons who have indicated that they wish to receive a copy of the DEIS.

If you have questions or need additional information, please contact Michele Easley, Project Lead, at the Kemmerer Field Office, address and e-mail shown above, or at (307) 828-4500.

Sincerely,

Robert A. Bennett
State Director

COMMENT ADDRESS

Please submit written comments to:	Moxa Arch Drilling Project Comments Attn: Michele Easley Bureau of Land Management Kemmerer Field Office 312 Highway 189 North Kemmerer, Wyoming 83101
Please submit electronic comments to:	Kemmerer_wymail@blm.gov with "Attention: Moxa Arch DEIS" in the subject line.

EXECUTIVE SUMMARY

Introduction

The United States Department of Interior (USDI) Bureau of Land Management (BLM) Kemmerer Field Office (KFO) has received a proposal from EOG Resources, Inc. (EOG) and other companies (Operators) to expand the existing natural gas drilling and field development operations in the Moxa Arch Area (MAA) of southwestern Wyoming. The Operators' proposed Moxa Arch Area Infill Gas Development Project (Project) encompasses approximately 475,808 acres of federal, state, and private lands in Sweetwater, Lincoln, and Uinta counties (Project Area). Federally administered land totals approximately 260,284 acres, plus 5,216 acres of split-estate lands.

The BLM KFO has prepared this draft Environmental Impact Statement (DEIS) in accordance with the National Environmental Policy Act of 1969 (NEPA), as amended. This DEIS analyzes the effects of the Project's proposed infill drilling and field development on the natural and human environment within, and in the vicinity of, the Project Area.

Currently within the Project Area, the BLM has authorized approximately 1,400 wells and associated access roads, pipelines, and ancillary facilities. Operation and maintenance of these facilities would continue as authorized by existing permits.

Proposed Action

The Operators propose infill drilling of approximately 1,861 new wells in addition to the existing producing wells in the Project Area, and the installation and operation of additional ancillary facilities, including roads; gas pipelines; and separation, dehydration, metering, and fluid storage facilities. Wells would be drilled to the Frontier and Dakota formations to depths of 11,000 to 12,000 feet. Approximately 1,226 of the wells would be drilled in the "core" area, and approximately 635 wells would be drilled in the "flank" area. Densities would range from 4 to 12 wells per section in the core area and 2 wells per section in the flank area. The precise locations of the proposed wells are not determined at this time.

The area of surface disturbance associated with drilling and completion activities would be approximately 18,650 acres over a 10-year drilling schedule. After interim reclamation is completed, the area of long-term disturbance associated with project development would be approximately 5,997 acres. The average life expectancy of a well is anticipated to be 40 years. The Operators would adhere to all lease conditions, federal and state laws and regulations, and best management practices (BMPs) required per agency guidance.

Scoping

Public and agency scoping was conducted to determine issues relative to the Proposed Action. All issues identified during scoping and BLM and interdisciplinary team (IDT) reviews were evaluated to identify the key issues that drove development of alternatives and the impact analyses.

Key issues included:

- Impacts to grazing and how permittees would be compensated for loss of animal unit months (AUMs) and other land impacts
- Potential for noxious weeds to spread through the area, which impacts rangeland health and decreases native species diversity
- Impacts to wildlife and their habitat, including big game, raptors, and sensitive species

- Potential changes in hunting and recreation in the area
- Impacts to surface water, groundwater, and riparian areas, including increased sedimentation and pollutant levels
- Impacts to the natural habitat, wildlife, and visual resources from the increased surface disturbance and well density, and the need to minimize disturbance
- Potential impacts to cultural resources
- Impacts to air quality, visibility, and odors from increased emissions
- Increased traffic and the need for transportation planning
- Potential economic gains and losses
- Potential increased crime in the area in the form of thefts, trespassing, illegal hunting, and drug use
- Potential impacts from hazardous materials spills, drilling fluids, and production water

Alternatives

Alternative A – No Action

The No Action Alternative would reject the Operators' proposal and continue with implementation of the previously approved development and surface disturbance. The 1996 Expanded Moxa Arch Area Natural Gas Development Project Environmental Impact Statement (EIS) and the 1997 Record of Decision (ROD) analyzed and approved drilling 1,325 wells in the MAA in addition to the 1,119 approved or completed wells existing at that time. The ROD limits the number of wells in identified zones based on big game habitat. As of June 2007, approximately 655 of the wells have been constructed and are in production or have not been plugged and abandoned. At current drilling rates, approximately 6 years would be required to drill the remaining 670 wells in the MAA. New, short-term, construction-related surface disturbance under the No Action Alternative would be approximately 11,590 acres, which would drop to approximately 3,217 acres after interim reclamation.

Alternative B

Alternative B would limit the amount of active surface disturbance in the MAA and would allow full field development under a scenario with the same surface disturbance allowed for the No Action Alternative. Alternative B would allow drilling up to 5,165 additional wells across all lands in the MAA over a 25-year period, as long as active, un-reclaimed surface disturbance associated with oil and gas drilling and exploration activities across the MAA is less than the 10,921 acres, as projected for the No Action Alternative. If active oil and gas related disturbance in the MAA exceeds 10,921 acres at any point during the approximate 25-year drilling phase of Alternative B, no new wells would be approved for federal lands or the federal mineral estate until reclamation reduces disturbance below the threshold. This alternative encourages increased reclamation and use of newly available technologies, reclamation techniques, and drilling and operations processes to reduce surface disturbance.

Alternative C

Alternative C would allow drilling up to 16 well pads per square mile across the core of the MAA and 4 well pads per square mile in the flank of the MAA to maximize resource extraction. Infill drilling as part of Alternative C would consist of approximately 5,165 new wells across the MAA, drilled over approximately 25 years. Surface disturbance associated with drilling and completion activities would be approximately 45,573 acres. After interim reclamation is completed, the area of long-term disturbance associated with project development would be approximately 15,357 acres for the 40-year life of the wells. Operators would adhere to the necessary site-specific BMPs presented for Alternative B.

Environmental Analysis

Air Quality

The modeling results indicate that for the Proposed Action and alternatives neither direct impacts nor cumulative source impacts would exceed any air quality standards or Prevention of Significant Deterioration (PSD) Class I area increments. There are no significant direct total nitrogen or sulfur deposition impacts at any Class I area for the Proposed Action and No Action Alternative. For Alternative C, the maximum nitrogen deposition at the Bridger Class I area slightly exceeds the NPS DAT for the three years of modeling, but at the other Class I areas, maximum nitrogen deposition is below the DATs. Project emissions plus the cumulative emissions may have an adverse impact on acidity at the Upper Frozen Lake for all alternatives, but Project emissions alone would not significantly increase acidity in any lake. Visibility impacts are anticipated for all alternatives, except the No Action Alternative. Ozone concentrations would be expected to remain below the National Ambient Air Quality Standards for the Proposed Action and all alternatives.

Geology

Impacts to topography and surface geology would be proportional to the degree of surface disturbance of each alternative. Geohazard risks are low for the Project Area and are restricted to steep slopes and bluffs adjacent to perennial streams and along the sides of residual mesas.

Paleontological Resources

The entire MAA bedrock surface carries a probable fossil yield classification (PFYC) of 5 (highest). Paleontological resource impacts are considered to be proportional to the level of surface disturbance for each alternative.

Mineral Resources

Depletion of natural gas resources depends on the number of wells allowed under each alternative. The Proposed Action would recover approximately 60%, the No Action Alternative would recover approximately 27.6%, and Alternatives B and C would recover approximately 85% of the estimated technically recoverable resource for the MAA. The restrictions on gas development over portions of the MAA resulting from conflicts with trona mining can negatively impact resource recovery.

Soils

All alternatives would result in disturbing both sensitive and non-sensitive soil types, and the extent varies by the area of disturbance. Interim reclamation efforts during well production and road maintenance would reduce residual disturbance acreage.

Water Resources

Potential impacts to surface water include increased levels of water flow and runoff, increased sediment yields and corresponding changes to salinity and turbidity, accidental spills, and increased water consumption and resulting water depletions. Surface water impacts would be proportional to the percentage of a watershed that is disturbed. The majority of surface disturbance would occur within the Blacks Fork Watershed.

Some local depletion of groundwater may occur under all alternatives. Relative use of groundwater is expected to be proportional to the number of wells drilled for each alternative. Impacts to groundwater quality are expected to be minimal and the same for all alternatives due to current casing and cementing policies.

Vegetation and Wetlands

For all alternatives, removing vegetation would result in increased soil exposure, loss of wildlife habitat, reduced plant diversity, and loss of livestock forage. The disturbed surface area increases the potential for non-native/noxious plant establishment, accelerates erosion, and changes the visual aesthetics of the area. The level of impact would be proportional to the acres disturbed for each alternative. Sensitive areas, such as wetlands, would be avoided to the extent practicable. Where impacts to wetlands are unavoidable, mitigation through the Section 404 process would reduce impacts.

Fisheries and Wildlife

Water depletions, sedimentation, accidental spills, or other impacts to water quality could cause direct mortality of aquatic organisms, including fish. Potential impacts to aquatic resources and fisheries are expected to be the same for the Proposed Action and the alternatives. All alternatives would affect some raptor breeding and home range habitat during drilling and completion. However, field surveys for raptors would establish restrictive buffers during nesting and brood rearing timeframes and adjust construction scheduling to minimize impacts. Fragmentation and surface disturbance may impact big game populations, foraging habitat, seasonal ranges, and migration corridors. Seasonal restrictions and mitigation measures would reduce long-term wildlife impacts.

Threatened and Endangered Species

Endangered Species Act (ESA)-listed species that are known to occur, or potentially occur, in the MAA include black-footed ferret (*Mustela nigripes*), Ute ladies'-tresses orchid (*Spiranthes diluvialis*), and the western yellow-billed cuckoo (*Coccyzus americanus occidentalis*). Impacts to these species from development in the MAA include habitat loss and increased stress from human presence and equipment. Endangered Colorado River fish species downstream of the MAA could be affected by depletions to the Colorado River system. Also, several BLM-listed sensitive species are known to occur or potentially occur within the MAA. The level of impact to federally-listed and BLM-listed species would generally be proportional to the density of wells and acres of surface disturbance. Seasonal restrictions, buffers, and other mitigation measures would reduce impacts to these species.

Cultural and Historical Resources

Indirect and direct impacts to cultural and historical resources would occur in proportion to the volume of new surface disturbance. The more acres of disturbance would make avoidance of sites more difficult, would increase the need for direct mitigation on sites, and would result in more discoveries and archaeological excavation. Adverse impacts would generally be avoided or mitigated; however, undocumented National Register of Historic Places (NRHP)-eligible sites could be impacted when not recognized.

Socioeconomics

Both beneficial and adverse socioeconomic impacts are anticipated as a result of the Proposed Action and alternatives. Project related employment and population growth would have effects on the region. Also, increases in federal, state, and local revenues from direct and indirect production and expenditures would occur. Under all alternatives, the Project would generate substantial revenues for state, county, and local governments, including area school districts, through state sales tax, federal income tax, ad valorem taxes (production property taxes), severance taxes, federal minerals royalties, and other taxes on facilities and production. The impacts from Alternatives B and C would be greater than any of the other alternatives, due to the number of new wells drilled and the length of the project drilling, completion, and production phases.

Grazing and Rangeland

Fish, wildlife, and domestic animals depend upon rangeland health for food and habitat. Impacts to rangeland health, livestock, grazing allotments, and all resource uses of rangelands would result with the implementation of the Proposed Action or any of the action alternatives. Impacts would vary in intensity depending upon vegetation and soil disturbance, reclamation success, weed control, road construction and use (i.e., dust and animal/vehicle collisions), success of rangeland improvements, and additional resources and costs incurred by government officials and grazing permittees. Under the Proposed Action and all alternatives, cattle and sheep grazing would likely continue throughout the duration of the project with stocking rate adjustments and requests for temporary non-use made annually by each livestock operation.

Recreation

Fishing, hunting, camping, and other recreational activities occur in the Project Area or vicinity. Impacts to recreational resources in the MAA are not expected to be significant, as the current recreational opportunities in the MAA are minimal. Indirect effects to recreational opportunities associated with wildlife may occur due to displacing species during construction and reclamation and may continue until these species return to the area. In general, the level of impact depends on the amount of surface disturbance and the number of mitigation measures that reduce disturbance to recreational resources, big game, and other wildlife.

Transportation

Traffic would increase on federal and state highways and county roads providing access to the MAA, primarily Interstate 80 (I-80), U.S. 30, and U.S. 189. Increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways and would result in a corresponding increase in the statistical probability of accidents on these highways. Total number of trips would increase in proportion to the level of development for each alternative. The BLM, cooperating agencies, and the Operators would continue to cooperatively develop long-term transportation management plans for existing and future roads.

Visual Resources

Visual resource impacts from natural gas development can result from increases in well pad density, miles of road and pipeline, traffic, and ancillary facilities within the MAA. Construction equipment and temporary facilities cause short-term impacts. The severity of impact to sites depends on the existing scenic quality, level of disturbance, reclamation potential, and visibility to viewers. Areas along major rivers, highways, railroads, and historic trails are categorized as Visual Resource Management (VRM) Class II and III, and all alternatives would result in significant visual impacts to these areas. Visual mitigation measures would occur in VRM Class II, III, and IV areas for all alternatives.

Health and Safety

Given the remote nature of the Project Area, health and safety risks to the public due to project development activities are expected to be generally low. Occupational hazards would be limited to project employees and contractors, rather than the general public. The potential for impacts related to the use of hazardous materials would be reduced by implementing a Hazard Communication Program, Spill Prevention Control and Countermeasure Plan, and other mitigation measures. Although a heightened risk of wildfire would occur in some areas, the risk to the public would be minimal.

TABLE OF CONTENTS

Page

Executive Summary ..... **i**

Chapter 1 Purpose and Need **1-1**
1.1. Introduction 1-1
1.2. Overview of the Proposed Project 1-5
1.3. Purpose and Need for the Project 1-7
1.4. Decisions to Be Made 1-8
1.5. Regulatory Setting 1-8
1.5.1. Federal Permits, Authorizations, and Coordination 1-9
1.5.2. Wyoming BLM Mitigation Guidelines and Practices for Surface-Disturbing and Disruptive Activities 1-13
1.5.3. Conformance with the Kemmerer Resource Management Plan 1-13
1.5.4. State and Local Permits, Authorization, and Coordination 1-13
1.6. Public Scoping 1-13
1.6.1. Public Scoping Process 1-14
1.6.2. Key Issues 1-14
1.6.2.1. Ranching and Grazing 1-14
1.6.2.2. Air Quality 1-15
1.6.2.3. Wildlife 1-15
1.6.2.4. Transportation 1-15
1.6.2.5. Recreation 1-16
1.6.2.6. Economics 1-16
1.6.2.7. Water 1-16
1.6.2.8. Cultural Resources 1-16
1.6.2.9. Noxious Weeds 1-16
1.6.2.10. Health and Human Safety 1-17
1.6.2.11. Surface Disturbance 1-17
1.6.2.12. Environmental Quality 1-17
1.6.2.13. Best Management Practices 1-17
1.6.2.14. General Industry Comments 1-18
1.6.2.15. BLM Management and NEPA Compliance 1-18

Chapter 2 Proposed Action and Alternatives **2-1**
2.1. Introduction 2-1
2.2. Alternative Development 2-1
2.3. Alternative Descriptions 2-3
2.3.1. Moxa Operators' Proposed Action 2-3
2.3.2. Alternative A 2-8
2.3.3. Alternative B 2-12
2.3.4. Alternative C 2-13
2.4. Features Common to All Alternatives 2-15
2.5. Alternatives Considered and Eliminated from Detailed Study 2-16
2.5.1. 2,730 Wells Drilled Using Maximum Rig Availability 2-16
2.5.2. Shortened Drilling Phase Alternative 2-16
2.5.3. 9 to 12 Wells Per Square Mile Across Entire MAA 2-16
2.5.4. Spatial and Temporal Phasing of Field Development 2-16
2.6. Comparison of Impacts by Alternative 2-18

Chapter 3 Affected Environment **3-1**
3.1. Air Quality 3-2

3.1.1. Climate ... 3-2
3.1.2. Air Quality ... 3-5
3.1.2.1. Concentrations ... 3-5
3.1.2.2. Visibility ... 3-8
3.1.2.3. Deposition ... 3-11
3.2. Geology and Mineral Resources ... 3-15
3.2.1. Surface Geology and Topography ... 3-15
3.2.2. Geohazards ... 3-17
3.2.3. Paleontological Resources ... 3-17
3.2.4. Mineral Resources ... 3-19
3.2.4.1. Oil and Gas ... 3-19
3.2.4.2. Trona ... 3-21
3.2.4.3. Other Minerals ... 3-22
3.3. Soils ... 3-22
3.3.1. Soil Characteristics ... 3-24
3.3.2. Soil Types ... 3-24
3.3.2.1. Sedimentary Upland Soils ... 3-24
3.3.2.2. Floodplains and Low Terrace Soils ... 3-24
3.3.2.3. Alluvial and High Terrace Soils ... 3-24
3.3.3. Sensitive Soils ... 3-27
3.4. Water Resources ... 3-27
3.4.1. Surface Water ... 3-27
3.4.1.1. Surface Water Uses ... 3-30
3.4.1.2. Surface Water Quality ... 3-30
3.4.2. Groundwater ... 3-31
3.4.2.1. Groundwater Use, Including Drinking Water ... 3-31
3.4.2.2. Groundwater Quality ... 3-32
3.5. Noise ... 3-32
3.6. Vegetation and Wetlands ... 3-33
3.6.1. Plant Communities ... 3-33
3.6.1.1. Wyoming Big Sagebrush ... 3-35
3.6.1.2. Vegetated Sand Dunes ... 3-35
3.6.1.3. Alkali Scrub ... 3-35
3.6.1.4. Barrens/Exposed Rock or Soil ... 3-36
3.6.1.5. Riparian/Wetlands ... 3-36
3.6.1.6. Agricultural Lands ... 3-36
3.6.1.7. Juniper Woodland ... 3-36
3.6.2. Cryptobiotic Soil Crusts ... 3-36
3.6.3. Riparian and Wetland Areas ... 3-37
3.6.3.1. Lowland Alkali Scrub ... 3-37
3.6.3.2. Riparian Forest/Shrub ... 3-37
3.6.3.3. Wet Meadow ... 3-38
3.6.3.4. Marsh ... 3-38
3.6.3.5. Aquatic Bed/Open Water ... 3-38
3.6.3.6. Riverine ... 3-38
3.6.3.7. Riparian Proper Functioning Condition ... 3-38
3.6.4. Noxious, Non-Native, and Invasive Plant Species ... 3-39
3.7. Fisheries and Wildlife ... 3-40
3.7.1. Fisheries and Aquatic Ecosystems ... 3-40
3.7.2. Waterfowl ... 3-41
3.7.3. Raptors ... 3-42

3.7.4. Big Game 3-42
3.7.4.1. Pronghorn 3-45
3.7.4.2. Mule Deer 3-47
3.7.4.3. Elk 3-47
3.7.4.4. Moose 3-50
3.8. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species 3-50
3.8.1. Federally Listed and Candidate Species 3-50
3.8.1.1. Black-footed Ferret 3-52
3.8.1.2. Colorado River Fishes 3-52
3.8.1.3. Ute Ladies'-tresses 3-54
3.8.1.4. Western Yellow-billed Cuckoo 3-54
3.8.2. Wyoming BLM Sensitive Species 3-54
3.8.2.1. BLM Sensitive Bird Species 3-55
3.8.2.2. BLM Sensitive Mammals 3-61
3.8.2.3. BLM Sensitive Amphibians 3-62
3.8.2.4. BLM Sensitive Fish 3-62
3.8.2.5. BLM Sensitive Plants 3-63
3.9. Cultural and Historical Resources 3-65
3.9.1. Cultural Resources Overview 3-66
3.9.1.1. Site Types 3-66
3.9.1.2. Prehistoric Site Types 3-66
3.9.1.3. Historic Site Types 3-67
3.9.1.4. Native American Sensitive Sites and Traditional Cultural Properties 3-68
3.9.2. Culture History Context and Chronology 3-69
3.9.3. Benchmark Sites 3-70
3.9.4. Discovered Sites 3-70
3.9.5. Highly Sensitive Archaeological Locales 3-71
3.10. Social and Economic Conditions Including Environmental Justice 3-72
3.10.1. Population and Demographics 3-72
3.10.1.1. Lincoln County 3-72
3.10.1.2. Sweetwater County 3-74
3.10.1.3. Uinta County 3-74
3.10.1.4. Sublette County 3-74
3.10.2. Economic Sectors and Employment 3-75
3.10.3. Income and Earnings 3-75
3.10.3.1. Earnings per Job and Per Capita Income 3-75
3.10.3.2. Industry Earnings 3-79
3.10.4. Housing 3-79
3.10.4.1. Lincoln County 3-80
3.10.4.2. Sweetwater County 3-81
3.10.4.3. Uinta County 3-81
3.10.4.4. Sublette County 3-82
3.10.5. Quality of Living 3-82
3.10.5.1. Public Facilities and Services 3-82
3.10.5.2. Crime 3-84
3.10.6. Taxes and Revenues 3-84
3.10.6.1. Wyoming 3-84
3.10.7. Study Area Taxes and Revenues 3-87
3.10.7.1. Availability of Information 3-87

3.10.7.2. State Royalties ... 3-87
3.10.7.3. Sales, Use, and Lodging Tax Collections ... 3-87
3.10.7.4. Ad Valorem Valuation and Taxes Levied ... 3-88
3.10.8. Environmental Justice ... 3-89
3.11. Land Use ... 3-90
3.11.1. Land Status/Prior Rights ... 3-90
3.11.2. Livestock Grazing and Rangeland Health ... 3-90
3.11.3. Recreation ... 3-91
3.11.3.1. Fishing ... 3-94
3.11.3.2. Hunting ... 3-94
3.11.4. Transportation ... 3-95
3.12. Visual Resources ... 3-97
3.13. Hazardous Materials ... 3-99
Chapter 4 Environmental Consequences ... 4-1
4.1. Introduction ... 4-1
4.1.1. Impact Analysis ... 4-1
4.1.2. Significance Criteria ... 4-1
4.1.3. Best Management Practices/Mitigation Measures ... 4-2
4.2. Air Quality ... 4-2
4.2.1. Introduction ... 4-2
4.2.1.1. Emissions ... 4-3
4.2.1.2. Near-field Impacts ... 4-4
4.2.1.3. Far-Field Impacts ... 4-5
4.2.2. Significance Criteria ... 4-9
4.2.2.1. Near-Field Pollutants ... 4-9
4.2.2.2. Far Field Pollutants ... 4-9
4.2.2.3. Ozone ... 4-10
4.2.3. Direct and Indirect Impacts ... 4-10
4.2.3.1. Near-field Impacts ... 4-10
4.2.3.2. Far-field Impacts ... 4-11
4.2.3.3. Ozone ... 4-12
4.2.4. Residual Impacts ... 4-13
4.2.5. Mitigation ... 4-13
4.3. Geology and Mineral Resources ... 4-13
4.3.1. Surface Geology and Topography ... 4-13
4.3.1.1. Introduction ... 4-13
4.3.1.2. Significance Criteria ... 4-13
4.3.1.3. Direct and Indirect Impacts ... 4-13
4.3.1.4. Residual Impacts ... 4-15
4.3.2. Geohazards ... 4-15
4.3.2.1. Introduction ... 4-15
4.3.2.2. Significance Criteria ... 4-15
4.3.2.3. Direct and Indirect Impacts ... 4-16
4.3.2.4. Residual Impacts ... 4-16
4.3.3. Paleontological Resources ... 4-16
4.3.3.1. Introduction ... 4-16
4.3.3.2. Significance Criteria ... 4-16
4.3.3.3. Direct and Indirect Impacts ... 4-16
4.3.3.4. Residual Impacts ... 4-16
4.3.4. Mineral Resources ... 4-17

4.3.4.1. Introduction ... 4-17
4.3.4.2. Significance Criteria ... 4-17
4.3.4.3. Direct and Indirect Impacts ... 4-17
4.3.4.4. Mitigation ... 4-19
4.3.4.5. Residual Impacts ... 4-19
4.3.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts ... 4-19
4.4. Soils ... 4-20
4.4.1. Introduction ... 4-20
4.4.2. Significance Criteria ... 4-20
4.4.3. Direct and Indirect Impacts ... 4-21
4.4.3.1. Proposed Action ... 4-21
4.4.3.2. Alternative A ... 4-22
4.4.3.3. Alternative B ... 4-22
4.4.3.4. Alternative C ... 4-22
4.4.4. Mitigation ... 4-22
4.4.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts ... 4-23
4.5. Water Resources ... 4-24
4.5.1. Surface Water ... 4-24
4.5.1.1. Introduction ... 4-24
4.5.1.2. Significance Criteria ... 4-24
4.5.1.3. Direct and Indirect Impacts ... 4-24
4.5.1.4. Mitigation ... 4-28
4.5.1.5. Residual Impacts ... 4-28
4.5.2. Groundwater ... 4-28
4.5.2.1. Introduction ... 4-28
4.5.2.2. Significance Criteria ... 4-28
4.5.2.3. Direct and Indirect Impacts ... 4-28
4.5.2.4. Mitigation ... 4-29
4.5.2.5. Residual Impacts ... 4-29
4.5.3. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts ... 4-29
4.6. Noise ... 4-29
4.6.1. Introduction ... 4-29
4.6.2. Significance Criteria ... 4-29
4.6.3. Direct and Indirect Impacts ... 4-30
4.6.3.1. Proposed Action ... 4-30
4.6.3.2. Alternative A ... 4-30
4.6.3.3. Alternative B ... 4-30
4.6.3.4. Alternative C ... 4-31
4.6.4. Mitigation ... 4-31
4.6.5. Residual Impacts ... 4-31
4.6.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts ... 4-31
4.7. Vegetation and Wetlands ... 4-31
4.7.1. Plant Communities ... 4-31
4.7.1.1. Introduction ... 4-31
4.7.1.2. Significance Criteria ... 4-32
4.7.1.3. Direct and Indirect Impacts ... 4-32
4.7.1.4. Mitigation ... 4-36
4.7.1.5. Residual Impacts ... 4-36
4.7.2. Cryptobiotic Soil Crusts ... 4-36
4.7.2.1. Introduction ... 4-36

4.7.2.2. Significance Criteria 4-36
4.7.2.3. Direct and Indirect Impacts..... 4-36
4.7.2.4. Mitigation 4-37
4.7.2.5. Residual Impacts 4-37
4.7.3. Riparian and Wetland Areas..... 4-37
4.7.3.1. Introduction..... 4-37
4.7.3.2. Significance Criteria 4-37
4.7.3.3. Direct and Indirect Impacts..... 4-37
4.7.3.4. Mitigation 4-38
4.7.3.5. Residual Impacts 4-38
4.7.4. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-38
4.8. Fisheries and Wildlife 4-38
4.8.1. Fisheries and Aquatic Ecosystems..... 4-38
4.8.1.1. Introduction..... 4-38
4.8.1.2. Significance Criteria 4-39
4.8.1.3. Direct and Indirect Impacts..... 4-39
4.8.1.4. Mitigation 4-40
4.8.1.5. Residual Impacts 4-40
4.8.2. Raptors..... 4-40
4.8.2.1. Introduction..... 4-40
4.8.2.2. Significance Criteria 4-41
4.8.2.3. Direct and Indirect Impacts..... 4-41
4.8.2.4. Mitigation 4-42
4.8.2.5. Residual Impacts 4-43
4.8.3. Big Game..... 4-43
4.8.3.1. Introduction..... 4-43
4.8.3.2. Significance Criteria 4-44
4.8.3.3. Direct and Indirect Impacts..... 4-44
4.8.3.4. Mitigation 4-49
4.8.3.5. Residual Impacts 4-50
4.8.4. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-50
4.9. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species 4-50
4.9.1. Federally Listed and Candidate Species 4-50
4.9.1.1. Introduction..... 4-50
4.9.1.2. Significance Criteria 4-50
4.9.1.3. Direct and Indirect Impacts..... 4-51
4.9.1.4. Mitigation 4-52
4.9.1.5. Residual Impacts 4-52
4.9.2. Wyoming BLM Sensitive Species..... 4-53
4.9.2.1. Introduction..... 4-53
4.9.2.2. Significance Criteria 4-56
4.9.2.3. Direct and Indirect Impacts..... 4-56
4.9.2.4. Mitigation 4-58
4.9.2.5. Residual Impacts 4-60
4.9.3. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-60
4.10. Cultural and Historical Resources 4-60
4.10.1. Introduction 4-60
4.10.2. Significance Criteria 4-62
4.10.3. Direct and Indirect Impacts 4-62

4.10.3.1. Proposed Action 4-62
4.10.3.2. Alternative A 4-63
4.10.3.3. Alternative B 4-63
4.10.3.4. Alternative C 4-63
4.10.4. Mitigation 4-64
4.10.5. Residual Impacts 4-64
4.10.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-64
4.11. Social and Economic Impacts Including Environmental Justice 4-65
4.11.1. Introduction 4-65
4.11.2. Significance Criteria 4-66
4.11.3. Direct and Indirect Impacts 4-67
4.11.3.1. Labor 4-67
4.11.3.2. Employment Estimate Methodology 4-68
4.11.3.3. Economic Activity from Development and Production 4-71
4.11.3.4. Housing 4-75
4.11.3.5. Quality of Living 4-76
4.11.3.6. Proposed Action 4-77
4.11.3.7. Alternative A 4-79
4.11.3.8. Alternative B 4-80
4.11.3.9. Alternative C 4-82
4.11.4. Mitigation 4-83
4.11.5. Residual Impacts 4-83
4.11.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-83
4.12. Land Use 4-84
4.12.1. Land Status/Prior Rights 4-84
4.12.2. Livestock Grazing and Rangeland Health 4-84
4.12.2.1. Introduction 4-84
4.12.2.2. Significance Criteria 4-84
4.12.2.3. Direct and Indirect Impacts 4-84
4.12.2.4. Mitigation 4-87
4.12.2.5. Residual Impacts 4-87
4.12.3. Recreation 4-87
4.12.3.1. Introduction 4-87
4.12.3.2. Significance Criteria 4-88
4.12.3.3. Direct and Indirect Impacts 4-88
4.12.3.4. Mitigation 4-89
4.12.3.5. Residual Impacts 4-89
4.12.4. Transportation 4-89
4.12.4.1. Introduction 4-89
4.12.4.2. Significance Criteria 4-90
4.12.4.3. Direct and Indirect Impacts 4-90
4.12.4.4. Mitigation 4-93
4.12.4.5. Residual Impacts 4-93
4.12.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-93
4.12.5.1. Livestock and Grazing Allotments 4-93
4.12.5.2. Recreation 4-94
4.12.5.3. Transportation 4-94
4.13. Visual Resources 4-94
4.13.1. Introduction 4-94
4.13.2. Significance Criteria 4-94

4.13.3. Direct and Indirect Impacts 4-95
4.13.3.1. Proposed Action 4-95
4.13.3.2. Alternative A 4-96
4.13.3.3. Alternative B 4-96
4.13.3.4. Alternative C 4-96
4.13.4. Mitigation 4-97
4.13.5. Residual Impacts 4-97
4.13.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-97
4.14. Hazardous Materials/Health and Safety 4-97
4.14.1. Introduction 4-97
4.14.2. Significance Criteria 4-98
4.14.3. Direct and Indirect Impacts 4-98
4.14.3.1. Health and Safety 4-98
4.14.3.2. Occupational Hazards 4-98
4.14.3.3. Pipeline Hazards 4-99
4.14.3.4. Hazardous Materials 4-99
4.14.3.5. Fire and Natural Hazards 4-99
4.14.4. Mitigation 4-99
4.14.5. Residual Impacts 4-100
4.14.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts 4-100
Chapter 5 Cumulative Impacts Analysis 5-1
5.1. Introduction 5-1
5.2. Past, Present, and Reasonably Foreseeable Future Activities 5-1
5.2.1. Moxa Arch Area CIAA 5-1
5.2.2. Watershed CIAA 5-3
5.2.3. Wildlife and Recreation CIAA 5-4
5.2.4. Four-County CIAA 5-5
5.2.5. Air Quality CIAA 5-7
5.3. Potential Cumulative Impacts by Resource 5-7
5.3.1. Air Quality 5-7
5.3.2. Geology, Geohazards, Mineral Resources, and Paleontology 5-7
5.3.2.1. Geology, Geohazards, and Mineral Resources 5-7
5.3.2.2. Paleontology 5-9
5.3.3. Soils 5-9
5.3.4. Water Resources 5-9
5.3.5. Noise 5-9
5.3.6. Vegetation and Wetlands 5-10
5.3.7. Wildlife and Fisheries 5-10
5.3.7.1. Fisheries and Aquatic Habitat 5-11
5.3.7.2. Raptors 5-11
5.3.7.3. Big Game Mammals 5-11
5.3.8. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species 5-12
5.3.8.1. Colorado River Fishes 5-12
5.3.8.2. Ute Ladies'-tresses Orchid 5-12
5.3.8.3. Western Yellow-billed Cuckoo 5-12
5.3.9. Wyoming BLM Sensitive Species 5-13
5.3.9.1. BLM Sensitive Bird Species 5-13
5.3.9.2. Greater Sage-Grouse 5-13
5.3.9.3. Bald Eagle 5-13
5.3.9.4. BLM Sensitive Mammals 5-14

5.3.9.5. BLM Sensitive Amphibians 5-14
5.3.9.6. BLM Sensitive Fish 5-14
5.3.10. Cultural Resources 5-14
5.3.11. Socioeconomics 5-15
5.3.12. Land Use 5-16
5.3.12.1. Grazing 5-16
5.3.12.2. Recreation 5-17
5.3.12.3. Transportation 5-17
5.3.13. Visual Resources 5-18
Chapter 6 Consultation and Coordination 6-1
6.1.1. Public Participation 6-1
6.1.2. List of Preparers 6-7
Chapter 7 References Cited 7-1
Chapter 8 Glossary 8-1

LIST OF MAPS

Page

Map 1-1. Moxa Arch Area Vicinity Map. 1-2

Map 1-2. Surface Ownership and Federal Fluid Mineral Estate in the MAA. 1-3

Map 1-3. Federal Fluid Mineral Leases in the MAA. 1-4

Map 1-4. MAA Core, Flank, and Existing Well Locations. 1-6

Map 2-1. Hypothetical Distribution of Wells and Well Pads in the MAA for the Operators' Proposed Action. Hypothetical well locations are for illustrative purposes only and do not reflect the actual locations of wells that would be drilled. 2-4

Map 2-2. Zones Defined in the 1997 ROD (BLM 1997a). 2-9

Map 2-3. Hypothetical Distribution of Wells and Well Pads in the MAA for Alternative A/No Action. Hypothetical well locations are for illustrative purposes only and do not reflect the actual locations of wells that would be drilled. 2-10

Map 2-4. Hypothetical Distribution of Wells in the MAA for Alternative C. Hypothetical well locations are for illustrative purposes only and do not reflect the actual locations of wells that would be drilled. 2-14

Map 3-1. MAA Air Quality Modeling Domain. 3-9

Map 3-2. Air Quality Monitoring Stations in Wyoming. 3-14

Map 3-3. MAA and Trona Mining Areas. The CIAA for Mineral Resources includes the MAA and the Known Sodium Leasing Area (KSLA). 3-18

Map 3-4. Watersheds in the MAA and CIAA for Vegetation, Riparian and Wetland, Soil, and Water Resources. 3-23

Map 3-5. Sensitive Soil Types in the MAA (BLM 1995a). 3-26

Map 3-6. Vegetation Cover Types in the MAA. 3-34

Map 3-7. Known Raptor Nest Distribution in the MAA. 3-43

Map 3-8. Pronghorn Herd Units and Range in the MAA and CIAA. 3-46

Map 3-9. Mule Deer Herd Units and Range in the MAA and CIAA. 3-48

Map 3-10. Elk Herd Units and Range in the MAA and CIAA. 3-49

Map 3-11. Moose Herd Units and Ranges in the CIAA. 3-51

Map 3-12. Prairie Dog Populations in the MAA. 3-53

Map 3-13. Sage-Grouse Lek Locations and Range in the MAA and CIAA. 3-58

Map 3-14. Livestock Grazing Allotments in the MAA and CIAA. 3-92

Map 3-15. Transportation Network in the MAA. 3-96

Map 3-16. Visual Resource Management Classifications in the MAA. 3-98

Map 5-1. Known Projects Falling within the CIAA Boundaries Used in Cumulative Impacts Determinations. This map reflects the extent of the known projects in the air quality cumulative impacts analysis. Cumulative impacts for other resources will not be analyzed at this scale and are described in more detail in this section. 5-2

LIST OF FIGURES

Page

Figure 3-1. Wind Rose for the Jonah Field Used for MAA Air Quality Modeling Efforts. 3-3

Figure 3-2. Long-term Temperature (top) and Precipitation (bottom) Trends in the United States. From NOAA Climate Prediction Center (http://www.cpc.noaa.gov). 3-4

Figure 3-3. Mean Annual Concentrations of Nitrogen Compounds near Pinedale, Wyoming. Concentrations typical in remote areas are: HNO_3 = 0.3 ppb, NO_3 = 0.2 ppb, NH_4 = 0.3 ppb. Data taken from CASTNET Pinedale Station PND165. 3-7

Figure 3-4. Visibility in the Bridger Wilderness. 3-11

Figure 3-5. Mean Annual Nitrogen Deposition for Hobbs Lake and Black Joe Lake. 3-12

Figure 3-6. Mean Annual Sulfur Deposition for Hobbs Lake and Black Joe Lake. 3-13

Figure 3-7. Green River Basin Stratigraphic Chart and MAA Mineral Resources. 3-16

Figure 3-8. Average Daily Natural Gas Production, MAA. 3-21

Figure 3-9. MAA Big Game Population Estimates Over 10 Years. 3-44

Figure 4-1. Estimated Recoverable Gas Resources in the MAA under Each Alternative. Recoverable Gas for Alternative B would be Identical to Alternative C. 4-18

LIST OF TABLES

Page

Table 1-1. Major Federal, State, and Local Permits, Approvals, and Authorizing Actions for the Moxa Arch Area Infill Gas Development Project. 1-10

Table 2-1. Summary of Estimated Existing Surface Disturbance in the MAA. 2-1

Table 2-2. Summary of Well Numbers, Infrastructure, Project Duration, and Surface Disturbance for the Four Alternatives Analyzed in Detail. Numbers are maximum values for each alternative. For the proposed action, Alternative A, and Alternative C the number of wells is the same as the number of well pads. 2-2

Table 2-3. Approximate Disturbance Estimates for New Wells that would be Drilled in the MAA under the Operators' Proposed Action. 2-5

Table 2-4. Approximate Disturbance Estimates for New Wells that would be Drilled in the MAA under Alternative A/No Action. 2-11

Table 2-5. Approximate Disturbance Estimates for New Wells that would be Drilled in the MAA under Alternative C. 2-13

Table 2-6. Comparison of Impacts by Alternative..... 2-19

Table 3-1. Critical Elements of the Human Environment, Moxa Arch Area Infill Gas Development Project, Wyoming, 2006..... 3-1

Table 3-2. Summary of Climate (1958–2005)..... 3-2

Table 3-3. Air Pollutant Background Concentrations, NAAQS/WAAQS and Prevention of Significant Deterioration (PSD) Increments (µg/m^3). 3-6

Table 3-4. Wyoming Particulate Summary for 2001 (µg/m3)..... 3-8

Table 3-5. Distances and Direction to Class I Areas. 3-10

Table 3-6. Distances and Direction to Class II Sensitive Areas and other areas of concern in southwest Wyoming. 3-10

Table 3-7. Summary of Current Atmospheric Deposition..... 3-12

Table 3-8. Distance and Direction to Sensitive Lakes..... 3-13

Table 3-9. Background Acid Neutralizing Capacity Values for Acid Sensitive Lakes..... 3-14

Table 3-10. Cumulative Oil and Gas Production in the MAA. 3-20

Table 3-11. Areas of Sensitive and Non-Sensitive Soils Within the MAA..... 3-25

Table 3-12. Watershed Acreages in the MAA..... 3-28

Table 3-13. Surface Water Bodies, Hydrologic Regimes, and WDEQ Classes within the MAA..... 3-29

Table 3-14. WDEQ 2004 303(d) List of Water Bodies in the MAA..... 3-30

Table 3-15. WDEQ Ground Water Quality Standards. 3-32

Table 3-16. Noise Levels of Commonly Heard Sounds. 3-32

Table 3-17. Noise Levels Typical of Gas Field Operations..... 3-33

Table 3-18. Primary Vegetation Communities in the MAA and CIAA (PIC Technologies 1996)..... 3-35

Table 3-19. Cover Types of Waters of the U.S., including Wetlands, in the MAA, based on NWI and GAP Vegetation Mapping..... 3-37

Table 3-20. Riparian Proper Functioning Condition Ratings for Streams within the MAA*. 3-39
Table 3-21. Wyoming Noxious Weed Species. 3-41
Table 3-22. 2003 Population Data on Big Game Herd Units that Occur in the MAA. 3-45
Table 3-23. Species with Federal Status that were Evaluated for the MAA. 3-50
Table 3-24. BLM Kemmerer Field Office Sensitive Animal Species and Potential Occurrence in the MAA, 2006. 3-56
Table 3-25. BLM Kemmerer Field Office Sensitive Plant Species Evaluated for the MAA, 2006. 3-63
Table 3-26. Cultural Chronology for the MAA ((BLM 1995a) updated by (BLM 2004a)).....3-69
Table 3-27. Historic Chronology for the MAA (after WYCRO system and BLM 1995a). 3-70
Table 3-28. Population Data for Sweetwater, Lincoln, Uinta, and Sublette Counties, Wyoming. 3-73
Table 3-29. Employment by Sector for the Period of 1990-2003.....3-76
Table 3-30. Three-County Employment Growth. 3-77
Table 3-31. Labor Force Summary 1990-2004. 3-78
Table 3-32. Summary of Mineral Royalties Received by Wyoming and Directly Distributed to Project Affected Cities from 2000-2004 (Thousands of Dollars).....3-85
Table 3-33. Total PILT Payments and Total Acreage PILT Payments/Acre. 3-86
Table 3-34. U.S. Census Bureau Community Statistics. 3-90
Table 3-35. Grazing Allotments within the MAA. 3-93
Table 3-36. Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management Assessment Results and Management Status for Allotments. 3-94
Table 3-37. Current Traffic and Accident Information. 3-97
Table 4-1. Maximum projected 8-hour ozone concentrations near the Project and in the 4 km grid domain due to Base Case emissions plus the Cumulative Emissions and comparisons with the NAAQS. 4-12
Table 4-2. Estimated reduction in oil and gas related surface disturbances that would result from directionally drilling specified percentages of 1,995 federally administered wells in the core from currently existing well pads. Estimates for 0% are the same as for Alternative C.....4-15
Table 4-3. Anticipated Disturbance Acreages for Sensitive and Non-sensitive Soils Types. 4-21
Table 4-4. Acres of Surface Disturbance Within the Four Major Watersheds that Overlap the MAA and Percent of the Watershed Affected. 4-25
Table 4-5. Acres of Surface Disturbance within 15 Watersheds (5th Order) that Overlap the MAA. Disturbances for Alternative B cannot be calculated but would likely have long-term impacts after interim reclamation similar to those estimated for Alternative A. 4-26
Table 4-6. Estimated disturbance to vegetation types across alternatives in the MAA (in acres).....4-33
Table 4-7. WGFD Impact Thresholds for Priority Wildlife Species and Habitat from Oil and Gas Development Activities. Adapted from WGFD 2004, Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats. 4-39
Table 4-8. Potential Impacts to Raptor Breeding and Home Range Areas in the MAA. 4-41

Table 4-9. Potential Impacts to Big Game Species in the MAA. 4-45
Table 4-10. Impacts to Prairie Dog Habitat. 4-52
Table 4-11. WGFD Impact Thresholds for BLM Sensitive Species and Habitat from Oil and Gas Development Activities 4-53
Table 4-12. Impacts to Potential Sage-Grouse Wyoming Big Sagebrush Habitat Over the LOP. 4-54
Table 4-13. Recommended Seasonal Stipulations for BLM Sensitive Species. 4-58
Table 4-14. Anticipated Impacts to Cultural Resources by Alternative. 4-61
Table 4-15. MAA Natural Gas Production Compared to National Annual Demand. 4-66
Table 4-16. Average Annual Well Operating Costs (2006 $$). 4-66
Table 4-17. Estimated Work Force Requirements for All Wells, All Alternatives.[1] 4-69
Table 4-18. Estimated Annual Work Force Requirements for All Alternatives Expressed in Worker Days.[1] 4-70
Table 4-19. Moxa Well Drilling and Completion Cost Estimates (2006 $). 4-72
Table 4-20. Economic Activity from Gas Drilling and Completion per Vertically Drilled Well (40% Local), Sweetwater, Uinta, and Lincoln Counties, Wyoming, 2006 (2003 $). 4-73
Table 4-21. Average Annual Economic Activity from Gas Drilling and Completion by Alternative (40% Local Labor) over Life of the Project (2006 $). 4-73
Table 4-22. Economic Activities from Gas Production Per Well, Sweetwater, Uinta, and Lincoln Counties, Wyoming, 2006. 4-74
Table 4-23. Average Annual Economic Activity from Oil and Gas Production. 4-75
Table 4-24. Estimated Taxes and Revenues Received by Governments from Moxa Arch Area Infill Gas Development Project (LOP) (2006$ using 2005 mill levies). 4-77
Table 4-25. Summary of Economic Activity Resulting from Natural Gas Development and Production over the LOP, Moxa Arch Area Infill Gas Development Project, Sweetwater, Lincoln, and Uinta Counties, 2006 (2006 $). 4-78
Table 4-26. Potential Disturbance to Grazing Allotments within the MAA. 4-86
Table 4-27. Total Number of Trips by Alternative. 4-90
Table 4-28. Proposed Action Traffic Estimates in Peak 10th Year of Drilling. 4-90
Table 4-29. Proposed Action Peak Drilling Year (Year 10) AADT Compared with 2005 AADT and Projected 2015 AADT on Affected Highways. 4-91
Table 4-30. Alternative C Traffic Estimates in Peak 25th Year of Drilling. 4-92
Table 4-31. Alternative C Peak Drilling Year (Year 25) AADT Compared with 2005 AADT and Projected 2025 AADT on Affected Highways. 4-93
Table 4-32. Impacts to VRM Class Areas within the MAA. 4-95
Table 5-1. CIAAs by Resource, MAA Infill Gas Development Project, Wyoming, 2006. 5-8
Table 5-2. Proposed Action Peak Drilling Year (Year 10) AADT Compared with 2005 AADT and 2012 AADT on Affected Highways. 5-17
Table 6-1. List of BLM Interdisciplinary Team EIS Preparers. 6-7
Table 6-2. List of Consultant Interdisciplinary Team EIS Preparers. 6-8

LIST OF ACRONYMS

AADT	average annual daily traffic
ACEC	Area of Critical Environmental Concern
ACHP	Advisory Council on Historic Preservation
AIRFA	American Indian Religious Freedom Act
AJE	annual job equivalents
AMP	Allotment Management Plan
ANC	acid neutralizing capacity
AO	Authorized Officer
APD	Application for Permit to Drill
AQRV	Air Quality Related Value
ARPA	Archaeological Resources Protection Act
AUM	animal unit month
BA	Biological Assessment
BCF	billion cubic feet
BLM	Bureau of Land Management
BMP	Best Management Practice
CAA	Clean Air Act
CAAQS	Colorado Ambient Air Quality Standards
CAP	Coordinated Activity Plan
CASTNet	Clean Air Status and Trends Network
CBNG	coalbed natural gas
CDOW	Colorado Division of Wildlife
CDPHE	Colorado Department of Public Health and Environment
CEQ	Council on Environmental Quality
CF	cubic feet
CFR	Code of Federal Regulations
CIAA	Cumulative Impact Assessment Area
COA	Condition of Approval
CRPA	Cooper Ridge Project Area
CWA	Clean Water Act
DAT	Deposition Analysis Threshold
dBA	A-weighted decibels
DCI	Division of Criminal Investigation
DEIS	Draft Environmental Impact Statement
DM	Department Manual
DOE	U.S. Department of Energy
DUI	Driving Under the Influence
dv	deciview
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
EOG	EOG Resources, Inc.
EOR	Enhanced Oil Recovery
EPA	Environmental Protection Agency
EPAct	Energy Policy Act
ESA	Endangered Species Act
FLM	Federal Land Manager
FLPMA	Federal Land Policy and Management Act
GAP	Gap Analysis Program
GIS	geographic information systems

GSP	Gross State Product
HABS/HAER	Historic American Building Survey/Historic American Engineering Record
HAP	Hazardous Air Pollutant
HRU	Hay Reservoir Federal Oil and Gas Unit
HTPA	Horse Trap Natural Gas Project Area
HUC	hydrologic unit code
I/O	input/output
IDLH	Immediately Dangerous to Life or Health
IDT	interdisciplinary team
IM	Instruction Memorandum
IMPROVE	Inter-Agency Monitoring of Protected Visual Environments
JGGC	Jonah Gas Gathering Company
KFO	Kemmerer Field Office
KSLA	Known Sodium Leasing Area
LAC	Level of Acceptable Change
LOP	life of project
MAA	Moxa Arch Area
MBO	million barrels of oil
MBTA	Migratory Bird Treaty Act
MEI	Maximum Exposed Individual
MLA	Mineral Leasing Act
MLE	Most Likely Exposure
MMCFD	million cubic feet per day
MMTA	Mechanically Mineable Trona Area
MNHP	Montana Natural Heritage Program
MP	mile post
NAAQS	National Ambient Air Quality Standards
NABBS	North American Breeding Bird Survey
NADP	National Atmospheric Deposition Program
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NGL	Natural Gas Liquids
NHPA	National Historic Preservation Act
NHT	National Historic Trails
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
OHV	Off-highway Vehicle
OSHA	Occupational Safety and Health Administration
PFC	Proper Functioning Condition
PFYC	Probable Fossil Yield Classification
PILT	Payments in Lieu of Taxes
PM	Particulate Matter
PMC	Coarse Particulate Matter
PMF	Fine Particulate Matter
ppb	parts per billion
ppm	parts per million

PSD	Prevention of Significant Deterioration
PWMTF	Permanent Wyoming Mineral Trust Fund
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
REL	Reference Exposure Level
RfC	Reference Concentration
RFD	Reasonable Foreseeable Development
RFFA	Reasonable Foreseeable Future Activities
RIP	Recovery Implementation Program
RMG	Reservoir Management Group
RMP	Resource Management Plan
ROD	Record of Decision
ROW	right-of-way
RSFO	Rock Springs Field Office
RV	recreational vehicle
SCIP	Special Federal Class I Increment Level Protection
SCS	Soil Conservation Service
SHPO	State Historic Preservation Office
SLAMS	State and Local Air Monitoring System
SMA	surface management agency
SPCCP	Spill Prevention, Control, and Countermeasure Plan
SSURGO	Soil Survey Geographic
SVR	standard visible range
SWEDA	Sweetwater Economic Development Association
SWRTR	Soils and Water Resources Technical Report
T&E	Threatened and Endangered
TCF	trillion cubic feet
TCP	Traditional Cultural Property
TDS	total dissolved solids
TMDL	total maximum daily load
TSS	Total Suspended Solids
UAAQS	Utah Ambient Air Quality Standards
UCR	Uniform Crime Reporting
UCREFRP	Upper Colorado River Endangered Fish Recovery Program
URF	Unit Risk Factor
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USDOT	U.S. Department of Transportation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VOC	Volatile Organic Compound
VRM	Visual Resource Management
WAAQS	Wyoming Ambient Air Quality Standards
WARMS	Wyoming Air Resources Monitoring System
WDA	Wyoming Department of Agriculture
WDAI	Wyoming Department of Administration and Information
WDEQ	Wyoming Department of Environmental Quality
WDEQ/AQD	Wyoming Department of Environmental Quality/Air Quality Division
WDEQ/WQD	Wyoming Department of Environmental Quality/Water Quality Division

WGFD	Wyoming Game and Fish Department
WHDP	Wyoming Housing Database Partnership
WOGCC	Wyoming Oil and Gas Conservation Commission
WOSLI	Wyoming Office of State Lands and Investments
WRPTC	Wyoming Rare Plant Technical Committee
WS	Wyoming Statute
WSEO	Wyoming State Engineer's Office
WSGWG	Wyoming Sage Grouse Working Group
WWCC	Western Wyoming Community College
WWDC	Wyoming Water Development Commission
WYCRO	Wyoming Cultural Records Office
WYDOT	Wyoming Department of Transportation
WyNDD	Wyoming Natural Diversity Database
WYPDES	Wyoming Pollutant Discharge Elimination System

CHAPTER 1 PURPOSE AND NEED

1.1. Introduction

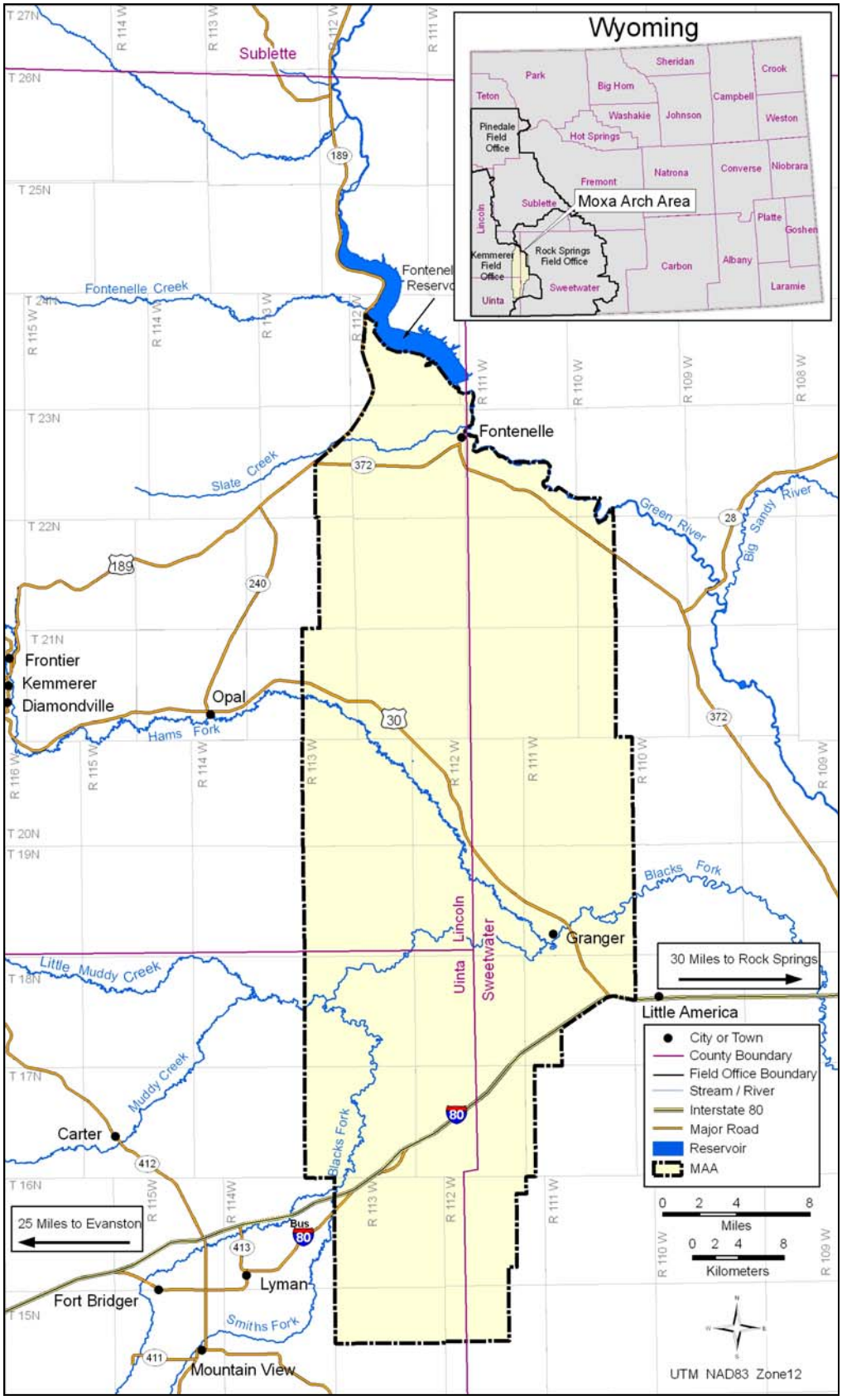
The United States Department of the Interior (USDI) Bureau of Land Management (BLM) Kemmerer Field Office (KFO) received a proposal from EOG Resources, Inc. (EOG) and other companies (Operators) to expand the existing natural gas drilling and field development operations on specific BLM-administered federal, state, and private lands in the Moxa Arch Area (MAA) of southwestern Wyoming (Project Area) (Map 1-1). The Operators' Proposed Action is known as the Moxa Arch Area Infill Gas Development Project (Project). Oil and gas leases of the subsurface mineral estate beneath these lands have been issued by the BLM (federal estate), the State of Wyoming, and private owners.

In response to this proposal and in compliance with the National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality (CEQ) regulations implementing NEPA, the BLM has prepared this Draft Environmental Impact Statement (DEIS) to analyze the effects of the Project's proposed infill drilling and field development on the natural and human environment within, and in the vicinity of, the Project Area. Lands for which impacts are analyzed in this DEIS are those previously addressed in the Expanded Moxa Arch Natural Gas Development Project EIS (BLM 1995a) and its Record of Decision (ROD) (BLM 1997a). These documents authorized 1,325 wells over 10 years. Prior to that, the Moxa Arch area was analyzed in the Amoco Production Company Moxa Arch Natural Gas Production Environmental Assessment (EA) issued for 149 wells (BLM 1991), and a supplemental EA (BLM 1992), which authorized an increase in well density per section from two to four.

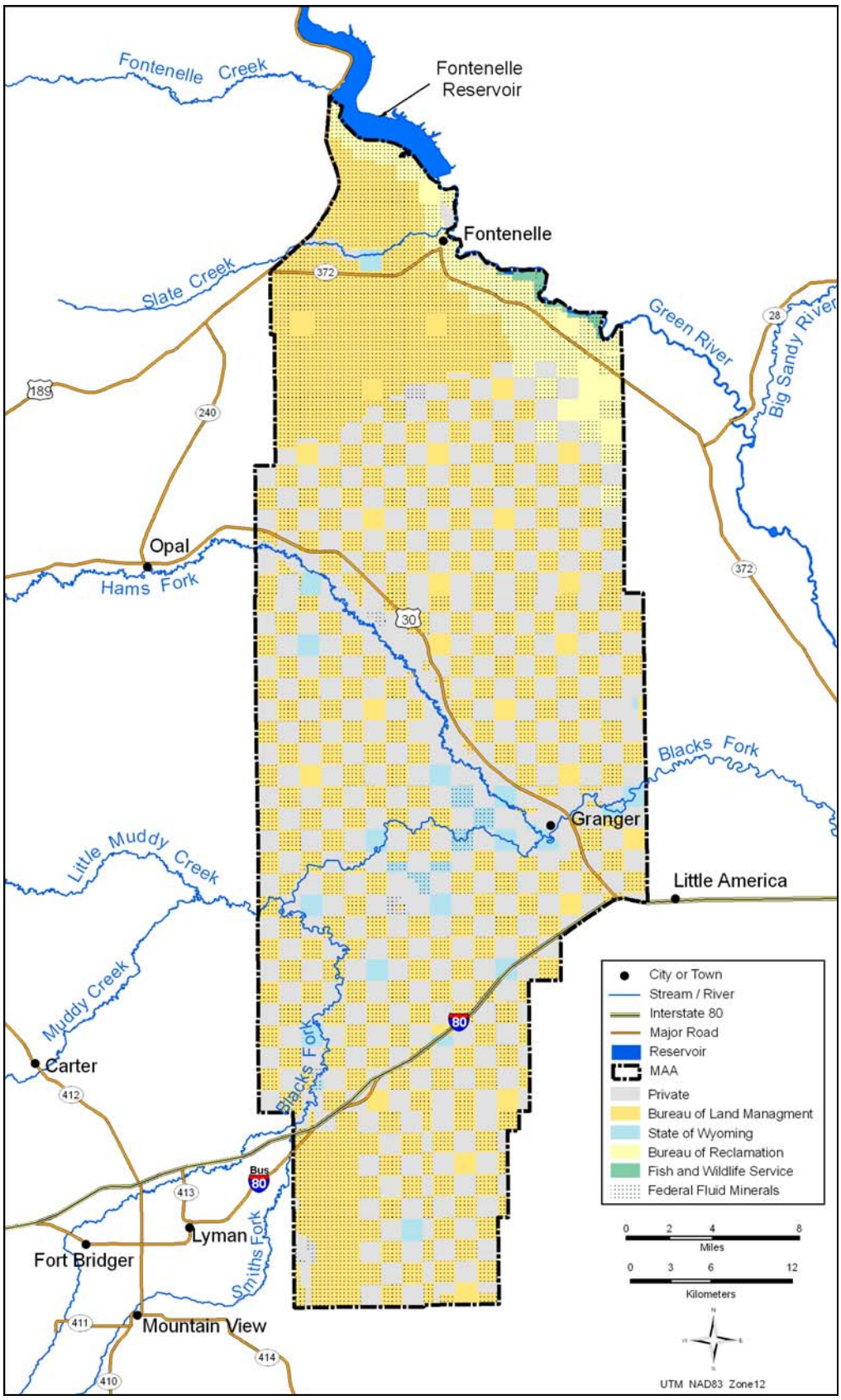
The Project Area consists of approximately 475,808 surface acres (approximately 744 square miles) of mixed (checkerboard) ownership of federal, state, and private lands in western Sweetwater, southeastern Lincoln, and northeastern Uinta counties, Wyoming (Map 1-2). Federally administered lands total approximately 260,284 acres (55% of the MAA); state ownership totals approximately 13,325 acres (3%); and private ownership totals approximately 202,199 acres (42%). Of the federal lands in the Project Area, approximately 231,719 acres are administered by the BLM, 26,958 acres are administered by the USDI Bureau of Reclamation (Reclamation), and 1,607 acres are administered by the U.S. Fish and Wildlife Service (USFWS). The majority of federal lands in the MAA are leased (Map 1-3) by 66 leaseholders. Approximately 30 companies operate on these leases.

Federal jurisdiction for the MAA extends to approximately 5,216 acres of split-estate lands (Map 1-2) with State of Wyoming and private surface ownership (3,112 acres are associated with State of Wyoming administered lands and 2,104 acres have private surface ownership). The Project Area is located within Townships 15 through 23 North (T15–23N), Ranges 111 through 113 West (R111–113W), 6th Principal Meridian, west of Green River, Wyoming, east of Lyman and Opal, Wyoming, and south of the Green River and Fontenelle Reservoir (Map 1-1). Interstate 80 (I-80) bisects the southern third of the Project Area.

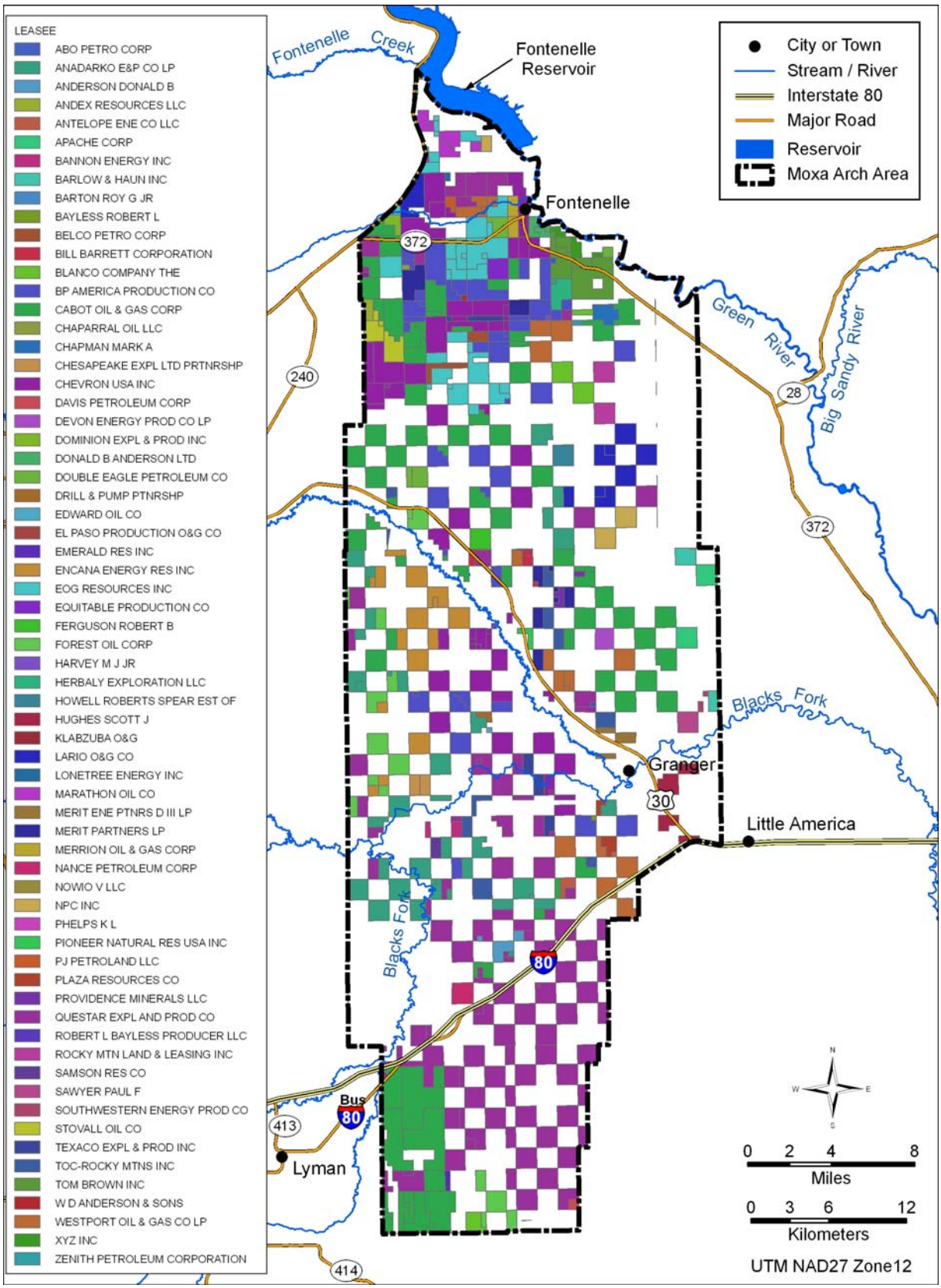
This DEIS provides the information necessary for the public and BLM decision-makers to understand the potential environmental impacts of the proposed Project, as well as the alternatives and the effects of applied protective mitigation measures developed as part of the analysis in this DEIS.



Map 1-1. Moxa Arch Area Vicinity Map.



Map 1-2. Surface Ownership and Federal Fluid Mineral Estate in the MAA.



Map 1-3. Federal Fluid Mineral Leases in the MAA.

The following federal, state, and local agencies acted as cooperators throughout the EIS process:

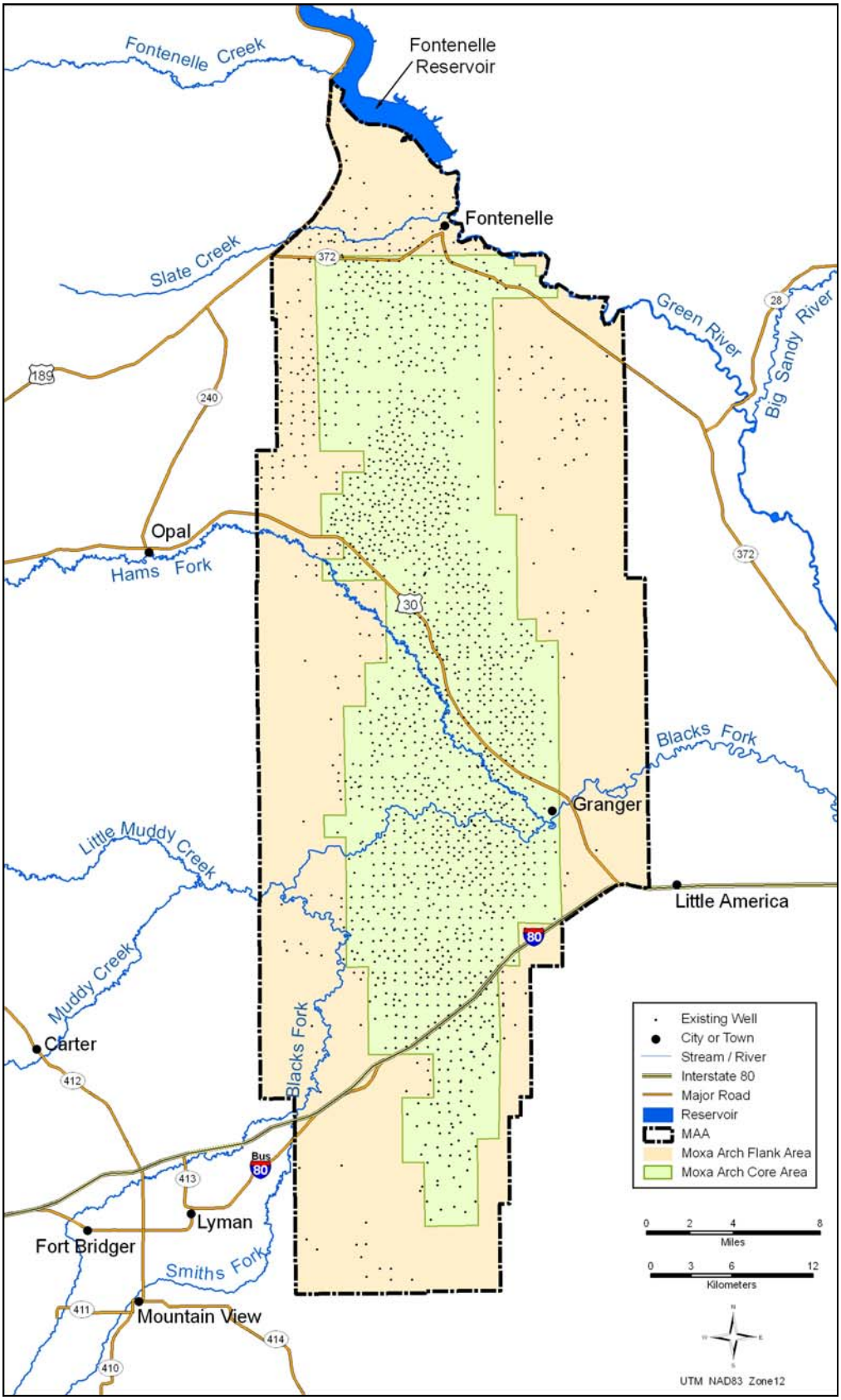
- BLM KFO – lead agency
- Reclamation
- USFWS
- U.S. Environmental Protection Agency (EPA)
- Office of State Lands and Investments
- Wyoming Department of Environmental Quality (WDEQ)
- Wyoming Governor's Planning Office
- Wyoming State Historic Preservation Office (SHPO)
- Wyoming Game and Fish Department (WGFD)
- Wyoming Department of Transportation (WYDOT)
- Wyoming Department of Agriculture (WDA)
- Lincoln County and Lincoln Conservation District
- Sweetwater County and Sweetwater County Conservation District
- Uinta County and Uinta County Conservation District

1.2. Overview of the Proposed Project

Based on current knowledge of natural gas reservoir characteristics (geology, flow from existing wells, anticipated recovery rates, and economics), the Operators anticipate field development in the Project Area to involve infill drilling of approximately 1,861 new wells in addition to the approximate 1,400 existing producing wells in the "core" and "flank" areas of the Project Area (Map 1-4). Also anticipated would be the installation and operation of additional ancillary facilities including roads; gas pipelines; and separation, dehydration, metering, and fluid storage facilities. Wells would be drilled to the Frontier and Dakota formations to depths of 10,000 feet to 13,000 feet.

The Operators estimate that approximately 1,226 additional wells would be drilled in the core area, and approximately 635 additional wells would be drilled in the flank area. The precise locations of the proposed wells are not determined at this time. Any depictions of specific well locations on maps included in this document are conceptual and are provided for illustrative purposes only. The Operators anticipate drilling infill wells at varying densities ranging from 4 wells to 12 wells per section in the core area and 2 wells per section in the flank area. The MAA contains several units in addition to non-unitized lands. The total number of estimated projected wells includes those wells that would be drilled in units. The total number of wells drilled would depend largely on variables outside of the Operators' control, such as production success, appropriate engineering technology, economic factors, commodity prices, availability of commodity markets, and lease stipulations and restrictions. The project alternatives are explained in detail in Chapter 2.

It is unknown whether additional gas transmission lines would be required to transport the gas produced from wells drilled under the Proposed Action. For the purposes of the Proposed Action and all project alternatives, no additional major gas transmission lines are assumed. If additional transmission lines are required, analysis of their impacts would be required under a separate NEPA process.



Map 1-4. MAA Core, Flank, and Existing Well Locations.

Wyoming BLM standard operating procedures and practices currently used in all surface-disturbing activities throughout the state would be employed for this project (see Appendix A, BLM Standard Stipulation/Mitigation Requirements, and Appendix B, Development and Operations Procedures). The procedures presented in Appendix A are used to ensure statewide consistency for avoiding and mitigating environmental impacts and resolving resource or land use conflicts. Appendix B procedures include details on project site planning, development, and operations including general plans and descriptions for Transportation, Reclamation, and Hazardous Materials. Additional appendices containing information related to operations and procedures, mitigation, and resource-specific issues include: Appendix C, Air Quality Technical Support Document; Appendix D, Biological Assessment; Appendix E, Reclamation Plan; and Appendix F, Cultural Resources.

Construction, development, production, and abandonment would comply with all applicable federal, state, and county laws, rules, and regulations (see Section 1.5). Best Management Practices (BMPs) committed to by the Operators include the design and construction of all new roads to a safe and appropriate standard to accommodate their intended use, painting of all new facilities a color that best allows the structures to blend in with the background, interim reclamation of well locations and access roads, and final reclamation and recontouring of all disturbed areas.

Reclamation would be conducted as soon as is practical on disturbed areas; this generally occurs simultaneously with ongoing development elsewhere in the field. Upon project completion, all wells not needed for production would be plugged and abandoned, surface facilities would be removed, and disturbed areas would be reclaimed and revegetated unless otherwise specified by the appropriate surface management agency (SMA). Final reclamation would include recontouring of all disturbed areas, including returning access roads to their original contour or to a contour that blends with the surrounding topography.

1.3. Purpose and Need for the Project

The Operators have submitted a Plan of Development to complete future infill drilling in the Moxa Arch Gas Field. The BLM has reviewed the current Proposed Action, and found that the proposal would have significant impacts not addressed or analyzed in the Expanded Moxa Arch Natural Gas Development Project EIS (USDI 1995). During this review it was determined that the proposed project had the potential to cause significant impacts to the human environment.

The purpose of the proposed project is to allow the Operators to exercise their rights to drill for, extract, remove, and market natural gas under valid existing oil and gas leases granted by the BLM, State of Wyoming, and private owners and to increase the daily gas delivery from the MAA to help meet the growing national demand for clean burning energy sources.

The development of federal gas leases is an integral part of the BLM gas leasing program under Mineral Leasing Act (MLA) of 1920, the Federal Land Policy and Management Act (FLPMA) of 1920, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987.

The proposed project meets the purpose and need and planning criteria for oil and gas development contained in the Kemmerer and Green River Resource Management Plans (RMPs) (BLM 1985, 1997b). The RMPs allow for:

- Continued oil and gas exploration, leasing, and development in accordance with applicable policies including the MLA of 1920 as amended, the Mining and Minerals Policy Act of 1970, the FLPMA of 1976, the National Materials and Minerals Policy, Research and Development Act of 1980, and the Federal Onshore Oil and Gas Leasing Reform Act of 1987, and
- Oil and gas development that recognizes and protects key resource values.

The BLM oil and gas leasing program encourages development of domestic oil and gas reserves. Natural gas is an integral part of the energy future of the United States because it is readily available and a market delivery infrastructure is already in place. By developing domestic reserves of clean burning natural gas, the United States (U.S.) would reduce dependence on foreign energy, such as natural gas from Mexico and Canada. The environmental advantages of burning natural gas rather than oil or coal were emphasized by the U.S. Congress and by the President when the Clean Air Act Amendments of 1990 were signed into law (42 United States Code [USC] 7671 et seq.). In addition, the Energy Policy Acts of 2001 and 2005 emphasize the development of domestic natural gas reserves for supply and economic stability.

Between 1991 and 2000, the U.S. used 17% more energy than in the previous decade while, during that same period, domestic energy production rose by only 2.3%. As a result, the U.S. has met almost all of its increased energy demand over the past 10 years through increased imports. U.S. energy consumption is expected to increase by 32% by the year 2020 (National Energy Policy, Report of the National Energy Policy Development Group, May 2001). According to the U.S. Department of Energy's Energy Information Administration, U.S. natural gas consumption is expected to range between 27 and 33 trillion cubic feet (TCF) by the year 2025, which represents a 21-48% increase over 2003 consumption. By developing domestic reserves of natural gas in the MAA, it will help to reduce dependence on foreign energy sources.

1.4. Decisions to Be Made

As a result of the analysis presented in this DEIS, the BLM will decide whether to allow, and under what conditions to allow, the development, operation, maintenance, and reclamation of expanded development/surface disturbances on federal lands and the federal mineral estate within the Project Area. The BLM will determine what levels of impacts are approved, and what Conditions of Approval (COAs), BMPs, mitigation, monitoring, and surveying would be required.

The ROD associated with this DEIS will not be the final review or the final approval for all actions associated with this Project. The BLM must review and authorize each component of the Project that involves the disturbance of federal lands on a site-specific basis. The method used to evaluate and authorize each surface-disturbing activity is normally an Application for Permit to Drill (APD), right-of-way (ROW) grant, or Sundry Notice, with supporting environmental record of review, which would be required before any construction can occur. Evaluations at this level include more precise locations for wells for thorough analyses, unlike the conceptual level analysis included in this DEIS.

1.5. Regulatory Setting

This DEIS incorporates key provisions of the FLPMA of 1976, which directs the BLM to manage public lands and their resource values to “best meet the present and future needs of the American people” (Section 103 [43 USC 1702]) and to coordinate resource management “without permanent impairment of the productivity of the land and the quality of the environment with consideration being given to the relative values of the resources and not necessarily to the combination of uses that will give the greatest economic return or greatest unit output” (Section 103 [43 USC 1702]). The FLPMA also states that it is appropriate that some lands be used “for less than all of the resources” (Section 103 [43 USC 1702]).

The BLM KFO is the lead agency for this DEIS because the vast majority of development is proposed for lands under its jurisdiction. The BLM has provided guidance, input, participation, and independent evaluation during DEIS preparation. Previously listed federal and state agencies and local governments participated in the preparation of this DEIS as cooperators. The BLM, in accordance with 40 Code of Federal Regulation (CFR) 1506.5(a) and (c), is in agreement with the information and

analyses presented in this DEIS and approves and takes responsibility for the scope and content of this document.

This DEIS was prepared in accordance with NEPA, and CEQ regulations implementing NEPA (40 CFR 1500–1508), and is in compliance with all applicable regulations and laws subsequently passed, including USDI requirements (Department Manual [DM] 516 [516 DM 1 through 6, 11], Environmental Quality (U.S. Department of the Interior 2005), guidelines listed in the BLM National Environmental Policy Act Handbook, H-1790-1 (BLM 1988), Guidelines for Assessing and Documenting Cumulative Impacts (BLM 1994), Washington Office Instruction Memorandum (IM) 2005-247 National Environmental Policy Act Compliance for Oil, Gas, and Geothermal Development, CEQ's Considering Cumulative Effects under the National Environmental Policy Act (Council on Environmental Quality 1997), and the Energy Policy Act (EPAct) of 2005.

1.5.1. Federal Permits, Authorizations, and Coordination

Consistent with regulations regarding federal oil and gas leasing and operations (43 CFR Parts 3100 and 3160, respectively), oil and gas leases are issued by the BLM. Stipulations may be added as terms of a lease at the time of lease issuance to reflect management guidance established in the applicable RMP.

Once the lease is issued, the leaseholder/operator must apply for and receive site-specific authorization(s) prior to drilling within the leasehold area. To meet required environmental obligations, the leaseholder/operator must submit to the BLM an APD or its associated application for ROW so that the appropriate environmental review may be prepared. Environmental documents such as an EA, Categorical Exclusion (including Energy Policy Act 390 Categorical Exclusions), or the appropriate environmental record of review for APD or ROW authorizations often include site-specific COAs that add further site-specific operation requirements. Drilling of federal minerals is subject to the BLM's Onshore Oil and Gas Orders (43 CFR Subpart 3164 – Special Provisions). BLM Onshore Order Nos. 1 and 2 require an applicant to comply with the following conditions:

- Operations must result in the diligent development and efficient recovery of resources;
- All activities must comply with applicable federal, state, and local laws and regulations applicable to federal leases;
- All activities must include adequate safeguards to protect the environment;
- Disturbed lands must be properly reclaimed; and
- All activities must protect public health and safety.

Onshore Order No. 1 specifically states that lessees and operators should be held fully accountable for their contractor's compliance with the requirements of the approved permit and/or plan (43 CFR Part 3160, March 7, 2007).

Pipeline and road ROWs on federal lands would be issued under the authority of the MLA of 1920, as amended, or the FLPMA. ROW grants authorizing construction of ancillary facilities, access roads, and pipelines would grant Operators certain rights subject to the terms and conditions incorporated into the grant by the BLM.

Nine Presidential Executive Orders (EOs) also affect implementation of the proposed Project. These EOs, which are binding on all government agencies, place restrictions on government approval of construction activities and apply to wetlands (EO 11990), floodplains management (EO 11988), migratory birds (EO 13186), environmental justice (EO 12898), Native American sacred sites (EO 13007), historic trails (EO 13195), cultural resources and historic preservation (EO 11593 and EO 13287), and invasive species (EO 13112).

The BLM must adhere to specific provisions regarding the draining of federal minerals from adjoining nonfederal lands. These provisions are codified in 43 CFR 3100.2, which states that, upon determination that lands owned by the U.S. are being drained of oil or gas by wells drilled on adjacent lands, the BLM may execute agreements with the owners of adjacent lands whereby the U.S. and its lessees shall be compensated for such drainage. In addition, where lands in any lease are being drained of their oil and gas content by wells either on another federal lease, issued at a lower rate or royalty, or on nonfederal lands, the lessee shall both drill and produce all wells necessary to protect the lease lands from drainage. In lieu of drilling necessary wells, the lessee may, with the consent of the BLM, pay compensatory royalty. These provisions are also incorporated in the lease terms contained in all federal oil and gas leases (Form 3100-11). A list of the major permits, approvals, and authorized actions necessary to construct, operate, maintain, and abandon project facilities is provided in Table 1-1.

Table 1-1. Major Federal, State, and Local Permits, Approvals, and Authorizing Actions for the Moxa Arch Area Infill Gas Development Project.

Agency	Permit, Approval, or Action	Authority
Office of the President of the United States	Protection and enhancement of the cultural environment	EO 11593
	Floodplains management	EO 11988
	Protection of wetlands	EO 11990
	Environmental justice	EO 12898
	Native American sacred sites	EO 13007
	Invasive species	EO 13112
	Protection of migratory birds	EO 13186
	Trails for America in the 21st century	EO 13195
	Preserve America	EO 13287
BLM	On Federal onshore lands: Permit to drill, deepen, or plug back (APD/Sundry process); authorization for flaring and venting of natural gas; plugging and abandonment of a well	MLA of 1920 (30 USC 181 et seq.); 43 CFR 3162, Onshore Oil and Gas Orders No 1 and No 2, Approval of Operations
	ROW grants and temporary use clearances on federal lands	MLA of 1920, as amended (30 USC 185); 43 CFR 2880; FLPMA (43 USC 1761–177 1); 43 CFR 2800
	Antiquities and cultural resource clearances on BLM-managed land	Antiquities Act of 1906 (16 USC Section 431– 433); Archaeological Resources Protection Act of 1979 (16 USC Sections 470aa–470ll); Preservation of American Antiquities (43 CFR 3); National Historic Preservation Act (NHPA) Section 106 (36 CFR 60.4)
	Approval to dispose of produced water from BLM/federal oil and gas wells	MLA of 1920 (30 USC 181 et seq.); 43 CFR 3164; Onshore Oil and Gas Order No. 7
	Endangered species clearances on BLM-managed lands	Endangered Species Act (ESA) of 1973, as amended et seq. (16 USC 1531)

Agency	Permit, Approval, or Action	Authority
Reclamation	ROW grants and temporary use clearances on federal lands	MLA of 1920, as amended (30 USC 185); 43 CFR 2880
U.S. Army Corps of Engineers (USACE)	Section 404 permits and coordination regarding placement of dredged or fill material in area waters and adjacent wetlands	Section 404 of the Clean Water Act (CWA) of 1972 (40 CFR 122-123, 230)
USFWS	Coordination, consultation, and impact review on federally listed threatened and endangered (T&E) species	Fish and Wildlife Coordination Act (16 USC Sec. 661 et seq.); Section 7 of the ESA of 1973, as amended (16 USC et seq.); Bald Eagle Protection Act, as amended (16 USC 668–668dd)
EPA	Spill Prevention, Control, and Countermeasure Plans (SPCCPs)	40 CFR 112
	Regulation of hazardous waste treatment, storage, and/or disposal	Resource Conservation and Recovery Act (42 USC 6901)
U.S. Department of Energy (DOE)	Regulation of interstate pipeline product transportation	Various sections of the USC and CFR
U.S. Department of Transportation (USDOT)	Control of pipeline maintenance and operation	49 CFR 191 and 192
Wyoming Department of Agriculture	Weed and pest control – county agency	Wyoming Weed and Pest Control Act (Wyoming Statute [WS] 11-5-102)
Wyoming Board of Land Commissioners/ Land and Investments Office	Approval of oil and gas leases, ROWs for long-term or permanent off-lease/off-unit roads and pipelines, temporary use permits, and developments on state lands	WS 37-1-101 et seq.
Wyoming Department of Environmental Quality - Water Quality Division (WDEQ/WQD)	Regulation of off-lease disposal of drilling fluids from abandoned reserve pits	Wyoming Environmental Quality Act (WS 35-11-301 through 35-11-311)
	National Pollutant Discharge Elimination System (NPDES) permits for discharging waste water and stormwater runoff	WDEQ Rules and Regulations, Chapter 18, Wyoming Environmental Quality Act (WS 35-11-301 through 35-11-311); Section 405 of the Clean Water Act (40 CFR 122–124)
	Administrative approval for discharge of hydrostatic test water	Wyoming Environmental Quality Act (WS 35-11-301 through 35-11-311)
Wyoming Department of Environmental Quality - Air Quality Division (WDEQ/AQD)	Permits to construct and permits to operate	Clean Air Act; Wyoming Environmental Quality Act (WS 35-11-201 through 35-11-212)

Agency	Permit, Approval, or Action	Authority
Wyoming Department of Environmental Quality - Solid Waste Division	Construction fill permits and industrial waste facility permits for solid waste disposal during construction and operations	Wyoming Environmental Quality Act (WS 35-11-501 through 35-11-520)
Wyoming Department of Transportation (WYDOT)	Permits for oversize, overlength, and overweight loads	Chapters 17 and 20 of the Wyoming Highway Department Rules and Regulations
Wyoming Oil and Gas Conservation Commission (WOGCC)	Permit to use earthen pit (reserve pits) on nonfederal lands	WOGCC Regulations (Section III; Rule 305)
	Authorization for flaring or venting of gas	WOGCC Regulations (Section III; Rule 326)
	Permit for Class II underground injection wells	WOGCC Regulations (Section III; Rule 346)
	Well plugging and abandonment	40 CFR 146; 40 CFR 147.2551
	Permit to drill, deepen, or plug back (APD process)	WOGCC Regulations (Section III; Rule 315)
	Change in depletion plans	Wyoming Oil and Gas Act (WS 30-5-110)
	Minimum safety standards for oil and gas activities	WOGCC Regulations (Rules 321-A, 327, and 328)
Wyoming State Engineer's Office (WSEO)	Permits to appropriate groundwater (use, storage, wells, dewatering)	WS 41-121 through 147 (Form UW-5)
	Permits to appropriate surface water	WS 41-201 (Form SW-1)
SHPO	Cultural resource protection, programmatic agreements, consultation	Section 106 of NHPA and Advisory Council Regulations (36 CFR 800)
Lincoln County	Oil and gas permits	Office of Planning and Development
	Small wastewater permits	Office of Planning and Development
	Driveway access permits	Office of Planning and Development
	Certified land corner recordation	Office of Planning and Development
	County road use agreement	Office of Planning and Development
Sweetwater County	Mineral extraction permit	Planning and Zoning Department
	Access permit	Planning and Zoning Department
	Building permit	Planning and Zoning Department
	ROW permit	Planning and Zoning Department
Uinta County	Land use permit	Planning Department
	Road access permit	Planning Department
	Encroachment permit	Planning Department
	Septic system permit	Planning Department

Note: This list is intended to provide an overview of the key regulatory requirements that would govern project implementation. Additional approvals, permits, and authorizing actions may be necessary.

1.5.2. Wyoming BLM Mitigation Guidelines and Practices for Surface-Disturbing and Disruptive Activities

The Wyoming BLM has adopted a standard set of guidelines and post-lease COAs that apply to all surface-disturbing activities on federal lands and minerals in Wyoming (Appendix A). These mitigation guidelines address a wide variety of environmental concerns. Upon request by the applicant, an exception to a lease stipulation or a COA may be granted by the BLM, following on-site review to determine if the exception is warranted. With the exception of specific mitigations excluded from the No Action Alternative (see Chapter 2), standard Wyoming BLM mitigation guidelines are applied to all alternatives analyzed in this DEIS.

1.5.3. Conformance with the Kemmerer Resource Management Plan

The Project Area lies within BLM-administered public lands guided by the Kemmerer RMP (BLM 1985). Management objectives and actions applicable to the Project within the Kemmerer Resource Area are as follows:

- Oil and gas leasing will continue throughout the Kemmerer Resource Area. As oil and gas leases expire, or otherwise terminate, the areas will, in most cases, continue to be re-offered for lease.
- All public lands within the resource area have been approved as suitable for oil and gas leasing and development, subject to certain stipulations. Resource management and protection stipulations will be developed and implemented on an "as-needed" basis to prevent undue adverse impacts to other resources.

The proposed natural gas infill drilling, field development, and production project is in conformance with management objectives defined in the Kemmerer RMP.

This DEIS references and incorporates NEPA documents that were previously developed for the Project Area, including the Expanded Moxa Arch Natural Gas Development Project EIS (BLM 1995a). The Project Area includes all of the lands analyzed in the 1996 DEIS and implemented through its ROD in March 1997 (BLM 1997a).

1.5.4. State and Local Permits, Authorization, and Coordination

The Proposed Action and alternatives are in conformance with the Wyoming State Land Use Plan (Wyoming State Land Use Commission 1979) and the current applicable land use, zoning, and/or growth plans for Lincoln, Sweetwater, and Uinta counties. The alternatives comply with all relevant state and county laws and regulations (Table 1-1).

1.6. Public Scoping

NEPA regulations (40 CFR 1500-1508) require the BLM to use an early scoping process to identify significant issues in preparation for impact analysis within the EIS development process. The principal goal of public scoping is to allow and encourage public participation, including federal, state, and local government agencies, which culminates in the public's identification of issues, concerns, potential impacts, and potential mitigations that require detailed analysis in the EIS. A proactive public scoping process was implemented by the BLM for this proposed Moxa Arch Area Infill Gas Development Project EIS.

1.6.1. Public Scoping Process

The formal public scoping process began with the publication of the Notice of Intent (NOI) in the Federal Register on October 7, 2005. The NOI announced the BLM's intent to prepare an EIS for the Operators' proposed Project and invited the public to comment and/or provide resource information. To support public understanding of the proposed Project and the EIS process and to provide an early opportunity for interested parties to submit scoping comments, the NOI also announced the BLM's intent to hold four public scoping meetings, one each in Evanston, Wyoming; Rock Springs, Wyoming; Lyman, Wyoming; and Kemmerer, Wyoming. Public notice of the dates, times, and locations of the four meetings were published in the Casper Star-Tribune, Rock Springs Rocket-Miner, Kemmerer Gazette, Uinta County Herald, Bridger Valley Pioneer, and the Little Chicago Review and was based on a BLM press release. The press release was also sent to the following radio stations for airing of public service announcements: KUGR, KZWB, KYCS, KFRZ, KAOX, KDWY, KOTB, and KEVA.

The four evening public meetings were held over a one-week period in mid-November 2005. The meetings were held in Evanston, Wyoming, on November 14, 2005; Rock Springs, Wyoming, on November 15, 2005; Lyman, Wyoming, on November 16, 2005; and Kemmerer, Wyoming, on November 17, 2005.

Numerous issues and concerns were identified and comments were submitted (post-marked) to the BLM from October 7, 2005 to December 2, 2005. While no written comments were received from the public during the scoping meetings, informal comments were shared with BLM staff and were noted.

All comments received during the scoping process were reviewed and analyzed. The BLM identified 15 key issues, based primarily on the assumed quantity, intensity, or duration of a potential impact; and/or the volume of agency or public interest in the issue. The range of alternatives was developed in response to the key issues identified during scoping, and the potential effects to these issues expected to result from varying levels of surface disturbance and/or inclusion or exclusion of various development guidelines/management protocols.

1.6.2. Key Issues

The following is a summary of the key issues that were brought forward during the scoping process for this EIS. More detailed descriptions of the comments, including the exact comments made, are provided in the scoping report that was developed for the project record for this EIS.

1.6.2.1. Ranching and Grazing

Comments directed toward grazing focused on the loss of animal unit months (AUMs) and how grazing permittees would be compensated for these losses. Respondent suggestions included hay or monetary compensation, new range improvements, or land purchase opportunities. Comments included concerns about other impacts to local economies that depend on ranching, and whether ranchers would be kept informed during the process. There was much interest in the reclamation and monitoring process and the ability to control erosion and weed infestation. Other issues raised included impacts of new or widened roads, property damage due to range improvements, loss of livestock to vehicle collisions, livestock competition with displaced game animals, proper fencing of well pads, and whether the proposed well density was necessary or whether more directional drilling could be done. Ranchers' comments also focused on potential adverse affects to private property values, as well as the loss of open space, scenic vistas, and historic landscapes, especially with the checkerboard pattern of land management.

1.6.2.2. Air Quality

Most comments directed toward air quality centered on the potential increase in emissions from sources such as drill rigs, compressors, and increased traffic associated with gas development. Suggested solutions included using low-emission equipment, using dust suppressants on roads, and requiring car-pooling to work sites. There were requests for less or no flaring at wells, and more use of air quality modeling. Other comments were related to better monitoring with proper analyses and effective mitigation techniques when standards are not met or visibility is degraded. One individual noted being affected by odors, seemingly from wells, plants, or traffic; and another expressed concern over effects on ozone concentrations.

1.6.2.3. Wildlife

A variety of concerns directed toward wildlife were raised during scoping. Primary issues addressed include the protection of crucial ranges, winter relief habitat, and breeding/spawning/nesting and other reproduction areas. Species of concern mentioned were sage-grouse, especially winter and breeding areas; pronghorn; and moose. Sensitive habitats listed included sagebrush steppes and fish-supporting waters. The general public had concerns about the effect of increased human activity on resident wildlife. Road-related issues included habitat displacement and fragmentation, more traffic/public access into habitats, and increased erosion and sedimentation that could result from constructing roads on slopes.

Specific mitigating measures mentioned in comments included protecting leks from noise, conducting a pronghorn study, developing a Wildlife Monitoring Plan for sage-grouse winter use, analyzing sagebrush treatments effects on species, using directional drilling to minimize habitat fragmentation and road building, maintaining connectivity and linkages between habitat parcels, focusing on the protection of keystone species and keystone resources (e.g., springs, mineral licks, riparian areas), prohibiting surface disturbance until the ESA consultation process is complete, and conducting off-site mitigation. There was also a reference to following guidelines in the BLM manual "Special Status Species Management, MS-6840." WGFD referred to its 2004 "Minimum Recommendations to Sustain Important Wildlife Habitats Affected by Oil and Gas Development" as the provisions to be adopted.

Suggestions for the EIS process included early ESA consultation with the USFWS and retaining reputable scientists for the ESA analyses, making wildlife stipulations part of any project activity, and disclosure of land disturbance by habitat/vegetation type. Respondents commented that data analyses should include compiling all available data (including that from the WGFD) to date for WGFD review; using scientifically supported methods to analyze indirect, related, cumulative, and long-term impacts, especially to sagebrush areas; and conducting a thorough documentation of groundwater and surface water flows and quality in order to analyze potential depletion effects to downstream listed fish.

1.6.2.4. Transportation

The most common concern related to transportation was avoidance of additional access points to U.S. Highway 30 (US 30) between Opal and Granger. The WYDOT expressed interest in being involved in transportation planning, and in keeping gas field access to a minimum. Individual respondents suggested adding turn lanes to US 30 and/or using the old highway as a service road for oil and gas trucks. Increased traffic (especially trucks) was a general concern, including the increase in fugitive dust on unimproved roads. One individual expressed concern about additional crossings of riparian areas and suggested using bridges to reduce habitat disturbances.

1.6.2.5. Recreation

The major concern related to recreation was that additional public access to the gas field would increase hunter success and, therefore, reduce opportunities for other hunters. One respondent noted that license sales might decrease with increased success in the area. Also, there was concern that the presence of gas wells might decrease the areas in which hunting is allowed.

1.6.2.6. Economics

Many comments related to economics focused on the beneficial impacts to local economies that would occur as a result of tax revenues collected from Operators. Other respondents had concerns about economic losses due to decreased access to leases, loss of grazing opportunities, and lower property values. Operators expressed concern about economic losses due to permitting delays, restrictions or stipulations on drilling, and the cost of using alternative-drilling technologies (e.g., directional drilling). Operators also voiced concerns about sustaining the economy and avoiding boom and bust cycles that are often associated with oil and gas development. Regarding economic analyses, some respondents suggested collecting data from local Operators already doing business in the area, rather than basing the analyses on the cost of well development.

1.6.2.7. Water

Comments directed toward water resources focused on potential effects to surface water and groundwater from releases of water used in construction or production, especially in riparian areas. There was concern that this water would contain elements from the soil or other pollutants. Comments noted that some water features within the Project Area are already considered "impaired" and that these would be further degraded, and could potentially be improved through mitigation. Other comments mentioned erosion and sedimentation, and the effects of new crossings on channel stability or flow velocities. Suggestions included keeping seismic activity away from streams and wetlands, and following the state water quality standards. Some landowners were also concerned about Project water needs competing with private water rights.

1.6.2.8. Cultural Resources

The respondents primarily referred to conducting necessary consultations with state and tribal traditional and religious leaders. Also, there were requests to comply with pertinent federal acts and to perform sufficient inventories prior to ground-breaking activities to determine resource values. Respondents stated that if "at risk" areas are identified, protections should be placed on an adequate-sized parcel to facilitate management.

1.6.2.9. Noxious Weeds

The primary concern related to noxious weeds was the continued spread of halogeton (*Halogeton glomeratus)* and cheatgrass (*Bromus tectorum*), which has already adversely impacted the sheep industry, and the loss of native species diversity. Respondents suggested that the BLM be aware of all the possible vectors for weed spread, work with landowners to develop native seed mixes, use mulch and some type of quick cover crop to reduce erosion, and comply with federal EO 13112. Another issue raised was poisonous plants. For the analysis, respondents would like to see the extent of the weed problems discussed along with probable causes, options for prevention, and restoration. One suggestion was to clean equipment prior to entering project sites.

1.6.2.10. Health and Human Safety

Public comments focused on the increased number of workers potentially leading to increased crime in the area in the form of thefts, trespassing, illegal hunting, and drug use. A general decreased feeling of safety was expressed. One respondent suggested mandatory drug tests for workers.

1.6.2.11. Surface Disturbance

These comments covered a variety of issues, including visual resources, riparian and habitat areas, and mitigation ideas. The most common comment was to decrease land disturbance by using directional drilling from existing pads. There was concern of degrading lands by adding to the cumulative effects from current disturbance. There was also concern regarding the success of past and ongoing reclamation efforts in the MAA.

Suggestions to minimize visual impacts included using low-profile structures and natural topography, avoiding ridgelines, applying appropriate coloration, and keeping well pad size to the minimum necessary.

Riparian areas were singled out for protection. Where crossings are necessary, respondents suggested using only perpendicular angles, trenching pipe for intermittent drainages, and boring under perennial drainages. A respondent commented that parallel pipelines should stay outside 100-year floodplains. Other comments were to crush instead of remove riparian vegetation where possible; revegetate as soon as possible; and use the smallest ROW possible.

One respondent stated that cumulative effects should take into consideration the conversion of mature vegetation into grasslands where seeding is conducted. Respondents were concerned about keeping total new disturbance on any one grazing lease to less than 150 acres, not including reclaimed areas. Regarding surface disturbance, WGFD pointed out that the proposed well density in the core area falls into their "high impact" category for some critical wildlife habitats and that off-site mitigation and/or habitat replacement should be considered early in the process.

1.6.2.12. Environmental Quality

The greatest concerns in this category were with noise impacts from drilling and ongoing operations, given the remoteness of the area; the release of test waters directly into streams; and adequate protection of sensitive, rare, and unique natural features and their ecosystems. One respondent stated that according to the FLPMA, natural resources and ecosystems on public lands are more important to the American public than are extractable resources. Suggestions to minimize disturbances included piping oil and gas away from sites rather than trucking the product, monitoring wells remotely, releasing test waters into retention basins, and conducting surveys for sensitive species so that areas where development is inappropriate can be identified and protected. Areas where disturbance effects are visible for long distances or long periods of time should also be taken into consideration.

1.6.2.13. Best Management Practices

Many of these comments focused around hazardous material handling and the need to exercise caution in storage and disposal, especially around riparian and wetland areas. Compliance with all U.S. EPA and Wyoming requirements for storm-water discharge was suggested, as was designing well pads to drain to an adequate-sized pit. Published BLM oil and gas BMPs were referred to. Closed-loop drilling was preferred, as well as the use of non-toxic drilling fluids, with no reserve pit or evaporation of these fluids permitted. Drilling fluids should be disposed of off-site at licensed facilities. Respondents requested that production water be re-injected into the formations where withdrawn, and that any holding ponds be lined and covered to protect birds. Comments indicated that drilling should only occur on areas of less than 25% slope and that staging, storage, and refueling areas should be

located more than 500 feet from wetlands, riparian areas, and floodplains. Respondents favor non-chlorine-based deicers and dust control agents.

1.6.2.14. General Industry Comments

Several respondents requested the use of existing roads to the extent possible. It was mentioned that the use of "Gold Book" standards for roads may encourage more public access, which brings increased weed spread, poaching potential, off-road vehicle use, and other disturbances. Other suggestions included using existing ROWs for utilities, burying utilities where possible, and to using anti-perching devices in areas where sage-grouse may be present. Reference was made to federal and state protection policies for sage-grouse areas. It was requested that any necessary lighting be redirected or shaded where possible. The public felt that the BLM should review appropriate well spacing based on best available environmental and technological data.

Industry respondents were concerned about "Adaptive Management" techniques that present unclear or changing goals and objectives that may favor special interest groups and be difficult for Operators to comply with. Also, it was stated that the BLM should adapt BMPs to fit new technologies where necessary. A number of respondents stated that Operators have existing lease rights and access to them should not be restricted.

1.6.2.15. BLM Management and NEPA Compliance

Several respondents provided a number of BLM management-related comments that focused primarily on the BLM's application of and compliance with the NEPA EIS process:

- Use the previous EIS (BLM 1995a) and ROD (BLM 1997a) as much as possible to minimize duplicated efforts.
- Because the previous EIS is 10 years old, new data should be gathered and analyses conducted in sound science manner according to NEPA, CEQ, FLPMA, and the MLA regulations.
- Do not use Categorical Exclusions during APD process to reduce or eliminate site-specific analyses.
- Avoid additional environmental degradation.
- For cumulative effects, consider all activities in area that have affected habitats.
- BLM should work with proponents, state and local agencies, and the general public.
- Use a whole ecosystem approach, despite the checkerboard land ownership.
- EIS purpose and need should consider environmental protection of public land.
- Include a rationale for all alternatives.
- Keep multiple uses in mind.

CHAPTER 2 PROPOSED ACTION AND ALTERNATIVES

2.1. Introduction

It is important for the reader to note that the BLM is authorized to approve actions on BLM-managed lands and federal minerals; however, analysis of the impacts to the human environment includes effects on all land ownership types. Any authorizations for the Moxa Arch Area Infill Gas Development Project must comply with the applicable Kemmerer RMP.

To develop alternatives, estimates of current disturbance in the MAA were necessary to establish baseline conditions. Total surface disturbance and oil and gas drilling and exploration disturbances were calculated. Existing disturbance associated with oil and gas drilling and exploration was estimated to be approximately 8,073 acres. This estimate was generated assuming that BLM's estimated 1,839 existing wells in the MAA have been reclaimed to 1.3 acres, that oil and gas service roads in the MAA have been reclaimed to a width of 28-30 feet, and that 70% of the disturbance associated with gathering lines has been reclaimed. These estimates do not consider disturbances associated with oil and gas activities such as major pipeline compressors or the Shute Creek gas plant. Those disturbances are included in the disturbance calculations for facilities sites (Table 2-1).

Total existing disturbance in the MAA was estimated to be approximately 13,149 acres. This includes the 8,073 acres estimated for oil and gas drilling and exploration activities added to the 5,076 acres of other disturbance [Table 2-1, from Table 2-6 of the Expanded Moxa Arch Natural Gas Development Project DEIS(BLM 1995a)].

Table 2-1. Summary of Estimated Existing Surface Disturbance in the MAA.

Disturbance Type	Acres	Percent of Disturbance	Percent of MAA
Oil and Gas Drilling and Exploration	8,073	61%	1.7%
Highways and Interstates	2,012	16%	0.4%
Railroad	1,550	12%	0.3%
Urban	94	<1%	<0.1%
Facilities Sites (including Shute Creek gas plant and major pipeline compressors)	1,420	11%	0.3%
Total MAA Disturbance	**13,149**	**100%**	**2.8%**

2.2. Alternative Development

The BLM identified a range of alternatives based on the issues, concerns, and opportunities identified from public scoping comments, interdisciplinary interaction between resource professionals, and collaboration with cooperating agencies as wells as the requirements and recommendations of NEPA and agency policy.

While numerous alternatives and specific actions were considered, four alternatives are studied in detail: Moxa Operators' Proposed Action, Alternative A/No Action, Alternative B, and Alternative C. Alternatives and specific actions considered and eliminated from detailed study are discussed in Section 2.5. Because the No Action Alternative does not eliminate the potential for future development it serves two functions, as the no action and as a low development alternative. Table 2-2 provides a summary of the four alternatives analyzed in detail.

Table 2-2. Summary of Well Numbers, Infrastructure, Project Duration, and Surface Disturbance for the Four Alternatives Analyzed in Detail. Numbers are maximum values for each alternative. For the proposed action, Alternative A, and Alternative C the number of wells is the same as the number of well pads.

	Proposed Action	Alternative A-No Action	Alternative B[1]	Alternative C
Development Summary				
Total Number of New Wells	1,861	670	5,165	5,165
Total Miles of New Roads	931	335	2,583	2,583
Total Miles of New Gathering Pipelines	931	335	2,583	2,583
Total Number of New Compressor Facilities	4	0	7	7
Approximate Pace of Development				
New Wells per Year	186	96	205	205
Drilling Phase - Years	10	7	25	25
Production/Interim Reclamation Phase - Years	40	40	40	40
Final Reclamation Phase - Years	10	10	10	10
Life-of-Project (LOP) - Years	60	57	75	75
Summary of Surface Disturbance				
Total Short-term Surface Disturbance LOP- Acres	18,650	10,258	45,573	45,573
Total Acres of Interim Reclamation	12,653	7,410	42,725	30,216
Long-term Surface Disturbance - Acres	5,997	2,848	2,848	15,357
Existing Oil and Gas Disturbance in MAA - Acres	8,073	8,073	8,073	8,073
Disturbance Expected After Successful Interim Reclamation of Short-term Disturbances – Acres[2]	14,070	10,921	10,921	23,430
Percent Oil and Gas Disturbance in MAA Over LOP	2.96%	2.30%	2.30%	4.92%
Total Surface Disturbance[3]-Acres	19,146	15,997	15,997	28,506
Percent Surface Disturbance in MAA	4.02%	3.36%	3.36%	5.99%

[1] Summary information for Alternative B is a combination of the No Action and Alternative C. Detailed descriptions of the components of this alternative are presented in Section 2.3.3. Values presented for Alternative B are maximum short-term disturbance values and might not be reflective of the actual short-term disturbance that could occur as a result of implementation of the alternative.

[2] Values presented for total disturbance after successful interim reclamation are reasonable estimates for the total disturbance that would be expected at any given time. This value would also be reflective of the total surface disturbance associated with oil and gas development over the LOP. For Alternative B the total disturbance at any time could not exceed 10,921 acres. For the Proposed Action and Alternatives A and C, the disturbance at any given time could be higher than the values presented.

[3] Values are sum of existing non oil and gas disturbances (Table 2-1) and total oil and gas development disturbances.

2.3. Alternative Descriptions

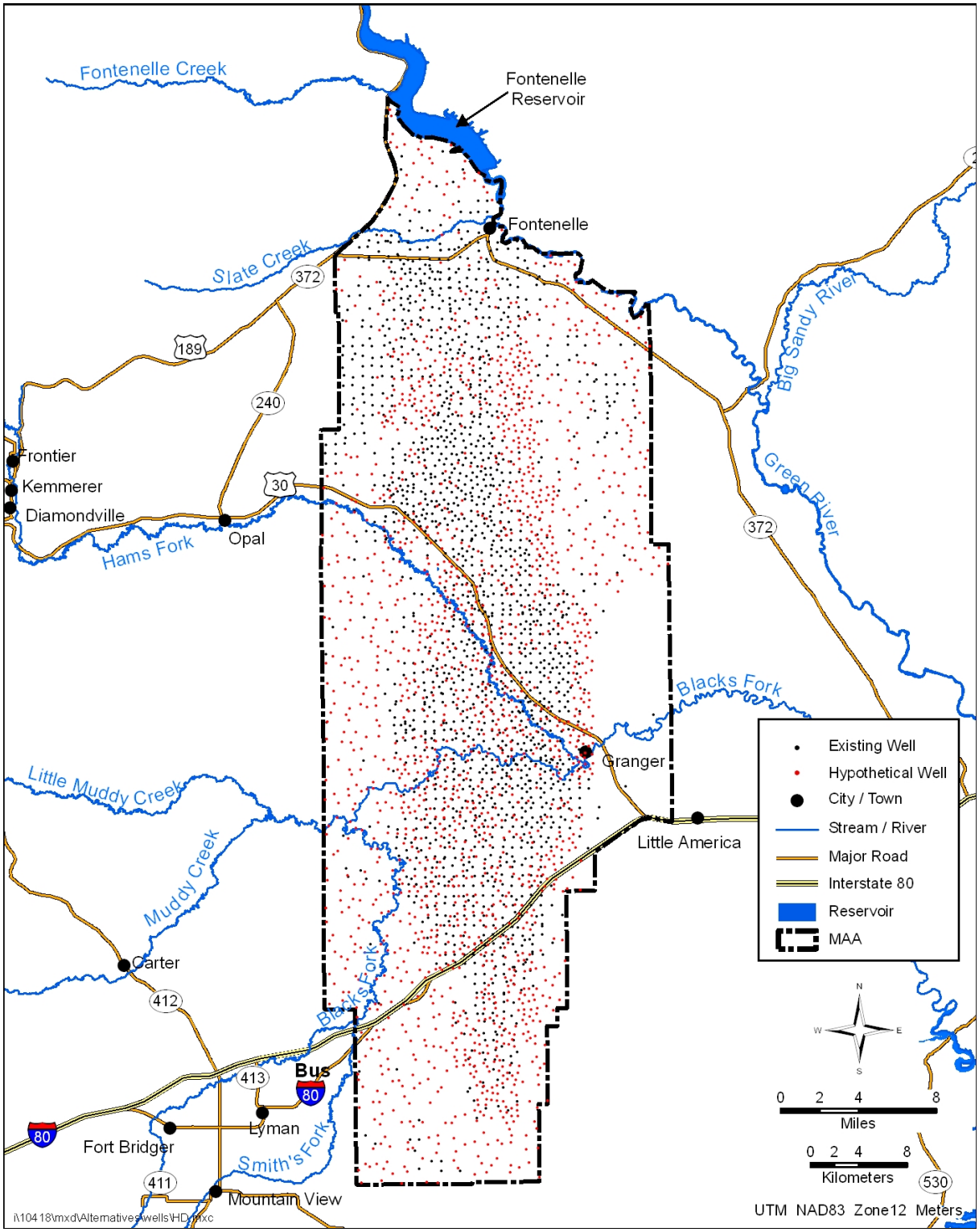
2.3.1. Moxa Operators' Proposed Action

Collectively, the Operators propose to drill 1,861 wells from 1,861 well pads to supplement existing production in the Project Area. Map 2-1 illustrates hypothetical locations of new well pads that would be developed as part of the operators' Proposed Action. The data presented in Map 2-1 are for illustrative purposes only and do not represent the actual location of wells that would be drilled. However, these randomly placed pad locations were used to assess potential direct and indirect impacts to resources analyzed in Chapter 4 of this document.

As a result of geologic information obtained through drilling conducted since the 1997 ROD, the proven production and flank areas were redefined from the areas considered in the 1996 EIS, such that the area currently proposed for more intense development ("core" area) would be reduced from the proven production area defined in 1996 (Map 1-3). The Operators estimate that approximately 1,226 additional wells would be drilled in the core area, and approximately 635 additional wells would be drilled in the flank area (Table 2-3). The Operators anticipate drilling infill wells to the Frontier and Dakota Formations at densities ranging from 4 to 12 well pads per section (approximately 160 to 53 acres per pad) in the core area and approximately 2 well pads per section in the flank area. Wells would be drilled conventionally (i.e., with vertical well bores from individual well pads). All proposed wells would be drilled during an approximate 10-year period after project approval. Although actual operations are subject to change as conditions warrant, the Operators' long-term development plan is to drill approximately 186 wells per year until the resource base is fully developed. The average life expectancy of a well is anticipated to be 40 years. Appendix B contains a summary of the operations used to develop wells in the MAA. These operations would be used for all alternatives unless otherwise noted.

Facilities associated with the project may include roads, gas pipelines, production facilities (separation, dehydration, metering, treating, fluid storage, compression), disposal well and/or surface disposal facilities, and equipment storage facilities. In general, gas will be transported via subsurface pipeline to centralized compression and treatment facilities, although some well site compression may be needed. Additional compression of the gathering system in the project area will likely be required and added to existing compression infrastructure over the 10-year development period. Additionally, it is estimated that 3 to 4 new compressors could be required to accommodate the maximum anticipated compression growth that would result from the Proposed Action. These additional compression facilities would likely be constructed on federal surface.

Current transmission pipelines in the MAA and throughout southwestern Wyoming would likely be sufficient to transport the recovered resources to market. For the Proposed Action and all project alternatives, if additional transmission pipelines are necessary to transport the gas recovered from the MAA, separate NEPA analysis would be required. Produced water will be transported by truck to water disposal wells or evaporation ponds. Project development will result in the construction of new roads and the use of roads previously constructed in the Project Area. New roads are expected to consist primarily of access roads. Existing arterial roads will provide the main access to the Project Area.



Map 2-1. Hypothetical Distribution of Wells and Well Pads in the MAA for the Operators' Proposed Action. Hypothetical well locations are for illustrative purposes only and do not reflect the actual locations of wells that would be drilled.

Table 2-3. Approximate Disturbance Estimates for New Wells that would be Drilled in the MAA under the Operators' Proposed Action.

Surface Ownership	BLM	USFWS	Reclamation	State of Wyoming	Private/ Fee	Total	Percent of MAA
Total Acres - Core	103,893	268	4,299	8,297	96,157	212,914	44.75
Total Acres - Flank	127,825	1,339	22,660	5,028	106,042	262,894	55.25
Total Acres in MAA	***231,718***	***1,607***	***26,959***	***13,325***	***202,199***	***475,808***	***100.00***
Numbers of Well Pads for Proposed Action							
Core	300	2	8	78	838	1,226	---
Flank	318	3	64	10	240	635	---
Total Well Pads	***618***	***5***	***72***	***88***	***1,078***	***1,861***	---
Short-Term Disturbance - Acres of Disturbance Associated with Drilling and Completion Phases[1]							
Core	3,040[2]	20	80	780	8,380	12,300	2.60
Flank	3,180	30	640	100	2,400	6,350	1.32
Total	***6,220***	***50***	***720***	***880***	***10,780***	***18,650***	***3.92***
Long-Term Disturbance - Acres of Disturbance After Interim Reclamation[3]							
Core	1,000	6	26	250	2,682	3,964	0.84
Flank	1,018	10	205	32	768	2,033	0.42
Total	***2,018***	***16***	***231***	***282***	***3,450***	***5,997***	***1.26***
Existing Oil And Gas Disturbance In Project Area						***8,073***	***1.70***
Total Projected Oil and Gas Disturbance After Interim Reclamation						***14,070***	***2.96***

[1] Surface disturbance associated with drilling and completion activities for each well pad. Disturbance calculations assume 10.00 acres per well for the Proposed Action: 2.75 acres per well pad, 3.0 acres for 0.5 mile of road per well pad, 3.0 acres for 0.5 mile of gathering pipeline per well pad, and 1.25 acres of additional disturbance to account for larger pads, increased roads and pipeline lengths, stock piles, diversion ditches, and additional cut and fill necessary on steeper slopes.

[3] Includes disturbance estimates for 4 additional 10-acre compression facilities

[3] Disturbance associated with production activities after interim reclamation. Disturbance after interim reclamation would be 3.2 acres for the Proposed Action: 1.0 acre per well pad, 1.7 acres for roads, and 0.5 acre for gathering pipelines

The area of new surface disturbance associated with drilling and completion activities would be approximately 18,650 acres (Table 2-2). Most of the disturbance would occur on private lands. Approximately 3.9% of the Project Area would be affected by short-term disturbance during construction, drilling, and completion activities. Because of the 10-year drilling schedule associated with the Operators' Proposed Action, approximately 1,865 acres (0.39% of the MAA) of new disturbance would occur each year for 10 years. The Operators would commit to the following reclamation procedures as part of all oil and gas development activities in the MAA:

- The Operators commit to monitor interim and final reclamation operations by performing inspections using an independent third party contractor. The objective is to provide a uniform performance-based evaluation of reclamation efforts and success across the MAA, regardless of surface ownership or lease operator. Reclamation performance assessment methodology

will be based upon requirements of both the KFO and the State of Wyoming. The duties of the contractor would include:

- visiting all MAA locations to document the progress of interim and final reclamation efforts;
- developing quantifiable documentation submitted to the BLM and State (agencies) on a periodic (TBD) basis (all other alternatives would require annual reports at a minimum per Appendix E);
- providing location/lease/operator data to the agencies in geographic information systems (GIS) format; and
- providing annual summary "progress" reports to the Operators by the contractor to track reclamation effectiveness.

- The Operators commit to engaging the services of reclamation professional/specialist to provide expertise/recommendations to the agencies and the operators. The goal would be to develop a workable written reclamation strategy specifically designed for the MAA that would be provided to the BLM and State of Wyoming. The strategy will incorporate the results of the ongoing monitoring effort and would be modified, if necessary, according to the reclamation monitoring results assessment. When monitoring results demonstrate that reclamation is being performed successfully, the strategy would be finalized as the "Moxa Area Reclamation Plan." The reclamation specialist would be responsible for:
  - developing an Initial Reclamation Plan and periodic revisions, if monitoring results indicate the need to alter reclamation procedures;
  - evaluating reclamation techniques used by the mining/other industries, reclamation techniques used in other BLM Field Offices, and their applicability to oil and gas operations in MAA. The results of the evaluation would be included in the Initial Reclamation Plan; and
  - determining how/if reclamation should vary in different areas of the MAA according to:
    - timing (including initiation, evaluation of results, etc.);
    - species composition, considering habitat viability, BLM cover requirements, and stormwater permit requirements; and
    - best procedures for an arid environment/drought.
- The Operators would provide funding for inspection and enforcement to augment and provide assistance to KFO inspection and enforcement personnel if determined necessary by the KFO. The need for funding and KFO support would be re-evaluated annually by the KFO and the Operators, concurrent with receipt of the annual reclamation monitoring progress report. The Operators would agree on method to provide funding for the activities contemplated on a yearly basis. The Operators would select a lead party to handle the billing process and to provide supervision of the third party contractors, professionals and specialists. The Operators would meet annually in the fourth quarter to approve a budget and selection of the personnel required herein.
- Offsite mitigation would be considered by the Operators if necessary and reclamation monitoring indicates poor results. The objective of offsite mitigation would be in part to improve/restore habitat in areas that would provide the most benefit to wildlife and result in the fewest conflicts with oil and gas development, as identified in the EIS analysis. The Operators need interagency commitment that any such efforts would be recognized by the BLM and State of Wyoming as actions to enhance species viability across land jurisdictions.

After interim reclamation is completed, the new long-term disturbance associated with project development would be approximately 5,997 acres. It is expected that this level of disturbance would be present for the life of the wells that are drilled (approximately 50 years: 10 years of drilling and 40 years of production). The Operators would continue to limit long-term surface disturbance as much as possible through the implementation of a road network that minimizes the construction of new access roads and by reclaiming as much of the short-term disturbance associated with roads and locations as is reasonable without limiting the requirements for ongoing and future production operations. The Operators would adhere to all conditions included with their leases and to all federal and state laws and regulations. The Operators would also commit to performing the following measures for all new wells that are drilled, per the requirements in BLM IM No. 2007-021:

- Interim reclamation of well locations and access roads soon after the well is put into production.

  The goal of this BMP is to minimize long-term loss of habitat, forage, visual resources, soils, and to prevent the introduction of invasive species. Portions of well pads and roads that would not be used during production operations would be recontoured, leaving only areas necessary for workovers and operations uncontoured. Salvaged topsoils would be spread across all disturbed areas except those that are needed to accommodate year-round traffic and operations. Well locations and reclaimed roads and gathering pipeline ROWs would be revegetated with a BLM-approved seed mixture. Where practical, road surfaces and turnarounds would also be revegetated. With low traffic roads, this would result in a hardpan, two-track road that is stable and requires less maintenance. To ensure continued energy production operations, the operator would be allowed to drive, park, and set up future workover and maintenance operations on newly revegetated areas. Where there is a moderate to high risk of wildfire, a small buffer area would be left around production facilities or grass would be mowed prior to workover setup. Where future wells are anticipated to be drilled from the same well location within two years, approval to delay interim reclamation may be granted.

- Painting of all new facilities a color that best allows the facility to blend with the background, typically a vegetated background.

  The goal of this BMP is to minimize visual contrast by making production facilities less noticeable. Above-ground production facilities would be painted with colors that allow the facilities to blend into the background. The BLM and the Operators would identify the best colors to match the surrounding vegetation and soil types. The Operator may need to paint drill rig anchors and minor working tips and edges of production facilities that are subject to Occupational Safety and Health Administration (OSHA) safety requirements a red, yellow, or orange color. The Operator would not be required to paint wooden structures, including distribution power poles. To minimize contrast, Operators would avoid lighter colors, white doors or roofs, galvanized silver electrical boxes and guardrails, and signs with white backgrounds.

- Design and construction of all new roads to a safe and appropriate standard, "no higher than necessary" to accommodate their intended use.

  The goal of this BMP is to minimize long-term loss of habitat, vegetation, soil, and visual resources. All roads would be designed and constructed to an appropriate standard that is no higher than necessary to adequately accommodate their intended function. Design, construction, and maintenance activities would be consistent with national policies for safety and resource protection. Operators would consider the anticipated average daily traffic, vehicle loads, vehicle speeds, potential for use by the public, soil types, season of use, and topography. In some cases, overland travel within a defined corridor or via two-track roads during dry conditions would be preferable to construction of all-weather access roads. On a

case-by-case basis, overland travel or two-track roads may be appropriate for exploratory wells or for wells where year-round access needs have been reduced. Where practical, roads should follow the contours of the land to minimize cuts and fills and visually obtrusive lines in the landscape. Overland or two-track roads would not be used in sensitive soil types or during saturated soil conditions.

- Final reclamation and recontouring of all disturbed areas, including access roads, to the original contour or a contour that blends with the surrounding topography.

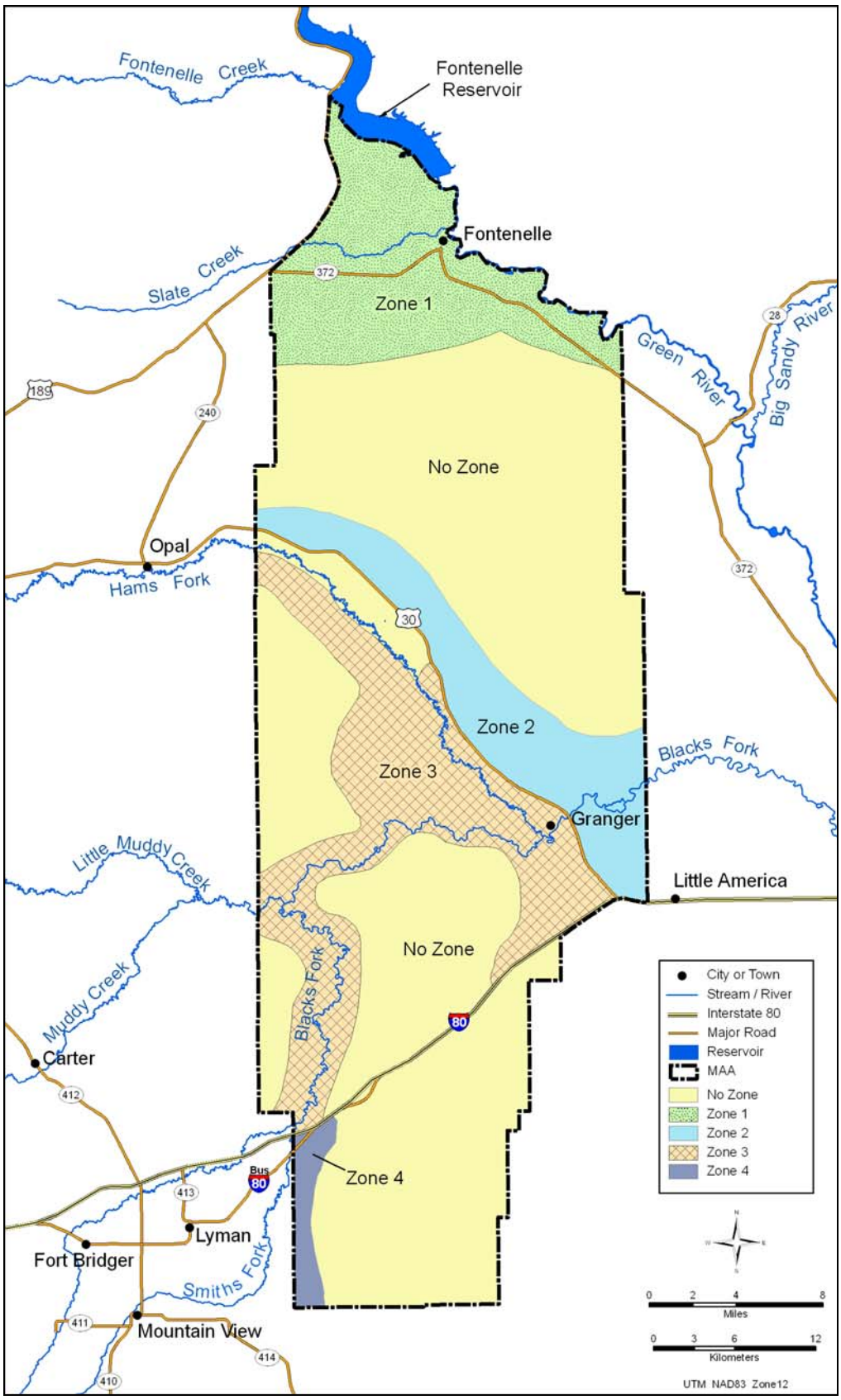
  The goal of this BMP is to restore the landform, vegetation, habitat, soil, and visual resources to the same conditions that occurred prior to well development. Topsoil will be stripped from areas that have not already been recontoured and redistributed uniformly over all disturbed areas. BLM-approved fertilizers will be used where applicable to encourage rapid regrowth of BLM-approved seed mixtures. Revegetation could result in color contrast initially that will decrease as native plants and shrubs recolonize. Nearly all roads would be recontoured to ensure that they blend into the surrounding landscape.

2.3.2. Alternative A

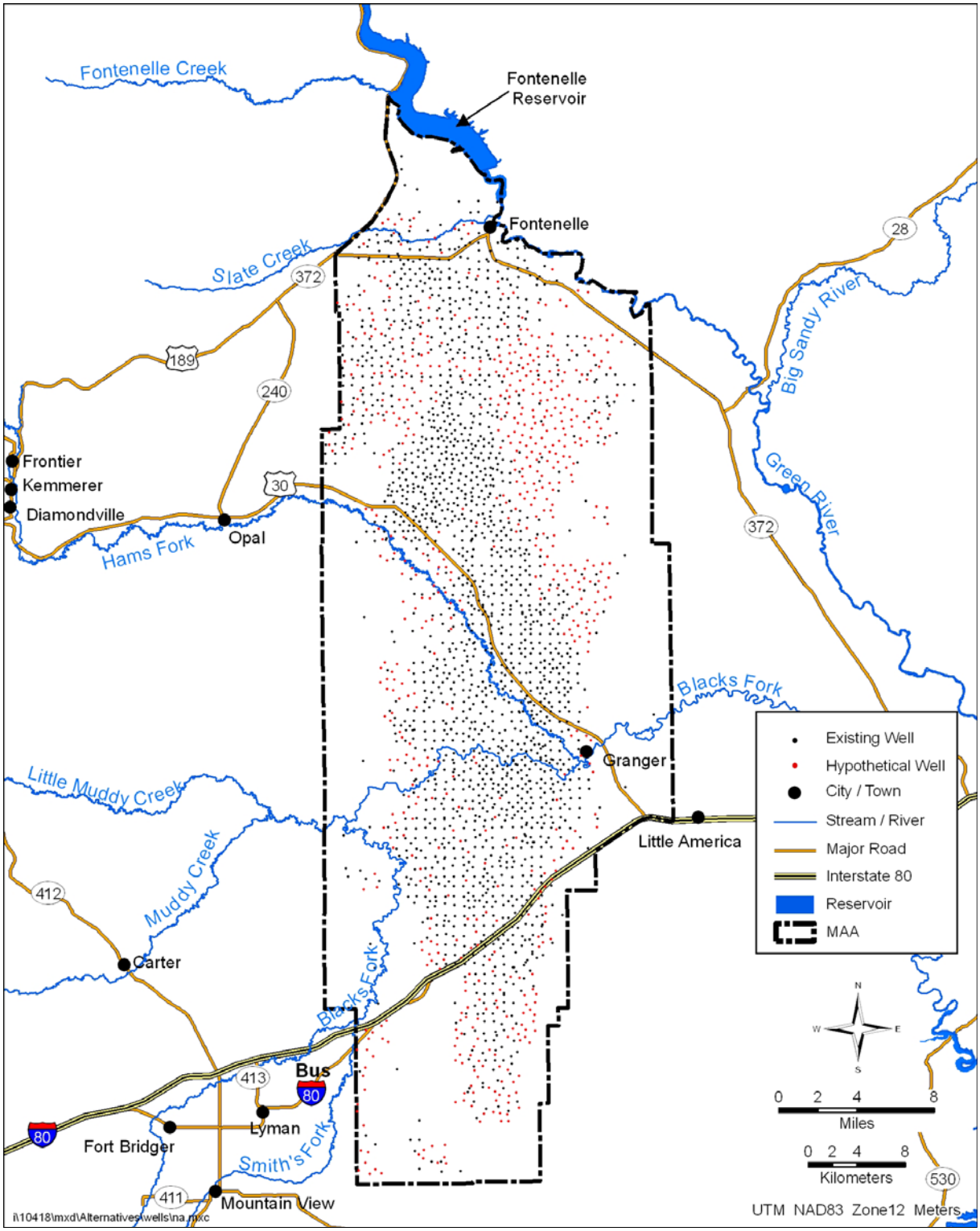
Alternative A is the No Action Alternative. As part of Alternative A, the BLM would reject the Operators' proposal and continue with implementation of the 1997 ROD (BLM 1997a). Authorizations for and impacts from previously approved development and surface disturbance would continue.

The 1996 EIS and the 1997 ROD analyzed the impacts of drilling 1,325 wells from the same number of pads (729 wells on federally administered lands and minerals) in the MAA in addition to the 1,119 approved or completed wells existing during the development of the 1996 EIS. The Record of Decision identified four zones corresponding to big game crucial habitat and one none-zone area in which drilling activities could occur (Map 2-2). In each zone a cumulative total number of wells was authorized to limit future development in these areas; 245 were authorized for Zone 1; 242 were authorized for Zone 2; 393 were authorized for Zone 3; and 23 were authorized for Zone 4. The remaining wells were authorized for non-zone area. The zones in Map 2-2 were defined in the 1997 ROD and unless stated otherwise are not part of any of the action alternatives for the current EIS. The operators previously committed to extensive reclamation and revegetation that has not been successful for a variety of reasons including poor practices, low reclamation success, drought, etc. The 1997 ROD specified that 3.7 acres of disturbance per well pad and associated roads and pipelines was acceptable. Current estimates indicate that actual reclamation success is closer to 4.3 acres per well pad and associated infrastructure (a difference of 0.6 acres). This has resulted in approximately 240 acres more disturbance than what was anticipated as part of the ROD. If all of the 1,325 well pads authorized for the No Action are drilled the total disturbance associated would be approximately 800 acres greater than authorized by the 1997 ROD.

According to WOGCC and BLM records, as of June 2007, of the 1,325 well pads authorized in the 1997 ROD, approximately 655 have been constructed and are in production or have not met the BLM requirements for bond release. Of the 670 wells that could still be drilled the majority would be drilled in non-zone areas. No additional wells would be drilled in Zone 2, and very few wells would be drilled in any of the other zones. At current drilling rates, approximately 6 years would be required to drill the remaining wells in the MAA. However, this would be beyond the 10-year drilling phase that was evaluated under the prior EIS. At the time of publication of this DEIS, it is likely that the number of remaining wells in each zone will be lower than the number reported as of June 2007. However, the June 2007 numbers will be used to compare the magnitude of impacts that would occur under the No Action Alternative with those that would occur under the Proposed Action or any other project alternative. Map 2-3 illustrates the hypothetical locations of wells that could be drilled as part of Alternative A/No Action.



Map 2-2. Zones Defined in the 1997 ROD (BLM 1997a).



Map 2-3. Hypothetical Distribution of Wells and Well Pads in the MAA for Alternative A/No Action. Hypothetical well locations are for illustrative purposes only and do not reflect the actual locations of wells that would be drilled.

New, short-term construction-related surface disturbance under the No Action Alternative would be approximately 10,258 acres. The area of long-term surface disturbance associated with the No Action Alternative would drop to approximately 2,848 acres after interim reclamation (Table 2-3). This would increase total surface disturbance in the MAA to approximately 2.3%. Because of the 6-year drilling schedule anticipated for the No Action Alternative, approximately 1,710 acres (0.35% of the MAA) of new disturbance would occur each year for 6 years. Estimates for state and private/fee lands might be underestimated. BLM cannot approve or deny development on state and private lands and industry might develop these lands at a pace and density similar to the Proposed Action. However, because of the uncertainty in the number of wells that would be drilled, disturbance estimates are based on what was authorized in the 1997 ROD, not what could be drilled in the future. Additionally, in the 1997 ROD, the Operators committed to reclaiming drilling sites (well pads) to 0.7 acres of disturbance. However, because of drought conditions, poor reclamation success, and other factors, the actual acres disturbed per well pad across the MAA are estimated to be approximately 1.3 acres. Because of uncertainty in the actual reclamation success across the Moxa, to be conservative, calculations of potential disturbance that might result from continued implementation of the 1997 ROD use the 2.1 acre estimate that was used in the 1996 DEIS (Table 2-4).

Table 2-4. Approximate Disturbance Estimates for New Wells that would be Drilled in the MAA under Alternative A/No Action.

Surface Ownership	BLM	USFWS	Reclamation	State of Wyoming	Private/ Fee	Total	Percent of MAA
Total Acres - Core	103,893	268	4,299	8,297	96,157	212,914	44.75
Total Acres - Flank	127,825	1,339	22,660	5,028	106,042	262,894	55.25
Total Acres in MAA	***231,718***	***1,607***	***26,959***	***13,325***	***202,199***	***475,808***	***100.00***
Numbers of Well Pads for No Action Alternative							
Core	198	0	2	14	176	390	---
Flank	123	0	12	2	143	280	---
Total Well Pads	***321***	***0***	***14***	***16***	***319***	***670***	---
Short-Term Disturbance - Acres of Disturbance Associated with Drilling and Completion Phases[1]							
Core	3,031	0	31	214	2,695	5,971	1.25
Flank	1,883	0	184	31	2,189	4,287	0.90
Total	***4,915***	***0***	***214***	***245***	***4,884***	***10,258***	***2.16***
Long-Term Disturbance - Acres of Disturbance After Interim Reclamation[2]							
Core	842	0	9	60	748	1,658	0.35
Flank	523	0	51	9	608	1,190	0.25
Total	***1,364***	***0***	***60***	***68***	***1,356***	***2,848***	***0.60***
Existing Oil And Gas Disturbance In Project Area						***8,073***	***1.70***
Total Projected Oil and Gas Disturbance After Interim Reclamation						***10,921***	***2.30***

[1] Surface disturbance associated with drilling and completion activities for each well pad. Based on the 1996 EIS, disturbance calculations were 15.31 acres for the No Action: 5.00 acres per well pad, 3.64 acres roads per well, and 6.67 acres gathering pipeline per well.

[2] Disturbance associated with production activities after interim reclamation. Based on the 1996 EIS, disturbance after interim reclamation would be 4.25 acres for the No Action: 2.1 acres per well pad, 2.15 acres for roads, and 0 acres for gathering pipelines.

2.3.3. Alternative B

Alternative B would place a limit on the amount of active surface disturbance in the MAA. The intent of this alternative is to allow the Operators to fully develop the MAA while conserving the key resource values identified during scoping and outreach to cooperating agencies as discussed in Chapter 1, section 1.6 in addition to meeting the objectives of the RMP and BLM's multiple use management goals.

Alternative B would allow for full field development under a scenario with the same surface disturbance allowed for Alternative A/No Action. Alternative B would allow for the drilling of up to 5,165 additional wells across all lands in the MAA (see Alternative C, section 2.3.4) over a 25 year period as long as active, un-reclaimed surface disturbance associated with oil and gas drilling and exploration activities across the MAA is less than the 10,921 acres (2.3% of the MAA) as projected for Alternative A/No Action (Table 2-3). Within 1-year of the signature of the record of decision for this project, the operators would provide BLM with a baseline calculation of disturbance with geospatial data layers supporting that calculation. That baseline would become the baseline from which all new disturbance would be measured and from which successfully reclaimed acreages would be subtracted.

As much as 45,547 acres could be disturbed over the life of the project if all wells are drilled from new well pads per the estimates for Alternative C, Table 2-5. However, if at any one time, active oil and gas related disturbance in the MAA exceeds 10,921 acres, no new wells would be approved for federal lands or the federal mineral estate until reclamation reduces disturbance below the threshold.

Per the reclamation plan committed to by the operators and described for the Proposed Action, the operators would submit quantifiable documentation and summary reports to the BLM to determine how many acres are available under the surface disturbance limit (the details of the reclamation plan that would be implemented as part of Alternative B is detailed in Appendix E). The operators would also provide an annual drilling plan that would outline the numbers of wells to be drilled, the estimated disturbance associated with those wells, and the location of the wells. Operators could drill up to 205 wells per year in the MAA as specified for Alternative C. However, the number of wells actually drilled per year would depend on the acreage available under the 10,921 acre cap and the estimated acres of disturbance for new wells proposed in the Operators' drilling plan. Those areas not meeting the 80% of pre-disturbance vegetative cover performance standard for interim reclamation (Appendix E) would be considered disturbed until evidence is provided that reclamation standards have been met. Once that evidence is provided, the successfully reclaimed acreage would be subtracted from the 10,921 acre cap and new wells could be authorized.

As stated in the Operators committed reclamation procedures and BMPs for the Proposed Action, numerous development and operating practices are available to reduce disturbance while still allowing development of the gas resources in the MAA. These include the optional practices identified in the following list. However, other options are available to minimize disturbance and operators would be encouraged to utilize newly available technologies, reclamation techniques, and drilling and operations processes to reduce surface disturbance. The techniques identified in the following list are not required under this alternative but will be analyzed in greater detail to provide a comparison between the other project alternatives. Any of these techniques may be utilized by the Operators to maintain surface disturbance below the maximum threshold of 10,921 acres.

- Burying of gathering pipelines in or adjacent to access roads and use of common ROWs and utility corridors. Burying gathering lines in or adjacent to the road or in common ROWs with existing surface disturbance decreases surface disturbance. Any co-location of pipelines with County roads would be coordinated with local government entities.
- Centralizing production facilities.

- Minimizing topsoil removal during drilling activities using techniques such as mat drilling, vegetation mowing, brush beating, or other operator identified and BLM approved technique.
- Drilling multiple wells from a single pad. Wells drilled from existing well pads would reduce surface disturbance per well by as much as 8.5 acres per well.

Table 2-5. Approximate Disturbance Estimates for New Wells that would be Drilled in the MAA under Alternative C.

Surface Ownership	BLM	USFWS	Reclamation	State of Wyoming	Private/ Fee	Total	Percent of MAA
Total Acres - Core	103,893	268	4,299	8,297	96,157	212,914	44.75
Total Acres - Flank	127,825	1,339	22,660	5,028	106,042	262,894	55.25
Total Acres in MAA	***231,718***	***1,607***	***26,959***	***13,325***	***202,199***	***475,808***	***100.00***
Numbers of Well Pads for Alternative C							
Core	1,906	0	89	137	1,631	3,763	---
Flank	676	0	115	25	586	1,402	---
Total Well Pads	***2,582***	***0***	***204***	***162***	***2,217***	***5,165***	---
Short-Term Disturbance - Acres of Disturbance Associated with Drilling and Completion Phases[1]							
Core	16,893[2]	0	783	1,206	14,353	33,235	6.98
Flank	5,949	0	1,012	220	5,157	12,338	2.59
Total	***22,842***	***0***	***1,795***	***1,426***	***19,510***	***45,573***	***9.58***
Long-Term Disturbance - Acres of Disturbance After Interim Reclamation[3]							
Core	5,743	0	263	404	4,811	11,221	2.36
Flank	1,994	0	339	74	1,729	4,136	0.87
Total	***7,737***	***0***	***602***	***478***	***6,540***	***15,357***	***3.23***
Existing Oil And Gas Disturbance In Project Area						**8,073**	**1.70**
Total Projected Oil and Gas Disturbance After Interim Reclamation						**23,430**	**4.92**

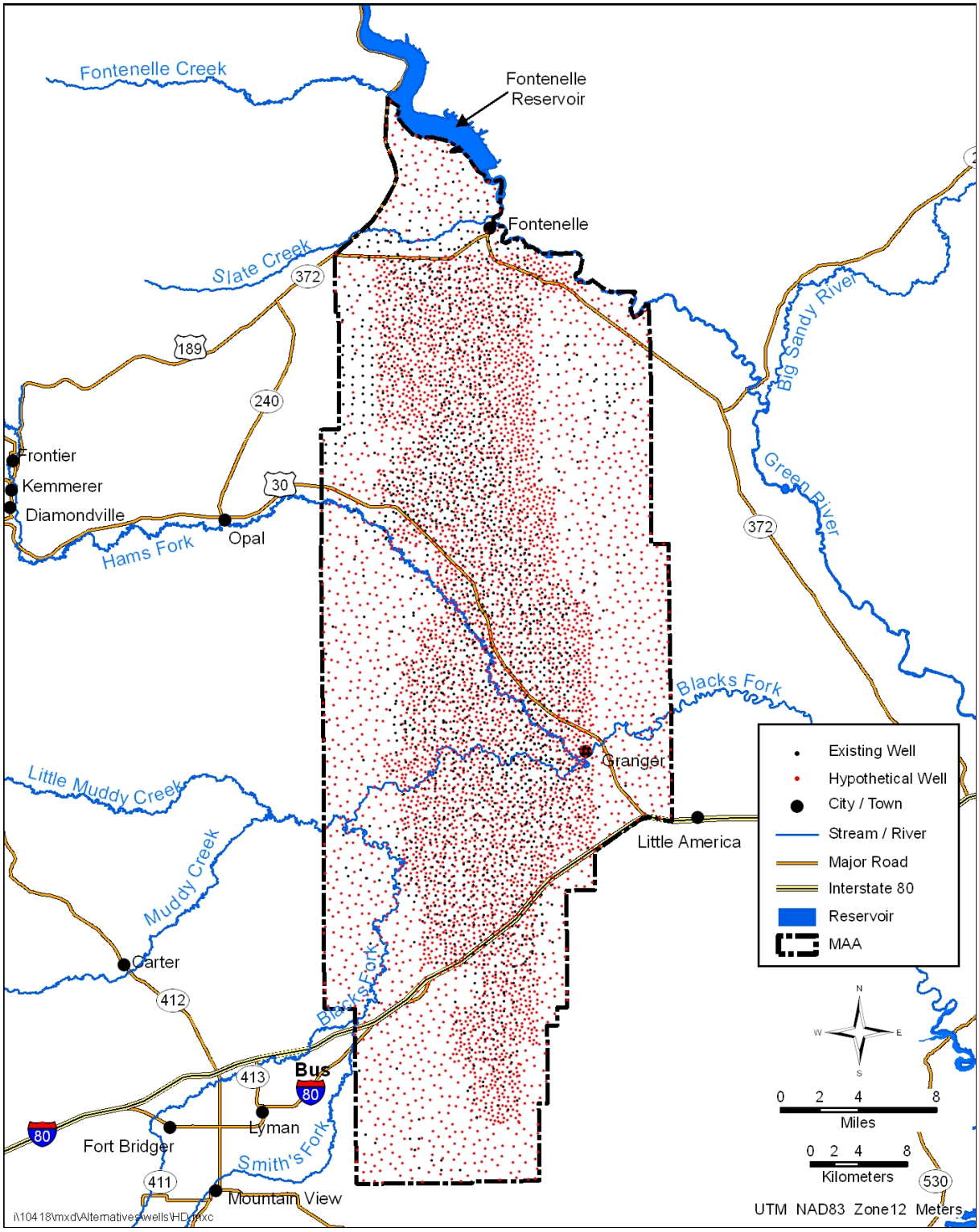
[1] Surface disturbance associated with drilling and completion activities for each well pad. Disturbance calculations assume 8.80 acres per well for Alternative C: 2.75 acres per well pad, 4.8 acres for 0.5 mile of collocated roads and gathering pipelines per well pad, and 1.25 acres of additional disturbance to account for pads, roads, and pipelines that require additional cut and fill.

[2] Includes disturbance estimates for 12 new 10-acre compression facilities on federal lands.

[3] Disturbance associated with production activities after interim reclamation. Disturbance after interim reclamation would be 2.95 acres for Alternative C: 1.0 acre per well pad and 1.95 acres for collocated roads and gathering pipelines.

2.3.4. Alternative C

Alternative C would allow the drilling of up to 16 well pads per square mile across the core of the MAA, and 4 well pads per square mile in the flank of the MAA. Based on data provided by the Operators in the MAA, this spacing is a conservative estimate of what would be required to maximize resource extraction in the core and allow for full definition of resource potential in the flank area. This spacing is already being observed on private lands in the MAA. Infill drilling as part of Alternative C would consist of approximately 5,165 new wells across the MAA (Table 2-4, Map 2-4).



Map 2-4. Hypothetical Distribution of Wells in the MAA for Alternative C. Hypothetical well locations are for illustrative purposes only and do not reflect the actual locations of wells that would be drilled.

Based on current drilling rig availability estimates, if wells are drilled at a rate of approximately 205 per year, all wells would be drilled during an approximate 25-year period after project approval. To reduce disturbance, roads and gathering pipelines would be collocated for all well pads. An estimated 7 to 12 new compressors could be required to accommodate the additional gas produced.

The area of surface disturbance associated with drilling and completion activities would be approximately 45,573 acres (Table 2-5). Most of the disturbance would occur on BLM-administered lands. Approximately 9.6% of the Project Area would be affected by short-term disturbance. Because of the 25-year drilling schedule associated with Alternative C, approximately 1,823 acres (0.38% of the MAA) of new disturbance would occur each year for 25 years.

After interim reclamation is completed, the area of long-term disturbance associated with project development would be approximately 15,357 acres. It is expected that this level of disturbance would be present for the life of the wells that are drilled (approximately 65 years; 25 years for drilling and 40 years for operations). Operators would adhere to the necessary site-specific BMPs presented for Alternative B.

2.4. Features Common to All Alternatives

Operational considerations and field development methods would be the same for all action alternatives. Unless otherwise noted in the description of the Proposed Action or each project alternative, Appendix B describes the proposed operations in the MAA. Operations for Alternative A/No Action would follow the descriptions provided in the 1997 ROD (BLM 1997a).

BMPs would be applied on a site-specific basis as necessary to reduce impacts associated with construction, drilling, operation, or reclamation activities. BLM's policies require that Field Offices use appropriate environmental BMPs for mitigating anticipated impacts to surface and subsurface resources. Environmental BMPs are state-of-the-art mitigation measures applied on a site-specific basis to reduce, prevent, or avoid adverse environmental or social impacts. Their application can "aid in achieving desired outcomes for safe, environmentally sound resource development, by preventing, minimizing, or mitigating adverse impacts and reducing conflicts."

In addition to the operator committed BMPs identified in the description of the Proposed Action, the following BMPs are identified in IM 2007-021 as those that should be considered on a case-by-case basis:

- Installation of raptor perch avoidance;
- Burying of distribution power lines and/or flow lines in or adjacent to access roads;
- Centralizing production facilities;
- Submersible pumps;
- Belowground wellheads;
- Drilling multiple wells from a single pad;
- Noise reduction techniques and designs;
- Wildlife monitoring;
- Placing seasonal restriction of public vehicular access;
- Avoiding placement of production facilities on hilltops and ridgelines;
- Screening facilities from view;
- Bioremediation of oil field wastes and spills; and
- Use of common utility or right-of-way corridors.

The above list is an example of what BMPs should be considered and is not a comprehensive list of potential BMPs that could be applied.

The operators' committed reclamation procedures described for the Proposed Action would be applied to alternatives B and C. These procedures would be added to the reclamation processes specified in Appendix E and would be required to comply with reclamation guidance provided in Onshore Oil and Gas Order Number 1.

2.5. Alternatives Considered and Eliminated from Detailed Study

Four alternatives were considered and eliminated from detailed study. These alternatives and the reasons for their elimination from further analysis are briefly described below.

2.5.1. 2,730 Wells Drilled Using Maximum Rig Availability

This alternative considered the possibility that the number of wells drilled would be based on maximum rig availability. Assuming 15 rigs, per the Operators' Proposed Action, and 20 days per well, approximately 273 wells could be drilled per year for 10 years, producing a total of 2,730 wells.

This alternative was removed from further consideration because it is anticipated that 15 rigs would not be available over the life of the project. Currently, 9 to 10 rigs operate in the MAA; additional rigs are unavailable due to development in other fields throughout southwestern Wyoming.

2.5.2. Shortened Drilling Phase Alternative

This alternative assumed that wells would be drilled based on maximum rig availability. Assuming 15 rigs, per the Operators' Proposed Action and 20 days per well, approximately that 273 wells could be drilled per year. However, instead of drilling more wells during a 10-year period due to maximum rig availability, this alternative focused on decreasing the drilling period to 7 years by increasing the wells drilled per year.

This alternative was removed from further consideration for the same reason as the previous alternative. Additionally, because this alternative produced the same amount of disturbance as the Operators' Proposed Action, it was reasoned that the intensity of disturbance and impacts on certain resources (biological and physical) would be increased by shortening the drilling phase.

2.5.3. 9 to 12 Wells per Square Mile across Entire MAA

This alternative involved drilling 9 to12 wells per square mile across the entire Project Area. This well density was developed using data from the BLM Wyoming's Reservoir Management Group (RMG), which indicated that the MAA would be most optimally drained at an average spacing of approximately 9 wells per square mile. However, the RMG recognized that in some cases, optimal resource recovery would require higher densities of infill drilling and that in some areas well density could not be estimated because of the unknown nature of the gas reserves (especially in unproven areas of the flank). It was also determined that certain areas may require more intensive development (such as proven areas in the core), and other areas may require fewer wells to fully develop the resource potential (such as flank areas). Additionally, in many areas drilling 9 to 12 wells per square mile would not be economically feasible, as the gas return from an individual well might not offset the costs of drilling. More detailed data from the Operators allowed BLM to develop Alternative C, which analyzes the impacts of a High Field Development Alternative.

2.5.4. Spatial and Temporal Phasing of Field Development

This Phased Development Alternative would include the same level of development as the Operators' Proposed Action, but the drilling would be phased by lease, section, or other factor. The intent of phased development was to decrease the impacts to the surface and resources in the MAA by allowing

only selected areas or selected numbers of wells to be drilled each year. Several options were considered for this alternative, and both temporal and spatial phased development scenarios were evaluated. Possible phased development alternatives included:

- **Drilling certain percentages of wells every year over the period of the drilling phase**
  The Operators Proposed Action and Alternative C already specify a temporally phased approach for drilling. The Proposed Action would have approximately 10% of proposed wells drilled every year for 10 years. Alternative C would have approximately 4% of 5,165 wells drilled every year for 25 years.

- **Drilling only on selected leases each year where some leases would be allowed to drill and others would not or, drilling certain percentages of a lease per year.**
  Because of the number of leaseholders (Map 1-3), the spatial complexity of the leases, the multiple operators, the variable size of the leases, and the checkerboard land ownership pattern, it would be very difficult to phase development by lease. Leases in the MAA were offered over a period of decades and the specific stipulations on how they can be developed and their expiration date varies substantially. Some leases are held by production, others are unitized, and others are neither. Additionally, the MAA is an existing gas field and most of the leased acreage has already had some level of development and disallowing drilling could constitute the taking of a lease right. Because of the varying size of the leases (Map 1-3) it would be difficult to specify a percentage of a lease or a minimum acreage threshold for development. By specifying a disturbance threshold by lease, it is likely that some smaller leaseholders and operators could be disadvantage while others with larger leases and more opportunity for development would be unjustly advantaged. Because of these complexities, the decision on which leases to drill on each year or how much disturbance could occur on each lease would likely be arbitrary and not supportable.

  The checkerboard land ownership pattern also does not provide an opportunity to achieve the goals of phased development. If BLM phased the drilling on federal lands and minerals in the checkerboard, nothing would prevent the operators from drilling on the private and state lands. This drilling would still cause impacts to the wildlife species that inhabit the checkerboard lands and would still impact resources such as water, air, socioeconomics, visual resources, and soils. By phasing, and slowing development in the checkerboard it could prolong field development and prolong the impacts that occur to the above resources.

- **Drilling certain percentages of wells in sensitive areas each year.**
  Because of many of the same reasons as stated above, this phased development scenario was not further analyzed. Because of the complexity of the land ownership and leasing pattern in the MAA, this alternative would not achieve the goals that it is intended to accomplish. In the checkerboard lands, if BLM specified that development on sensitive lands would be limited, the operators could move to non-federal lands where impacts could occur to sensitive resources such as wildlife habitat, big game winter range, cultural resources, soils, and a number of other resources.

  Additionally, because of the varying lease conditions, stipulations, and conditions of approval across the MAA, BLM could be limited in its ability to prevent development in sensitive areas. Because the MAA is an existing field, many of the sensitive areas already have development occurring in them. Alternative B was developed to address development in sensitive areas. Alternative B provides the tools necessary to avoid impacts to sensitive areas, to focus on reclamation of these areas, and to reduce disturbance across the project area.

2.6. Comparison of Impacts by Alternative

The table on the following pages (Table 2-6) discusses the potential impacts that could occur to selected resources as a result of implementing the Operators' Proposed Action or any of the project alternatives.

Table 2-6. Comparison of Impacts by Alternative.

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Air Quality				
Concentrations of criteria pollutants and Hazardous Air Pollutants (HAPs)	Potential near-field concentrations would be well below applicable National Ambient Air Quality Standards (NAAQS), Wyoming Ambient Air Quality Standards (WAAQS), and PSD Class II Increment for all pollutants; potential Hazardous Air Pollutant (HAP) impacts would be below applicable health-based levels and within acceptable cancer risk ranges for carcinogens	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Sulfur and nitrogen deposition	Potential total deposition would be below the applicable levels of concern (LOCs)	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Acid neutralizing capacity for sensitive lakes	Project total ANC would be below the applicable LOCs	Same as Proposed Action	Same as Proposed Action	Same as Proposed Action
Visibility in Class I and sensitive Class II areas	Potential significant project visibility impact would be 1 day at Bridger Class I area. Potential significant cumulative impact would be 45 days at Bridger.	There would be no impact from the project. Potential cumulative visibility impact would be 42 days.	Same or less than Alternative C.	Potential significant project visibility impact would be 5 days at Bridger. Potential significant cumulative visibility impact would be 50 days at Bridger.
Ozone	The maximum estimated daily maximum 8-hour ozone concentrations near the Project are below the 8-hour ozone standard.	Concentrations would be lower than the Proposed Action	Same or less than Alternative C.	Concentrations would be higher than the Proposed Action but would not be expected to exceed the NAAQS.

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Geology, Minerals, and Paleontology				
Surface Geology	Short-term disturbance of 18,650 acres; 13,279 acres disturbed after interim reclamation; no lasting effects after final reclamation and recontouring	Short-term disturbance of 10,258 acres; 2,848 acres disturbed after interim reclamation; no lasting effects after final reclamation and recontouring	Short-term impacts could be as high as Alternative C. Long-term impacts same as Alternative A.	Short-term disturbance of 45,573 acres; 22,641 acres disturbed after interim reclamation; no lasting effects after final reclamation and recontouring
Geohazards	Low risk of landslide risks along steep slopes and bluffs adjacent to perennial streams and along the sides of residual mesas.	Same as PA	Same as PA	Same as PA
Paleontological Resources	During construction, potential for damage/destruction and also discovery of important fossils.	Same as PA but lower potential for damage/destruction and discovery	Same or less than Alternative C.	Same as PA but higher potential for damage/destruction and discovery
Minerals	Depletion of 60% of the technically recoverable gas resource for the MAA; no potential conflicts with trona mining	Depletion of 28% of the technically recoverable gas resource for the MAA; no potential conflicts with trona mining	Same as Alternative C.	Depletion of 85% of the technically recoverable gas resource for the MAA; possible conflicts with trona mining if MMTA restrictions are relaxed or released

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Soils				
Disturbance to sensitive soils	6,432 acres disturbance during 10-year drilling and construction phase; 2,068 acres after interim reclamation	3,731 acres disturbance during drilling and construction phase; 1,034 acres after interim reclamation	Could be as high as Alternative C but would likely be lower because of emphasis on reclamation.	15,367 acres disturbance during drilling and construction phase; 5,173 acres after interim reclamation
Disturbance to non-sensitive soils	12,213 acres disturbance during drilling and construction phase; 3,926 acres after interim reclamation	6,524 acres disturbance during drilling and construction phase; 1,810 acres after interim reclamation	Could be higher than Alternative C if all development shifts into non-sensitive soils to improve reclamation success. Would likely be lower than alternative C if technologies like directional drilling are used.	30,196 acres disturbance during drilling and construction phase; 10,176 acres after interim reclamation
Water Resources				
Watershed Disturbances	<1% new disturbance of Upper Green, Slate Creek, Blacks Fork, and Muddy Creek watersheds. Slightly greater than No Action	<0.5% new disturbance of Upper Green, Slate Creek, Blacks Fork, and Muddy Creek watersheds	Same or lower than Alternative C.	<1% new disturbance of Upper Green and Muddy Creek watersheds, 1.2% in Slate Creek, and 1.9% in Blacks Fork
Surface Water Quantity	3,722 acre-feet of water required over LOP, 374 acre-feet per year	1,340 acre-feet of water required over LOP, 223 acre-feet per year	Same as Alternative C	10,300 acre-feet of water required over LOP, 414 acre-feet per year
Surface Water Use and Quality	No significant impacts would be expected	Same as PA	Same as PA	Same as PA
Groundwater Use and Quality	Some local depletion to groundwater could occur under all alternatives. Groundwater use is expected to be proportional to the level of development for each alternative.	Same as PA	Same as PA	Same as PA

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Vegetation and Wetlands				
Wetland and riparian vegetation types	Impacts would not be significant because of BLM stipulations and CWA regulations, some impacts might occur where roads, pipelines, or well pads intersect those vegetation types	Impacts would not be significant, impacts would be less than PA	Same or less than Alternative C.	Impacts would not be significant because of BLM stipulations and CWA regulations, impacts would be greater than PA
New short-term disturbance of any vegetation type greater than 10% of its availability	No significant impacts to any vegetation class. Desert shrub/sagebrush has greatest disturbance	No significant increases to vegetation disturbance. Less disturbance that PA.	Same or less than Alternative C.	Significant impacts to vegetated sand dunes, alkali scrub, and agriculture/ croplands. Possible significant impacts to desert shrub/sagebrush and barrens.
Increase in populations of noxious or invasive plants	No significant increases in noxious weeds expected because of BLM stipulations and current operator management practices	Same as PA	Same as PA	Same as PA
Fisheries and Aquatic Ecosystems				
Impacts to fisheries and aquatic ecosystems resulting in loss of habitat function or life history requirements	No significant impacts would be expected because of protection of wetland and riparian habitats as well as mitigation measures currently in place for water resources	Same as PA	Same as PA	Same as PA
Disruption/loss of vital/high value riparian and aquatic resources	Impacts would not be significant because of BLM stipulations and CWA regulations	Same as PA	Same as PA	Same as PA

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Raptors				
Substantial loss of habitat function or disruption of life history requirements of a species or population segment	BLM stipulations for timing and location of drilling operations during raptor nesting periods would reduce impacts	Similar to PA but with lower potential for impacts to nesting birds	Less than Alternative C.	Similar to PA but with higher potential for impacts to nesting birds
Surface disturbance of more than 5% of area within 0.5 mile buffer around 106 known nests	4.3% disturbance during drilling and completion activities, 1.4% disturbance after interim reclamation	2.3% disturbance during drilling and completion, <1% after interim reclamation	Less than Alternative C.	9.8% disturbance during drilling and completion activities, 3.3% after interim reclamation. Impacts could be significant.
Big Game				
Greater than 5% disturbance in crucial ranges or 10% disturbance in non-crucial ranges	Disturbance in all crucial habitats for pronghorn and elk would be less than 5%; disturbance to all other habitats for all big game species would be less than 10%. Increased habitat fragmentation and encroachment on migration routes could cause significant impacts.	All disturbances would be less than the PA and would fall below the 5% and 10% thresholds	Less than Alternative C. Impacts could be significant.	Short-term impacts to pronghorn crucial range would be 9.2% and would exceed the 5% threshold of significance; short-term impacts to pronghorn spring-summer-fall habitat would be 10.2% and would exceed 10% threshold; 11.9% of mule deer habitat would be disturbed; 10.1% of elk crucial severe winter relief would be expected. Encroachment on migration routes could cause significant impacts.

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Well counts that would result in extreme impacts to big game crucial ranges as defined by WGFD	High, but not extreme, impacts to pronghorn crucial ranges in core; extreme impacts to elk crucial range in the core, high impacts to elk crucial range in the flank.	Moderate to high impacts to pronghorn crucial ranges; same as PA for elk	Less than Alternative C.	High impact to pronghorn crucial habitat but greater than PA; extreme impact to elk crucial habitat in both core and flank
ESA Protected Species and BLM Sensitive Species				
Ute ladies'-tresses orchid	Impacts avoided on federal lands through Application for Permit to Drill (APD) and on-site process as well as BLM required buffers around wetlands and riparian areas.	Same as PA	Same as PA	Same as PA
Bald eagle	No significant impacts	Same as PA	Same as PA	Same as PA
Colorado River fishes	Potential depletion to Colorado River Basin of 3,722 acre-feet over the LOP, 374 acre-feet per year	Potential depletion to Colorado River Basin of 1,514 acre-feet over the LOP, 216 acre-feet per year	Same as Alternative C.	Potential depletion to Colorado River Basin of 10,300 acre-feet over the LOP, 414 acre-feet per year
Black-footed ferret	No direct impacts, impacts to potentially suitable prairie dog towns	Same as PA but lower development in prairie dog towns	Same or less than Alternative C.	Same as PA but higher development in prairie dog towns
Yellow-billed cuckoo	No significant impacts	Same as PA	Same as PA	Same as PA
Greater sage-grouse	Impact to 3.7% of available sagebrush habitat, "high" level of impact using WGFD definitions. Impacts could cause significant impacts to some lek site or in some brood rearing habitat	Impact to 1.9% of available sagebrush habitat, "moderate" level of impact using WGFD definitions	Less than Alternative C. Impacts could be significant.	Impact to 9.2% of available sagebrush habitat, "high" level of impact using WGFD definitions. Impacts would be significant.

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Cultural and Historical Resources				
Vandalism and illegal collection	Impacts would be proportional to the amount of disturbance for each alternative.	Lower potential for impacts than PA	Same as or less than Alternative C.	Higher potential for impacts than PA
Non-mitigated impacts to eligible sites	Impacts would be proportional to the amount of disturbance for each alternative.	Lower potential for impacts than PA	Same or less than Alternative C.	Higher potential for impacts than PA
Socioeconomics and Environmental Justice				
Increased demand for housing that exceeds supply and results from project activities	Majority of workforce (60%) would come from outside the area. Current housing in area is inadequate to meet increased demands and population growth.	Current housing is adequate.	Same as Alterative C	Similar to PA with greater potential for housing shortages.
Increases in demand for local government facilities or services that exceed existing capacity and are not offset by adequate revenues	School capacity is adequate. Sewer and transportation is inadequate. Additional law enforcement personnel and costs would be necessary. Ad valorem, severance tax, and mineral royalties tax would generate approximately $1.17 billion in revenue for county, state, and federal governments that would help to offset costs of increased infrastructure.	School capacity is adequate. Ongoing upgrades to the sewer system would be sufficient for the No Action. Ad valorem, severance tax, and mineral royalties tax would generate approximately $541 million in revenue for county, state, and federal governments that would help to offset costs of increased infrastructure.	Same as Alternative C	School capacity is adequate. Sewer and transportation is inadequate. Additional law enforcement personnel and costs would be necessary. Ad valorem, severance tax, and mineral royalties tax would generate approximately $1.68 billion in revenue for county, state, and federal governments that would help to offset costs of increased infrastructure.
Employment and income	Would generate up to 7,894 worker years in new employment including 22,993 jobs during drilling and construction and 4,872 jobs during production.	Would generate up to 3,211 worker years in new employment including 9,353 jobs during drilling and construction and 2,252 jobs during production.	Same as Alternative C	Would generate up to 21,911 worker years in new employment including 63,814 jobs during drilling and construction and 7,007 jobs during production.

Resource	Proposed Action (PA)	Alternative A	Alternative B	Alternative C
Population	Peak population increase would be approximately 264 individuals	Peak population increase would be approximately 165 individuals	Same as Alternative C	Peak population increase would be approximately 283 individuals
Land Use				
Land Status/Prior Rights	No changes expected	Same as PA	Same as PA	Same as PA
Loss of AUMs	The reduction in animal unit months (AUMs) from the Proposed Action would not be a significant loss	Same as PA but fewer AUMs lost	Same as Alternative A/No Action.	Same as PA but more AUMs lost
Impacts to livestock	Possible decreased forage quality near roads, increased potential for collisions with livestock, potential for spread of some invasive weeds	Same as PA but less impact	Same as Alternative A/No Action.	Same as PA but more impact
Recreation	Some impacts to recreation experiences for primitive camping, hunting, fishing, and open recreation. Level of impact would be roughly proportional to the amount of development for each alternative.	Fewer impacts than PA	Less than Alternative C. Likely impacts would be closer to impacts of No Action or PA.	Greater impacts than PA
Transportation				
Number of trips in peak development year	85,298 trips	49,258 trips	Same or less than Alternative C.	103,817 trips
Percent of projected 2015 Average Annual Daily Traffic volumes	I80 – 1.4% US 30 – 7.2% US 189 – 2% WY 372 – 1.5% WY 240 – 1.7%	Not expected to change from current conditions or those conditions projected in 1995 EIS (BLM 1995a)	Same or less than Alternative C.	I80 – 1.5% US 30 – 8.2% US 189 – 2.1% WY 372 – 1.7% WY 240 – 1.7%

Resource	Proposed Action (PA)	Alternative A	Alternative B:	Alternative C:
Visual Resources				
Disturbance within various visual resource classes	Class II – 2,217 acres Class III – 4,787 acres Class IV – 11,646 acres	Class II – 702 acres Class III – 2,144 acres Class IV – 7,413 acres	Same or less than Alternative C. Long-term impact same as Alternative A/No Action	Class II – 4,180 acres Class III – 44,276 acres Class IV – 27,116 acres
Hazardous Materials/Health and Safety				
Potential for increased risk to the public	Increased risks would not be significant	Same as PA	Same as PA	Same as PA

CHAPTER 3 AFFECTED ENVIRONMENT

This chapter describes existing conditions of the physical, biological, cultural, socioeconomic, and visual resources in the MAA and identifies associated resource-specific cumulative impact assessment areas (CIAAs). The resources and their respective CIAAs addressed in this EIS were identified during previous Moxa Area NEPA analyses, scoping for this EIS, and interdisciplinary team (IDT) and Cooperating Agency reviews. The information contained in Chapter 3 is directly relevant to the materials and analyses described in Chapter 4. The reader should keep this in mind when reading the two chapters to gain maximum understanding of how the Proposed Action and project alternatives will affect the current environment in the MAA.

Critical elements of the human environment (BLM 1988, 1999b), their status in the MAA, and their potential to be affected by the proposed project are listed in Table 3-1. Of the 14 critical elements potentially affected, 4 are not present in the MAA and are not addressed further in this document. This EIS addresses the 10 critical elements of the human environment that may be affected and discusses existing conditions, potential direct and indirect project effects (Chapter 4), and cumulative impacts on other resources (Chapter 5), including topography, mineral resources, geologic hazards, paleontological resources, soil, noise, vegetation, wildlife and fisheries resources, cultural and historical resources, socioeconomics, land use, livestock/grazing management, recreation, transportation, and visual resources.

Table 3-1. Critical Elements of the Human Environment, Moxa Arch Area Infill Gas Development Project, Wyoming, 2006.

Critical Element	Status in MAA	Addressed in this EIS
Air Quality	Potentially affected	Yes
Areas of Critical Environmental Concern	Not present, Not affected	No
Cultural Resources	Potentially affected	Yes
Environmental Justice	Potentially affected	Yes
Farmlands (Prime or Unique)	Not present, Not affected	No
Floodplains	Potentially affected	Yes
Native American Religious Concerns	Potentially affected	Yes
Noxious Weeds	Potentially affected	Yes
Threatened and Endangered Species	Potentially affected	Yes
Wastes, Hazardous or Solid	Potentially affected	Yes
Water Quality (Drinking, Surface and Groundwater)	Potentially affected	Yes
Wetlands/Riparian Zones	Potentially affected	Yes
Wild and Scenic Rivers	Not present, Not affected	No
Wilderness	Not present, Not affected	No

Source: (BLM 1988, 1999b).

3.1. Air Quality

Regional air quality is influenced by the interaction of meteorology, climate, the magnitude and spatial distribution of local and regional air pollutant sources, and the chemical properties of emitted air pollutants. The following sections summarize the existing climate and air quality within the area potentially affected by the proposed infill drilling activities in the MAA. A detailed assessment of potential air quality impacts is presented in Appendix C.

3.1.1. Climate

The MAA is located in a semi-arid, mid-continental climate regime typified by dry, windy conditions, limited rainfall, and long, cold winters (Trewatha and Horn 1980). Table 3-2 summarizes climate components in the area potentially affected by the proposed project, based on data collected at several long-term meteorological stations located near the MAA.

Table 3-2. Summary of Climate (1958–2005).

Wyoming Meteorological Station	Description
Kemmerer Water Treatment Station	Mean annual temperature: 39.3 °F Mean annual precipitation: 9.78 inches Mean annual snow depth: 2 inches Mean annual snowfall: 50.9 inches
Rock Springs	Mean annual temperature: 44.1 °F Mean annual precipitation: 8.51 inches Mean annual snow depth: 1 inch Mean annual snowfall: 49.2 inches
LaBarge	Mean annual temperature: 39 °F Mean annual precipitation: 8.03 inches Mean annual snow depth: 1 inch Mean annual snowfall: 31.7 inches

Source: (Western Regional Climate Center 2006).

The MAA region is subject to strong, gusty winds that are often accompanied by snow and blizzard conditions during winter months. Winds frequently originate from the west to northwest, and the mean annual wind speed is 9 miles per hour. A wind rose illustrating the distribution of wind speed and direction for the MAA is provided in Figure 3-1.

Wind strength and frequency affects dispersion of noises, odors, and transport of dust and other airborne elements. Therefore, the region's strong winds increase the potential for atmospheric dispersion of pollutants.

Temperature in southwestern Wyoming is expected to increase by 0.25 to 0.40 degrees Fahrenheit per decade while temperatures in surrounding locations in Utah, Wyoming, and Colorado are expected to increase by 0.40 to 1.2 degrees Fahrenheit per decade (Figure 3-2). Precipitation across western Wyoming is expected to decrease by 0.1 to 0.6 inches per decade with the largest decrease expected in southwestern Wyoming (Figure 3-2).

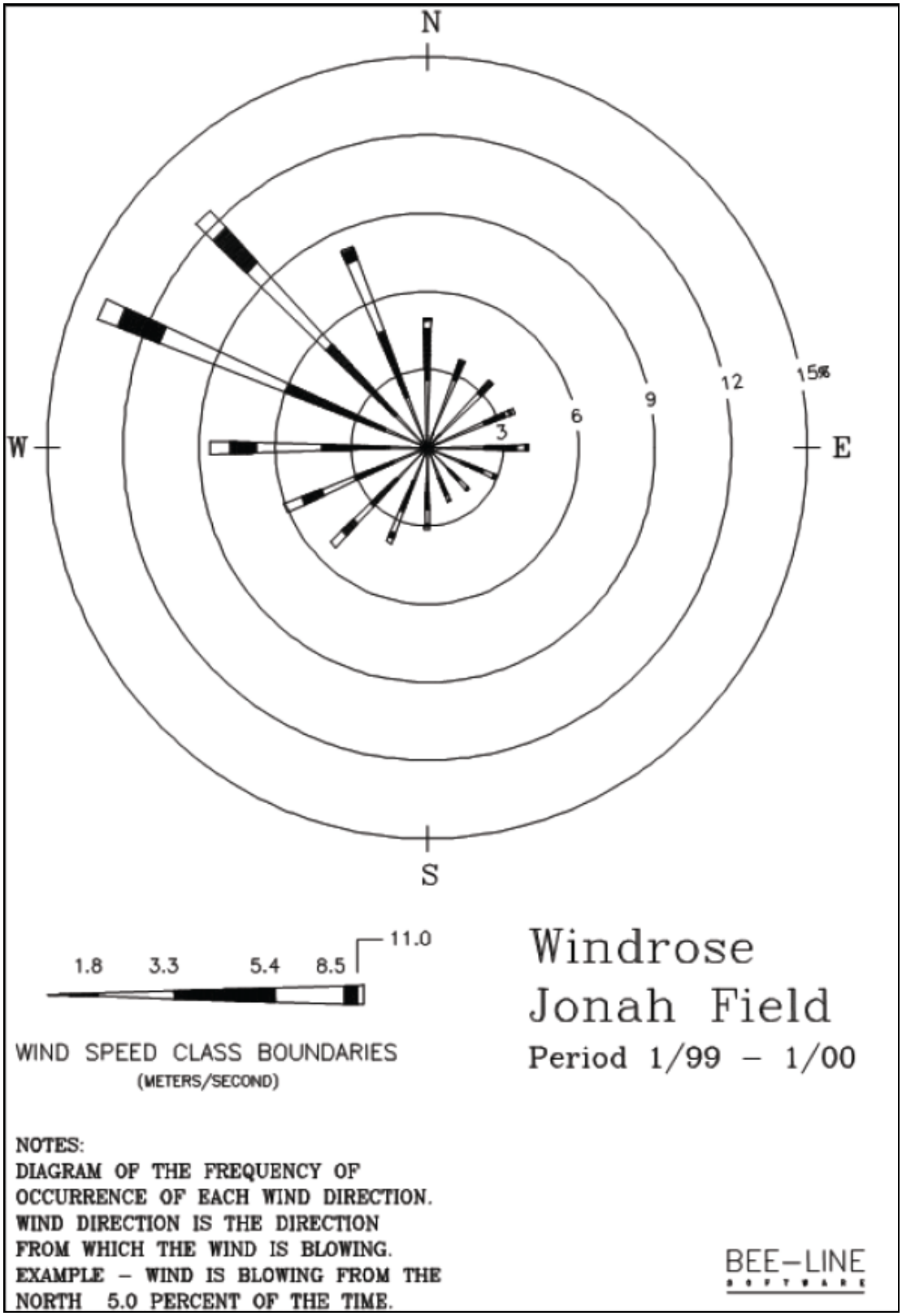


Figure 3-1. Wind Rose for the Jonah Field Used for MAA Air Quality Modeling Efforts.

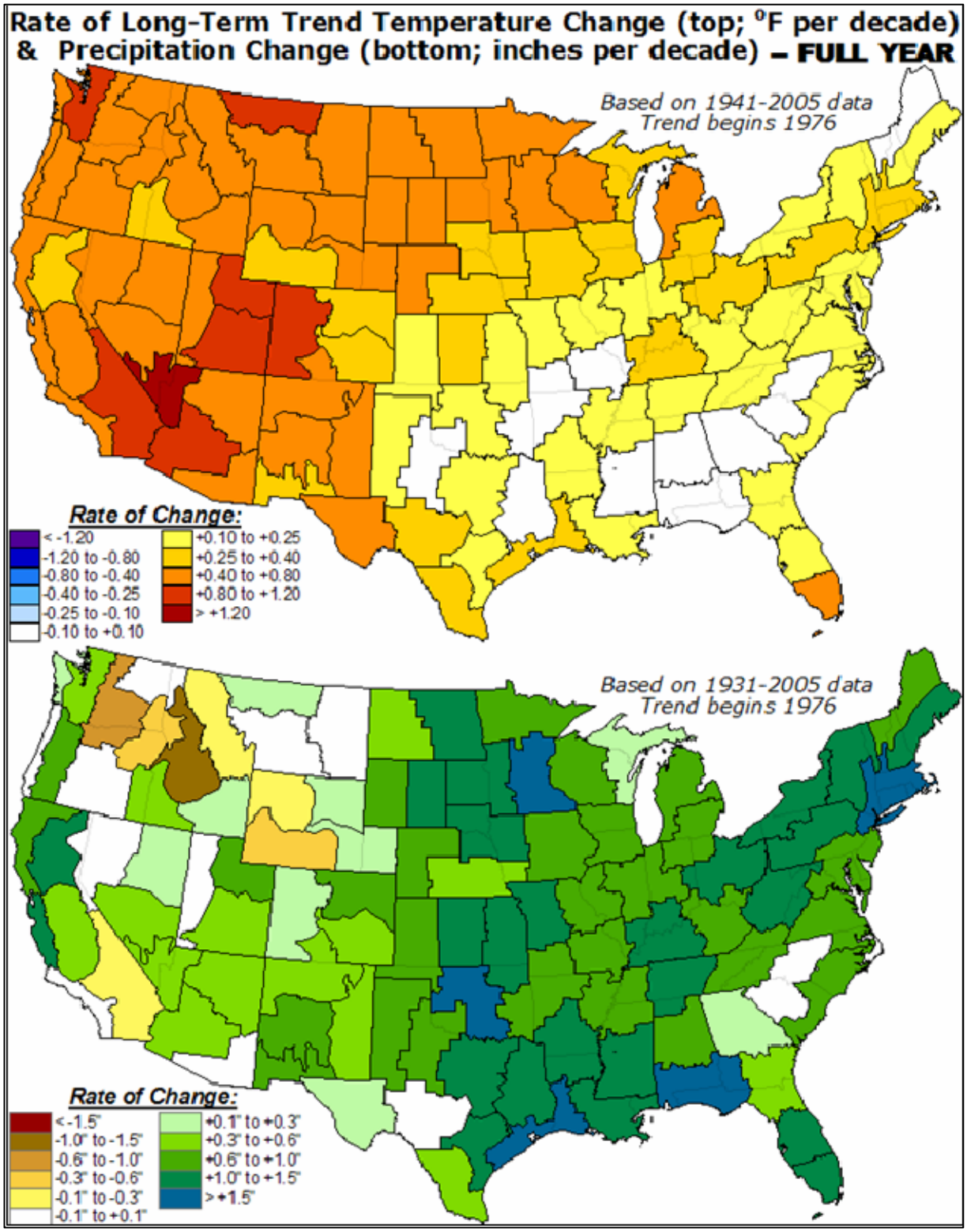


Figure 3-2. Long-term Temperature (top) and Precipitation (bottom) Trends in the United States. From NOAA Climate Prediction Center (http://www.cpc.noaa.gov).

3.1.2. Air Quality

A variety of pollutants can affect air quality; these pollutants and their effects on health, visibility, and ecology are described in the following sections, along with data on existing air quality conditions found within the Moxa Arch study area.

3.1.2.1. Concentrations

Pollutant concentration can be defined as the mass of pollutant present in a volume of air and is reported in units of micrograms per cubic meter ($\mu g/m^3$), parts per million (ppm), or parts per billion (ppb). The State of Wyoming has used monitoring and modeling to determine that the area potentially affected by the proposed project is currently in compliance with Wyoming and federal concentration standards. In addition, non-reference method monitoring systems are operational, including the *Clean Air Status and Trends Network* (CASTNet) and *Wyoming Air Resources Monitoring System* (WARMS). Data from these systems have been determined to be representative of the Project Area.

Criteria air pollutants are those for which national concentration standards have been established. Pollutant concentrations greater than these standards represent a risk to human health or welfare. Table 3.3 presents background concentrations of criteria air pollutants as determined by the Wyoming Department of Environmental Quality–Air Quality Division (WDEQ-AQD). Background concentrations are in compliance with applicable Wyoming and national ambient air quality standards (WAAQS/NAAQS). Also included in Table 3-3 are Prevention of Significant Deterioration (PSD) increments for Class I areas (wilderness areas with protected air quality status due to their pristine condition) and Class II areas (wilderness areas with protected air quality status due to their sensitive condition). All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis. NAAQS/WAAQS have been established for the following criteria pollutants:

Carbon monoxide (CO) is an odorless, colorless gas formed during combustion of any carbon-based fuel, such as during operation of engines, fireplaces, furnaces, etc. Because carbon monoxide data are generally collected only in urban areas where automobile traffic levels are high, recent data are often unavailable for rural areas. Background carbon monoxide data were collected in Ryckman Creek (BLM 1983) in southwest Wyoming and in Rifle and Mack, Colorado during the late 1970s and the early 1980s. These are the most representative available data for the Project Area. Background carbon monoxide concentrations were 5.6–14% of the applicable WAAQS (Table 3-3)

Nitrogen dioxide (NO_2) is a highly reactive compound formed at high temperatures during operation of fossil fuel combustion. At high concentrations, it can form a red-brown gas. At concentrations in excess of the EPA air quality standard, it is a respiratory irritant; however, all areas of the United States are in compliance with this air quality standard. During fossil fuel combustion, NO is released into the air which reacts in the atmosphere to form NO_2. NO plus NO_2 is a mixture of nitrogen gases, collectively called nitrogen oxides (NO_x). NO_x emissions can convert to ammonium nitrate particles and nitric acid which can cause visibility impairment and atmospheric deposition. Nitrogen dioxide can contribute to "brown cloud" conditions and ozone formation, and can convert to ammonium (NH_4), nitrate particles (NO_3), and nitric acid (HNO_3). Figure 3-3 shows mean annual concentrations of nitrogen compounds at the Pinedale CASTNet site from 1989 through 2004. Nitrogen dioxide data were collected in Green River, Wyoming, from January 2001 to December 2001. Background concentrations of nitrogen dioxide were 3.4% of the applicable WAAQS (Table 3-3).

Table 3-3. Air Pollutant Background Concentrations, NAAQS/WAAQS and Prevention of Significant Deterioration (PSD) Increments (µg/m^3).

Pollutant/Averaging Time	Background Concentration (µg/m^3)	NAAQS and WAAQS (µg/m^3)	Percent of NAAQS and WAQQS	Incremental Increase Above Legal Baseline[a]	
				PSD Class I	PSD Class II
CO					
1-hour	3,336[†] 2,229[††]	40,000	8.3%[†] 5.6%[††]	n/a	n/a
8-hour	1,381[†] 1,148[††]	10,000	13.8%[†] 11.5%[††]	n/a	n/a
NO_2[‡]					
Annual	3.4	100	3.4%	2.5	25
(O_3)[€]					
8-hour	147	157	93.6%		
PM_{10}[i]					
24-hour	48	150	32.0%	8	30
Annual	25	50-WAAQS	50.0%	4	17
$PM_{2.5}$[i]					
24-hour	15	35-NAAQS 65-WAAQS	42.9% 23.1%	n/a	n/a
Annual	7.8	15	52.0%	n/a	n/a
(SO_2)[ii]					
3-hour	29	1,300	2.2%	25	512
24-hour (National)	43	365	11.8%	5	91
24-hour(Wyoming)	18	260	6.9%	5	91
Annual (National)	9	80	11.3%	2	20
Annual (Wyoming)	5	60	8.3%	2	20

n/a = not applicable, PSD = prevention of significant deterioration.

a All NEPA analysis comparisons to the PSD increments are indented to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

† Background data collected by Amoco at Ryckman Creek for an 8-month period during 1978–1979, summarized for the Riley Ridge Project (BLM 1983)

†† Background data collected at Rifle and Mack, Colorado in conjunction with proposed oil shale development during the early 1980's.

‡ Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during the period January–December 2001 (Air Resource Specialists 2002).

€ Background data collected at Green River Basin Visibility Study site, Green River, Wyoming, during the period June 10, 1998, through December 31, 2001 (Air Resource Specialists 2002).

i Background data for PM10 collected by Wyoming Department of Environmental Quality/Air Quality Division (WDEQ/AQD) at Rock Springs, Wyoming, in 2005. PM2.5 based on a 1:3.2 PM2.5:PM10 ratio based on three full years of PM10 data (1997-1999) collected in Rock Springs as part of the Green River Basin Visibility Study. These data have been determined by WDEQ/AQD to be the most representative data available.

ii Background data for Wyoming (3 hour, 24 hour and annual) collected at the Craig Power Plant site and oil shale areas from 1980-1984 (CDPHE 1996).

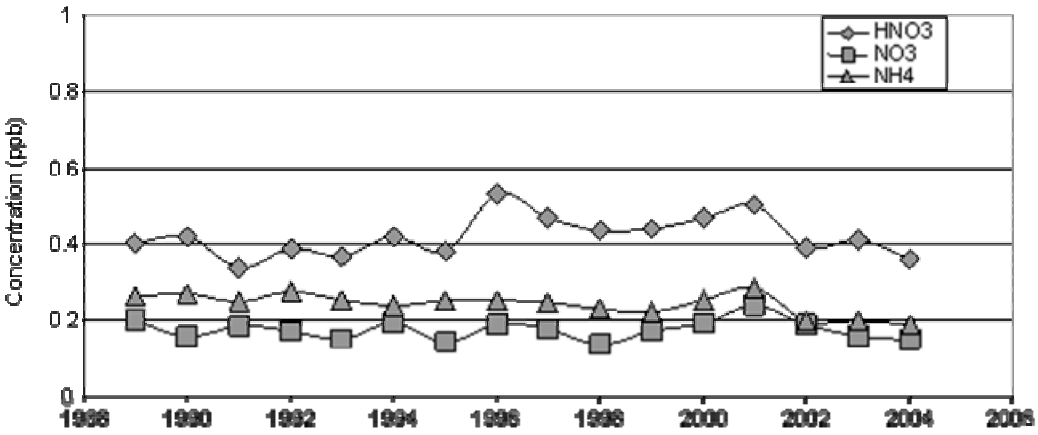


Figure 3-3. Mean Annual Concentrations of Nitrogen Compounds near Pinedale, Wyoming. Concentrations typical in remote areas are: HNO_3 = 0.3 ppb, NO_3 = 0.2 ppb, NH_4 = 0.3 ppb. Data taken from CASTNET Pinedale Station PND165.

Ozone (O_3) is a faint blue gas that is generally not emitted directly into the atmosphere but is formed in the atmosphere from complex photochemical reactions involving NO_2 and volatile reactive organic compounds (VOC). Internal combustion engines are one source of NO_x. However, coal fired power plants often have the highest NO_x emissions although any combustion source will produce NO_x. Sources of VOCs include automotive emissions, paint, varnish, oil and gas operations and some types of vegetation. The faint acrid smell common after thunderstorms is caused by ozone formation by lightning. O_3 is a strong oxidizing chemical that can burn lungs and eyes, and damage plants. Ozone is a severe respiratory irritant at concentrations in excess of the federal standards. EPA is currently in the process of revising the ozone standard as part of its statutory requirements under the CAA.

Ozone data were collected in Green River, Wyoming, from 1998 to 2001 and show background concentrations of ozone to be 93.6% of the applicable WAAQS (Table 3-3). Additional ozone monitoring at the Pinedale CASTNet site shows that concentrations of ozone there are typical of remote areas.

Particulate matter (PM) refers to the small particles (i.e., soil particles, pollen, etc.) suspended in the air that settle to the ground slowly and may be re-suspended if disturbed. Ambient air particulate matter standards are based on the size of the particle. The two types of particulate matter are:

- PM_{10} (particles with diameters less than 10 micrometers): small enough to be inhaled and capable of causing adverse health effects.
- $PM_{2.5}$ (particles with diameters less than 2.5 micrometers): small enough to be drawn deeply into the lungs and cause serious health problems. These particles are also the main cause of visibility impairment.

Background concentrations of PM10 are 32-50% of the applicable WAAQS (Table 3-3). Other regulatory monitoring of particulate matter showed that concentrations were in compliance with applicable WAAQS.

The WDEQ-AQD monitors particulate matter throughout the State of Wyoming with the State and Local Air Monitoring System (SLAMS). Table 3-4 summarizes particulate matter concentrations in Wyoming during 2001. Annual PM_{10} background concentrations for the MAA exceed the statewide average, while MAA $PM_{2.5}$ concentrations fall below the statewide average.

Table 3-4. Wyoming Particulate Summary for 2001 (µg/m3).

Pollutant	Annual Background for MAA	Annual Statewide Average
PM_{10}	33	22
$PM_{2.5}$	5	8

Sulfur dioxide (SO_2) and sulfates (SO_4) form during combustion from trace levels of sulfur in coal or diesel fuel. Sulfur dioxide also participates in chemical reactions and can form sulfates and sulfuric acid in the atmosphere. Background concentrations of sulfur dioxide are 2–12% of the applicable WAAQS (Table 3-3).

Sulfur dioxide concentrations typically range from 1 to 10 ppb (2.6 to 26 µg/m^3) in remote areas, and from 20 to 200 ppb (52 to 520 µg/m^3) in polluted areas (Seinfeld 1986). Average weekly concentrations of sulfur dioxide at the Pinedale CASTNet site are 0.3 ppb (0.8 µg/m^3) and are typical of remote or unpolluted areas.

Mean annual sulfate concentrations are typically 0.6 ppb (2.5 µg/m^3) or less in remote areas, and 2.5 ppb (10 µg/m^3) or more in urban areas (Stern et al. 1973). Mean annual concentrations of sulfate are 0.5 ppb (2 µg/m^3) at the Pinedale CASTNet site and are typical of remote or unpolluted areas.

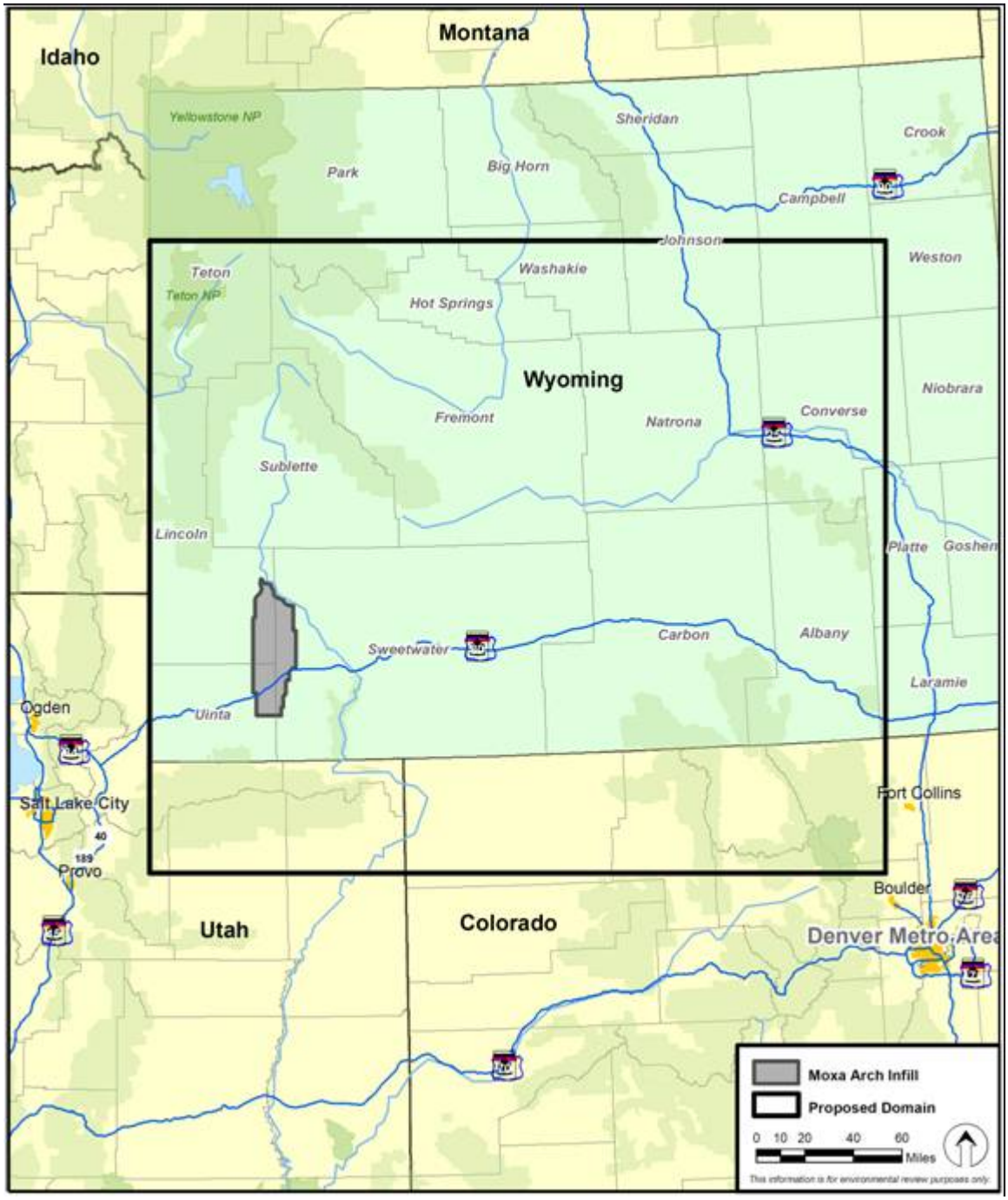
Lead (Pb) is a heavy metal that occurs naturally in ores, but it also occasionally exists in air emissions from industrial processes. Because it is not an anticipated byproduct of the proposed project, lead is not considered in this EIS.

3.1.2.2. Visibility

The 1997 Clean Air Act (CAA) amendments declared "as a National Goal the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas in which impairment results from manmade air pollution." The CAA gives federal managers the affirmative responsibility, but no regulatory authority, to protect air quality-related values, including visibility, from degradation.

PSD increments limit air quality degradation and ensure that areas with clean air continue to meet NAAQS, even during economic development. The PSD program goal is to maintain pristine air quality required to protect public health and welfare from air pollution effects and "to preserve, protect and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic or historic value."

PSD increments have been established for NO_2, SO_2, and PM_{10}. Comparisons of potential PM_{10}, NO_2, and SO_2 concentrations with PSD increments are intended only to evaluate a threshold of concern. The allowable PSD increment depends on an area's classification. Class I areas have lower increments, due to their protected status as pristine areas. PSD Class I and other sensitive areas located within the air quality modeling domain and the distance of each from the MAA are shown on Map 3-1. Federal Class I areas to be evaluated are listed in Table 3-5. Several additional areas are classified as PSD Class II, where lower incremental air quality limits are imposed due to less pristine background air quality. PSD Class II areas are listed in Table 3-6.



Map 3-1. MAA Air Quality Modeling Domain.

Table 3-5. Distances and Direction to Class I Areas.

Class I Area	Distance From MAA (km)	Direction From MAA
Bridger Wilderness Area	95	North
Fitzpatrick Wilderness Area	105	North
Grand Teton National Park	170	North
Mount Zirkel Wilderness Area	261	East
Teton Wilderness Area	120	North
Washakie Wilderness Area	186	North

Table 3-6. Distances and Direction to Class II Sensitive Areas and other areas of concern in southwest Wyoming.

Sensitive Class II Areas	Distance From MAA (km)	Direction From MAA
Bridger Butte	53	
Dinosaur National Monument [a]	125	
Flaming Gorge National Recreation Area	28	East
Fontenelle Reservoir	Adjacent	North
Gros Ventre Wilderness	195	
Popo Agie Wilderness Area	108	Northeast
Seedskadee National Wildlife Refuge	Adjacent	North
Wind River Roadless Area	166	

[a] Class II PSD area with Special Federal Class I Increment Level Protection (SCIP) for SO_2. Annual mean concentration and the 24-hour and 3-hour maximum concentrations cannot exceed established baseline levels by more than 2 ug/m3, 5 ug/m3, and 25 ug/m3, respectively.

A wide variety of pollutants can impact visibility, including particulate matter, nitrogen dioxide, nitrates (compounds containing NO_3), and sulfates (compounds containing SO_4). Fine particles suspended in the atmosphere decrease visibility by blocking, reflecting, or absorbing light.

Two types of visible impairment can be caused by emission sources: plume impairment and regional haze. Plume impairment occurs when a section of the atmosphere becomes visible due to the contrast or color difference between a discrete pollutant plume and a viewed background, such as a landscape feature. Regional haze occurs when pollutants from widespread emission sources become mixed in the atmosphere and travel long distances. (For more information on visibility impairment, please see the *Moxa Arch Drilling Project Air Quality Technical Support Document*, Appendix C).

Visibility is quantified in terms of the deciview (dv), which is defined as a change in visibility that is perceptible to the average human, and in terms of the standard visible range (SVR), which is defined as the distance that an average human can see. Visibility data are calculated for each day, ranked from cleanest to haziest, and reported into three categories:

- 20% cleanest: mean visibility for the 20% of days with the best visibility
- Average: the annual mean visibility
- 20% haziest: mean visibility for the 20% of days with the poorest visibility

Visibility data were collected in the Bridger Wilderness from 1989 to 2003. The mean annual SVR varies from 198–162 miles (or 2–4 dv) on clear days, 133–109 miles (or 6–8 dv) on average days, and 12-10 miles (or 10–12 dv) on hazy days (Figure 3-4).

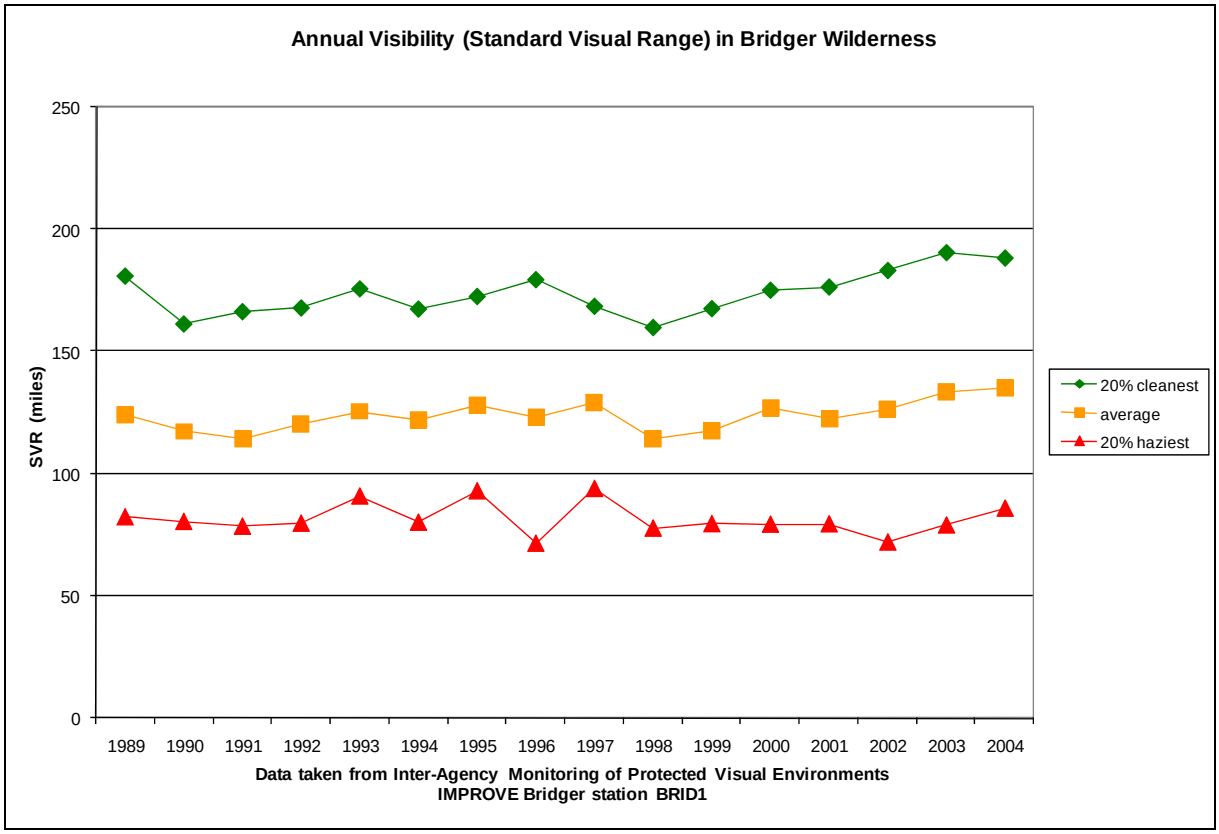


Figure 3-4. Visibility in the Bridger Wilderness.

3.1.2.3. Deposition

Through a process called atmospheric deposition, air pollutants fall out of the atmosphere and are deposited on terrestrial and aquatic ecosystems. These pollutants are deposited via wet deposition (precipitation) and dry deposition (gravitational settling of particles and gaseous pollutants that adhere to soil, water, and vegetation). Substances deposited include:

- Acids, such as sulfuric acid and nitric acid (HNO_3) (sometimes referred to as "acid rain")
- Air toxins, such as pesticides, herbicides, and VOCs
- Nutrients, such as nitrate and ammonium (NH_4^+)

Deposition is reported as the mass of material deposited on an area (kilogram per hectare per year). Total deposition refers to the sum of airborne material transferred to the Earth's surface by both wet and dry deposition.

A brief summary of current atmospheric deposition in the Project Area is included in Table 3-7. These data represent several locations in the CIAA, including Pinedale, Gypsum Creek, and Yellowstone National Park.

The natural acidity of rainwater is represented by pH values ranging from 5.0 to 5.6 (Seinfeld 1986). Precipitation pH values lower than 5.0 are considered acidified and may adversely affect plants and

animals. A voluntary level of concern for a decrease in pH levels in rainwater has been estimated to be 0.1–0.2 (U.S. Department of Agriculture 1989).

Table 3-7. Summary of Current Atmospheric Deposition.

Deposition Component	Description
Precipitation pH	Precipitation pH demonstrates some acidification • Pinedale: 4.8–5.4 • Gypsum Creek: 5.0–5.4 • Yellowstone National Park: 5.2–5.6
Total nitrogen deposition	Total nitrogen deposition is less than levels of concern • Pinedale: 1.0–1.5 kg/ha-year
Total sulfur deposition	Total sulfur deposition is less than levels of concern • Pinedale: 1–2 kg/ha-year

Total deposition voluntary levels of concern have been estimated for several areas (U.S. Department of Agriculture 1989). Estimated total deposition guidelines include the "red line" (defined as the total deposition that the area can tolerate) and the "green line" (defined as the acceptable level of total deposition).

Total nitrogen deposition guidelines for the Bridger Wilderness include the red line (set at 10 kg/ha-year) and the green line (set at 3–5 kg/ha-year). Actual mean annual total nitrogen deposition ranged from below 1.5 kg/ha-year to above 3.5 kg/ha-year (Figure 3-5). Total sulfur depositions guidelines for include the green line (set at 5 kg/ha-year) and the red line (set at 20 kg/ka-year). Mean annual total sulfur deposition ranged from 1 kg/ha-year to nearly 3 kg/ha-year (Figure 3-6). For sulfur, the measured baseline deposition is well below the voluntary levels of concern (green line). For Nitrogen, some deposition levels exceed the lower limits of the green line.

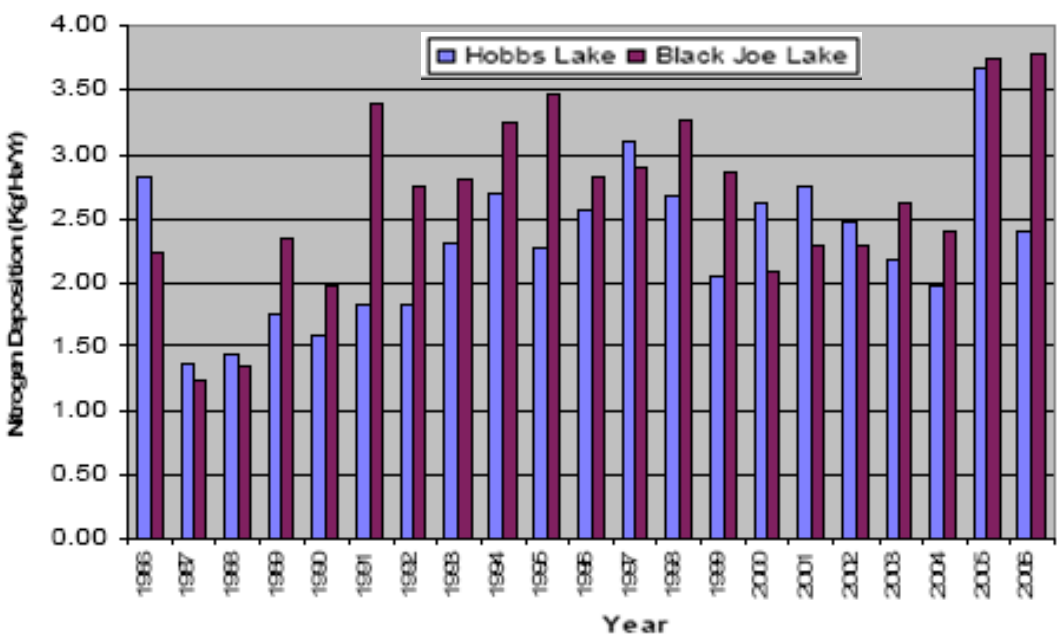


Figure 3-5. Mean Annual Nitrogen Deposition for Hobbs Lake and Black Joe Lake.

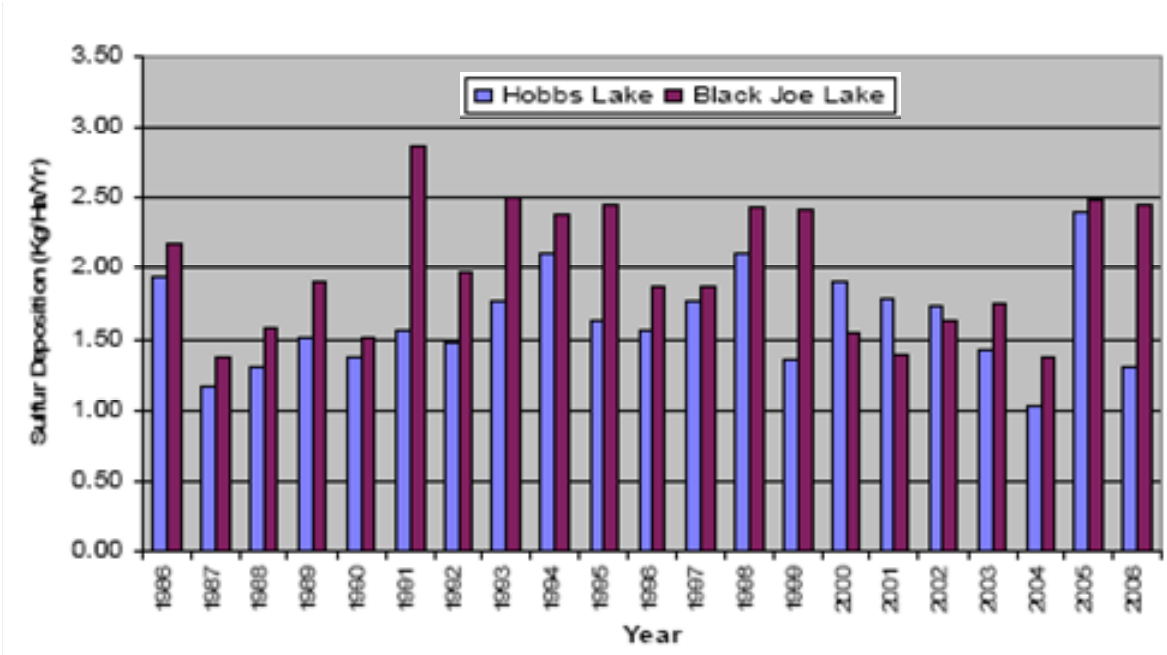


Figure 3-6. Mean Annual Sulfur Deposition for Hobbs Lake and Black Joe Lake.

Atmospheric deposition of nitrogen and sulfur compounds can cause acidification of lakes and streams. One expression of lake acidification is a change in acid neutralizing capacity (ANC), which is a lake's ability to resist acidification from atmospheric deposition. ANC is expressed in units of micro-equivalents per liter (µeq/l). Lakes with ANC values of 25 to 100 µeq/l are considered to be sensitive to atmospheric deposition; lakes with ANC values of 10 to 25 µeq/l are considered to be very sensitive; and lakes with ANC values of less than 10 are considered to be extremely sensitive. Table 3-8 summarizes distances and direction from the MAA to sensitive lakes in the CIAA.

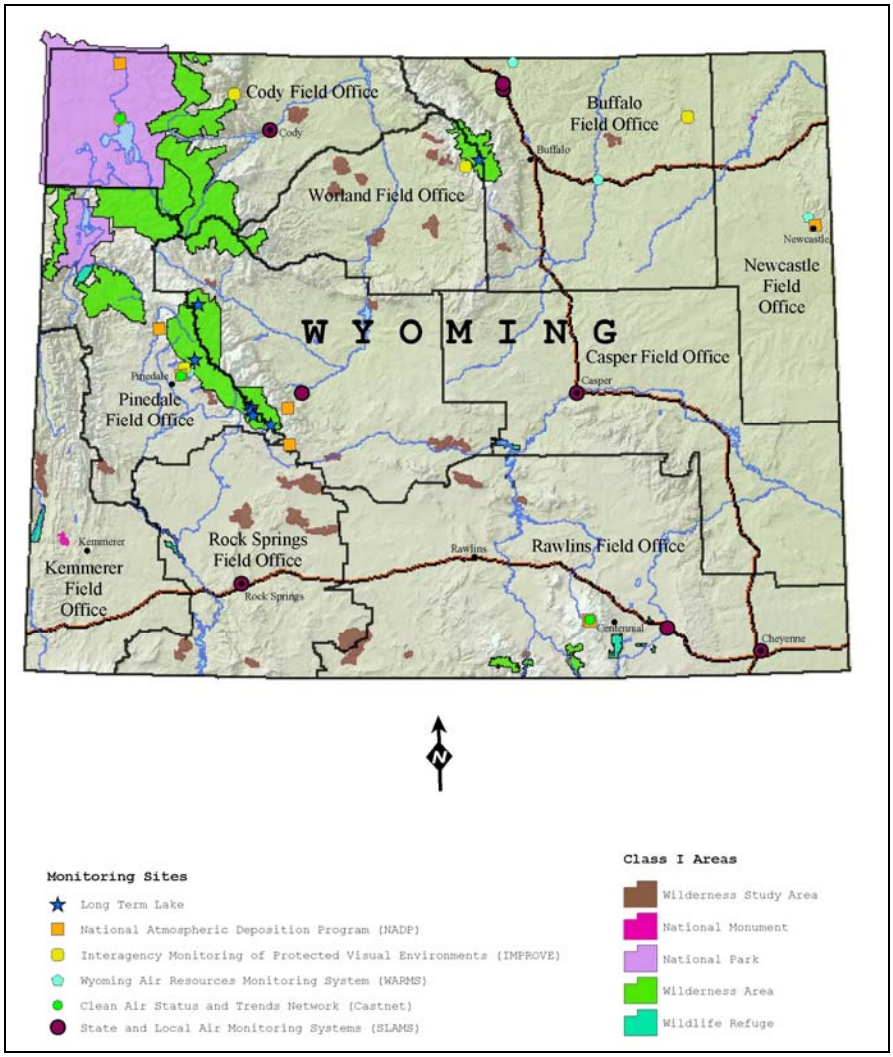
Table 3-8. Distance and Direction to Sensitive Lakes.

Sensitive Lake Receptors	Distance From MAA (km)	Direction from MAA
Black Joe Lake, Bridger Wilderness Area	142	North
Deep Lake, Bridger Wilderness Area	139	North
Hobbs Lake, Bridger Wilderness Area	156	North
Lazy Boy Lake, Bridger Wilderness Area	188	North
Upper Frozen Lake, Bridger Wilderness Area	137	North
Ross Lake, Fitzpatrick Wilderness Area	194	North
Lower Saddlebag Lake, Popo Agie Wilderness Area.	140	North

Site-specific lake water chemistry background data (pH, acid neutralizing capacity - ANC, total bulk deposition of nitrate, sulfate etc.) have been collected by the USFS in several high mountain lakes in the nearby Wilderness Areas. Lakes considered sensitive to acid deposition for which background data were collected are shown on Map 3-2. Deposition data – total nitrogen and sulfur, nitrate and sulfate – from 1986 through 2006 are shown below.

Lake acidification is measured in terms of change in ANC, which is the lake's buffering capacity to resist acidification from atmospheric deposition of acid compounds such as sulfates and nitrates. Measured background ANC data for USFS identified sensitive lakes within the modeling domain are

provided in Table 3-9. The 10th percentile lowest ANC values were calculated for each lake, following procedures provided by the U.S. Forest Service (USFS). The ANC values proposed for use in this analysis, and the number of samples used in the calculation of the 10th percentile lowest ANC values, are provided in Table 3-9.



Map 3-2. Air Quality Monitoring Stations in Wyoming.

Table 3-9. Background Acid Neutralizing Capacity Values for Acid Sensitive Lakes.

Lake	Wilderness Area	10th Percentile Lowest ANC Value (µeq/l)	Number of Samples	Sensitivity
Black Joe	Bridger	67.1	67	Sensitive
Deep	Bridger	59.7	64	Sensitive
Hobbs	Bridger	69.9	71	Sensitive
Lazy Boy	Bridger	10.8	3	Extremely Sensitive
Upper Frozen	Bridger	6.0	8	Extremely Sensitive
Ross	Fitzpatrick	60.4	33	Sensitive
Lower Saddlebag	Popo Agie	54.2	32	Sensitive

The USFS considers lakes with ANC values greater than 25 microequivalents per liter (μeq/l) to be sensitive to atmospheric deposition and lakes with ANC values less than or equal to 25 μeq/l are considered extremely sensitive. Of the lakes for which data is presented in Table 3-9, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive.

The USFS has identified a specific methodology to determine acceptable changes in ANC, which are used to evaluate potential air quality impacts from deposition at acid sensitive lakes. The USFS has established a level of acceptable change (LAC) of no greater than a 1 μeq/l change in ANC (from human causes) for lakes with existing ANC levels less than or equal to 25 μeq/l. A limit of 10 percent change in ANC reduction was adopted for lakes with an ANC greater than 25 μeq/l.

3.2. Geology and Mineral Resources

The MAA is located within the Bridger Basin (Raisz 1963) portion of the Wyoming Basin physiographic province (Fenneman 1931). The greater Green River structural basin comprises the bulk of the Wyoming Basin and occupies much of southwestern Wyoming and portions of northwestern Colorado. The Green River Basin was subdivided during the latter portions of the Laramide Orogeny, in the early Tertiary period, into the present series of separated structural basins by the creation of thrust-induced, regional anticlines (Lillegraven, Snoke, and McKenna 2002).

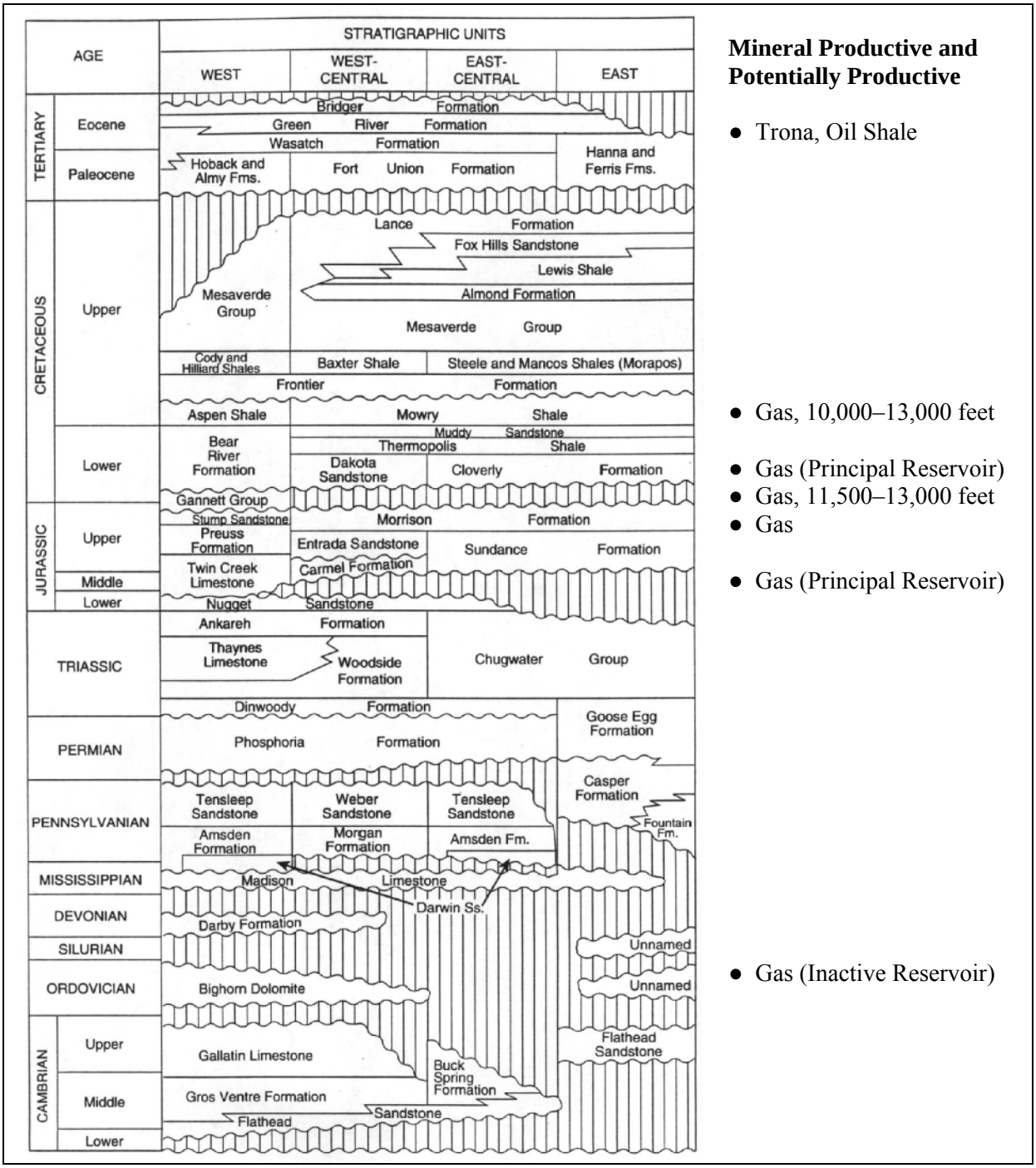
The buried Moxa Arch is situated in the western half of the Bridger topographic basin and does not display the relief exhibited by the natural gas-productive Rock Springs Uplift to the east. The Bridger Basin is bounded to the northeast and south by the basement-cored Wind River Range and Uinta Mountains, respectively. The western border is formed by surface expression of the Cordilleran Overthrust Belt, 12 or more miles west of the MAA. The Arch trends in a slightly arcuate north-south orientation, roughly parallel to the structural grain of the Overthrust Belt.

3.2.1. Surface Geology and Topography

The CIAA for surface geology and topography is the MAA. Topography within the MAA consists of low relief plains, low hills, and occasional buttes and rims. Elevations range from 7,200 feet southeast of I-80 to approximately 6,200 feet where the Blacks Fork River exits the MAA. The MAA is drained by a series of easterly flowing, principally intermittent and ephemeral streams.

Surface geology is composed of outcrops of the Bridger Formation and the Laney Member of the upper Green River Formation, both Eocene in age. Approximately 95% of the MAA is underlain by the Bridger Formation, consisting of mudstones, claystones, siltstones, and sandstones with minor interbeds of marl and limestone and some thin lignites and tuff. The Laney Member consists primarily of shale, siltstone, and marlstone in the MAA (Love and Christiansen 1985; Sullivan 1980). Overlying the bedrock formations are areas of Quaternary alluvium along major drainages, colluvium, wind-blown sand, and terrace gravels (M'Gonigle and Dover 1992; Dover and M'Gonigle 1993). The Eocene rocks form complex inter-fingering relationships between the Green River Formation to the east and the semi-contemporaneous upper Wasatch and lower Bridger Formations to the west. Depositional environments consist of early Eocene fluvial sediments of the main body of the Wasatch Formation, succeeded by lacustrine (Green River) and lake-marginal (lower Bridger) middle Eocene sediments.

A sedimentary section approximately 20,000 feet thick covers the crest of the Moxa Arch (Blackstone 1993). A generalized stratigraphic column for the Green River Basin is indicated in Figure 3-7. A number of rock units in the area, which produce mineral resources, are indicated on the chart.



Mineral Productive and Potentially Productive

- Trona, Oil Shale
- Gas, 10,000–13,000 feet
- Gas (Principal Reservoir)
- Gas, 11,500–13,000 feet
- Gas
- Gas (Principal Reservoir)
- Gas (Inactive Reservoir)

Source: (BLM 2004b)

Figure 3-7. Green River Basin Stratigraphic Chart and MAA Mineral Resources.

3.2.2. Geohazards

The geologic hazard CIAA covers approximately 651,288 acres, and is identical to the mineral resources CIAA (Section 3.2.3) (Map 3-3).

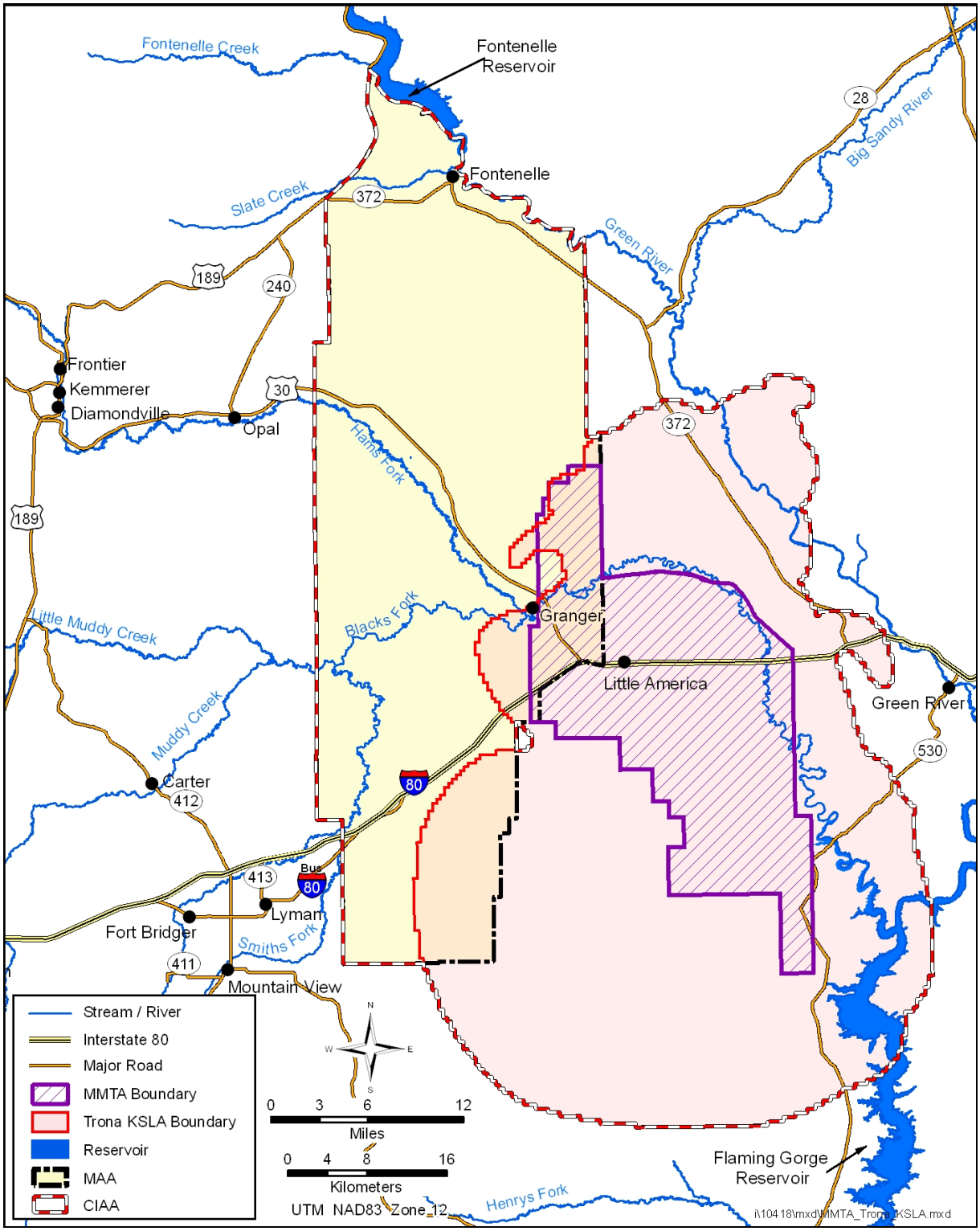
The MAA is considered to be at low risk for geologic hazards. Major landslides have not been mapped in the area. Low slopes are characteristic of most of the MAA, with the exception of the sides of buttes and rims, and are not conducive to large mass wasting events. Potential exists for small landslide areas and slump features on the steeper slopes associated with bluffs along perennial streams. Minor landslide areas have been mapped in the southern extremity of the Project Area along Big Dry Creek and Mud Springs Hollow (BLM 1995a). The area is not prone to liquefaction events (Case 1986a).

The western portion of Wyoming, within roughly 50 miles of the state border, is considered to be a high seismic risk zone capable of generating powerful earthquakes. Although seismic events are rare, faults in this area have exhibited ground motion effects to at least Richter magnitude 7.5 (Intensity "X" on the Modified Mercalli Scale). The earthquake belt is associated with the regional Overthrust Belt and remains an active seismic area. The nearest mapped fault with known or suspected Quaternary activity is the Rock Creek Fault, located more than 25 miles west of the Project Area. The maximum age of the most recent faulting is approximately 4,700 years, based on Carbon 14 dating, with an estimated Richter magnitude of approximately 7.0 (Intensity "IX" on the Modified Mercalli Scale) (Case 1997).

The Project Area, in contrast, is considered a fairly low seismic risk zone due to the low intensity of seismic activity. Three earthquakes have been mapped within the northern, central, and southeastern portions of the Project Area. These events, occurring in 1956, 1982, and 1993, were recorded at Richter magnitudes 4.5, 1.6, and 2.5, respectively (Case et al. 1995). The MAA appears to be an area of low- to very low-frequency earthquake activity and is not located over any identified mined-out areas or areas of known mine subsidence (Case 1986b). Priority 1 or 2 Abandoned Mine Lands that could constitute a geohazard if mine subsidence occurred have not been identified within the Project Area (Office of Surface Mining 2006).

3.2.3. Paleontological Resources

Portions of the MAA are covered by various unconsolidated surficial deposits, which are not known to yield scientifically important fossils in Wyoming (BLM 1995a). Surface bedrock geology is limited to the Bridger Formation, which covers approximately 95% of the area, and the underlying and inter-fingering Green River Formation Laney Member exposed along some drainages north of Township 20 North (M'Gonigle and Dover 1992; Sullivan 1980). The Green River rocks were deposited in a variety of dominantly lacustrine environments in Lake Gosiute, one of three intermontane basin lakes present in the Greater Green River and Uinta Basins from late Paleocene into late Eocene time. Lake Gosiute persisted from early to middle Eocene time and was succeeded and infilled by dominantly lake-marginal and fluvial sediments of the Bridger Formation in the late middle Eocene (Sullivan 1980). Lake Gosiute is interpreted as being a shallow playa lake that fluctuated considerably in size. The Laney Member represents the maximum extent of the lake, prior to its desiccation, and is world famous for the quality of its fossil fish fauna (Grande 1984).



Map 3-3. MAA and Trona Mining Areas. The CIAA for Mineral Resources includes the MAA and the Known Sodium Leasing Area (KSLA).

In the vicinity of the Project Area, the Laney Member consists of an upper Cow Hollow Bed and lower Craven Creek Bed, divided by the Whiskey Butte Member of the Bridger Formation. One of the four Lake Gosiute fossil localities (G-1) documented by Grande (1984) is located immediately northeast of the Project Area on the northeastern shore of Fontenelle Reservoir. The lower Laney Member there contains a diverse fauna of various fish species, insects, mollusks, and ostracods. Birds, salamanders, turtles, and crocodilians are rarely found. Numerous plant fossils include sycamore remains and algal stromatolite mounds not found elsewhere in the Laney Member (Grande 1984; BLM 1995a).

Exposures of the Bridger Formation are limited to the lower portions of the formation, the Bridger A and overlying Bridger B units (M'Gonigle and Dover 1992), which contain widespread ash and limestone marker beds. The "G" marker is conventionally taken as the boundary between the A and B units. These marker beds are present across the Project Area and are locally rich in invertebrate fossils. A diverse fossil fauna has been recovered from numerous localities from both units across the Project Area. Common fossils include various fish and reptilians, particularly large turtles and crocodilians.

More than 130 fossil locations are cited in the 1995 Moxa Arch Area Natural Gas Development Project Draft EIS (BLM 1995a), almost all of which represent finds from the Bridger Formation. Those data are incorporated here by reference. Since publication of the Draft EIS, minimal scientifically significant fossil discoveries in the vicinity of the Project Area have been made (Winterfeld 2006). The BLM currently uses a Probable Fossil Yield Classification (PFYC) system to rate rock units for the potential of yielding scientifically significant fossils and to better focus management attention. The system rating ranges from 1 (lowest probability) to 5 (highest). In the vicinity of the Project Area, both the Green River and Bridger Formations have been assigned level 5 ratings.

3.2.4. Mineral Resources

The mineral resource CIAA covers approximately 651,288 acres in the MAA and the Known Sodium Leasing Area (KSLA) (Map 3-3). Mineral resources within this area are generally as described below for the MAA.

3.2.4.1. Oil and Gas

The Moxa Arch is a prolific producer of natural gas. As of March 2006, the Wyoming Oil and Gas Conservation Commission (WOGCC) (WOGCC 2006) indicated a total of 1,208 productive wells (including wells currently shut in) within the Project Area, almost all of which are gas-productive and mostly located within the Core Area. This number is different than the 1,839 wells used for disturbance calculations in Chapter 2 because many wells that are no longer in production have not met reclamation standards for abandonment and because the wells in the 1,839 count include wells that have been drilled or are approved for drilling since March 2006. Current production is spread among 24 fields within the Project Area. All active production is from the Cretaceous, with approximately 90% of wells completed in the Upper Cretaceous Frontier Formation at depths of 10,000 to 13,000 feet; an additional 17% in the Lower Cretaceous Dakota Formation at depths of 11,500 to 13,000 feet; and approximately 2% scattered among other Cretaceous sandstone units. Since initial production at Church Buttes Field in 1956, the Moxa Arch has produced more than two TCF of natural gas and nearly 16 million barrels of associated liquids (WOGCC 2006). Table 3-10 summarizes cumulative oil and gas production data for the MAA.

From 1989 to 1995, natural gas production from the Moxa Arch rose steeply to an average of nearly 450 million cubic feet per day (MMCFD) before beginning a steady decline. Additional drilling since

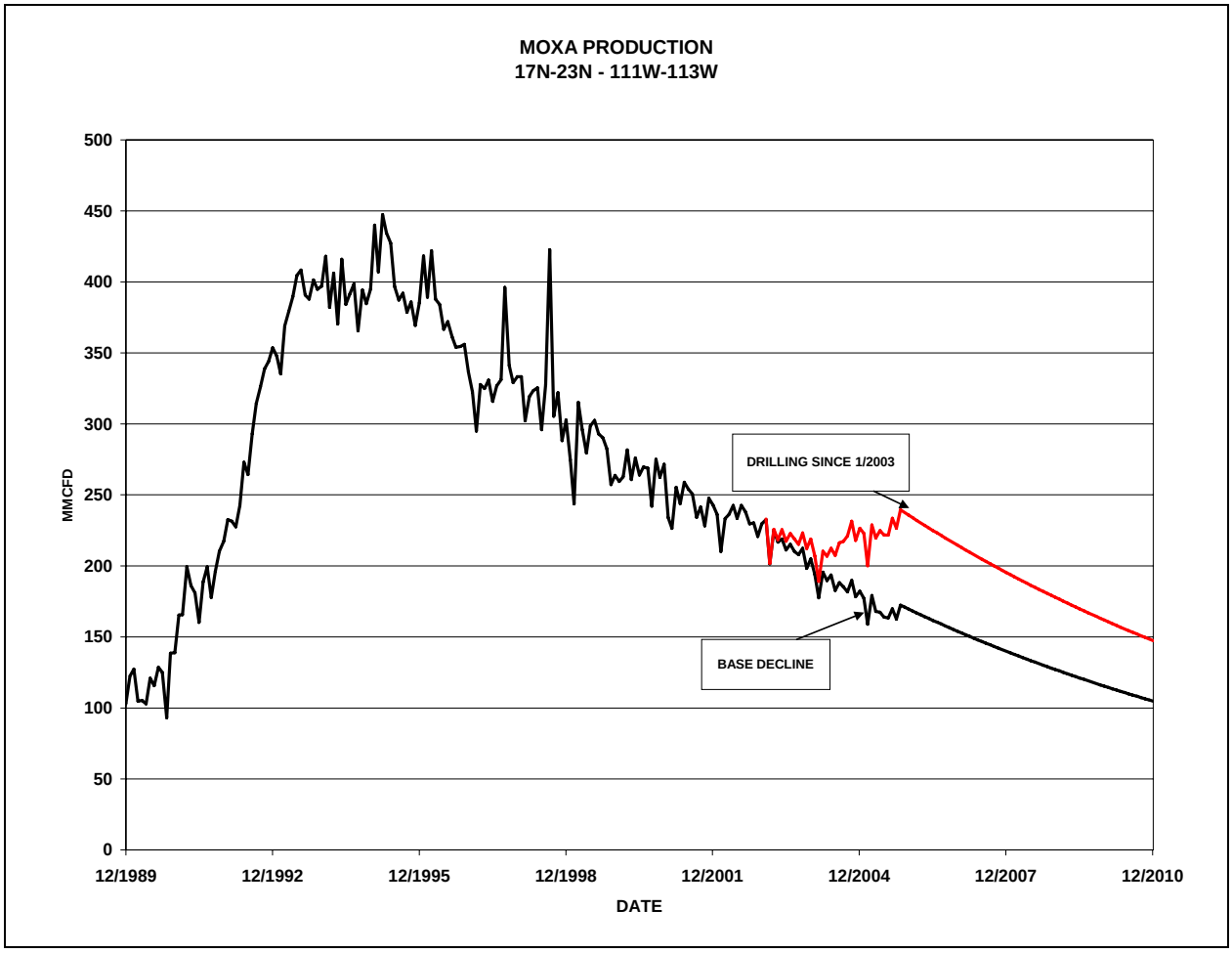
2002 has led to modest production increases (IHS Energy 2006). Figure 3-8 summarizes daily gas production for the MAA.

Table 3-10. Cumulative Oil and Gas Production in the MAA.

Field Name	Discovery	Productive Wells	Oil (Bbls)	Gas (MCF)
Big Dry Creek	1981	2	66,188	921,468
Black Jack	1976	3	98,301	3,263,816
Bruff	1974	380	4,779,519	801,844,228
Church Buttes	1956	139	1,423,799	585,515,010
Cow Creek	1960	1	2,559	19,607,198
Cow Hollow	1986	124	1,669,436	125,319,482
Emigrant Springs	1958	47	880,210	50,984,456
Fabian Ditch	1976	47	776,384	149,446,118
Haven	1994	1	110,110	4,712,264
Legacy	1989	4	279,660	1,065,998
Moxa	1961	3	11,821	8,456,374
Opal	1959	3	44,179	2,794,115
Pipeline Crossing	1977	1	2,044	382,201
Sevenmile Gulch	1976	66	838,587	105,130,156
Shute Creek	1975	59	896,584	58,618,897
Storm Shelter	1975	11	342,714	14,171,398
Sugarloaf Butte	1990	5	489,050	1,698,899
Trumpeter	1991	1	12,532	129,721
Verne	1975	12	188,864	11,594,859
Whiskey Butte	1975	183	1,663,023	192,132,382
Wild Hare Gulch	1977	6	48,757	3,879,742
Wilson Ranch	1973	81	1,240,835	136,587,112
Ziegler's Wash	1989	7	46,234	3,850,892
Unassigned (Wildcat)	N/A	21	N/A	N/A
TOTALS		**1,208**	**15,911,390**	**2,282,106,786**

Source: Production data as of 3/01/2006 from WOGCC (http://wogcc.state.wy.us/)
Bbls = billion barrels
MCF= million cubic feet
N/A = not available

Potential for shallower production (above the Frontier), at least within the Core Area, is considered minimal due to the extensive penetration of these horizons. Potential for future production below the Cretaceous is more problematic. At least eight wells have penetrated a significant portion of the pre-Cretaceous section to depths below 17,500 feet, including at least two wells to the Cambrian section (Blackstone 1993). In 1967 and 1972, Wexpro attempted completions in two wells in the Morgan Formation (Pennsylvanian) at around 18,000 feet. These wells were subsequently abandoned after producing small amounts of oil and gas. Two active disposal wells inject to the Madison Formation (Mississippian) (WOGCC 2006).



Source: (IHS Energy 2006).

Figure 3-8. Average Daily Natural Gas Production, MAA.

3.2.4.2. Trona

The world's largest known trona deposit is located within the Green River Basin in Wyoming and adjoining areas in northern Colorado. Trona is a hydrous sodium carbonate that is refined into soda ash and other useful industrial chemicals. The mineral provides important support for the manufacture of glass, chemicals, soaps and detergents, and pulp and paper (BLM 2004b). Trona is an evaporate mineral which was deposited in the Wilkins Peak Member of the Green River Formation during periods when Eocene Lake Gosiute was evaporating to near disappearance. There are 42 identified trona evaporitic layers identified in what were the deeper portions of Lake Gosiute, 25 of which are thick enough to be commercially mineable. The total mineable resource is estimated at approximately 134 billion tons and represents the most valuable industrial mineral produced in Wyoming (Harris 1993). The trona deposits occur at depths of 400 to 3,500 feet below the surface (BLM 2004b). Five mines and associated plants operate east of the MAA in Sweetwater County with a processing capacity of 1.15 to 2.85 million tons per year (Harris 2004). Wyoming production in 2004 was 18.5 million short tons at an average price of $35.47 per ton (WDAI 2005).

The BLM-designated Known Sodium Leasing Area (KSLA) represents public lands available for leasing for trona mining. A portion of the KSLA overlaps the eastern portion of the MAA. Because of safety concerns associated with oil and gas drilling in an area of active underground mining, the BLM has declared a moratorium on oil and gas leasing and development within a large portion of the KSLA known as the Mechanically Mineable Trona Area (MMTA). A decision regarding the future of

oil and gas development and trona mining within the MMTA is a NEPA action pending completion of the current revision of the Kemmerer RMP (BLM 2006b; Clawson 2006). Map 3-3 portrays the KSLA and MMTA in relation to the MAA.

3.2.4.3. Other Minerals

The development potential for other mineral resources in or adjacent to the Project Area is low to non-existent. The MAA and the entire Bridger Basin are underlain by the Green River Coal Field, which contains coals of Tertiary and Cretaceous ages. However, the coals are buried at depths that make recovery economically infeasible. The nearest surface-mineable coal occurs west of Kemmerer and on the east side of the Rock Springs Uplift, both considerably outside the MAA (BLM 2004b). Similarly, no production of coalbed natural gas (CBNG) has occurred within or near the MAA (WOGCC 2006). BLM considers the MAA to have no potential for CBNG production, except in the northern portion of the area, where the potential is rated "low" (BLM 2004b).

The Laney, Wilkins Peak, and Tipton Shale members of the Green River Formation all contain oil shale layers. Total estimated in-place reserves of oil shale within the Green River Formation in the Green River Basin are 244 billion barrels (BLM 2004b). However, these reserves are buried at depths of 500 feet to several thousands of feet, progressively deepening to the south (WOGCC 2006). While mining appears to be currently infeasible, future in-situ recovery technologies could potentially allow access to this resource.

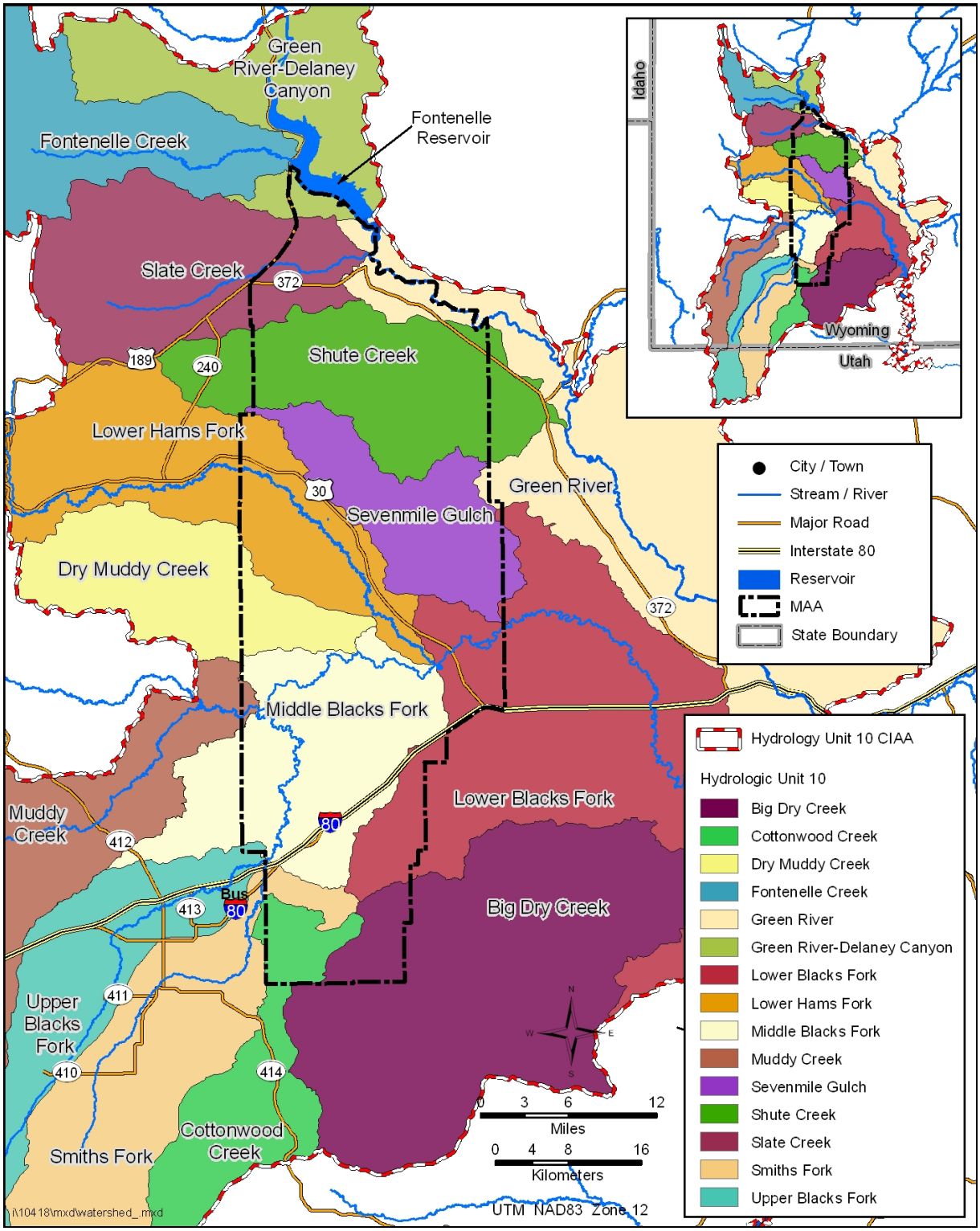
Sulfur is recovered from sour natural gas at Exxon Mobil's Shute Creek plant (BLM 2004b). Alluvial sand and gravel deposits suitable for construction aggregate and associated quarries are located along major perennial streams crossing the Project Area. Windblown sand deposits occur in scattered areas, particularly in the northern part of the MAA south of Fontenelle Reservoir (Harris 2004).

3.3. Soils

The CIAA for soil resources is the combined 15 watersheds that drain the MAA and covers approximately 2,510,900 acres (Map 3-4). Approximately 2.8% (13,149 acres) of the MAA is currently disturbed from various activities. Disturbance resulting from oil and gas field development activities, primarily from well pads, roads, and gathering pipeline is approximately 8,073 acres. Approximately 1.75% of non-sensitive soils in the MAA are currently disturbed from field development activities, and about 1.5% of all sensitive soils are currently disturbed. Conservative estimates of disturbances to soils could be higher than 13,149 acres because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).

Soils within the MAA are developing on mostly smooth and undulating topographic surfaces with inclusions of locally high relief in areas of badlands, tableland breaks, and stream valleys and terraces. Differences in parent material, moisture, elevation, topographic slope, aspect, position, and management, including erosion condition, are the main factors that contribute to differentiation of soils into various types, each composed of a unique set of characteristics.

Existing soils information is compiled in the Soils and Water Resources Technical Report (SWRTR) for the Expanded Moxa Arch Area Natural Gas Development Project (BLM 1995b). More recent soils mapping and information for the MAA is not available (Natural Resources Conservation Service (NRCS) 2005; Roberts 2006). Soils information compiled in the 1995 SWRTR was provided by statewide NRCS (Soil Conservation Service [SCS]) soils reports published in the 1970s and 1980s, as well as unpublished NRCS soils data.



Map 3-4. Watersheds in the MAA and CIAA for Vegetation, Riparian and Wetland, Soil, and Water Resources.

3.3.1. Soil Characteristics

Within the MAA, soils are grouped into three geomorphology-controlled classes based on geologic substrate (BLM 1995b). Aeolian deposits, including sand dunes, occupy areas in both the sedimentary uplands and high stream terraces.

- Residuum and colluvium of sedimentary uplands,
- alluvial deposits of stream floodplains and low terraces, and
- alluvial deposits of alluvial fans, and high stream terraces.

3.3.2. Soil Types

3.3.2.1. Sedimentary Upland Soils

Soils of the sedimentary uplands occupy nearly level to rolling plains over approximately 85% of the MAA. Site-specific slopes range from approximately 0% (flat) to 70% (very steep). These soils are developing in residuum and colluvium derived from siltstones, mudstones, shales, and sandstones of the Bridger Formation and the Laney Member of the Green River Formation. Most soils are moderately deep (40 to 60 inches to underlying rock), well drained, and moderately permeable. Surface textures are mostly medium, and the water table is typically more than 60 inches below the surface. Runoff varies from low to high, increasing with slope and with clay content of surface soil layer (topsoil). Erodibility is generally moderate; erosion potential ranges from slight to severe, increasing with slope, slope length, reduced coarse fragment content, and reduced protective cover. In localized areas within the MAA, reclamation efforts on these upland soils may be limited by elevated soil salinity and alkalinity (sodium) levels. In addition to areas of aeolian sand deposits, this geomorphic soils group supports areas of badland, totaling approximately 33% of this group.

3.3.2.2. Floodplains and Low Terrace Soils

Within the MAA, floodplain soils occur in bottomlands adjacent to major drainages, including the Hams Fork, Blacks Fork, and Smiths Fork Rivers, and Cottonwood Creek, Muddy Creek, and Little Muddy Creek. The majority of slopes range from 0 to 6%, with isolated slopes approaching 15%. These bottomlands comprise approximately 10% of the MAA. The alluvial soils are developing in water-transported materials/sediments eroded from upland soils and weathered shales and sandstones. Surface textures are medium, and the water table ranges from 30 to 60 inches below the surface. Soils are deep (greater than 60 inches to rock), poorly drained, and moderately permeable. Runoff potential is moderately high to high. Erodibility is moderate; erosion potential is slight to moderate based on the minimal gradient slopes of the drainage bottoms and the shortness of most sideslopes of shallow valleys in the MAA. Areas of elevated salinity and sodium, which may limit reclamation, are present in these soils.

3.3.2.3. Alluvial and High Terrace Soils

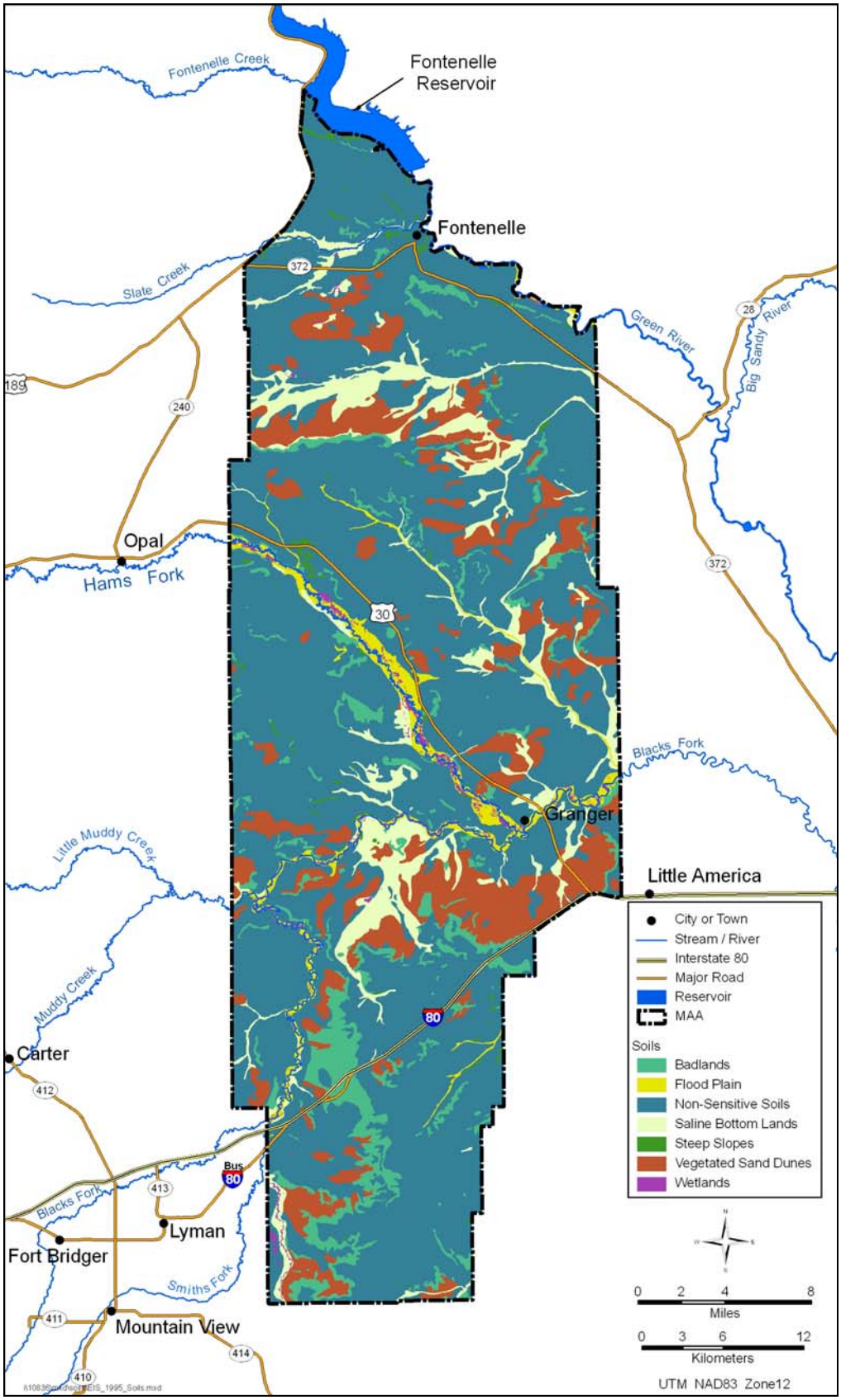
Alluvial fan and terrace soils occupy the remaining approximately 5% of the MAA. These soils are developing in alluvial deposits of similar origin at the mouths of ephemeral side drainages, and as terraces composed of coarser materials higher up in the drainages. Slopes range from 0 to 30%; areas of steep slope are limited. These fan and high terrace soils are mostly deep, well drained, moderately to rapidly permeable, gravelly to stony, sandy loams to loams, and can have a cobbly (rock covered) surface. Runoff potential ranges from low to moderately high with increasing slope. Erodibility is low to moderate; erosion potential is slight to high, with higher potentials associated with steeper

slopes and lower coarse fragment content. These soils typically do not pose limitations on reclamation success; however, excessive coarse fragment content may make them droughty.

From these three principal groups of soils, seven specific types of soils that may pose limitations on implementing oil and gas development (BLM 1995b), and a single, more variable group of soils that would not generally pose limitations on development (Map 3-5). Table 3-11 (BLM 1995a) lists those types of soils that pose limitations or are considered "sensitive" with regard to proposed additional development in the MAA.

Table 3-11. Areas of Sensitive and Non-Sensitive Soils Within the MAA.

Category	Nature of Sensitivity	Approximate Area (acres)	Percent of Total Area	Reclamation Potential
Non-sensitive soils	N/A	327,100	69	Fair to good, some areas of poor to fair
Sensitive Soils				
Sand dune soils	Very high erosion, non-cohesive texture	61,300	13	Limited
Steep slopes	High erosion, slope instability, high coarse fragment content	2,200	0.4	Poor
Badland soils	Heavy texture, high erosion, slope instability, high visibility, high sodium	31,200	6.5	Poor
Saline/sodic bottomland soils	Heavy texture, instability, high water table, high erosion, poor bearing strengths	37,000	7.8	Poor
Wetland soils	Heavy texture, high moisture content, high water table, low bearing strengths, frequent flooding, and/or inundation, association with surface water	4,700	1.0	Fair to excellent
Floodplain soils	Frequent flooding and/or inundation, high water table, association with surface water	12,300	2.6	Fair to good
Total Sensitive		**148,700**	**31**	
Total Non-Sensitive		**327,100**	**69**	
Total		**475,800**	**100**	



Map 3-5. Sensitive Soil Types in the MAA (BLM 1995a).

3.3.3. Sensitive Soils

Soils posing limitations to oil and gas development are those that are sensitive to disturbance and/or may pose difficulties to revegetation and reclamation efforts. The nature of sensitivity, aerial extent, and anticipated reclamation potential for each of the seven sensitive soil categories/units are presented in Table 3-11 (BLM 1995a). Sensitive soils occupy approximately 148,700 acres (31%) of the MAA (Map 3-5). The majority of existing disturbance from oil and gas field development in sensitive soil types occurs in saline bottom lands and vegetated sand dunes. Soils designated as "sensitive" are those having physical and/or chemical characteristics that could inhibit or limit successful stabilization and revegetation in the reclamation of sites disturbed by construction and the operation of oil and gas facilities, including roads, well pads, pipelines, and ancillary facilities.

Specific characteristics that limit the reclamation and revegetation potential of the seven sensitive soil types in the MAA are:

- high potential for accelerated erosion, including dune soils,
- shallow soils with limited available plant growth media,
- steep topography – combination of accelerated erosion potential and shallow soils,
- soils with limited water-holding capacity and nutrient adsorptive capacity,
- heavy textured, clayey soils that are poorly drained and have slow infiltration and permeability rates, and
- high potentials for excessive compaction, and/or high levels of soil salinity and/or levels of adsorbed sodium.

Non-sensitive soils, which occupy approximately 327,100 acres (69%) of the MAA, generally would not pose limitations to reclamation efforts (Table 3-11) (Map 3-5). However, due to limited depth of topsoil and droughty nature of some non-sensitive soils in the MAA, these soils would require the application of appropriate reclamation measures to ensure successful stabilization and revegetation of disturbed locations.

3.4. Water Resources

The major water bodies and alluvial aquifers within the MAA and vicinity provide a variety of sources for surface water and groundwater. Water resource uses in the MAA include municipal/domestic, public/industrial, and agricultural/irrigation.

3.4.1. Surface Water

The CIAA for surface water resources is the combined area of the 15 5th order watersheds that drain the MAA, as well as Fontenelle Reservoir and Green River south to the Flaming Gorge Dam, including Flaming Gorge Reservoir. This CIAA covers a total of 2.5 million acres (Table 3-12, Map 3-4).

Surface water resources in the MAA include rivers, streams, livestock ponds, small detention reservoirs, playas, seeps, and springs. Developed wells provide drinking water for livestock. Many of these same wells, along with wells drilled for oil and gas development, support small perennial and ephemeral impoundments.

The MAA lies within the Green River Basin, the northernmost part of the Colorado River Basin. The Green River Basin consists of lands in Wyoming, Colorado, and Utah that drain to the Green River, the largest tributary of the Colorado River (State West Water Resource Corporation 2001). Major water bodies within the basin include Fontenelle Reservoir bordering the north side of the MAA, and Flaming Gorge Reservoir to the southeast. The Hams Fork and Blacks Fork Rivers, major tributaries

of the Green River, drain through the MAA. Peak flows usually occur in May and June as snowmelt water moves through the basin. Summer thunderstorms can add to summer and autumn base flows.

Table 3-12. Watershed Acreages in the MAA.

4th Order Watershed/ 5th Order Watershed	**Total Acreage**	**Acres within MAA**	**Percent of Watershed in MAA**
UPPER GREEN			
Fontenelle Creek	146,387	97	0.07%
Green River-Delaney Canyon	109,271	4,753	4.35%
UPPER GREEN-SLATE CREEK			
Slate Creek	129,185	23,044	17.84%
Shute Creek	119,124	86,265	72.42%
Green River	256,200	16,331	6.37%
BLACKS FORK			
Sevenmile Gulch	73,358	69,952	95.36%
Lower Hams Fork River	158,504	59,025	37.24%
Dry Muddy Creek	93,865	20,771	22.13%
Lower Blacks Fork River	291,407	46,385	15.92%
Middle Blacks Fork River	130,844	105,604	80.71%
Upper Blacks Fork River	207,497	575	0.28%
Smiths Fork River	210,483	8,601	4.09%
Cottonwood Creek	83,714	16,074	19.20%
Big Dry Creek	265,848	16,853	6.34%
MUDDY CREEK			
Muddy Creek	235,213	1,478	0.63%
TOTAL	**2,510,900**	**475,808**	

Portions of the Upper Green River, Upper Green River-Slate Creek, Blacks Fork River, and Muddy Creek 4th order watersheds overlap the MAA. Most of the Project Area is within the Blacks Fork watershed. In Table 3-12, these major watersheds are further broken down into 5th order watersheds, or hydrologic units, to show specific areas of the watersheds that fall within the MAA boundary. Watershed boundaries are shown on Map 3-4.

Currently, the most impacted watershed from existing disturbance related to oil and gas field development is the Sevenmile Gulch watershed (about 2.5% disturbed). About 2% of Middle Blacks Fork and Lower Hams Fork are currently disturbed. Existing disturbance also impacts about 1.7% of the Slate Creek watershed, 1.6% of the Shute Creek watershed, 1.4% of the Dry Muddy Creek watershed, 1.3% of the Green River watershed, and about 1% of the Lower Blacks Fork watershed. The remainder of the existing disturbance impacts less than 1% of each of the remaining seven watersheds that overlap the MAA. Conservative estimates of disturbances to watersheds could be higher than percentages above because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).

Average annual precipitation in the MAA is low, producing an average of less than 1 inch of runoff per year (Lowham et al. 1985; State West Water Resource Corporation 2001). However, isolated runoff events such as summer thunderstorms can produce localized high-energy flows that far exceed this level. Numerous stream channels occur in the area, but most are intermittent or ephemeral. Based on a stream channel analysis conducted in 1995 (BLM 1995b), streams in the MAA are sensitive to disturbance and to increases in surface runoff or tributary inflow and sediment. The streams have a

moderate to high sediment supply, and stream bank erosion potential is high to very high (ECOTONE Environmental Consulting 1995). Table 3-13 lists major named water bodies in the MAA, their hydrologic regime, and WDEQ flow class.

Table 3-13. Surface Water Bodies, Hydrologic Regimes, and WDEQ Classes within the MAA.

Water Body	Hydrologic Regime	WDEQ Class
Streams		
Big Muddy Creek	P	2
Blacks Fork River	P	2
Blumel Draw	E	3
Buff Draw	E	3
Butcher Knife Draw	E	4
Caterpillar Draw	E-I	3
Chicken Draw	E	4
Cottonwood Creek	I	3
Cow Hollow Creek	E	4
Dry Creek	E	4
Dry Muddy Creek	E-I	4
Dry Wash	E	4
Grassy Hollow	E	3
Green River	P	2
Hams Fork River	P	2
Hank Hollow	E	3
Jackknife Draw	E	3
Meadow Springs Wash	I	4
Mud Spring Hollow	E	3
Porter Hollow	E	3
Sevenmile Gulch	E-I	4
Shute Creek	E-I	4
Slate Creek	I-P	2
Smiths Fork River	P	2
South Fork Shute Creek	E-I	4
Telephone Draw	E	4
Tin Can Draw	E	4
West Otterson Wash	E	4
Yellow Point Fork	E	4
Zieglers Wash	E	4
Other Water Bodies		
Fontenelle Reservoir	P	2
Shute Creek Lake	E	-
Butcher Knife Spring	I	-
Carter Spring	I	-
Meadow Spring	I	-
Shurtliff Spring	I	-

Sources: (Lowham et al. 1985; BLM 1995b)
E = Ephemeral, I = Intermittent, P = Perennial; Class 1 = Highest natural quality and value, Class 2 = Support game fish, Class 3 = Support non-game fish only, Class 4 = Do not have the natural water quality to support fish

3.4.1.1. Surface Water Uses

Surface water uses within the MAA include municipal/domestic, agricultural/irrigation, and industrial. Irrigated agricultural production is the largest water user in the Green River Basin. Approximately 6,200 acres of irrigated agricultural lands occur within the MAA, diverting approximately 24,800 acre-feet of water per year from perennial streams (BLM 1995b).

In the oil and gas extraction industry, water used for well drilling, completion, and testing purposes is obtained from the Blacks Fork, Hams Fork, and Green Rivers as a result of approved water appropriation permits obtained from the State of Wyoming (State Engineer's Office) and from commercial or privately owned water source wells. Water may be recycled for use in drilling, completion, workover, well abandonment, and hydrostatic pipeline testing operations.

A maximum of 18,000 barrels (roughly 1.8 acre-feet) of water are required for drilling, completion, and hydrostatic testing of gathering lines for each new well. Approximately 10,000 barrels (1 acre-foot) of water are needed to perform drilling operations for each well; however, if permitted by the State of Wyoming and BLM, the reuse of some or most of the drilling fluids in subsequent drilling operations may conserve some water. Approximately 2,500 barrels (0.25 acre-foot) of water are needed to perform completion and testing operations on each well drilled to the Dakota Formation and 2,500 to 5,000 barrels are needed for wells to the Frontier Formation.

Surface water is also used for hydrostatic testing of newly constructed gathering pipelines. Drilling water is sometimes used for hydrostatic testing. Approximately 2,700 gallons of water is required to test 1 mile of 4-inch pipeline. Hydrostatic test water that is not used in drilling operations is disposed of as approved by the BLM and/or the state.

3.4.1.2. Surface Water Quality

WDEQ categorizes water bodies into four major classes for surface water quality (WDEQ 2001b). Class 1 waters are those in which no further water quality degradation by point source discharges will be allowed. Considerations employed during the designation of these waters include quality, aesthetic, scenic, recreation, and other values of present and future benefit to people. Class 2 waters are those other than Class 1 that support game fish or have the potential to support game fish, including nurseries and food sources. Class 3 waters support, or have potential to support, non-game fish only. Class 4 waters do not have the hydrological or water quality potential to support fish. Many of the major water bodies in the MAA are Class 2AB waters (support game fisheries and are also protected for drinking water, non-game fisheries, and other uses) (Tables 3-13 and 3-14).

Table 3-14. WDEQ 2004 303(d) List of Water Bodies in the MAA.

Water Body	Class	Location	Impairment
Blacks Fork/Green Rivers	2AB	From confluence with Hams Fork River upstream to above Smiths Fork River	Fecal coliform
Hams Fork/Green Rivers	2AB	Diamondville	pH > 9
Smiths Fork/Green Rivers	2AB	From confluence with Blacks Fork past Cottonwood Creek	Habitat degradation
Smiths Fork/Green Rivers	2AB	From confluence with Blacks Fork to undetermined distance upstream	Fecal coliform
East Fork Smiths Fork River	2AB	From confluence with West Fork upstream to Utah state line	Habitat degradation
West Fork Smiths Fork River	2AB	From confluence with East Fork upstream to Utah state line	Habitat degradation

Source: (WDEQ 2004)

WDEQ identifies waters that are not supporting their designated uses and/or need to have a total maximum daily load (TMDL) established in order to meet their uses. The WDEQ 2004 303(d) List of Waters Requiring TMDLs identifies locations along the Blacks Fork, Hams Fork, and Smiths Fork Rivers as water bodies with water quality impairments. In addition, segments of the Smiths Fork River are listed as water bodies with water quality threats. Since 2002, segments of the Blacks Fork, Hams Fork, and Smiths Fork Rivers and Muddy Creek were delisted for ammonia, fecal coliform, and chlorine threats (Table 3-14).

The WGFD (Tyrrel 2001) classifies streams under five designations. Most of the streams within the MAA are designated as Class 5 streams (low production trout waters, incapable of supporting fisheries). The lower Blacks Fork River, lower Cottonwood Creek, and portions of the Smiths Fork River are Class 4 streams (low production trout waters, fisheries of local importance but incapable of sustaining fishing pressure). Portions of the Blacks Fork and Smiths Fork Rivers and Cottonwood Creek are Class 3 streams (important trout waters, fisheries of regional importance). The Green River between Fontenelle Reservoir and Flaming Gorge Reservoir is a Class 2 stream (very good trout waters, fisheries of statewide importance).

The Colorado River Basin Salinity Control Forum was created in 1973 to address the issue of increasing salinity in the lower reaches of the Colorado River. It has developed measures to monitor and reduce salt loading to comply with Section 303 of the Clean Water Act. Without this program, it is projected that Colorado River salinity would gradually limit use of the river. Irrigation is the leading cause of increased salinity from human use in the basin. As part of the Forum, BLM developed a program to reduce the contribution of salts to the Colorado River from BLM-administered public lands. Salt reduction is achieved by controlling both point and non-point sources of salt contributions. In Wyoming, the WDEQ administers the National Pollutant Discharge Elimination System (NPDES) permitting program within the Colorado River Basin. All permits for industrial and municipal discharges are written in conformance with the associated Forum policies. Currently, waters in the Wyoming portion of the Colorado River Basin are good to very good. No waters are currently listed for salinity-related impacts (Colorado River Basin Salinity Control Forum 2005).

3.4.2. Groundwater

The groundwater CIAA is the MAA and adjacent potential drawdown areas. Groundwater available in the Green River Basin occurs in (1) unconsolidated floodplain and terrace deposits; (2) conglomerates and sandstones of the Bridger Formation; (3) the Laney Member of the Green River Formation; and (4) sandstones, limestones, mudstones, and shales of Mesozoic and Paleozoic age (BLM 1979, 1995b). The majority of the groundwater supplies are developed from Quaternary and Tertiary aquifers. In the MAA, most groundwater is obtained from shallow alluvial aquifers and from the Tertiary Wasatch Formation (BLM 1995b). Aquifer recharge occurs from the Overthrust Belt to the west and, to a limited extent, from the Hams Fork and Green Rivers.

3.4.2.1. Groundwater Use, Including Drinking Water

In the Green River Basin in the vicinity of the MAA, groundwater is currently used for domestic drinking water supply, public supply, industrial uses, and irrigation. Drinking water supplies and industry are the two primary uses of groundwater in the basin. Industries in the area that obtain their primary water supply from groundwater are coal mining, uranium mining, and oil and gas production (State West Water Resource Corporation 2001).

Produced water from oil and gas wells is often confined to a storage tank prior to transport by water hauling trucks to disposal facilities. It is typically disposed of via subsurface injection or surface evaporative pits, or it may be used in subsequent drilling operations. Disposal facilities, including injection wells, currently occur in the MAA.

3.4.2.2. Groundwater Quality

Wyoming has identified standards for classifying groundwater quality. Class I groundwater is defined as water suitable for domestic use. Class II groundwater is defined as water suitable for agricultural use where soil conditions and other factors are favorable. Class III groundwater is defined as water suitable for livestock. Class IV groundwater is defined as water suitable for industry. Water quality standards for total dissolved solids (TDS), chloride, and iron are listed for each class in Table 3-15. Quality standards for Class IV water vary by the type of industrial use. Much of the groundwater in the Green River Basin area is above 1,000 mg/l TDS (Lowham et al. 1985) and would meet standards for agriculture and livestock purposes.

Table 3-15. WDEQ Ground Water Quality Standards.

WDEQ Class	Use	TDS (mg/l)	Chloride (mg/l)	Iron (mg/l)
Class I	Domestic	500	250	0.3
Class II	Agriculture	2,000	100	5.0
Class III	Livestock	5,000	2,000	--
Class IV	Industrial	--	--	--

Source: (WDEQ 2005)
mg/l = milligrams per liter
TDS = total dissolved solids

3.5. Noise

Noise in the MAA is primarily associated with existing natural gas development construction and operations. Other noise sources include vehicle traffic along I-80, US 30, US 189, and local roads; railroads; occasional aircraft; wind; thunderstorms; livestock; and wildlife. Noise levels depend on many factors, including distance from the source, wind conditions, and terrain. The EPA has established a 55 A-weighted decibels (dBA) standard for acceptable environmental noise. Noise levels greater than 55 dBA may disturb local residents and recreators and could displace area wildlife. The degree of disturbance depends on the receptor's distance from the noise source, noise intensity, noise duration, and the sensitivity of the receptor. Negative environmental effects are not expected for noise averaging 55 dBA over 24 hours. Examples of commonly heard sounds and noise levels are listed in Table 3-16.

Table 3-16. Noise Levels of Commonly Heard Sounds.

Sound	dBA	Description
Normal breathing	10	Barely audible
Rustling leaves	20	
Soft whisper (at 16 feet)	30	Very quiet
Library	40	
Quiet office	50	Quiet
Normal conversation (at 3 feet)	60	
Busy traffic	70	Moderately noisy
Noisy office, factory	80	
Heavy truck (at 49 feet)	90	Loud

Sources: (Tipler 1991; BLM 2005)

Noise from construction and production operations in the MAA sometimes may exceed 55 dBA (Table 3-17). Typically, these noise levels decline below the 55-dBA level of significance at 3,500 feet from the source (BLM 1991, 1995a). Noise levels measured during natural gas construction, similar to those that would potentially occur within the MAA, range from 70 to 90 dBA within 50 feet

of the activity (BLM 2006a). Noise levels at the Luman and Falcon compressor stations, north of the MAA, measured between 69 and 86 dBA at the source and 58 and 75 dBA (depending on the direction) 1 mile from the source. Flaring is the loudest noise resulting from operations; however, using flowback separators reduces flaring noise levels (BLM 1999a, 2006a).

Table 3-17. Noise Levels Typical of Gas Field Operations.

Operation	Distance	dBA
Flaring	On-site	97.9
Flaring	0.1 mile	66.3
Flaring with Flowback Separator	On-site	63.7
Drilling Rig	On-site	77.5
Drilling Rig	0.25 mile	50.1
Compressor Station	On-site	63.8
Compressor Station	0.25 mile	39.5
Natural Gas Production Site	On-site	47.5
Interstate-80	On-site	72.2
Interstate-80	0.25 mile	48.4

Sources: (BLM 2005).

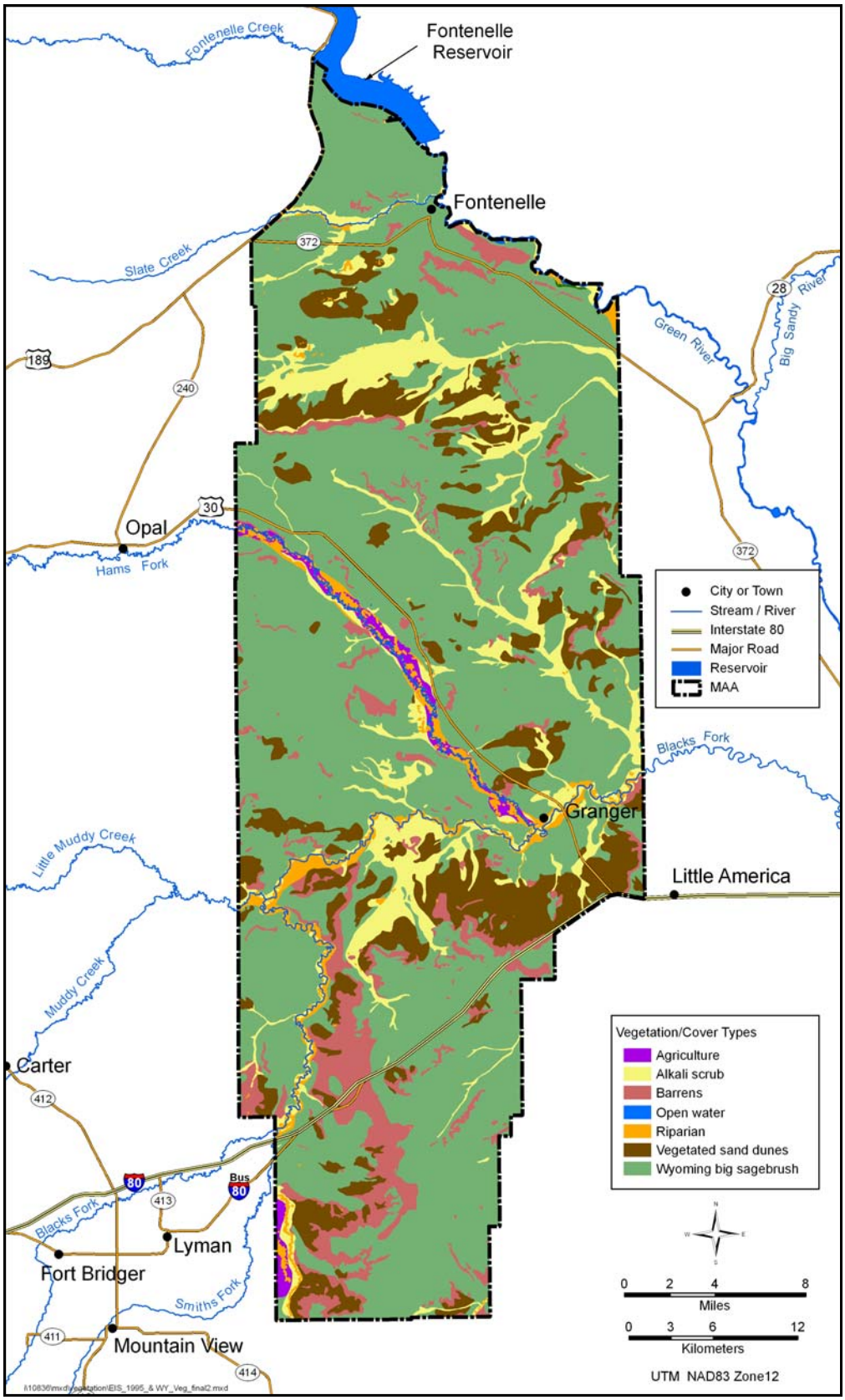
Noise-sensitive areas in the MAA include residences, leks and nests, raptor nests, and big game crucial winter ranges. There are few residences in the area, and most are sufficiently distant from noise sources. Studies have indicated that noise disturbances within 200 meters may affect sage-grouse lek attendance (Connelly et al. 2004; Wyoming Sage-grouse Working Group (WSGWG) 2003; WSGWG 2003). Continuous anthropogenic noise may disrupt auditory displays between March 1 and May 15 if it occurs near an occupied sage-grouse lek (WGFD 2004). Noise from continuous or frequent traffic can disturb leks within two miles of roads and may reduce the number of active leks as far as four to five miles from the source (Connelly et al. 2004).

3.6. Vegetation and Wetlands

The CIAA for vegetation resources is made up of the 15 5th order watersheds that drain the MAA, which encompasses 2,510,900 acres (Map 3-4). Disturbances to sagebrush and other vegetation cover types could be higher than reported in the following sections because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).

3.6.1. Plant Communities

The MAA is located in the Northern and Central Intermountain Desertic Basin vegetation ecoregion (Thornburg 1982). Vegetation was mapped for the MAA using satellite imagery and other records according to the National Vegetation Classification System (Gap Analysis Program [GAP]), which identifies mapped polygons at the plant community level (PIC Technologies 1996). Seven distinct cover types are dominant within the MAA (Map 3-6, Table 3-18). The following descriptions were obtained from the previous Moxa Arch EIS Vegetation and Wetlands Technical Report (BLM 1995d).



Map 3-6. Vegetation Cover Types in the MAA.

Table 3-18. Primary Vegetation Communities in the MAA and CIAA (PIC Technologies 1996).

Vegetation Cover Type	Approx. Total Area (acres) in MAA	Approx. Percentage of MAA
Wyoming Big Sagebrush	312,400	66%
Vegetated Sand Dunes	61,300	13%
Alkali Scrub	48,100	10%
Barrens/Exposed Rock and Soil	39,100	8%
Riparian/Wetlands	8,700	2%
Agriculture/Cropland	5,900	1%
Approximate Total	**475,500**	**99.9%***

* 0.1% of the MAA is inundated by open water and does not contribute to total vegetation calculations.

3.6.1.1. Wyoming Big Sagebrush

The primary vegetative community type in the MAA and CIAA is Wyoming big sagebrush. Currently, about 2% (6,200 acres) of this community is impacted by disturbance from oil and gas field development activities in the MAA. This community includes numerous complexes, the most dominant being Wyoming big sagebrush (*Artemisia tridentata*) and mixed-grass prairie. Communities change with elevation, soil depth, slope, and precipitation. On average, this community is 40 to 70% shrubs, 30 to 60% grasses, and 10% forbs. Overall cover ranges from 6 to 40%, depending on moisture.

Approximately 66%, or 312,400 acres, of the MAA is dominated by Wyoming big sagebrush (Table 3-18), which occurs in low precipitation areas at elevations below 7,500 feet. Sagebrush, rabbitbrush (*Chrysothamnus* spp.), four-winged saltbush (*Atriplex canescens*), and broom snakeweed (*Gutierrezia sarothrae*) are the dominant vegetative species in this community. Within the community, areas of rolling hills and windswept ridges are predominantly grass covered. Wheatgrasses (*Pascopyrum smithii* and *Elymus lanceolatus*) are the primary species, but other grasses and forbs are present, as well as occasional shrubs, including sagebrush and Gardner saltbush (*Atriplex gardneri)*. Composition is typically 40 to 80% grasses in these areas.

3.6.1.2. Vegetated Sand Dunes

GAP vegetation data indicate that the MAA contains approximately 61,300 acres of stabilized, vegetated sand dunes forming a complex mosaic with associations of mixed desert shrub and alkali scrub (PIC Technologies 1996). Wyoming big sagebrush is dominant, and rabbitbrush commonly occurs, as well as alkali scrub species such as greasewood and Gardner saltbush. Currently, about 2% of this community is disturbed from existing oil and gas development activities in the MAA.

3.6.1.3. Alkali Scrub

Alkali scrub communities encompass approximately 48,100 acres of the MAA. Currently, about 2% of this community is disturbed from existing oil and gas development activities in the MAA. Vegetation in these communities consists primarily of shrub species (70 to 90%) including greasewood, horsebrush (*Tetradymia* spp.), Gardner saltbush, and sagebrush species. Overall ground cover averages 13%, but may be higher depending on moisture levels.

Alkali scrub communities occur in both upland and lowland areas in the MAA. Lowland alkali scrub occurs along poorly drained bottomlands and floodplains of perennial and intermittent streams with highly saline-alkaline soils. Identified playas are included in this cover type. Though not formally mapped as playas, areas mapped as closed basins are playas that fill in during average snow years.

3.6.1.4. Barrens/Exposed Rock or Soil

Areas classified as "barren" are subject to extreme geomorphological or environmental conditions that hinder vegetation establishment. Barren lands also include areas where human disturbance has resulted in exposed areas of reduced native vegetation, primarily in areas of oil and gas development, road construction, and concentrated grazing. Areas of shale and rock outcrops, eroding sand dunes, alluvial deposits, windswept and steep slopes, and ridges occur throughout the MAA, comprising approximately 8% of the total area. Currently, about 1% of this community is disturbed from existing oil and gas development activities in the MAA. Vegetation common to these areas is either low-growing or adapted to extremes of wind, weather, and poor soil development. Primary species composition is small, mounding or "cushion" species, including stemless goldenweed (*Stenotus acaulis)*, spoonleaf milk vetch (*Astragulus spatulatus*), and moss phlox (*Phlox briodes*). Grass species and big sagebrush are also found in these areas in limited amounts.

Areas of eroding substrates support plant species that are tolerant of soil instability. These areas of shifting sandstone and shales, commonly called badlands, support Gardner saltbush, sagebrush, rabbitbrush, and wheatgrasses. Vegetative cover in these areas is low, ranging from 5 to 20%.

3.6.1.5. Riparian/Wetlands

Riparian and wetland communities are found along hydrologic features of water bodies, including rivers, streams, lakes, and drainages, and support distinct plant compositions that are dependent upon saturated soils. Areas included in this classification cover approximately 8,700 acres in the MAA (Table 3-18). Currently, about 1% of this community is disturbed from existing oil and gas development activities in the MAA. Additional details on riparian and wetland habitats are provided in Section 3.6.3 below.

3.6.1.6. Agricultural Lands

Agricultural and croplands comprise approximately 5,900 acres of the MAA (Table 3-18) and occur primarily along floodplains. Currently, about 2% of this community is disturbed from existing oil and gas development activities in the MAA. Hay production occurs along the Hams Fork River, with orchardgrass (*Dactylis glomerata*), sweetclover (*Melilotus* spp.), alfalfa (*Medicago sativa*), timothy (*Phleum pretense*), smooth brome (*Bromis inermis*), and wheatgrasses providing vegetative cover.

3.6.1.7. Juniper Woodland

Juniper Woodland occupies the least amount of area of all cover types along the Green River in the northern third of the project area. This cover type is not visible on Map 3-6, and therefore does not appear in the legend. There is no existing disturbance in this plant community within the MAA. Juniper Woodland areas occur on shallow, rocky, poorly developed soils particularly on the drier south- and east-facing slopes. The juniper overstory (*Juniperus osteosperma* and *J. scopulorum*) is 8 to 20 feet high. A variety of understory shrubs and herbaceous species may occur, but groundcover is generally sparse (8 to 23%). Understory species include sagebrush, rabbitbrush, plains prickly pear cactus (*Opuntia polyacantha*), goldenweed (*Haplopappus* spp.), phlox, bluebunch wheatgrass (*Agropyrom spicatum*), Indian ricegrass (*Oryzopsis hymenoides*), junegrass (*Koeleria macrantha*), and needle-and-thread (*Stipa comata*).

3.6.2. Cryptobiotic Soil Crusts

Formed by living organisms and their byproducts, cryptobiotic soils are a surface crust of soil particles bound together by organic materials. Crusts are predominantly composed of cyanobacteria, green and brown algae, mosses, and lichens. However, liverworts, fungi, and bacteria may also be important components. Cryptobiotic crusts are fairly observable in the landscape. Mature crusts of the Great

Basin and Colorado Plateau are usually darker than the surrounding soil, can reach a thickness of up to 10 centimeters, and may display aboveground configurations known as pinnacles or pedicles.

Ecologically, crusts contribute to a number of functions in the environment. Because they are concentrated on the soil surface, crusts primarily affect processes that occur at the soil-air interface. These include soil stability and erosion, atmospheric nitrogen fixation, nutrient contribution to plants, soil-plant-water relations, infiltration, seedling germination, and plant growth (USGS 2003). Crusts are likely to cover undisturbed surfaces within the project area (Glennon 2006) however, no accurate surveys have been completed to identify the extent of these crusts.

3.6.3. Riparian and Wetland Areas

Jurisdictional waters of the U.S. within the MAA include special aquatic sites, jurisdictional wetlands, actively flowing stream channels, dry ephemeral drainages with active channels, and open waters. A reconnaissance-level field investigation of the MAA identified vegetation and waters of the U.S. for the 1995 Moxa Arch EIS and is detailed in the Vegetation and Wetlands Technical Report (BLM 1995d; ECOTONE Environmental Consulting 1995). The survey used USFWS National Wetland Inventory (NWI) maps and aerial photographs to locate and verify wetlands.

Table 3-19 summarizes cover types of waters of the U.S., including wetlands, identified within the MAA. The Cowardin classification system is used to define these wetland and special aquatic types (Cowardin et al. 1979).

Table 3-19. Cover Types of Waters of the U.S., including Wetlands, in the MAA, based on NWI and GAP Vegetation Mapping.

Waters of the U.S. Cover Type	Acres
Lowland Alkali Scrub*	--
Riparian Forest/Shrub	3,900
Wet Meadow	2,350
Marsh	200
Aquatic Bed/Open Water	300
Riverine	1,950
Total	**8,700**

* In the NWI map delineations, Lowland Alkali Scrub is included in the Riparian Forest/Shrub cover type.

Wetlands are lands between terrestrial and aquatic systems where substrates are at least periodically saturated with water (Cowardin et al. 1979). Plants and animals that live in wetlands are adapted for life in water or in saturated soil. According to the U.S. Army Corps of Engineers (USACE), a wetland has hydrophytic vegetation, hydric soil, and hydrology (USACE 1987). Wetlands that meet these three criteria are referred to as jurisdictional wetlands and are regulated by the USACE under Section 404 of the Clean Water Act.

3.6.3.1. Lowland Alkali Scrub

Refer to Section 3.6.1.3 for a description of this cover type.

3.6.3.2. Riparian Forest/Shrub

Based on vegetation mapping, forest-dominated riparian habitat occupies 351 acres of the MAA, and shrub-dominated riparian habitat occupies 3,566 acres. These coverages constitute approximately 0.1% and 0.8%, respectively, of the MAA.

Riparian forest and shrub communities are found along hydrologic features of water bodies, including rivers, streams, lakes, and drainages, and support distinct plant compositions that are dependent upon saturated soils. Dominant trees and shrubs include cottonwoods, willows, tamarisk, silver buffaloberry, black hawthorn, and boxelder. Other species include redtop, rushes, and sedges. Fluctuating water levels, storm runoff, and occasional heavy livestock and wildlife use influence plant composition. The effects of erosion and irrigation withdrawals are apparent in portions of the MAA where altered stream channels have eliminated riparian vegetation access to water.

3.6.3.3. Wet Meadow

Wet meadow was delineated on approximately 2,350 acres of the MAA, primarily adjacent to the perennial Green, Hams Fork, and Blacks Fork Rivers. Wet meadows are characterized by a shallow or near-surface water table and remain saturated during part of the growing season. Grasses and grass-like plants, with some broadleaf herbs and few shrubs, dominate wet meadows. Dominant species in alkali wet meadows include scratchgrass (*Muhlenbergia asperifolia*), bulrushes (*Scirpus* spp.), and alkali cordgrass (*Spartina gracilis*). Species in freshwater wet meadows include sedges, Torrey rush (*Juncus torreyi*), bluegrasses (*Poa* spp.), reed canarygrass (*Phalaris arundinacea*), and bluejoint reedgrass (*Calamagrostis canadensis*).

3.6.3.4. Marsh

Marsh areas have been identified on approximately 200 acres of the MAA. In marshes, surface ponding and/or soil saturation is present for a longer portion of the growing season than in wet meadows. These wetland areas are associated with bottomlands of perennial reaches of streams and support typical emergent vegetation. Dominant species include cattails (*Typha* spp.) and bulrushes.

3.6.3.5. Aquatic Bed/Open Water

Approximately 300 acres of aquatic bed and open water have been mapped in the MAA, primarily associated with gravel pits and stock ponds. Aquatic bed and open water areas include man-made bodies of water such as reservoirs, stock ponds, detention ponds, sloughs, old meander scars of perennial streams; as well as surface waters with very low velocity flows. Aquatic bed water levels are shallow (<6.6 feet deep) with warm temperatures during summer months (Cowardin et al. 1979). Vegetation includes submerged-rooted or floating-leaved plant types such as watercress (*Nasturtium officinale*), buttercup (*Ranunculus* spp.), duckweed (*Lemna* spp.), and pondweed (*Potamogeton* spp.). Open water areas are usually deeper than aquatic beds (>6.6 feet deep) and lack rooted emergent or submerged vegetation (USACE 1987; Cowardin et al. 1979). Within the CIAA, Fontenelle and Flaming Gorge Reservoirs are considered open water areas.

3.6.3.6. Riverine

Riverine areas comprise approximately 1,950 acres of the MAA and contain flowing, channelized water on an ephemeral, intermittent, and/or perennial basis. Vegetation is usually present along the channel banks. The riverine cover type includes perennial rivers, such as the Green, Blacks Fork, Hams Fork, and Smiths Fork Rivers; Big Muddy Creek; and ephemeral and intermittent streams and their exposed channel banks.

3.6.3.7. Riparian Proper Functioning Condition

Riparian areas have been periodically inventoried using the proper functioning condition (PFC) analysis and classification system developed by the BLM in 1993. Qualitative ratings are assigned to monitor health of these systems over time by evaluating riparian ecologic and hydrogeomorphic function. Areas within the MAA that have been rated for PFC include Slate Creek, Cottonwood

Creek, Muddy Creek, and small portions of the Hams Fork, Blacks Fork, and Smiths Fork Rivers. These most recent assessments were conducted in 1998 and 1999 (Table 3-20).

Table 3-20. Riparian Proper Functioning Condition Ratings for Streams within the MAA*.

Stream Name	Allotment Name	Functional Rating	Date Inventoried
Slate Creek	Slate Creek and Seedskadee	PFC	6/25/1998
Slate Creek	Slate Creek and Seedskadee	FAR-NA	6/25/1998
Slate Creek	Graham Reservoir	FAR-NA	6/25/1998
Muddy Creek	Little Creek, Leroy, Coal Mine Draw, Bigelow	FAR-NA	6/24/1998
Cottonwood Creek	Poverty, Bench and Lyman Cattle	NF	5/20/1998
Smiths Fork River	Highway and South Monument	FAR-NA	5/20/1998
Hams Fork River	HF and Granger	FAR-NA	7/12/1999
Blacks Fork River	Granger	FAR-NA	7/12/1999

Functional Rating: FAR-NA = Functional At Risk with no Apparent Upward/downward Trend, PFC = Proper Functioning Condition, NF = Nonfunctional
*PFC assessments are completed only on BLM surface

Riparian wetland areas may be rated as PFC, functional-at risk, or nonfunctional. Properly functioning riparian areas have adequate vegetation and landform to dissipate stream energy, filter sediment, retain floodwater, and develop root systems for stable banks. These elements are necessary to reduce erosion, improve water quality, and withstand high flow events. Functional-at risk areas possess some of these elements, while nonfunctional areas clearly lack the elements listed in the PFC definition. If an area is rated as functional-at risk, then a determination of trend toward PFC (upward) or away from PFC (downward) is made, if possible. The upward/downward trend was not apparent for at-risk streams within the MAA.

3.6.4. Noxious, Non-Native, and Invasive Plant Species

On February 3, 1999, Executive Order (EO) 13112 was signed by President Clinton. The primary purpose of this EO was to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species cause. Noxious weeds are officially designated non-native plant species that are invasive and/or can become monocultures. The spread of invasive, non-native plant species can cause harm to land value, native ecology, agricultural interests, wildlife habitat, livestock forage, riparian resources, and aesthetic and visual values of land, and can create economic concern due to loss of rangeland productivity and costs of control. Weeds are most common in areas of the Moxa Arch that have been disturbed and not properly reclaimed and revegetated. Examples include roadsides, livestock congregation areas, pipelines, drill sites.

In 1994 field investigators observed areas of infestation up to 20 acres in size of perennial pepperweed (*Lepidium latifolium*), Russian thistle (*Salsola iberica*), halogeton (*Halogeton glomeratus)*, and whitetop (*Cardaria pubescens*) (ECOTONE Environmental Consulting 1995). Perennial pepperweed was found in wet meadows and near Fontenelle Reservoir. The Fontenelle Reservoir area (including the campgrounds) also contains tamarisk (*Tamarix* spp.). While not on the Wyoming noxious weed species list, cheatgrass (*Bromus tectorum*) is also a weed species of concern in the MAA as it is known to establish monocultures that exclude native vegetation species.

Halogeton is a weed of particular concern with regard to development activities within Wyoming and is known to occur within the MAA (Bezanson 2006). While not aggressively invasive, it is highly poisonous to sheep and is known to affect other livestock as well. Halogeton is an establishing species were soil impacts have changed the soil composition and nutrients within an area that has been

disturbed. This species is located on the majority of the well pad locations initially after both interim and final reclamation activities have occurred. Because the species is not invasive it typically is easily out-competed with the establishment of perennial native species. Other species of concern, including Russian thistle and black henbane, form the early cover for disturbance areas until the perennial native species become established.

Some of the invasive, non-native, and noxious plant species require disturbance to become established and some do not. What appears to be more critical is the transportation of seeds along roads via vehicles and construction equipment. Table 3-21 lists Wyoming noxious weed species and their occurrence within the MAA. Included in the table are weeds identified on the Wyoming Priority Pest List (Wyoming Weed and Pest Council 2004). Impacts resulting from noxious weeds will not be analyzed in a separate section in Chapter 4 but will be assessed for plant communities discussed in sections 3.6.1 and 3.6.3.

3.7. Fisheries and Wildlife

The MAA and vicinity provides habitat and sustenance for a variety of wildlife species and fisheries. The aquatic/riparian and terrestrial habitats in the MAA are suitable breeding, foraging, and migration areas for various mammals, birds, and invertebrates.

3.7.1. Fisheries and Aquatic Ecosystems

The CIAA for fisheries is the combined 15 watershed area that drains the MAA, Fontenelle Reservoir, the Green River, and Flaming Gorge Reservoir, an area of approximately 2,551,204 acres (Map 3-4).

Surface water is relatively rare or infrequent in the MAA. Although numerous stream channels occur within the MAA boundary, the majority of them are ephemeral. The WGFD classifies most of the streams within the area as Class 5 (incapable of supporting fisheries). The Green River, which borders the Moxa Arch on the northeast, is a Class 2 stream (very good trout waters). Portions of the Blacks Fork River are Class 3 (important trout waters) and Class 4 (low-production trout waters). Other perennial streams in the MAA capable of to supporting fish species are the Hams Fork River, Slate Creek, and their major tributaries. Fontenelle Reservoir on the northern project boundary also supports populations of fish.

Stocked fish species include rainbow trout, brown trout, cutthroat trout, brook trout, whitefish, channel catfish, and smallmouth bass in Fontenelle Reservoir; and kokanee in Flaming Gorge Reservoir and the Green River. Colorado River cutthroat trout is the only salmonid species native to the MAA and Green River Basin. However, other cutthroat species, such as the Bonneville and Snake River cutthroats, have been introduced as part of fisheries management programs by the WGFD (discussed further in Section 3.8.2 below).

3.7.2. Waterfowl

All waterfowl species are protected under the Migratory Bird Treaty Act of 1918 (MBTA). The Flaming Gorge and Fontenelle Reservoirs provide the largest areas of waterfowl habitat in the project vicinity. Within the project boundary, there is little open water habitat that would be attractive to waterfowl, although the Hams Fork and Blacks Fork Rivers and ephemeral flows along Shute and Slate Creeks can temporarily support waterfowl stopover or breeding habitat. Seasonally flooded playas provide additional important stopover/resting habitat for migrating species. Migratory waterfowl likely fly over portions of the Project Area and/or use grasslands or croplands for foraging. Major additional impacts to waterfowl are not expected to result from implementation of the Proposed Action or alternatives and no additional analysis will be conducted in Chapter 4 of this document.

Table 3-21. Wyoming Noxious Weed Species.

Scientific Name	Common Name	Wyoming Noxious Weed List	2004 Wyoming Priority Pest List	County Noxious Weed List[1]	Occurs Within MAA[2]
Agropyron repens	quackgrass	X		L, S, U	
Arctium minus	common burdock	X		L, S, U	
Avena fatua	wild oat			L	
Cardaria draba, C. pubescens	hoary cress, whitetop	X		L, S, U	X
Carduus acanthoides	plumeless thistle	X		L, S, U	
Carduus nutans	musk thistle	X		L, S, U	X
Centaurea diffusa	diffuse knapweed	X	X	L, S, U	
Centaurea macculosa	spotted knapweed	X	X	L, S, U	X
Centaurea repens	Russian knapweed	X	X	L, S, U	
Centaurea solstitialis	yellow starthistle		X	U	
Chrysanthemum leucanthemum	ox-eye daisy	X		L, S, U	
Cirsium arvense	Canada thistle	X	X	L, S, U	X
Cirsium vulgare	bull thistle				X
Convulvulus arvensis	field bindweed	X		L, S, U	
Cynoglossum officinale	houndstongue	X		L, S, U	
Euphorbia esula	leafy spurge	X		L, S, U	
Fraseria discolor	skeletonleaf bursage	X		L, S, U	
Halogeton glomeratus	halogeton				X
Hordeum jubatum	foxtail barley			S	
Hyoscyamus niger	black henbane			S, U	X
Hypericum perforatum	common St. Johns wort	X			
Isatis tintoria	dyers woad	X		L, S, U	X
Lepidium latifolium	perennial pepperweed	X		L, S, U	X
Linaria dalmatica	dalmation toadflax	X	X	L, S, U	
Linaria vulgaris	yellow toadflax	X	X	L, S, U	
Lythrum salicaria	purple loosestrife	X	X		
Onopordum acanthium	scotch thistle	X		L, S, U	
Sonchus arvensis	perennial sowthistle	X		L, S, U	
Tamarix spp.	tamarisk	X	X		X
Tanacetum vulgare	common tansy	X			
Thermopsis montana	mountain thermopsis			S	X

Source: (Wyoming Weed and Pest Council 2004)
[1] L = Lincoln; S = Sweetwater; U = Uinta; [2] (Bezanson 2006)

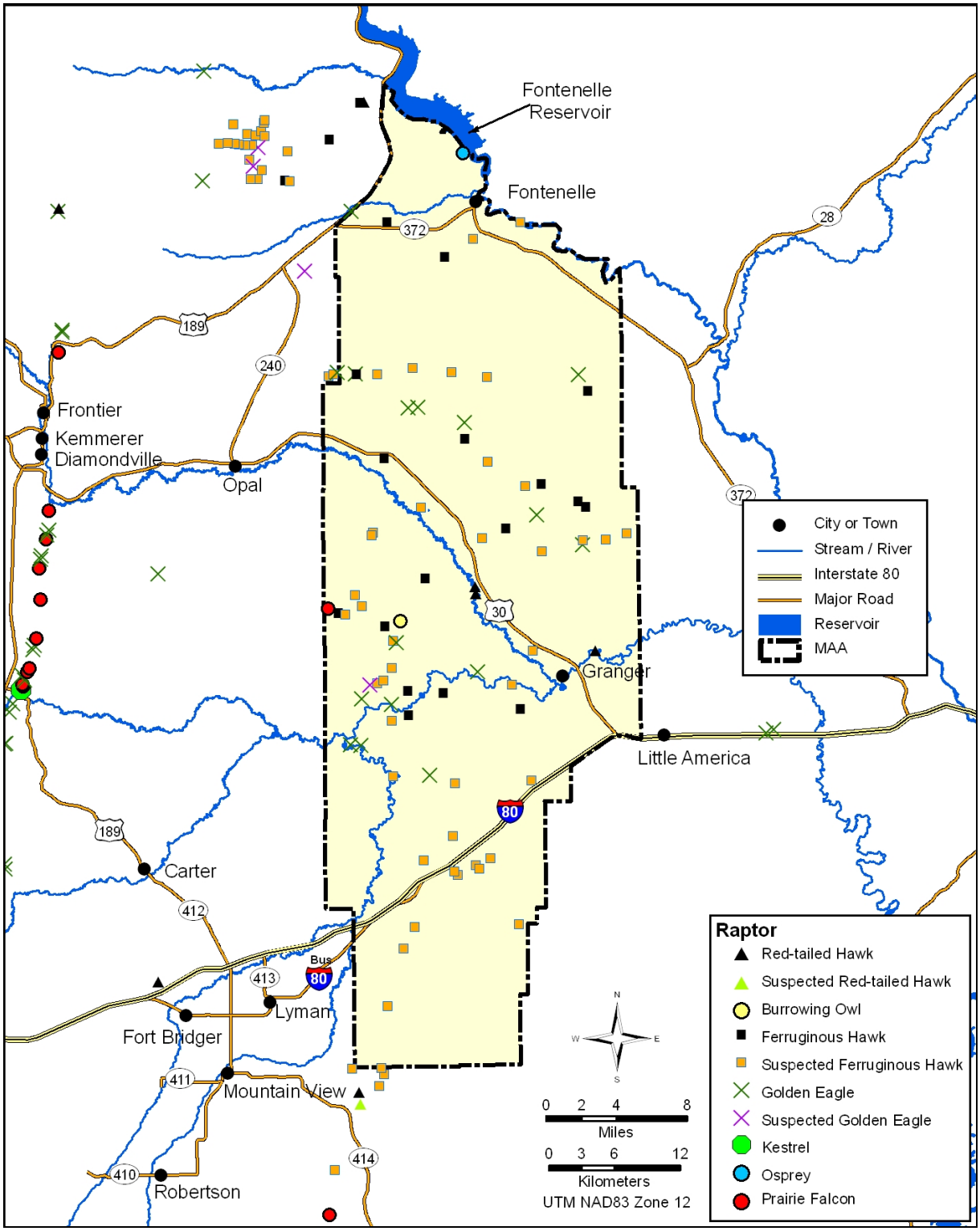
3.7.3. Raptors

The CIAA for raptors is the entire range for the affected species within the BLM Wyoming KFO management area. All raptor species and their active nests have protection under the MBTA; several species present in the MAA are listed as BLM sensitive; the bald eagle (*Haliaeetus leucocephalus*) and golden eagles (*Aquila chrysaetos*) are protected under the Bald and Golden Eagle Protection Act of 1940. Federally listed, BLM sensitive, and other special-status raptors are discussed in Section 3.8. Raptor foraging and nesting habitats are distributed across the MAA (Map 3-7). Golden eagles, red tailed hawk and great horned owls (*Bubo virginianus*) are year-round residents in the MAA; other raptors are migratory. Other raptor species include prairie falcon (*Falco mexicanus*), golden eagle, northern harrier (*Circus cyaneus*), ferruginous hawk (*Buteo regalis*), (Cooper's hawk (*Accipiter cooperii*), red-tailed hawk (*Buteo jamaicensis*), rough-legged hawk (*Buteo lagopus)*, sharp-shinned hawk (*Accipiter striatus*), Swainson's hawk (*Buteo swainsoni*), American kestrel (*Falco sparverius*), merlin (*Falco columbarius*), burrowing owl (*Athene cunicularia*), and osprey (*Pandion haliaetus*). The northern harrier, golden eagle, and prairie falcon are considered species of local interest in Wyoming (Nicholoff 2003). Bald eagles, which were removed from the endangered species list in 2007, are primarily winter and migratory visitors to the MAA. These large raptors are most often found where tall trees occur near large water bodies that include open water in winter. Bald eagle roost sites recorded during raptor surveys for the 1995 EIS (BLM 1995a) were on the northwest corner of Fossil Buttes National Monument (approximately 28 miles northwest of the MAA) and north of Woodruff Narrows Reservoir (approximately 42 miles west of MAA).

The majority of records in the Project Area vicinity for bald eagles occurred southeast of Fontenelle Reservoir along the Green River and around Flaming Gorge Reservoir, which is approximately 22 miles southeast of the MAA. Both reservoirs contain suitable nesting habitat for the bald eagle. At least one contractor survey recorded an active bald eagle nest in the MAA near Fontenelle Reservoir (O & G Environmental Consulting 2003). Because of the number of sightings, the Green River corridor from Fontenelle Reservoir to Flaming Gorge Reservoir is important for bald eagle foraging and, likely, for roosting. Therefore, it is expected that these raptors might fly over the Project Area between Fontenelle Reservoir, Flaming Gorge Reservoir, and other smaller water bodies in the vicinity, especially during winter months. Several individual eagle sightings have occurred within the MAA along the Hams Fork River; however, bald eagles would not be expected to spend time in the MAA unless roost trees or winter hunting and scavenging areas are present.

3.7.4. Big Game

Four big game species occur in the MAA and are managed by the WGFD: pronghorn (Antilocapra americana), mule deer (Odocoileus hemionus), elk (Cervus elaphus), and moose (Alces alces). These animals are managed in major herd units, for which yearly population estimates and objectives are compiled to help wildlife managers regulate animal numbers, primarily through numbers of hunting licenses sold. Table 3-22 presents these data for the herd units that occurred, at least partially, within the MAA in 2003. Big game population fluctuations over a 10-year period are presented in Figure 3-9.



Map 3-7. Known Raptor Nest Distribution in the MAA.

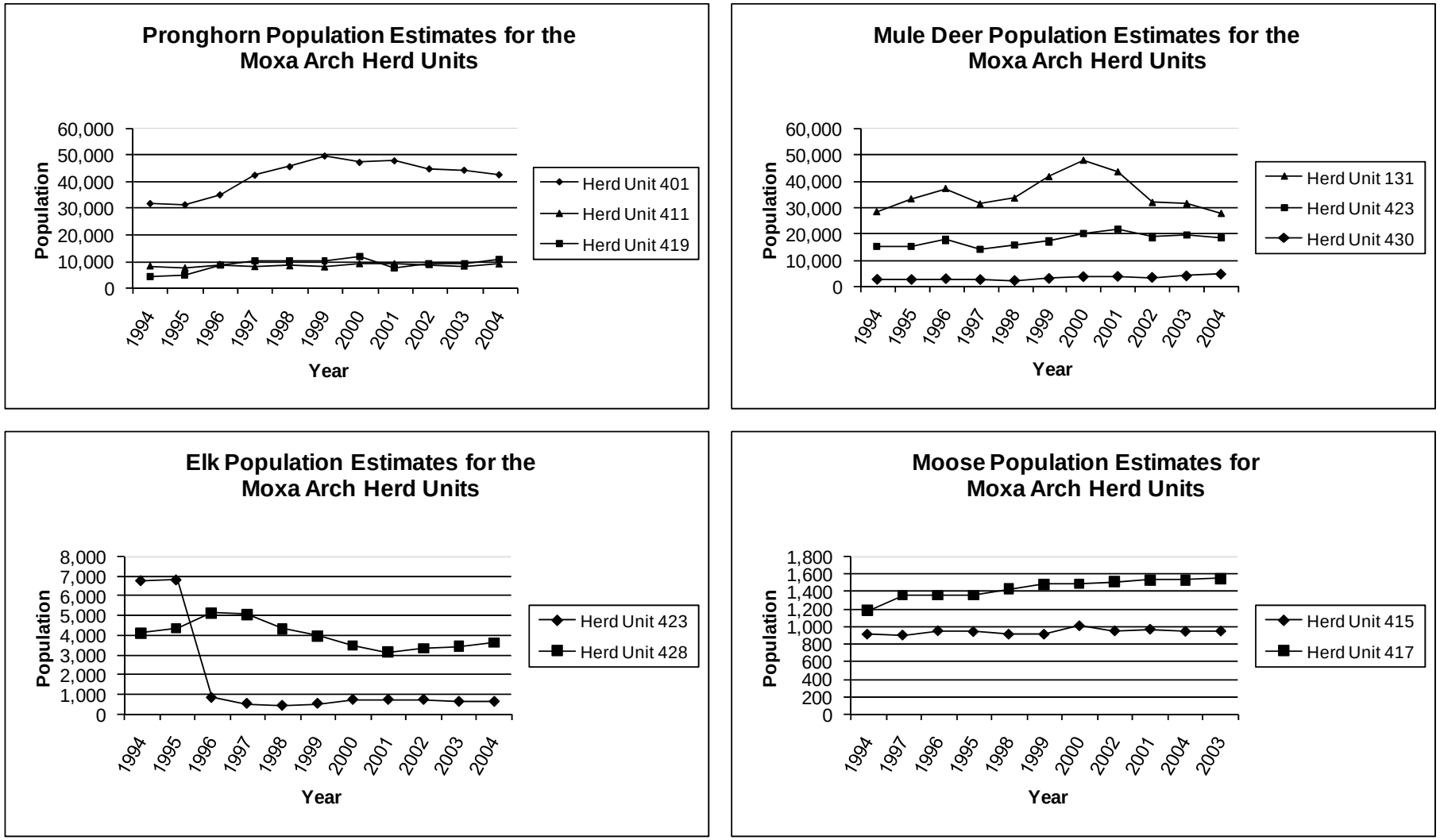


Figure 3-9. MAA Big Game Population Estimates Over 10 Years.

Table 3-22. 2003 Population Data on Big Game Herd Units that Occur in the MAA.

Species	Herd Unit	Herd Unit Number	Population Estimate	Population Objective
Pronghorn	Sublette	401	44,200	48,000
	Carter Lease	419	8,834	6,000
	Uinta-Cedar Mountain	411	8,200	10,000
Mule Deer	Steamboat	430	3,700	4,000
	Wyoming Range	131	31,367	50,000
	Uinta	423	19,437	20,000
Elk	West Green River	428	3,386	3,100
	Uinta	423	600	600
Moose	Lincoln	417	1,540	1,650
	Uinta	415	937	900

Source: (Dobey 2005)

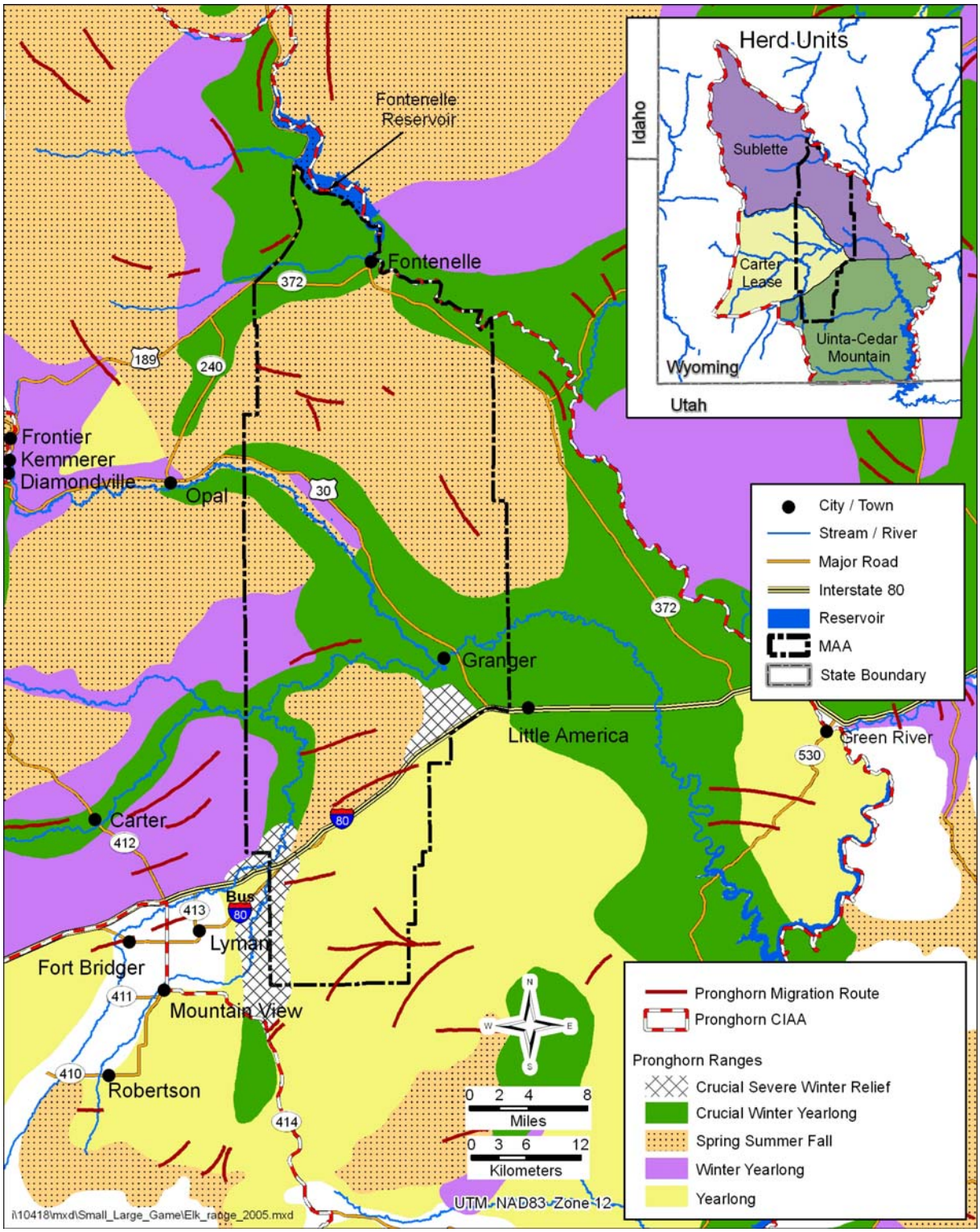
3.7.4.1. Pronghorn

The CIAA for pronghorn is the combined range and migration corridors of the Sublette, Carter Lease, and Uinta-Cedar Mountain pronghorn herd units, which encompass 2,397,359 acres (Map 3-8).

Pronghorn seasonal habitats are found throughout the MAA, and ranges that encompass 475,808 acres (100% of the Project Area) were mapped by the WGFD (Map 3-8). Pronghorn population trends for these herd units have been fairly stable over the past 10 years (Figure 3-9). The boundaries for these units in the Project Area generally correspond with the major highways: U.S. Interstate 80 (I-80) and US 30. Fencing for livestock has been a barrier for pronghorn migration and movement.

Pronghorn use the MAA year-round. The WGFD has determined that crucial winter year-long range occurs along the Hams Fork and Blacks Fork Rivers and covers approximately 153,517 acres, or approximately 32% of the MAA (Map 3-8). The WGFD defines “crucial range” as having properties necessary to maintain a specific population level (theoretically the population objective) during 8 out of 10 years (Wildlife Society 1990). The area north of US 30 is predominately spring/summer/fall range, and the area south of I-80 contains yearlong pronghorn habitat. Small portions of the MAA (about 17,401 acres in the extreme southwest corner and central east region) provide crucial severe winter relief, the most limiting habitat type for pronghorn during severe weather episodes. Multiple migration routes have been identified by the WGFD in the Project Area and appear to be linked to movements of the individual herd units within their ranges.

Currently, about 2% of pronghorn spring/summer/fall range and crucial winter yearlong range are disturbed by existing oil and gas field development activities within the MAA. About 1% of winter yearlong, yearlong, and crucial severe winter relief ranges are currently disturbed. Disturbances to these habitat types could be higher than reported because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).



Map 3-8. Pronghorn Herd Units and Range in the MAA and CIAA.

3.7.4.2. Mule Deer

The CIAA for mule deer is the combined range and migration corridors of the Steamboat, Wyoming Range, and Uinta mule deer herd units, which encompass 5,876,598 acres (Map 3-9). Limited portions of the MAA provide suitable habitat for mule deer (approximately 60,062 acres or 13% of the MAA) (Map 3-9). More important mule deer habitat is available west of the Project Area within the CIAA. Stream corridors of the MAA are the most valuable yearlong habitat for mule deer. Currently, about 3% of mule deer yearlong range and less than 1% of winter yearlong range are disturbed by existing oil and gas field development activities within the MAA. Disturbances to these habitat types could be higher than because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).

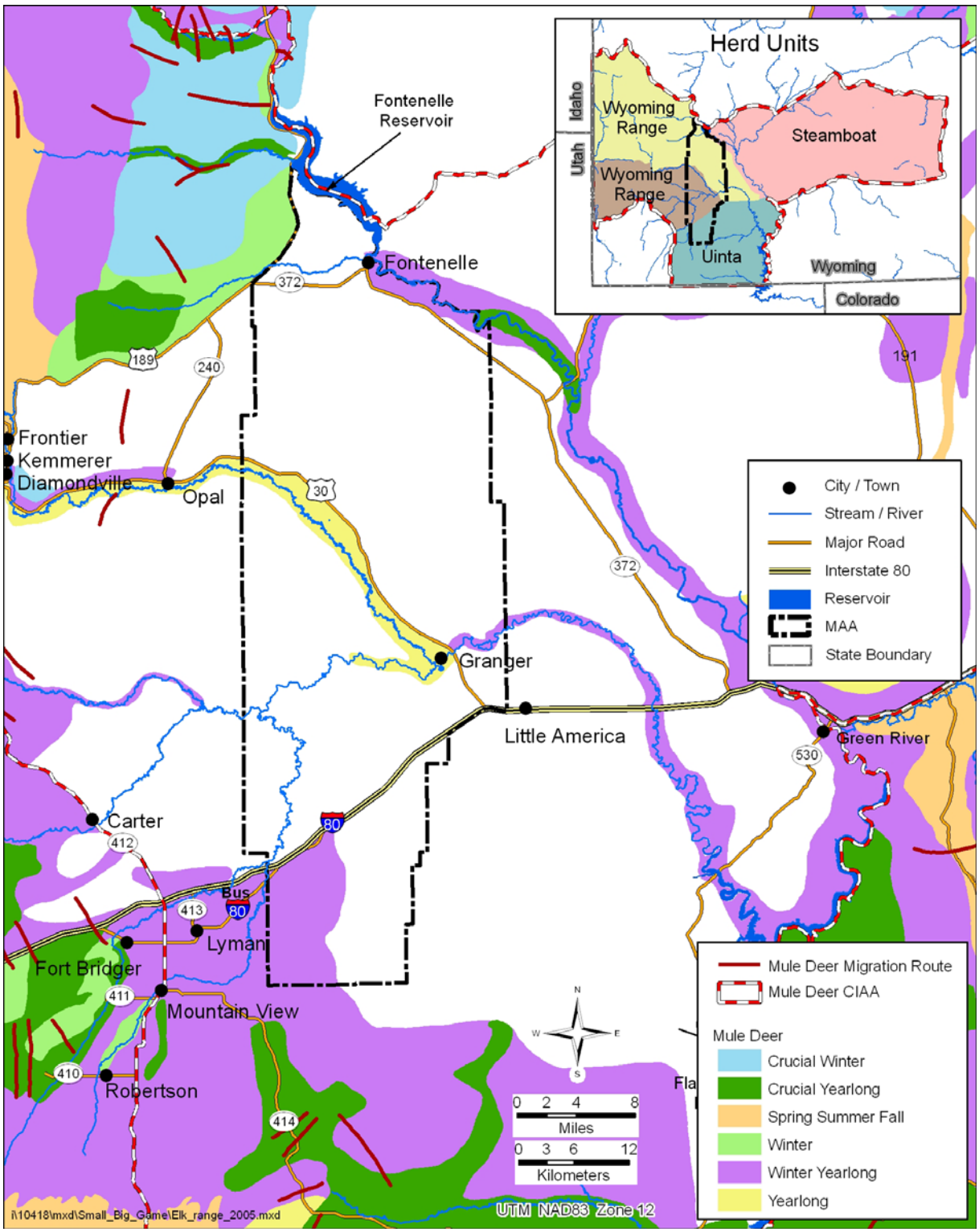
As determined by the WGFD, the southwest corner of the MAA contains winter yearlong habitat for mule deer, which is used by the Uinta herd unit (Map 3-9). Some yearlong habitat exists along the Hams Fork drainage south of US 30 and is used by the Wyoming Range herd unit. In the extreme northeast corner of the MAA along the Green River, downstream of the Fontenelle Reservoir and within the Seedskadee National Wildlife Refuge (NWR), a small band of winter/yearlong mule deer range exists, which is part of the Steamboat herd unit. No crucial range exists within the Project Area boundary, although crucial yearlong and crucial winter ranges occur northwest of the northern boundary of the Project Area within the CIAA. No mule deer migration routes have been identified within the MAA boundary (Map 3-9).

Mule deer observations in the MAA occur along the Hams Fork River/US 30 yearlong range riparian habitat, in the Seedskadee NWR, and along well-traveled roads such as I-80 and State Highway 372 (SH 372) (Map 3-9). Herd unit population fluctuations for mule deer have remained relatively stable over 10 years, with the Wyoming Range herd unit showing an increase beginning in 1998, peaking in 2000, and decreasing back to typical numbers by 2002 (Figure 3-9).

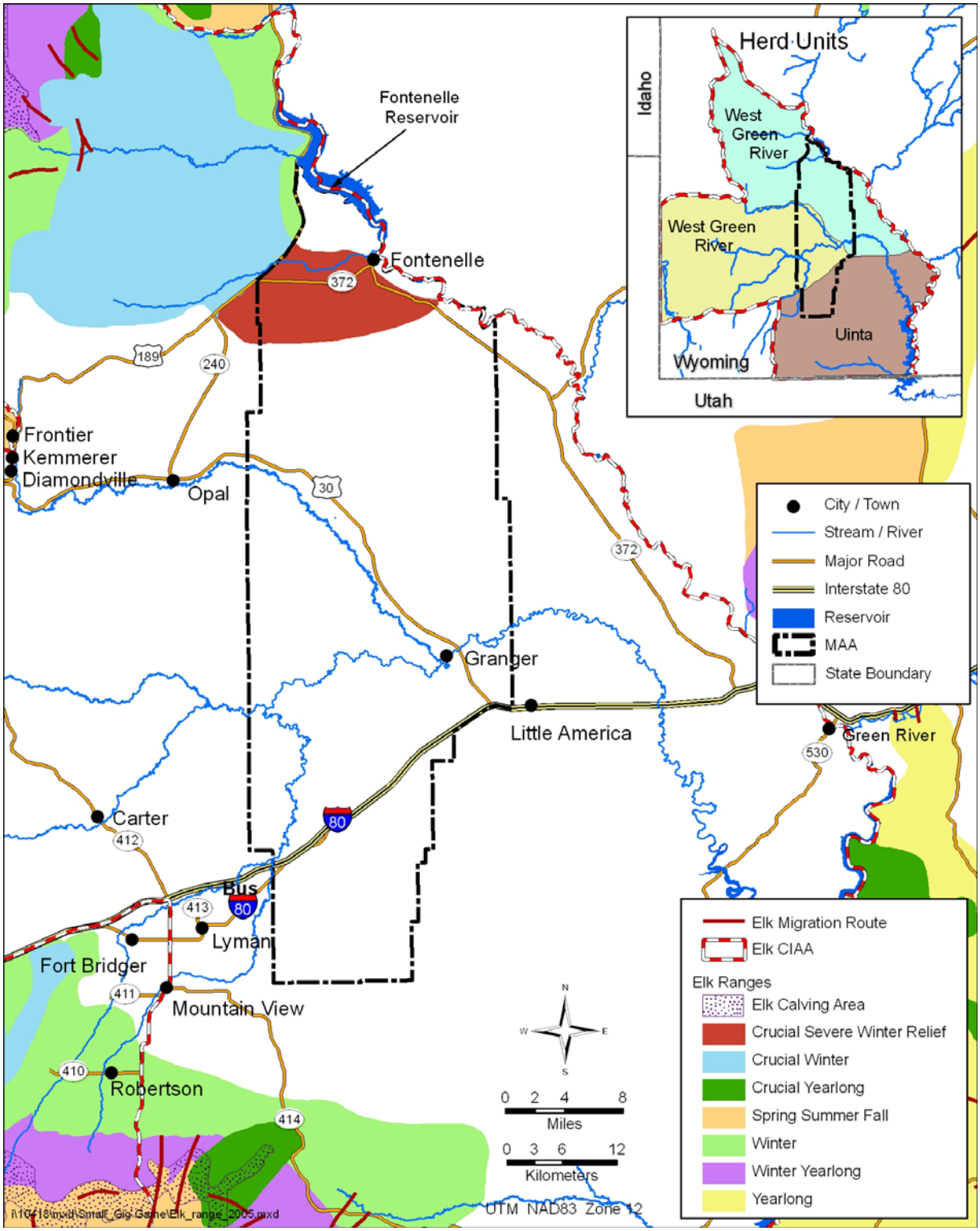
3.7.4.3. Elk

The CIAA for elk is the combined range and migration corridors of the West Green River and Uinta elk herd units, which encompass 3,053,717 acres (Map 3-10). Only a small portion of the MAA (35,753 acres, or approximately 8% of the total area of the herd units) is classified by the WGFD as being important range for elk (Map 3-10). Elk crucial severe winter relief habitat was mapped by WGFD in the northern portion of the Project Area south of Slate Creek within the range of the West Green River herd unit. Currently, about 2% of elk crucial severe winter relief habitat is disturbed by existing oil and gas field development activities within the MAA. Disturbance to crucial severe winter relief habitat could be higher than because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a). However, as much of the habitat area is in the northern sections of the flank, the 2% disturbance estimate is likely close to what actually has occurred.

Elk use of the MAA is rare but might be important to allow a portion of the population to survive the occasionally extreme severe winter. No elk migration routes have been recorded within the MAA (Map 3-10). Only three elk sightings have been recorded within the Project Area in 30 years. Population fluctuations for the herd units that occur within the MAA were relatively stable between 1994 and 2004 (Figure 3-9). The graph for the Uinta herd unit shows a drop between 1995 and 1996, but this change was attributed to the use of a different data modeling system, and not to population declines. The post-1995 numbers reflect a more accurate population estimate for elk in that herd unit within Wyoming.



Map 3-9. Mule Deer Herd Units and Range in the MAA and CIAA.



Map 3-10. Elk Herd Units and Range in the MAA and CIAA.

3.7.4.4. Moose

The CIAA for moose is the combined range and migration corridors of the Lincoln and Uinta elk herd units, which encompass 4,018,140 acres (Map 3-11). Moose have been classified as Class 3 Native Species Status by the WGFD, due to declining populations and vulnerable habitat. Due to a lack of perennial surface water throughout the MAA, moose habitat is limited to the major riparian areas (52,480 acres or 11% of the MAA) (Map 3-11). However, within those areas, moose sightings are relatively common. The WGFD has identified yearlong moose habitat along the Hams Fork and Blacks Fork River corridors within and west of the MAA within the CIAA (Map 3-11). A small area of winter yearlong habitat exists along the Blacks Fork River east of US 30, along the extreme northeast boundary of the Project Area in the Seedskadee NWR, and along the Green River. Currently, about 2% of moose yearlong range and less than 1% of winter yearlong range are disturbed by existing oil and gas field development activities within the MAA. All of these areas are within the range of the Lincoln herd unit. Many more sightings occur in areas of the CIAA to the northwest and southwest of the MAA where winter yearlong habitat occurs (Map 3-11). Three moose migration routes have been recorded by the WGFD within the MAA: one north of SH 372 near the Fontenelle Reservoir, one along Slate Creek, and one that crosses US 30 near the Blacks Fork/Hams Fork confluence near Granger (Map 3-11). MAA herd unit population fluctuations were relatively stable between 1994 and 2004 (Figure 3-9).

3.8. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species

This section discusses the federally listed and Wyoming BLM sensitive bird, mammal, amphibian, reptile, fish, and plant species that occur, or have the potential to occur, in the MAA and vicinity. Regulatory review of these species and their habitats is required to ensure compliance with the ESA. A Biological Assessment (BA) describing the potential impacts of the preferred alternative on Threatened, Endangered, and Candidate species can be located in Appendix D.

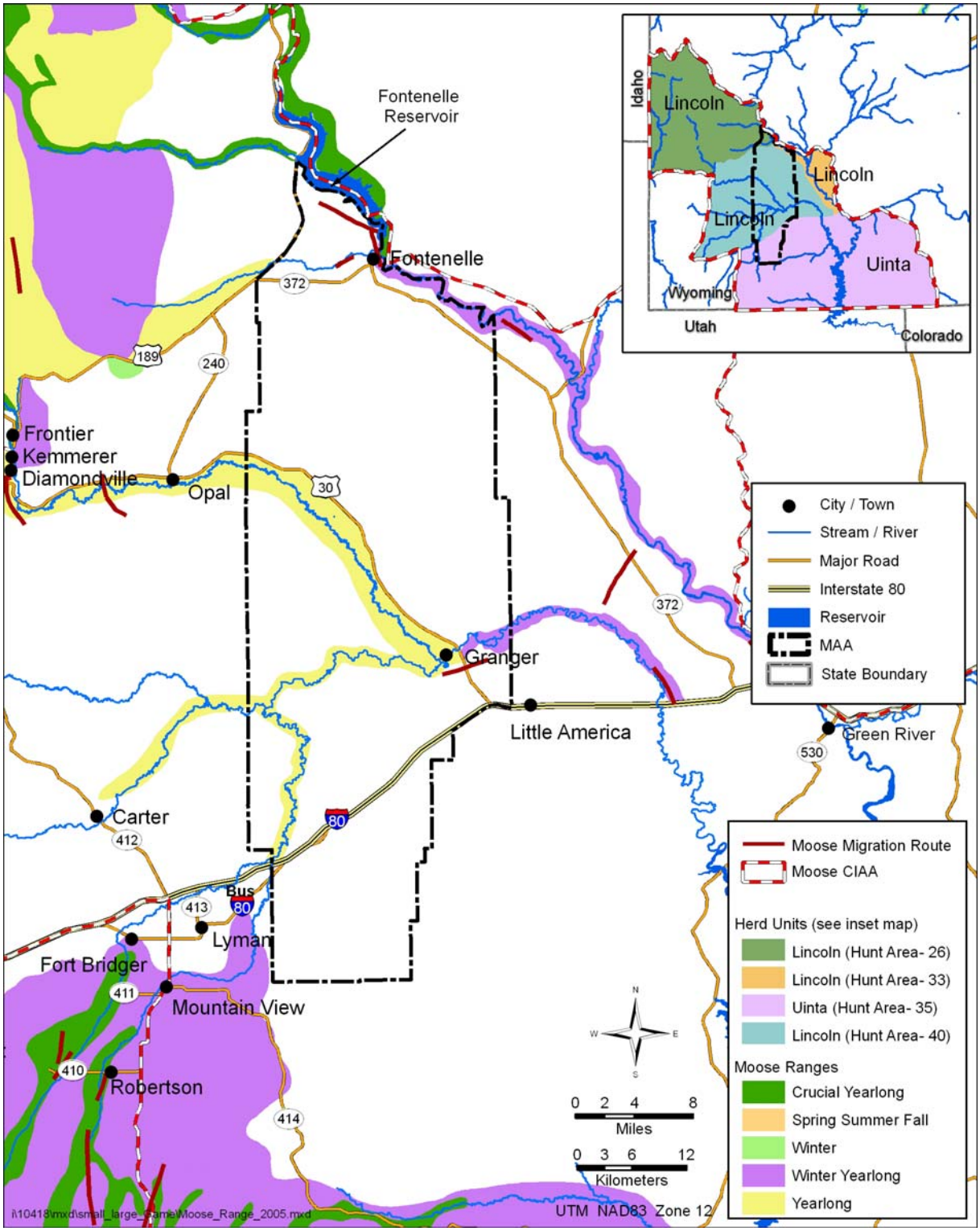
3.8.1. Federally Listed and Candidate Species

Species listed under the ESA must be analyzed by federal agencies whenever agency actions may affect those species or their occupied habitats. ESA-protected or candidate species that potentially occur in the MAA are listed in Table 3-23. In addition, four downstream Colorado River fish species may be affected by depletions to the Colorado River system. Three additional ESA-protected species may occur in the KFO but do not occur in the MAA.

Table 3-23. Species with Federal Status that were Evaluated for the MAA.

Common Name	Scientific Name	Federal ESA Status	Likely to Occur in Project Area?
Black-footed ferret	*Mustela nigripes*	E / experimental	Low likelihood
Colorado pikeminnow	*Ptychocheilus lucius*	E	No*
Humpback chub	*Gila cypha*	E	No*
Bonytail chub	*Gila elegans*	E	No*
Razorback sucker	*Xyrauchen texanus*	E	No*
Canada lynx	*Lynx canadensis*	T	No
Gray wolf	*Canis lupus*	T / experimental	No
Ute ladies'-tresses orchid	*Spiranthes diluvialis*	T	Low likelihood
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	C	Low likelihood

T = threatened, E = endangered, C = candidate for listing; experimental populations have been re-introduced
* = may occur downstream and be affected by water depletions to the Colorado River Basin



Map 3-11. Moose Herd Units and Ranges in the CIAA.

3.8.1.1. Black-footed Ferret

The 1995 EIS determined that 63% of the MAA is suitable habitat for black-footed ferrets due to the numbers and densities of prairie dog colonies. Historic records of black-footed ferret include several sightings from the 1970s in the Seedskadee NWR (WyNDD 2006). Black-footed ferrets were reintroduced to northwest Colorado beginning in 2001, approximately 80 miles from the MAA, and are breeding and thriving (Colorado Division of Wildlife 2005). Black-footed ferret reintroductions also occurred in Uinta County, Utah, southwest of the MAA, and in the Shirley Basin, central Wyoming, approximately 150 miles east of the MAA. Recent undocumented sightings have also occurred southeast of the MAA along the Colorado/Wyoming border near the Hiawatha natural gas field.

An intensive white-tailed prairie dog colony mapping effort was conducted for the 1995 EIS to determine potential black-footed ferret habitat for reintroduction. The study determined that 10% of the MAA contained prairie dog colonies, over 89% of which had burrow densities greater than eight per acre and were considered "towns" by the USFWS (Map 3-12). A USFWS-defined prairie dog complex (grouping of adjacent towns) comprises 63% of the MAA, and 3,982 acres within the complex qualified in 1995 as suitable black-footed ferret reintroduction habitat (BLM 1995c). Currently, about 2% of the prairie dog colonies are disturbed by existing oil and gas field development activities within the MAA. Disturbance to prairie dog towns and black-footed ferret habitat could be higher than the 2% calculated, especially in the core, because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).

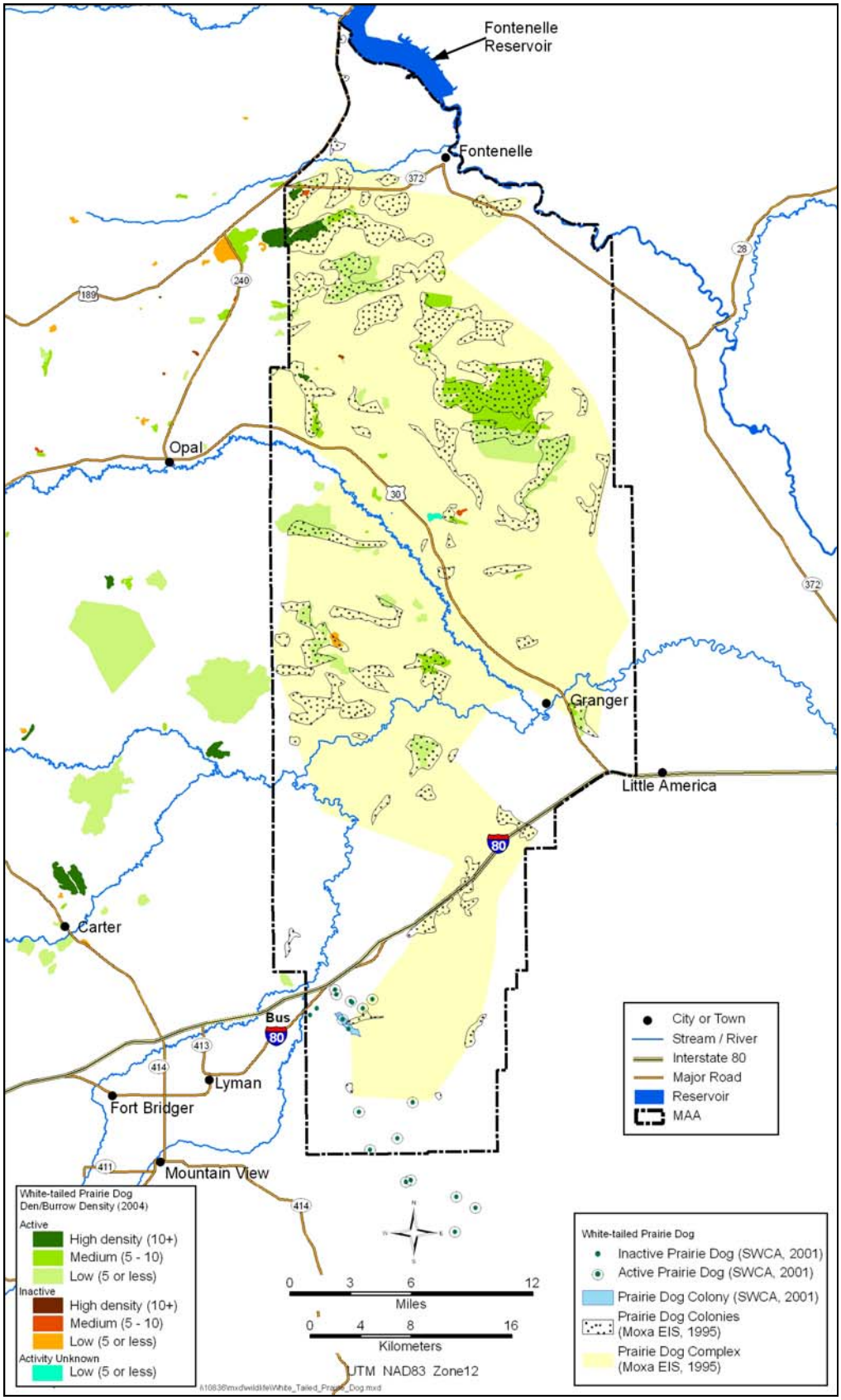
Additional information compiled for these species consists of contractor survey data collected primarily over the past 5 years (2001-2005) in support of various energy development projects. No black-footed ferrets were found during 34 surveys covering at least 83,840 acres within the MAA. Survey data provided valuable information on existence and relative abundance of the white-tailed prairie dog, a BLM sensitive species, and other shortgrass prairie wildlife.

3.8.1.2. Colorado River Fishes

The Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub are endemic fish species that once thrived in the Colorado River system. Dam installation and the introduction of non-native fish changed the river environment and put these fish at risk (USFWS 2006). Critical habitat was not designated in Wyoming for any of the four listed species (Federal Register 59:54, 1994), but has been delineated in the Green River in northern portions of both Colorado and Utah near the Wyoming border. These species have not been documented within the MAA.

The primary concern for these fish species is effects due to upstream water depletions from the proposed project. Under the *Recovery Implementation Program for Endangered Species in the Upper Colorado River Basin* (RIP), water depletions from tributary waters jeopardize the continued existence of these endangered fish. Tributaries are defined as contributing to instream flow, and depletion is defined as water that would contribute to flows if not intercepted or removed from the system. The RIP was developed as a cooperative effort between the states of Colorado, Utah, and Wyoming; the Bureau of Reclamation; the USFWS; private water development interests; and various environmental groups. The RIP implementation agreement was signed by governors of the three states, the Secretary of Interior, and the Administrator of the Western Area Power Administration.

A 2000 Biological Opinion covering Colorado River depletions for livestock uses concluded that individual projects causing 100 acre-feet or more of average annual water depletion would not be included in a programmatic approach and would require further consultation with the USFWS and, potentially, a fee.



Map 3-12. Prairie Dog Populations in the MAA.

3.8.1.3. Ute Ladies'-tresses

Ute ladies'-tresses is a federally listed threatened orchid species that requires streamside or wet meadow habitats on sub-irrigated alluvial soils (Spackman et al. 1997). Its known range is along the Front Range of the Rocky Mountains of Colorado, with outlying populations in Nevada, Wyoming, and Utah. In Wyoming, the orchid is known from the western Great Plains in Converse, Goshen, Laramie, and Niobrara Counties on portions of Antelope Creek, Horse Creek, and Niobrara River watersheds (Heidel 2007). Recent information from the Wyoming Natural Diversity Database (WyNDD) indicates that there are nine occurrences of Ute ladies'-tresses in Wyoming (Heidel 2007). The nearest known location of this plant to the MAA in 1995 was more than 35 miles from the Project Area in Daggett County, Utah, along the Green River (BLM 1995a).

A habitat occurrence study was conducted for the 1995 EIS (BLM 1995a), and probability of occurrence for Ute ladies'-tresses was determined to be "possible." Field reconnaissance trips were conducted to determine areas of potential habitat. Approximately 11,333 acres of "low-potential" habitat were identified for this orchid (BLM 1995a). Areas of potential habitat occurred primarily along the Hams Fork River, Blacks Fork River and its southern tributaries, and a narrow band along Slate Creek. WyNDD reports that 18 sections along the Blacks Fork River have been surveyed for Ute ladies'-tresses, but none are recorded (WyNDD 2006).

No orchids have been found during four contractor surveys conducted for energy and communications ROWs in the MAA. Project-specific surveys may be necessary in suitable mesic habitats.

3.8.1.4. Western Yellow-billed Cuckoo

The western population of the yellow-billed cuckoo is a candidate for federal listing. Although a population status review in 2001 determined that listing was warranted, the species was precluded from listing. The western populations of these cuckoos occur in relatively large, unfragmented stands of riparian habitat dominated by cottonwood and a well developed understory below approximately 7,000 feet elevation. The species' distribution, however, is patchy and fragmented into disjunct populations in the West (WyNDD 2005).

Suitable breeding habitat for the cuckoo consists of a mosaic of riparian vegetation, including healthy shrub or sapling thickets, multi-aged stands of trees, wet meadows, and open water. Mapped potential breeding distribution for the yellow-billed cuckoo includes portions of southwestern Wyoming in Lincoln, Sweetwater, and Uinta Counties, but its occurrence is considered "very rare" and transient or migratory (WyNDD 2005). Very little habitat for yellow-billed cuckoo may be present in the Hams Fork River floodplains and within the Green River corridor on the northern boundary of the MAA, where cottonwoods provide adequate cover.

The nearest documented sightings of yellow-billed cuckoo in the MAA vicinity occurred along I-80 approximately 28 miles west of the Project Area, along the Green River about 8 miles east of the Project Area, and along SH 414 approximately 2 and 16 miles from the Project Area boundary. Occurrence data received from WyNDD indicated that no yellow-billed cuckoos have been documented within the Project Area (WyNDD 2006).

3.8.2. Wyoming BLM Sensitive Species

The BLM is mandated to consider impacts to sensitive species on BLM-administered lands to ensure that activities do not contribute to the listing of any species under the provisions of the ESA. The Wyoming BLM maintains a list of sensitive species that facilitates directed species management efforts and habitat maintenance activities. The goals of the Wyoming sensitive species policy include:

- maintenance of sensitive species and habitat components in functional ecosystems within BLM-administered lands;
- consideration of sensitive species in BLM land management decisions;
- prevention of additional species listings under the ESA; and
- prioritization of conservation efforts for sensitive species and their habitats.

Those animal species listed for the KFO as sensitive that may occur in the MAA are presented in Table 3-24.

3.8.2.1. BLM Sensitive Bird Species

3.8.2.1.1. Raptors

Thirteen bird species listed as sensitive by the BLM were analyzed for their presence in the MAA (Table 3-24). The peregrine falcon, ferruginous hawk, burrowing owl, and northern goshawk are BLM sensitive raptors in the KFO. Some nesting areas used by sensitive raptor species on a long-term basis, especially by ferruginous hawks, exist within the MAA. Raptor nests are often associated with topographic features such as ridgelines, rock outcrops, and prominent trees surrounded by open country.

Peregrine falcons nest on cliffs or ridges near open country and/or water, where they primarily hunt birds. A peregrine falcon was recorded in the spring of 1997 in the Seedskadee NWR in the northeast corner of the MAA (WyNDD 2006). Three peregrine falcon sightings have been documented in the region, but outside the MAA boundary.

Ferruginous hawks prefer open country where they can detect prey from the air. They nest in trees, large shrubs, and occasionally on the ground on a ledge, riverbank, or hillside (Udvardy 1977). Suitable habitat for this species, in the form of shrub-steppe and shortgrass prairie, occurs throughout the MAA. Ferruginous hawks have been documented throughout the MAA (Map 3-7) and have been primarily associated with topographic features such as benches, ridgelines, and mesas (BLM 1995c).

Burrowing owls almost exclusively associate themselves with prairie dog colonies and use the burrows for nesting. These small raptors return from migration during late March and April and are known to re-use previous nesting areas. Several white-tailed prairie dog colonies occur throughout the Project Area, and many sightings of burrowing owls were made in the MAA during contractor surveys in 1994, including eleven active burrows (BLM 1995c). Documented burrowing owl activity is greatest in Whiskey Basin, located in the northeast section of the Project Area, where prairie dog colonies are most dense. Other documented owl activity occurs near Zieglers Wash and Muddy Creek (BLM 1995c).

A few sightings of northern goshawk have been recorded along the Green River east of the Project Area, and some to the west in the CIAA. These were likely migrating goshawks. Mature conifer and aspen forest required by northern goshawks are not present in the MAA; therefore, this species would not be expected to occur in the Project Area.

Table 3-24. BLM Kemmerer Field Office Sensitive Animal Species and Potential Occurrence in the MAA, 2006.

Species Common Name	Scientific Name	Occurrence within MAA
Birds		
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Possible
Peregrine falcon	*Falco peregrinus*	Occasional
Ferruginous hawk	*Buteo regalis*	Known
Northern goshawk	*Accipiter gentilis*	Occasional
Burrowing owl	*Athene cunicularia*	Known
Greater sage-grouse	*Centrocercus urophasianus*	Known
Long-billed curlew	*Numenius americanus*	Occasional
Loggerhead shrike	*Lanius ludovicianus*	Known
Sage thrasher	*Oreoscoptes montanus*	Known
Brewer's sparrow	*Spizella breweri*	Known
Sage sparrow	*Amphispiza belli*	Known
White-faced ibis	*Plegadis chihi*	Occasional
Trumpeter swan	*Olor buccinator*	Likely, Introduced
Mammals		
Long-eared myotis	*Myotis evotis*	Possible
Pygmy rabbit	*Sylvilagus idahoensis*	Known
White-tailed prairie dog	*Cynomys leucurus*	Known
Idaho pocket gopher	*Thomomys idahoensis*	Unlikely
Amphibians		
Northern leopard frog	*Rana pipiens*	Known
Great Basin spadefoot	*Spea intermontana*	Known
Boreal chorus frog	*Pseudacris maculata*	Likely
Fish		
Bonneville (or Bear River) cutthroat trout	*Oncorhynchus clarki utah*	Introduced
Colorado River cutthroat trout	*Oncorhynchus clarki pleuriticus*	Possible
Snake River (or fine-spotted) cutthroat trout	*Oncorhynchus clarki*	Introduced
Roundtail chub	*Gila robusta*	Known
Flannelmouth sucker	*Catostomus latipinnis*	Known
Bluehead sucker	*Catostomus discobolus*	Known
Leatherside chub	*Gila copei*	Unlikely

Known – resident or breeding populations documented in Project Area.
Likely – no populations documented in Project Area but populations present in vicinity or CIAA and suitable habitat occurs in Project Area.
Unlikely – no populations in vicinity or habitat does not occur in Project Area.
Occasional – documented occurrences in Project Area or CIAA likely to be migratory.
Possible – suitable habitat could occur in Project Area and presence in area is possible.
Introduced – populations not native to Project Area, or have been introduced to augment existing populations.

3.8.2.1.2. Greater Sage-Grouse

Widespread declines in greater sage-grouse populations throughout the West led to a petition to list the species as threatened under the ESA. Because a large portion of sage-grouse habitat occurs on Public Lands managed by the BLM, this species' welfare and management is of significant concern to the agency. A 2003 USFWS decision determined that federal listing was not warranted. The Wyoming Greater Sage-Grouse Conservation Plan concluded that using the concepts of rangeland health as a management philosophy and maintaining a mosaic of vegetation seral stages would be most beneficial to sustaining sage-grouse populations (WSGWG 2003). Techniques include improving reclamation practices for disturbed areas by including vegetation preferred by sage-grouse, aggressively fighting noxious weed spread, and managing grazing plans to assure compatibility of livestock and sage-grouse. WGFD manages sage-grouse, along with other upland game birds, in three management areas within the MAA: Seedskadee (Area 4), Uinta (Area 5), and Flaming Gorge (Area 6). These areas correlate closely with big game herd units and are divided by the major highways I-80 and US 30. The areas encompass over five million acres and make up the CIAA for sage-grouse.

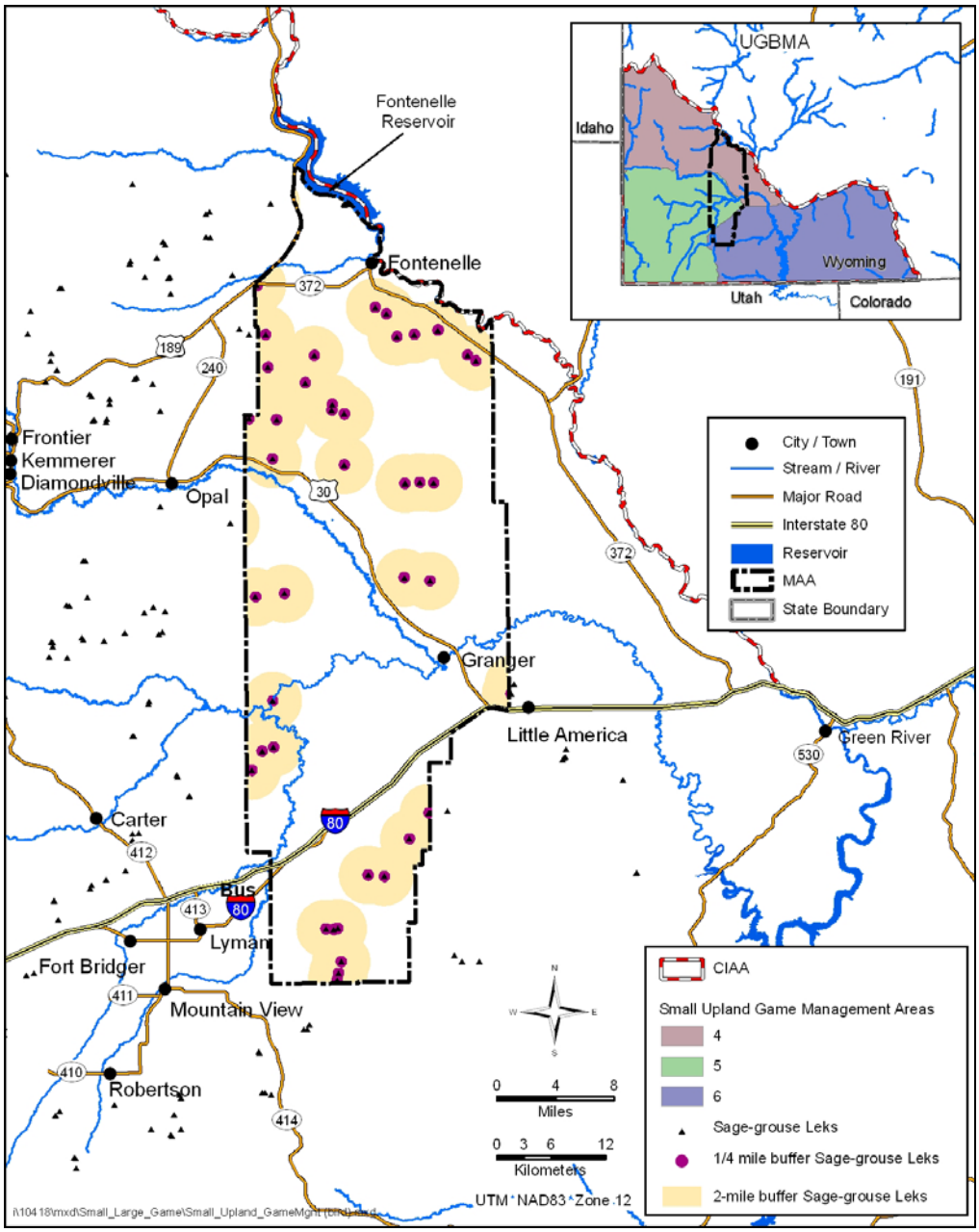
The sage-grouse depends almost exclusively on healthy sagebrush habitat for year-round survival. Also important is the presence of grasses and forbs in the understory (WSGWG 2003). Plant composition and condition, spatial arrangement on the landscape, and seasonal availability are the habitat components most important for sage-grouse. Habitat quantity and quality determine whether the population is migratory or year-round in a specific area. Leks (breeding display areas) typically occur in open areas surrounded by sagebrush. Nesting habitat in Wyoming is generally described as sagebrush that has a canopy cover between 15 and 30 percent and height between 11 and 32 inches. Brood-rearing habitat consists of open sagebrush with a greater abundance of forbs. Sagebrush cover is typically between 10 and 25 percent and has slightly higher grass and forb cover than that of nesting habitats. Greater sage-grouse are sensitive to disturbance during the breeding nesting and early brood rearing timeframes; therefore, the BLM has developed seasonal stipulations for activities within these habitats.

Sagebrush tall enough to have leaves and buds above the snow line provides the sage-grouse winter diet, and populations tend to return to historically used winter areas. Theses birds make use of shorter shrubs for roosting on non-stormy nights. Roosting and winter-feeding sites can be as far as 5 miles and 1,000 feet in elevation apart (WSGWG 2003). The WGFD is in the process of mapping sage-grouse winter habitat (Christiansen 2005).

Because sage-grouse are of value as a game species and are classified as BLM sensitive, the BLM and WGFD have compiled sage-grouse lek information in Wyoming for many years. Sage-grouse population levels; lek activity, numbers and sizes; and level of survey effort have varied annually. In 2004, a team of experts assessed the status of sage-grouse and its habitat across 11 U.S. states and one Canadian province (Connelly et al. 2004). The resulting data summary suggests an overall declining sage-grouse population in Wyoming. Sage-grouse numbers throughout Wyoming fell to a record low in the mid 1990s, recovered by 2000, and then fell again as drought affected habitat in the early 2000s. A WGFD 2004 sage-grouse statewide trend analysis detected stabilization in breeding populations in 2003, with a slight increase in 2004 after the 2000-2002 drought affected populations (Christiansen 2004).

Suitable habitat for breeding, brood rearing, and winter-feeding occurs throughout the MAA and vicinity. Total potential habitat includes available sagebrush/desert shrub vegetation, which covers 316,800 acres in the MAA. Approximately 6,200 acres of this habitat is already disturbed by past oil and gas development activities. Disturbance could be higher than the 6,200 acres in some areas of the core and flank because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a). Lek concentrations occur in northern, west-central, and southern portions of the MAA (Map 3-13). A total of 41 occupied leks currently exist in the MAA as

of 2006 (Map 3-13). WGFD defines "occupied" as having been used by sage-grouse for breeding within the previous 10 years. BLM defines a lek as "occupied" if it has been used by sage-grouse for at least 1 season within the last 10 years. Management protections are applied to "occupied" leks, including stipulations within a 2-mile buffer (173,332 acres of the MAA).



Map 3-13. Sage-Grouse Lek Locations and Range in the MAA and CIAA.

3.8.2.1.3. Sagebrush Obligate Birds

Sagebrush obligates are species that depend on stands of big sagebrush during at least a portion of their life cycle. Sagebrush obligate birds that are also listed as BLM sensitive include the sage thrasher, Brewer's sparrow, and sage sparrow. Sagebrush shrublands that may contain suitable habitat for these species are shown on Map 3-6. U.S. Geological Survey (USGS) North American Breeding Bird Survey (NABBS) information indicated a relatively high annual average number of sightings for sage thrasher, Brewer's sparrow, and sage sparrow for their Seedskadee NWR route over 37 years of

surveys (Sauer, Hines, and Fallon 2005). State NABBS trend data indicate that populations of these species have remained relatively stable over the survey period.

The Brewer's sparrow, a summer resident in Wyoming, is a sagebrush obligate that depends on relatively flat shrub-steppe habitats from the Great Plains states west to Arizona and Nevada. Surveys have shown that large populations of Brewer's sparrows occur in southwestern Wyoming, primarily where dense sagebrush stands have an average canopy height of less than 5 feet (Hansley and Beauvais 2004a). Nests are often placed in the largest shrubs within the densest stands of a large patch. This habitat profile is similar to that of the greater sage-grouse and occurs within the Project Area. Brewer's sparrows have been documented in the southern MAA, in the Seedskadee NWR, and east of the Project Area along the Green River.

Known breeding distribution of the sage sparrow, a summer resident in Wyoming, was mapped in southwestern Wyoming, peaking in Sweetwater County (Hansley and Beauvais 2004b). This songbird occurs in sagebrush habitats during the breeding season, and correlations have been made between bird density and height and density of big sagebrush. To attract sage sparrows, a sagebrush stand needs to encompass at least 30 acres. Breeding pairs typically have 5-acre territories (Hansley and Beauvais 2004b). A pair will often choose the tallest live shrubs in the densest stands for its nest site, similar to Brewer's sparrows. Sage sparrows likely inhabit portions of the Project Area during the breeding season where large, undisturbed sagebrush stands remain.

The breeding distribution of the sage thrasher, a summer resident in Wyoming, includes shrub-steppe communities dominated by big sagebrush at elevations between 4,200 and 6,700 feet, and was mapped as occurring in southwestern Wyoming (Buseck, Keinath, and McGee 2004). This bird seems to prefer plant stands that are approaching climax condition and are less disturbed than surrounding areas (Buseck, Keinath, and McGee 2004). Sage thrashers typically place their nests within or under mature, living shrubs with good basal cover. Foraging habitat contains a diversity of shrubs, forbs, and grasses in an open understory within 5 meters (16.4 feet) of the nest (Buseck, Keinath, and McGee 2004). A nesting population of sage thrashers requires at least 100 hectares (247 acres) to persist, with reported densities of less than one sage thrasher per hectare (Buseck, Keinath, and McGee 2004). This information indicates that increased habitat fragmentation would impact sage thrashers and likely other sage obligate species by reducing the number of suitable sized nesting areas.

3.8.2.1.4. Other Sensitive Birds

Mountain Plover

Suitable breeding habitat for this member of the shorebird family often overlaps with that of prairie dogs and consists of shortgrass prairie. Mountain plover habitat can include active livestock grazing allotments and even heavily grazed areas, as this species evolved with bison. Mountain plover are frequently found in xeric upland flats and slopes with pebbly soils and low-growing or no vegetation, and in lowland flats with little to no vegetation. These birds arrive in Wyoming in early April to establish breeding territories.

The Wyoming population of mountain plover is estimated at fewer than 1,500 (WyNDD 2005). Overall western populations declined at an estimated annual rate of 3.6% from 1966 to 1991, due to conversion of grassland to agricultural and other developments (Knopf 1995). During wildlife surveys for the 1995 Moxa EIS, 15 individual mountain plover sightings were recorded, primarily in the central Project Area (BLM 1995c). It was determined that suitable habitat for nesting and foraging mountain plovers was plentiful within or near prairie dog colonies in the MAA, and the presence of juvenile birds confirmed breeding (BLM 1995c).

Since 2001, nine mountain plover surveys were conducted along various pipeline and fiber optic ROWs, and numerous habitat suitability studies were combined with other species surveys in the

MAA. Positive results from surveys conducted during 2002, 2004, and 2005 indicate that the Cow Hollow area in the northern portion of the MAA is an active mountain plover breeding area (Aster Canyon Consulting 2005; Buys and Associates 2002; Dana Consultants 2004). Although many portions of the Project Area have not been surveyed for this species, suitable habitat may exist.

Long-Billed Curlew

Wyoming populations of this species fluctuate widely; however, significant declines have occurred during the last century, primarily due to habitat loss (Dark-Smiley and Keinath 2004). This species' preferred nesting areas include shortgrass and mixed-grass prairie grasslands near open water, which is rare in the MAA. Taller grass areas and shrublands may be used during brood rearing for cover. Summer habitat includes agricultural lands such as plowed fields and pastures. Long-billed Curlew have been recorded along agricultural lands along the Ham's Fork River (Roberts 2003). State distribution is sparse and patchy, with the most consistent breeding areas in the state occurring in irrigated meadows of the upper Green River Basin near Pinedale (Dark-Smiley and Keinath 2004). A recent population was documented on the Hams Fork drainage north of Kemmerer (WyNDD 2005). Long-billed curlews have also been recorded in areas outside the MAA to the southwest and northeast. Of the grassland endemic birds, only the long-billed curlew was recorded during the NABBS survey of the Seedskadee NWR route.

White-Faced Ibis

The white-faced ibis was a Category 2 federal candidate in 1995 when the original Expanded Moxa Arch EIS was written. White-faced ibis have been observed in the MAA, primarily along the Green River in the Seedskadee NWR and southwest of the MAA. The species primarily occupies wet meadows and shallow water associated with seasonal playas and perennial streams and rivers, which is uncommon in the MAA. White-faced ibis may pass through the area to rest or feed during migration. The species was not seen during wildlife surveys for the EIS (BLM 1995c). WyNDD data include one record of a white-faced ibis in the northeast portion of the Project Area in 1983 (WyNDD 2006).

Trumpeter Swan

The trumpeter swan was not analyzed in the 1985 RMP/EIS or in the 1995 EIS. Trumpeter swan sightings are frequent along the Green River northeast of the Project Area. Since 1994, the WGFD, in cooperation with the Wyoming Wetland Society, has been releasing captive-raised swans in the Green River Basin to increase the species' range in western Wyoming (outside the established Greater Yellowstone population). A WGFD 2003 press release reported 30 adult swans and 20 cygnets (young of the year) from the Upper Green River Basin to Seedskadee NWR. Few swans used the Green River drainage prior to the restoration project, but the 2003 flock comprised 30% of the state's adult summer population and contributed 50% of the state's cygnets. Swans would not be expected to spend time in the Project Area beyond stopping at open water areas (e.g., Hams or Blacks Fork Rivers) to rest or feed during migration.

Loggerhead Shrike

The loggerhead shrike has been recorded in Uinta, Lincoln, and Sweetwater Counties in Wyoming (Keinath and Schneider 2005). This species prefers open country with scattered trees and large shrubs at lower elevations, relative to surrounding topography. For nesting, presence of dense shrubs or trees with open herbaceous areas for foraging nearby seems to be important. Loggerhead shrikes have been known to inhabit fencerows between pastures, old orchards, mowed roadsides, cemeteries, and other human-influenced areas, but are not likely to nest in these areas (Keinath and Schneider 2005). Loggerhead shrike observations were frequently collected in the MAA during ground surveys for prairie dogs (BLM 1995c). The majority of sightings occurred in the central Project Area and were associated with brushy areas containing trees and shrubs taller than 6 feet. It is likely that loggerhead shrike nest throughout the Project Area (BLM 1995c).

3.8.2.2. BLM Sensitive Mammals

Four mammal species listed as BLM sensitive were analyzed for their presence in the MAA (Table 3-24). White-tailed prairie dog was discussed previously in association with Black-footed ferret and burrowing owls. The other three mammal species are discussed below.

3.8.2.2.1. Long-Eared Myotis

The long-eared myotis inhabits coniferous forests across Wyoming up to 9,300 feet elevation. This bat uses bark, tree cavities, stumps, caves, and buildings for resting/roosting spots. Where trees are less plentiful, it will use crevices in cliffs, rocks, abandoned mines, and occasionally buildings and bridges. Long-eared myotis forage along streams and reservoirs and usually roost near water. It is unknown whether they inhabit the MAA, but the numerous rocky ridgelines provide potential roosting habitat; water is less common and would be the limiting factor. Long-eared myotis have been recorded on Seedskadee NWR and along the Green River approximately 20 miles east of the MAA.

3.8.2.2.2. Pygmy Rabbit

The pygmy rabbit prefers habitat that includes big sagebrush, rabbitbrush, and sometimes greasewood interspersed with grasses and forbs up to 7,000 feet elevation in the Great Basin. In the MAA, pygmy rabbit prefer sandy dune areas with tall sagebrush. Suitable foraging and shelter habitat consists of taller, evenly distributed dense stands of big sagebrush that grow between 6,200 and 7,350 feet elevation (Purcell and Hubert 2005), making this species a sagebrush obligate. Pygmy rabbits dig burrows in loose soils that extend to a depth of one meter and contain chambers for resting and nesting. Burrows may have several entrances, and several rabbits may share entrances/burrows. Because of the loss of dense sagebrush stands, pygmy rabbit numbers have been declining across their range. In 2003, a petition to list the rabbit under the ESA was filed, but the USFWS concluded in May 2005 that a lack of sufficient scientific evidence precluded a detailed review of the species.

Few surveys have targeted the pygmy rabbit, so little is known about populations and distribution within Wyoming. A University of Wyoming modeling effort showed known and predicted pygmy rabbit distributions converging in southwest Wyoming in the vicinity of the MAA (Keinath and Thurston 2005). The entire Project Area lies within the mapped range of the species (BLM 1995c), however, most of the dense sagebrush in the MAA is not considered suitable habitat for the pygmy rabbit due to the clayey nature of the soils. Pygmy rabbit sightings were mapped in the MAA for the BLM EIS during prairie dog colony surveys (BLM 1995c). A burrow study that included a small portion of the northern Project Area mapped 29 burrows being used by, and likely constructed by, pygmy rabbits. The majority of contractor sightings have occurred in the northern half of the MAA. A survey for the Rendezvous Gas Phase V Pipeline in the central Project Area indicated the presence of several pygmy rabbits along the route (O & G Environmental Consulting 2005). BLM has been requiring surveys since 2005 when potential habitats are identified through onsite inspections of oil and gas developments. Protocol requires that the Operators survey the locations prior to construction and two years of follow-up surveys to study the impacts of construction on this species. Sizeable populations were observed during 2006 surveys in the vicinity of Church Buttes and Shute Creek.

3.8.2.2.3. Idaho Pocket Gopher

The Idaho pocket gopher was not analyzed in the 1985 RMP or in the 1995 EIS. This rodent was only recently described as a species separate from the northern pocket gopher (*Thomomys talpoides*). The species is only known to occur in two counties of Utah and in limited areas of Idaho, Montana, and Wyoming. This gopher inhabits shrub steppe, grasslands, and subalpine mountain meadows, but favors shallow, rocky soils (in contrast to the northern pocket gopher, which prefers deeper, less rocky soils) in sagebrush, sage-grasslands, and mountain meadows. No records of the species occur in the MAA.

3.8.2.3. BLM Sensitive Amphibians

Three amphibian species listed as BLM sensitive were analyzed for their presence in the MAA (Table 3-24).

3.8.2.3.1. Northern Leopard Frog

This species, formerly abundant across its range, has undergone population declines or has become locally extinct in many parts of the western U.S. (Smith and Keinath 2004). This includes portions of western Wyoming, although the species may still be common locally and in other parts of the state. The northern leopard frog is found in swamps or marshes at lower elevations on the plains, to beaver ponds in higher montane zones in Wyoming at elevations up to 9,000 feet (Cervoski et al. 2004). This species requires permanent standing water for egg laying, which occurs around limited areas of perennial waters in the Project Area. Factors that may contribute to species vulnerability are its dependence on small ponds for breeding, predation by introduced fish, and susceptibility to disease and environmental toxins (Smith and Keinath 2004). This species has been documented in the MAA.

3.8.2.3.2. Boreal Chorus Frog

The boreal chorus frog, a subspecies of the western chorus frog, occurs throughout Wyoming, including central Lincoln County in the Bridger-Teton National Forest. The preferred habitat of this species is marshes, ponds, and small lakes with perennial water sources (Cerovski et al. 2004). Boreal chorus frogs have been affected by *Chytrid* fungus in Colorado, and effects to Wyoming populations are currently unknown. Populations have not been documented in the MAA.

3.8.2.3.3. Great Basin Spadefoot

This species occurs in habitats that are drier than those required by most amphibians. These habitats include grasslands and sagebrush steppes at elevations below 6,000 feet, west of the Continental Divide. Distribution of the species in Wyoming is patchy, but does include Sweetwater, Uinta, and Lincoln Counties (Buseck, Keinath, and Geraud 2005). Abundance of the spadefoot is unknown across its range but is considered relatively stable. As with most amphibians, the Great Basin spadefoot requires access to ephemerally flooded areas for breeding; therefore, its natural habitat is limited in the MAA by the lack of available water. However, suitable habitat is present around springs, seeps, playas, and stock ponds in the Project Area, and two records of the species exist from summer 2005 (Crews 2006).

3.8.2.4. BLM Sensitive Fish

Seven fish species listed as BLM sensitive were analyzed for their presence in the MAA (Table 3-24). Perennial and ephemeral streams within the MAA that are able to support fish species are the Hams Fork River, Blacks Fork River, Slate Creek, Muddy Creek, Smiths Fork River, and Cottonwood Creek.

3.8.2.4.1. Colorado River Cutthroat Trout

The Colorado River cutthroat trout is the only salmonid species native to the MAA and Green River Basin. However, other cutthroat species likely have been introduced by the WGFD as part of fisheries management programs. The Colorado River cutthroat trout requires cold, clear water in rocky, steep-gradient streams. Although this game fish is rare, it has been recorded in the Green River and its tributaries, including the Blacks Fork River just east of the Project Area in 1997 (WyNDD 2006). The Bonneville and Snake River cutthroat trout are not native to the Project Area.

3.8.2.4.2. Roundtail Chub

This species prefers large rivers or lakes of the Colorado River drainage, primarily inhabiting slow-moving waters adjacent to areas of faster water (Woodling 1985). Roundtail chubs spawn in early summer and feed on terrestrial and aquatic insects, algae, and small fish. The roundtail chub has been

documented in the MAA, specifically in the Blacks Fork River, the Green River near Fontenelle, and near the confluence of the Blacks Fork and Hams Fork Rivers (WyNDD 2006).

3.8.2.4.3. Flannelmouth Sucker

The flannelmouth sucker has been recorded in the Hams Fork and Blacks Fork Rivers within the MAA. It also occurs in large rivers, including the Green River, and in smaller streams and lakes, including Flaming Gorge Reservoir (WyNDD 2006). This species inhabits riffles, runs, eddies, and backwaters as a bottom feeder preying on invertebrates (Woodling 1985). Flannelmouth suckers spawn in May to early August, and young move to shorelines.

3.8.2.4.4. Bluehead Sucker

The bluehead sucker is found in a variety of habitats from headwater streams to large rivers, preferring moderate to fast currents (Woodling 1985). These suckers feed on algae, invertebrates, and other materials on stream bottoms. The species spawns in spring or summer, but little is known about their breeding habits (Woodling 1985). The bluehead sucker was recorded in the Blacks Fork River within the Project Area. It is a rare resident of larger streams and rivers in several western Wyoming drainages (WyNDD 2006).

3.8.2.4.5. Leatherside Chub

The leatherside chub is found in pools of clear, cool streams with relatively calm waters of the Upper Snake River drainage, including Bear River in Uinta County (WyNDD 2006). This chub occurs in scattered populations that may no longer have connectivity due to drought, stream dewatering, dams, and introduced predatory species (State of Utah 2006). This fish species has not been recorded in the MAA (WyNDD 2006) and is not native to the Project Area.

3.8.2.5. BLM Sensitive Plants

Eight plant species listed as BLM-sensitive were evaluated for potential to occur in the MAA (Table 3-25). Southwest Wyoming has the highest concentration of endemic plant species in the state (WyNDD 2006).

Table 3-25. BLM Kemmerer Field Office Sensitive Plant Species Evaluated for the MAA, 2006.

Common Name	Scientific Name	Occurrence within MAA
Trelease's racemose milkvetch	*Astragalus racemosus* var *treleasei*	Likely
Entire-leaved peppergrass	*Lepidium integrifolium* var *integrifolium*	Possible
Large-fruited bladderpod	*Lesquerella macrocarpa*	Likely
Manyhead or western bladderpod	*Lesquerella multiceps*	Unlikely
Low bladderpod	*Lesquerella prostrata*	Possible
Beaver Rim phlox	*Phlox pungens*	Possible
Tufted twinpod	*Physaria condensata*	Possible
Dorn's twinpod	*Physaria dornii*	Possible

Likely – no documented occurrence in Project Area but documented occurrence in vicinity or CIAA and suitable habitat occurs in Project Area.
Unlikely – no documented occurrence in vicinity or habitat does not occur in Project Area.
Possible – suitable habitat could occur in Project Area and presence in area is possible.

Geology, topography, elevation, moisture regimes, and soil types are all used to determine suitable habitat for sensitive plants. Special-status plants were included in habitat analyses for the 1995 EIS but included only two of the currently listed BLM sensitive species (large-fruited bladderpod and Beaver Rim phlox), and the federally listed Ute ladies'-tresses orchid (see Section 3.8.1.4). All three plants were determined to have suitable habitat extensive enough to map on a large scale within the MAA (ECOTONE Environmental Consulting 1995).

GIS data compiled by the BLM from 1987 through 2000 for the MAA and vicinity indicated that none of the eight BLM sensitive plant species in Table 3-25 are known to occur within the MAA. Data received from the WyNDD confirmed no records of the BLM sensitive plants within the MAA (WyNDD 2006). The nearest known location of one of these plant species is for the Trelease's racemose milkvetch, which occurred approximately 2 and 7 miles west of the Project Area near I-80. A mapped occurrence of the large-fruited bladderpod occurred about 5 miles west of the MAA. Other known locations of these sensitive plants occur farther north, west, and southwest of the Project Area.

3.8.2.5.1. Trelease's Racemose Milkvetch

Trelease's racemose milkvetch is only known to occur in Colorado and Wyoming (Schroeder 2005), and in northeast Utah (WyNDD 2005). Distribution in Wyoming is limited to the Green River Basin in Uinta County and eastern foothills of the Wyoming Range in Sublette County. This milkvetch prefers outwash flats and fluted badland slopes derived from shale at elevations between 6,500 and 8,300 feet (WyNDD 2005).

3.8.2.5.2. Entire-leaved Peppergrass

Entire-leaved peppergrass has been recorded only in Wyoming, Colorado, and New Mexico (Schroeder 2005). This species is considered critically imperiled because of extreme rarity both in Wyoming and globally, and it is known from less than five occurrences (WyNDD 2006). It has been recorded in Lincoln and Uinta Counties in areas near water dominated by saline vegetation, such as greasewood and saltbush.

3.8.2.5.3. Large-fruited Bladderpod

The large-fruited bladderpod is endemic to the western edge of the Great Divide Basin (Fertig, Refsdal, and Whipple 1994). Suitable habitat (low potential) for this low-growing, biennial herb has been mapped along Slate Creek, in the Shute Creek drainage, in Seven Mile Wash, around and south of the Blacks Fork River, and near Granger (ECOTONE Environmental Consulting 1995). Suitable habitat occurs on barren gypsum-clay hills, benches, and flats, between 7,200 and 7,700 feet elevation (Fertig, Refsdal, and Whipple 1994).

3.8.2.5.4. Manyhead Bladderpod

The manyhead, or western, bladderpod occurs on dry, gravelly limestone ridges and slopes with thin pockets of soils (WyNDD 2005). This species is only known from one record in Wyoming, in extreme northwestern Lincoln County in the Targhee National Forest. It is not likely to occur in the MAA.

3.8.2.5.5. Low or Prostrate Bladderpod

Low or prostrate bladderpod has been documented only in Lincoln and Uinta Counties in Wyoming, but it also occurs in Idaho and Utah. This plant occurs on dry, sparsely vegetated desert slopes of limey clays and soft sandstones of the Green River, Wasatch, and Bridger Formations (Fertig 2000).

3.8.2.5.6. Beaver Rim Phlox

The Beaver Rim phlox is a perennial herb endemic to Fremont and Sweetwater Counties in the Wind River Basin of Wyoming (Fertig, Refsdal, and Whipple 1994). Suitable habitat (low potential) was mapped across the northern MAA throughout the Slate Creek drainage south of Fontenelle Reservoir,

in the headwaters of Seven Mile Wash, and in the western portion of the Project Area around Hams Fork (ECOTONE Environmental Consulting 1995). Habitat for this phlox contains sparsely vegetated slopes on sandstone, siltstone, or limestone substrates between 6,000 and 7,400 feet (Fertig, Refsdal, and Whipple 1994). This plant can grow on semi-barren, rocky desert hill slopes of bedrock, usually of the Amsden and Phosphoria Formations.

3.8.2.5.7. Dorn's and Tufted Twinpods

These species prefer similar soil types of shale on dry ridges or slopes, with the tufted twinpod having few plant associates and the Dorn's growing with mountain-mahogany and rabbitbrush at elevations up to 7,200 feet (Fertig, Refsdal, and Whipple 1994). The tufted twinpod is known to occur only in three Wyoming counties (Lincoln, Sublette, and Uinta) and inhabits sparsely vegetated calcareous or shale slopes and ridges between 6,500 and 7,000 feet elevation (Fertig, Refsdal, and Whipple 1994). As of 2002, the tufted twinpod was considered to be stable, as several known populations are currently protected in Fossil Buttes National Monument and on BLM-managed lands (Fertig 2002).

3.9. Cultural and Historical Resources

Cultural and historical resources, which are managed pursuant to the National Historic Preservation Act of 1966 (NHPA), the Archaeological Resources Protection Act of 1979 (ARPA), and other statutes, are the nonrenewable remains of past human activity. The following sections discuss the cultural and historical resources within the MAA.

Cultural setting and a historic overview specific to the BLM KFO planning area are provided in the *Cultural Resources Class I Regional Overview for the BLM Kemmerer Planning Area, Wyoming* (BLM 2004a). This document encompasses and references cultural and historical resources within the MAA. Specifically, cultural setting and historic overview for the region and applicable to the MAA are provided in the "Cultural Chronology" section of that document (BLM 2004a). There, like previous EIS documents for the MAA, the Class I regional overview describes previous cultural resource investigations applicable to the area within context of the greater Green River Basin geographic subregion (BLM 2004a). Specifically, the Class I Regional Overview explains:

> This subregion contains the greatest concentrations of cultural resources in the planning area, largely because its eastern portion is the Moxa Arch Natural Gas Field where more than half of the cultural inventories in the planning area have been conducted over the past 30 years. However, the tremendous densities of prehistoric camps, lithic scatters and archeological landscapes are certainly reflections of concentrated ancient land use, in which prehistoric occupants utilized a variety of critical resources that occurred throughout the basin for thousands of years (BLM 2004a).

Both the Expanded Moxa Arch DEIS (BLM 1995a) and the Class I Regional Overview summarize the existing cultural resource database for the Green River Basin subregion. These summaries recognize the Wyoming Cultural Records Office (WYCRO), administered by Wyoming SHPO, as the comprehensive repository for records of previous cultural resource investigations and data in the subregion. Additionally, the Class I Regional Overview provides a discussion of the limitations of that best-available database. Because previous cultural resource investigations and data for the subregion containing the MAA are fully, adequately, and recently summarized within other resource management documents, this information is not fully repeated here. For a general understanding of the cultural resources in this area, the Class I Regional Overview (BLM 2004a) and the Expanded Moxa Arch DEIS (BLM 1995a) can be referenced.

3.9.1. Cultural Resources Overview

The cultural resource and archaeological record of the MAA has been identified and established through Class III cultural resource inventories (100% coverage pedestrian surveys), informal surveys, construction monitors, test excavations, salvage excavations, formal data recovery excavations, examination of ethnographic materials used to determine ethnic origin, local informant interviews, consultation with modern Native Americans, archival sources, and the historic record. Cultural/historical resources are already affected by infrastructure and mineral field development in the MAA core, although levels of disturbance do diminish outward from the core into the flank. Approximately 5,105 sites have been recorded as of 2004 (BLM 2004a) within the Green River Basin subregion, and approximately 2,768 as of April 2006 for the MAA, according to the WYCRO database. Of the 5,105 cultural sites in the Green River subregion, 4,720 were prehistoric and 385 were historic; of these, 117 are multi-component prehistoric/historic sites (BLM 2004a).

3.9.1.1. Site Types

Cultural resources are normally identified as tangible properties, which are generally defined within a range of site types. Of the 2,768 known cultural properties within the MAA, the majority are prehistoric archaeological sites. The Class I Regional Overview estimated that, across the entire Green River Basin subregion, approximately one known site occurs per each 9 acres (an average of 71 sites per section). Over half of all previous inventories occurred in the MAA where, resultantly, the greatest concentrations of cultural and historic sites in the Green River subregion have been identified (BLM 2004a). The MAA has a relatively high density of prehistoric archaeological sites, but the historic period sites, though less numerous, are also significant, with some area historic resources being of National Landmark quality.

3.9.1.2. Prehistoric Site Types

The Expanded Moxa Arch DEIS (BLM 1995a) summarizes the range of prehistoric site types in the subregion within broad classifications generally useful for comparison of sites. The five specific site types identified include:

> Lithic Scatter: Lithic scatters are defined by the presence of chipped stone debitage and/or chipped stone tools. The sites contain no features or evidence of features (fire-cracked rock). In terms of cultural behavior, these sites represent short duration activities, although the site may have been used more than once. The sites are primarily associated with the production of stone tools.
>
> Open Camp: Open campsites contain evidence of a broader range of activities, including residential locations associated with the collection, processing, and consumption of food resources. The site may contain lithic debitage, chipped stone tools, ground stone tools, and pottery.
>
> Quarry: Sites defined as quarries are locations where unmodified raw tool stone was collected and initially processed. In the Moxa analysis area, this includes both primary and secondary deposits of suitable material. The Green River and Bridger formations contain numerous chert-bearing members that were exploited by the aboriginal populations. In some geologic settings, chert and quartzite specimens have been secondarily redeposited as lag cobbles.
>
> Rock Art: Rock art sites are rare in the analysis area. These sites consist of either painted (pictographs) or pecked/incised designs. The designs consist of both geometric and anthropomorphic motifs. These sites are thought to represent religious or ceremonial locales. There is a single rock art site in the analysis area.

Features Only: Sites that are grouped into this category consist solely of features and lack any other associated portable cultural material.

Sites that do not fit one of the categories described above are typed as 'other' and include few actual sites. The above site descriptions are based on the remains as they appear at the time of documentation and on interpretation of site situation at that time. More nuanced characteristics of site types and "composite" site types are tabulated for the Green River Basin subregion in the Class I Regional Overview (BLM 2004a). Although the Class I Regional Overview describes several additional site types, these can all be conformed to the Expanded Moxa Arch DEIS site types.

3.9.1.3. Historic Site Types

The Expanded Moxa Arch DEIS summarizes the range of historic site types in the subregion based on category of general use. That document and the Class I Regional Overview both identify the following eight historic site types: general historic debris, stockherding sites, urbanism/tourism sites, homestead/ranch sites, burials, irrigation canals, transportation sites, and mineral exploration/extraction sites. Sites that do not fit these categories are classified as 'unassigned' site types.

General historic debris sites: These sites contain historic artifacts and refuse of usually unidentifiable functional association or they occur as litter or dumps along transportation routes or other convenient locales. Stock herding sites are similar to historic debris sites, except they tend to contain artifacts or positioning suggestive of association with livestock tending, such as a sheepherder's camp. Although hundreds of these archaeological site types are recorded in the MAA, due to their ubiquity and general inability to produce a useful contribution to knowledge of regional history, as a class they have been excluded from formal future recordation requirements under the 2006 State Protocol agreement between the Wyoming BLM and SHPO.

Urbanism/tourism sites: These sites include abandoned and occupied town sites and associated municipal areas (BLM 1995a). The original location of Little America, an urbanism/tourism site, is within the MAA (BLM 1995a). Mine exploration and extraction sites tend to be industry rather than settlement focused, such as mineral processing or milling sites. Ranching and homesteading sites are those considered as historic occupation sites, as defined by the Expanded Moxa Arch DEIS (BLM 1995a). Irrigation sites, such as canals, are often associated with these latter occupation sites, as may be some historic burials. The historic Whitney Cemetery is located within the MAA. Some historic burials may also be associated with transportation sites. Transportation sites include historic trails, highways, and railroads. Historic trails that cross the MAA include the Emigrant (Oregon/California/Mormon) Trails and their alternate routes, such as the Slate Creek Cutoff, Hams Fork Cutoff, and the Blacks Fork Cutoff. Later stage, freight, mail, and military routes, like the Overland Trail and the Pony Express trails, also traverse the area. The following is an excerpt from the 1995 DEIS:

> Emigrant graves, debris scatters, stage stations, and pristine ruts are found along the trails. Local topographic features, such as Church Butte, were popular camping places along the Oregon Trail. The old Lincoln Highway (US 30) is recorded in the area.… The 1868 Union Pacific railroad mainline traverses the analysis area. There are also a number of Union Pacific camps (Verne, Church Buttes, Granger) associated with the mainline. The 1880s Oregon Shortline and associated section camps (Nutria, Moxa, Donovan, Hassett) are within the analysis area. In addition,

it appears tie drivers may have used Fontenelle Creek to float rail ties to the Green River. (BLM 1995a)

3.9.1.4. Native American Sensitive Sites and Traditional Cultural Properties

In the late nineteenth century, the MAA was used predominantly by the Shoshone Tribe, although the Bannock, Ute, and other tribes frequented the Upper Green River (BLM 2004a). Sites relating to prehistoric tribal use exist, but identifying specific tribal affiliation to these remains is difficult. Some prehistoric sites, as well as some of the more recent Native American use sites, may be considered respected areas or sensitive sites by modern Native Americans and may be formally considered Traditional Cultural Properties (TCPs).

Sites and properties within this class are protected by numerous laws, including the Native American Graves Protection and Repatriation Act (NAGPRA), the American Indian Religious Freedom Act (AIRFA), and various executive orders (e.g., EO 13007). NAGPRA addresses treatment of inadvertent discoveries on federal lands, and AIRFA and EO 13007 further allow Native tribes access to and ceremonial use of sacred sites and culturally sensitive areas.

A "TCP" can be generally defined as a property that is eligible for inclusion in the National Register of Historic Places (NRHP) because of its association with the cultural practices or beliefs of a living community that are (1) rooted in the community's history, and (2) important in maintaining the continuing cultural identity of the community. TCPs or culturally sensitive properties tend to be considered sacred or respected places (areas that local Native American tribes consider sensitive, important for current uses [e.g., plant collection], and/or of religious importance) pursuant to EO 13007.

Human burials, rock alignment sites, rock art, and modern-day Native American use, extraction, or religious sites are considered sensitive or sacred to modern Native Americans. Several such site types, including burial, rock art, and multiple rock alignment (including 'stone circle') sites, have been identified in the area, but Native American tribes have not yet identified any specific TCP locations within the MAA (BLM 2004a). However, one specific culturally sensitive site, a stone circle site (48LN3156), was identified on Wyoming state lands in the MAA during previous consultation with the Northern Ute and Eastern Shoshone Tribes (Harrell 2006).

Non-archaeological site types, such as springs, rivers, trails, migration routes, procurement areas, hunting grounds, and vision quest locales, may also be considered sacred to Native American tribes. For instance, within the project area vision quest sites might be located in non-prominent areas, such as along the banks of river ways, as well as in prominent locales, such as at stone circle sites on high mesas. Although such sites may potentially exist in the MAA, Native American tribes have not yet identified any specific sensitive non-archaeological site locations there (Jess 2006). The Northern Arapaho Tribe has expressed concern related to plants located within the MAA that are culturally identifiable to the Arapaho (White 2006).

Wyoming BLM consultation with potentially affected Native American tribes concerning the identification and management of specific TCPs and other sensitive sites began circa 1998; this consultation resulted in several recommendations concerning the management of sensitive/sacred/respected sites, disturbance buffers, holistic management approaches and guidelines, and sensitive area management preferences of Native American traditional practitioners. Past consultation at stone circle site 48LN3156 has resulted in the Northern Ute and Eastern Shoshone tribes requesting notification prior to any work within a 1-mile radius of that site. The general theme of the consultation has been to leave these areas undisturbed.

Representatives of the Eastern Shoshone, Shoshone-Bannock, Northern Arapaho, and Northern Ute tribal groups, in particular, have visited the BLM KFO area for consultation, which has primarily been site- and site type-specific. However, non-site based management, in preference to "piecemeal" site-based management, has been proposed by the Ute and Shoshone as a consideration for culturally sensitive areas, and concerns regarding plant resources have been expressed by the Northern Arapaho (White 2006).

Native American Consultation was specifically initiated for the MAA to identify any environmental or cultural resource concerns and areas of traditional or cultural significance that may be affected by the proposed project, and to allow tribal participation in the development of preliminary alternatives to the proposed project. Notification letters were sent by April 2006 to the four tribes, the Arapaho Business Council (Northern Arapaho Tribe), the Shoshone Business Council (Eastern Shoshone Tribe), Shoshone-Bannock Tribes, and Uintah and Ouray Ute Tribe (Northern Ute Tribe) requesting consultation; prior letters had been sent inviting these Tribal organizations to participate as cooperating agencies. Consequently, the four tribes requested and were provided with information regarding the proposed project. A summary of tribal consultation results is on file with the BLM KFO, and comments received have been incorporated into this review of Native American Sensitive Sites and Traditional Cultural Properties.

3.9.2. Culture History Context and Chronology

The general cultural setting and historic overview for the Green River Basin subregion, including the MAA, is described in detail in the Class I Regional Overview (BLM 2004a). According to the Expanded Moxa Arch DEIS (BLM 1995a), archaeological investigations indicate that the Green River Basin, including the MAA were used by prehistoric groups as much as 10,000 years before present. Historic use of the area began in the nineteenth century with the arrival of trappers, explorers, and westward-bound emigrants. Completion of the Union Pacific Railroad in 1868 expanded opportunities for historic use of the area. The Wyoming Basin prehistoric cultural chronology is summarized in Table 3-26. The Historic period chronology is summarized in Table 3-27.

Table 3-26. Cultural Chronology for the MAA ((BLM 1995a) updated by (BLM 2004a)).

Period	Phase	Age (Years Before Present [B.P.])
Paleoindian	-	circa 12,000 to 8,500
Early Archaic	-	circa 8,500 to 4,300
	Great Divide	circa 8,200 to 6,500
	Opal	circa 6,500 to 4,300
Late Archaic	-	circa 4,300 to 1,800
	Pine Spring	circa 4,300 to 2,800
	Deadman Wash	circa 2,800 to 1,800
Late Prehistoric Period	-	circa 1,800 to 300
	Uinta	circa 1,600 to 650
	Firehole	circa 650 to 250
Protohistoric	-	circa 300 to 200
Historic Era (Native American)	-	circa 200 to present

Table 3-27. Historic Chronology for the MAA (after WYCRO system and BLM 1995a).

Period (Euro-American)	Key Regional Themes	Age (A.D.)
Early Historic	Euro-American exploration/frontiers	circa 1801 to 1842
	Fur trade	circa 1825 to 1842 (local)
Pre-Territorial	Native American removal	circa 1843 to 1867
	Westward emigration	circa 1843 to 1867
	Early railroading (transcontinental)	circa 1864 to 1868
	Early homesteading/ranching	post–1862 to 1868
Territorial	Settlement/ranch growth	circa 1868 to 1889
Expansion	Community growth and World War I	circa 1890 to 1919
Depression	With Roaring 20s and Dust Bowl eras	circa 1920 to 1939
World War II era	'Home Front' culture and economy	circa 1940 to 1946
Post-World War II	Expanded oil/gas industry growth	circa 1947 to 1955
Modern	With Cold War era	circa 1956 to present

3.9.3. Benchmark Sites

Numerous significant archaeological sites from all prehistoric periods and nationally significant historic sites have been found in the MAA (Appendix F). The Class I Regional Overview identifies and summarizes, by period of significance, the sampling of benchmark sites that have been confirmed in the MAA. These benchmark sites are not meant to capture the entire population of area sites that have substantially contributed to knowledge of area prehistory and history; rather, they are representative of the periods and phases that they help to culturally and chronologically define within the region.

Benchmark historical sites in the MAA are defined by the nationally significant transcontinental transportation corridor that crossed the Continental Divide throughout the historic and modern eras in Wyoming. These include the Emigrant Trails and their variants, such as the Oregon/California/Mormon Trails and the Blacks Fork, Hams Fork, and Slate Creek cutoffs; stage, freight, and mail routes, such as the Overland Trail and the Pony Express; railroads, such as the Union Pacific Railroad main line and the Oregon Short Line Railroad; and highways, such as the Lincoln Highway. Because of their linear expanse, many historic transportation routes have been segmented by later development and disturbances, and all portions do not retain integrity contributing to the NRHP eligibility of the overall historic site.

Benchmark archaeological sites in the MAA are known for the Prehistoric era, from the Paleoindian period; the Early Archaic period, Great Divide and Opal phases; the Late Archaic period, Pine Spring and Deadman Wash phases; and the Late Prehistoric, Uinta, and Firehole phases. As such, the MAA has produced archaeological data from significant site investigations that has contributed to the definition of regional prehistory across all periods.

3.9.4. Discovered Sites

Most MAA benchmark archaeological site or component investigations result from subsurface discoveries made during construction activities. Discoveries have occurred in a number of different construction contexts, including well pad stripping and leveling, access road construction, and pipeline trench construction. All but one benchmark archaeological site studied in the MAA was found during the course of investigations for mineral field infrastructure development, usually pipeline

development. The one exception (48UT1241) was discovered during a fiber optic cable-trenching project.

With the intensification of cultural resource investigations in the MAA under Section 106 of the NHPA since 1975, prehistoric site discoveries in the MAA have occurred in a number of management contexts. Those contexts include discoveries at previously recorded archaeological sites at which subsurface components were not expected or detected (sometimes despite extensive, small-scale subsurface testing and probing across the site area), previously unidentified sites with surface expressions that are often very sparse, and previously unidentified sites lacking any surface expression. The latter sites are by far the most prevalent discoveries and the most problematic, because no favorable or adequate current methodology exists to identify them in a cost- and time-effective manner prior to the construction that tends to expose them.

Discovered archaeological sites have included locales with possible house pits and other structural remains and basins with low to moderate densities of artifacts; locales with stained layers and basin features with moderate densities of associated flaked stone artifacts and bone, including human bone; locales consisting primarily of basin features with few associated artifacts; and locales with a single hearth or cultural stain. The occurrence of dune fields in the area appears to have skewed the prevalence of open campsites in proportion to general lithic scatters. The majority of sites recorded in dune areas have evidence of encampment; fewer are lithic procurement locales or simple lithic scatters.

In portions of the MAA where dune deposits are prevalent, discoveries are typically made when substantial subsurface disturbance occurs during development projects. Extensive testing and trenching has been conducted at MAA sites from the 1970s to the present. These efforts indicate that dune deposits across the Project Area, where intact or stabile, have preserved cultural materials from shallow depths a few centimeters below ground surface to greater depths reaching nearly 2 meters below surface. Multiple buried cultural layers and component activity areas have commonly been found in dune areas across area sites.

Generally, under all depths of dune deposits, past testing has found cultural sterile gravel, cobble, or carbonate subsoil. These subsoils tend to be visible in deflated, blowout, or wind-scoured areas adjacent to dunes. Overall, past environmental data indicate that subsurface archaeological potential for either historic or prehistoric sites might be limited by the extent of shallow soil and bedrock regolith in areas outside of sand dune deposits. Exceptions can occur at drainages where alluvial fill can preserve intact cultural layers.

3.9.5. Highly Sensitive Archaeological Locales

This section discusses the most highly sensitive archaeological locales in the MAA, which are most susceptible to the threat of impact from ground-disturbing activities. Development and implementation of specific activity plans may be necessary to ensure that these valuable resource areas are adequately protected from direct or indirect impacts related to MAA development.

Based on known site location and geographic/geomorphologic studies, highly sensitive archaeological locales are prevalent in areas where aeolian and alluvial sediments have aggraded. Dominant aeolian features in the MAA are dunes and sand sheets, both of which have the potential to contain interpretable subsurface archaeological contexts (Map 3-5). Alluvial sediments bordering the ephemeral, intermittent, and permanent stream channels also have the potential to bear interpretable archaeological contexts (Map 3-4). While these general patterns are useful for interpreting areas of high archaeological sensitivity, the development of more rigorous sensitivity models requires detailed digitized soils spatial data. Until the Soils Survey Geographic (SSURGO) Database is developed for the MAA by the NRCS (NRCS 2006), archaeological sensitivity models will be coarse-grained and of

limited utility. SSURGO data are scheduled to be completed for the area no later than 2008 (NRCS 2006). SSURGO spatial data are linked to a sophisticated database that provides information on soil age, potential depth to bedrock, susceptibility to erosion, productivity, and particle size range for soil map units at a 1:24,000 scale. These data would allow development of comprehensive models of archaeological sensitivity for the area. This need has been indicated by the past work of Miller (Miller 1992, 1996) and Western Wyoming Community College's (WWCC) "Southwest Wyoming GIS Project," which is an attempt to achieve better understanding of the formation of prehistoric landscapes through geographic analysis of approximately 3,500 archaeological sites known in the area. Upon completion of the SSURGO data for the MAA, site data compiled by WWCC can be combined with soils spatial data to produce a comprehensive, testable model of archaeological sensitivity for the MAA.

3.10. Social and Economic Conditions Including Environmental Justice

The area of potential socioeconomic effect related to oil and gas development revenues is the counties in which the project is located: Sweetwater, Uinta, and Lincoln. As part of the socioeconomic CIAA, Sublette County will also be addressed in this section. Although Sublette County may not experience direct or indirect socioeconomic impacts, cumulative impacts could potentially occur there.

3.10.1. Population and Demographics

Population and demographics of the potentially affected counties and communities are presented in the following sections. More detailed information is contained in Appendix G – Socioeconomic Baseline Information. Population and demographic data were obtained from the U.S. Census Bureau (U.S. Census Bureau 2000b, 2000c, 2000a, 2005a, 2005b, 2005c), Taylor and Lieske (2002), and the Wyoming Department of Administration and Information (WDAI) (WDAI 2003, 2002a, 2001, 2000) and the Wyoming Housing Database Partnership (Western Economic Services 2006). The Sonoran Institute EPS uses Bureau of Economic Analysis (BEA) population data, which differs from census totals; however, percentages tend to approximate calculations based on census data.

Overall, population in the three-county region (Sweetwater, Uinta, and Lincoln) increased from 1990 to 2004 by 4.3%, from a population of 69,253 to 73,156 (Table 3-28) (WDAI 2006). According to Wyoming intercensal data (Western Economic Services 2006), by 2005, the population of the three county area had increased to 73,913. Growth in the study area can be primarily attributed to mineral resources development and service industries.

3.10.1.1. Lincoln County

As shown in Table 3-28, Lincoln County population increased by 15.4% between 1990 and 2000. Wyoming census population estimates for 2005 show that the county experienced an approximate 9.8% growth increase since 2000 (Table 3-28) (WDAI 2006), with 2005 population estimated at 15,999. The majority of Lincoln County residents lived in rural areas in 2000.

Table 3-28. Population Data for Sweetwater, Lincoln, Uinta, and Sublette Counties, Wyoming.

Location	Population			Change in Population (%)		Projected Population			
	1990 [1]	**2000 [1]**	**2005[2,3]**	**1990-2000**	**2000-2005**	**2010 [4,5]**	**2015 [4,5]**	**2020 [4,5]**	**2025 [4,5]**
U.S. (thousands)	248,709	281,421	296,410	13.2	5.3	308,935	322,365	335,804	349,439
Wyoming	453,588	493,782	509,294	8.9	3.1	519,595	529,352	533,534	529,031
Sweetwater County	38,823	37,613	37,975	-3.1	0.4	35,567	34,293	32,759	NR
Rock Springs	19,050	18,708	18,772	-1.7	0.7	17,670	17,038	16,275	NR
Green River	12,711	11,808	11,787	-7.1	-0.2	12,057	12,205	12,347	NR
Lincoln County	12,625	14,573	15,999	15.4	9.8	16,991	18,111	19,293	NR
Kemmerer	3,020	2,651	2,560	-12.2	-3.4	2,881	3,071	3,271	NR
Diamondville	864	716	695	-17.1	-2.9	785	837	891	NR
LaBarge	493	431	421	-12.6	-2.3	468	490	507	NR
Uinta County	18,705	19,742	19,939	5.5	1.0	19,824	20,000	20,168	NR
Evanston	10,904	11,507	11,459	5.5	-0.1	11,464	11,566	11,662	NR
Lyman	1,896	1,938	1,937	2.2	-0.1	1,933	1,950	1,966	NR
Sublette County	4,843	5,290	6,926	22.2	17.0	7,161	7,697	8,135	NR
Big Piney	454	408	455	-1.3	11.5	491	528	558	NR
Marbleton	634	720	811	16.9	12.6	874	940	993	NR
Pinedale	1,181	1,412	1,658	20.3	18.3	1,688	1,814	1,918	NR

[1] Wyoming Department of Administration and Information. 2000. 1990 Census of Population and Housing: Profiles for State, Counties, and Major Cities and Towns. (WDAI 2001). [2] Source: (U.S. Census Bureau 2005a). [3] Source: (U.S. Census Bureau 2005b). [4] Source: (U.S. Census Bureau 2005c). [5] Source: (WDAI 2002a)

In Lincoln County, Kemmerer/Diamondville and LaBarge are the communities most likely to be affected by the proposed project. From 2000 to 2005, Kemmerer and Diamondville showed a decline in population (-3.4% and -2.9%, respectively), according to Wyoming estimates. The estimated 2005 population was 2,560 in Kemmerer and 695 in Diamondville. Between 1990 and 2000, LaBarge experienced a 12.6% decrease in population, and 2005 population estimates reflect a 2.3% decline in population since 2000 (U.S. Census Bureau 2005a). However, 2005 data indicate that populations in these communities are stabilizing or growing, likely caused by increased development in the energy sector. Local government data indicate that most of the growth that has occurred in the area has been since 2004. Additional evidence of this growth occurred in new school enrollment numbers. In 2005, 30 new students enrolled in the LaBarge public school system (Jonathan Teichert, Lincoln County Senior Planner, personal communication).

3.10.1.2. Sweetwater County

In 2000, the Sweetwater County population was 37,613, down from 38,823 (-3.1%) in 1990 (U.S. Census Bureau 2000b) (Table 3-28). According to U.S. Census Bureau estimates, population in the county increased slightly between 2000 and 2005 (1.0%).

Sweetwater County had a population density of 3.6 people/square mile. According to the 2000 Census, 89.1% (33,512) of Sweetwater County's population lived in urban clusters. Of the 4,101 rural residents, only 416 (10.1% of rural residents; 1.1% of county residents) resided on farms. Rock Springs and Green River are the communities most likely to be affected in Sweetwater County. Rock Springs reflected Sweetwater County's trend, declining 1.7% between 1990 and 2000. From 2000 to 2004 the population in Rock Springs increased slightly to 18,746 (0.2%) according to the Census. In 2004, Rock Springs had the largest estimated population in the entire study area (18,746). Conversely, the total U.S. and Wyoming state populations increased from 1990 to 2004, showing growth rates of 4.3% and 2.6 %, respectively, between 2000 and 2004 (U.S. Census Bureau 2005a, 2005b).

To get a more accurate estimate of current population in the county, in 2006 the Sweetwater Economic Development Association (SWEDA) estimated population in several communities, including Rock Springs and Green River, using the number of Pacific Power electrical hook-ups. Based on 2.57 persons per household, total population in the Rock Springs area was estimated at 26,278. The 2006 estimate for incorporated Rock Springs (21,832) shows a 16.5% (3,086) increase over the estimated 2004 population (18,746). The incorporated and unincorporated population estimates for Green River are 12,061 and 622, respectively, for a total population of 12,683 in the Green River area. The population of incorporated Green River increased by 254 (2.2%) from 2004 to 2006.

3.10.1.3. Uinta County

As shown in Table 3-28, Uinta County population increased by 5% between 1990 and 2000. Wyoming census population estimates for 2005 show that the county experienced a 1.0% growth increase since 2000 (Table 3-28) (WDAI 2006).

In Uinta County, Evanston is the community most likely to be affected by the proposed project. As summarized in Table 3-28, Evanston's growth increased by 5.5% from 1990 to 2000, but showed a 0.1% decline from 2000 to 2005 (WDAI 2006).

3.10.1.4. Sublette County

The Sublette County population in 2000 was 5,920, up from 4,843 (22.2%) in 1990 and up from 4,548 (30.2% overall) in 1980 (U.S. Census Bureau 2000b). Sublette County has no urban areas, as defined by the U.S. Census Bureau; therefore, the entire population is considered rural. Of the total population, 477 (8.1%) are farm residents, while 5,443 (91.9%) are nonfarm residents (U.S. Census

Bureau 2000b). Sublette County has a population density of 1.2 people per square mile. Between 2000 and 2005 the population of Sublette County increased 17.0% to 6,926 largely as a result of increased energy development.

3.10.2. Economic Sectors and Employment

The economy in Sweetwater, Lincoln, and Uinta Counties has historically depended on industrialized activities, including mining, oil and gas development, power generation, and related services, as well as agricultural activity, including grazing and farmland. Employment growth has fluctuated in some sectors of the economy since 1990 due to the 2001 to 2003 recession. However, activity during the past two to three years shows significant increases in oil and gas development and production, which will be reflected in the mining and services sectors. Table 3-29 lists employment figures by sector for Sweetwater, Lincoln, and Uinta Counties from 1990 to 2003.

In 2003, mining sector employment (including oil and gas) was not disclosed for Sweetwater County, but represented 7% of the 9,311-person workforce in Lincoln County and 6% of the 12,226-person workforce in Uinta County. In addition to retail trade, other important sectors in Sweetwater County included services (21%) and government (17%). In Lincoln County, services and construction represented 19% and 17%, respectively, of total employment. In Uinta County, these two sectors represented 17% and 11%, respectively, of total employment. In Sublette County, these two sectors represent 21% and 11%, respectively.

Employment of proprietors contributed to 21% of new employment from 1970 to 2003, and 40% of new employment since 1993. In 1970, proprietors represented 18.0% of total employment; by 2003, they represented 19.9% (Table 3-30).

Both labor force and employment have increased throughout the study area and the State of Wyoming for the period of 1990 to 2004, as seen in Table 3-31. Labor force statistics reflect employment by residence, unlike employment by sector statistics, which reflect employment by work location.

3.10.3. Income and Earnings

Income and earnings data were obtained from various sources but principally from the Sonoran Institute Economic Profile System (EPS) database which uses different sources of information including BEA and Wyoming state data as source information. This section described earnings per job, per capita income, and new income per industry.

3.10.3.1. Earnings per Job and Per Capita Income

Average earnings per job in Sweetwater County, in 2000 dollars, have risen from $30,073 in 1970 to $36,048 in 2000. In 1999, average earnings per job ($36,048) in Sweetwater County, were higher than the state ($27,037) and lower than the nation ($36,316). Average earnings per job in Lincoln County, in Year 2000 dollars, adjusted for inflation, have fallen from $29,833 in 1970 to $23,145 in 2000. In 1999, average earnings per job in Lincoln County, ($23,145) were lower than the state ($27,037) and the nation ($ 36,316). Average earnings per job in Uinta County, in real terms, have fallen from $28,009 in 1970 to $24,595 in 2000. In 1999, average earnings per job in Uinta County ($24,595) were lower than the state ($27,037) and the nation ($36,316).

Table 3-29. Employment by Sector for the Period of 1990-2003.

Number of Jobs															
Employment Sector	**Lincoln County**			**Sweetwater County**			**Uinta County**			**Sublette County**			**Wyoming**		
	1990	**2000**	**2003**	**1990**	**2000**	**2003**	**1990**	**2000**	**2003**	**1990**	**2000**	**2003**	**1990**	**2000**	**2003**
Farm Employment	733	698	671	220	205	197	373	412	403	402	412	385	12,476	12,624	12,192
Ag Services	77	149	100	81	188	(D)	99	121	96	83	132	99	3,353	5,769	3,155
Mining	667	517	642	4,889	3,717	(D)	1,078	0	684	315	325	645	20,840	19,387	20,881
Construction	444	863	1,626	1,533	1,509	(D)	615	864	1,317	261	427	502	15,782	2,879	27,544
Manufacturing	614	530	345	745	1,649	1,232	330	462	375	(D)	91	(D)	11,203	13,583	10,940
Transportation, Communication & Utilities	568	582	223	1,987	1,785	1,173	581	675	753	145	108	116	16,583	17,084	14,070
Wholesale Trade	80	133	(D)	648	615	(D)	151	203	212	(D)	55	16	7,633	8,812	8,000
Retail Trade	1,083	1,389	983	3,739	4,447	2,946	1,826	2,203	1,647	409	603	461	47,252	57,824	39,577
Finance, Insurance, and Real Estate	307	471	601	1,125	1,127	1,304	431	526	717	184	228	284	17,167	21,303	23,367
Services	1,040	1,278	1,785	3,760	4,749	5,133	2,315	(D)	2,025	599	905	977	61,294	83,161	110,728
Federal Civilian	146	110	127	262	266	250	88	84	82	91	96	107	7,589	7,400	7,482
Federal Military	75	84	84	228	215	206	100	113	109	28	41	41	6,311	6,204	6,349
State Government	136	126	133	278	269	287	549	562	605	74	72	(D)	13,150	13,820	14,570
Local Government	903	1,195	1,299	3,261	3,540	3,463	1,327	1,404	436	364	470	(D)	31,838	36,682	38,706
Total full and part time employment	6,873	8,125	9,311	22,856	24,281	25,017	9,872	11,379	12,226	2,955	3,965	4,704	272,471	328,532	342,363

Source: (Bureau of Economic Analysis 2003). (D) = Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals. BEA does not provide this information.

Table 3-30. Three-County Employment Growth.

Total Employment	1970	% of Total	1993	% of Total	2003	% of Total	New Employ. (70-03)	% of New Employ.	New Employ. (93-03)	% of New Employ.
Total full-time and part-time employment	16,386	100%	41,698	100%	46,554	100%	30,168	100%	4,856	100.0%
Wage and salary jobs	13,432	82.0%	34,391	82.0%	37,305	80.1%	23,873	79.1%	2,914	60.0%
Total number of proprietors	2,954	18.0%	7,307	18.0%	9,249	19.9%	6,295	20.9%	1,942	40.0%
Non-farm proprietors	2,074	12.7%	6,272	15.0%	8,212	17.6%	6,138	20.3%	1,940	40.0%
Farm proprietors	880	5.4%	1,035	2.5%	1,037	2.2%	157	0.5%	2	0.0%

Proprietors include sole proprietorships, partnerships, and tax-exempt cooperatives. A sole proprietorship is an unincorporated business owned by a person. A partnership is an unincorporated business association of two or more partners. A tax-exempt cooperative is a nonprofit business organization that is collectively owned by its members.

Wage and salary employment refers to employees.

Source: (Bureau of Economic Analysis 2003)

Table 3-31. Labor Force Summary 1990-2004.

Location/Year	Labor Force	Employment	Unemployment	Unemployment Rate (%)
Sweetwater County				
1990	20,354	19,281	1,073	5.3
2000	20,714	19,890	824	4.0
2004	21,846	21,087	759	3.5
Lincoln County				
1990	5,778	5,413	365	6.3
2000	7,357	7,071	286	3.9
2004	8,213	7,893	320	3.9
Uinta County				
1990	9,903	9,251	652	6.6
2000	10,459	10,039	420	4.0
2004	10,906	10,464	442	4.1
Sublette County				
1990	2,710	2,631	79	2.9
2000	3,560	3,445	105	2.9
2004	4,561	4,458	103	2.3
Wyoming				
1990	236,043	223,531	12,512	5.3
2000	266,862	256,616	10,246	3.8
2004	281,847	270,810	11,037	3.9

Source: (Wyoming Department of Employment 2005a).

This decline in earnings may reflect a reduced level of economic activity in the primary economic sectors of southwestern Wyoming during the 2000 time period and increases in lower paying trade and service sector positions. However for the aggregated three-county region, average earnings per job, adjusted for inflation, have risen from $32,714 in 1970 to $38,012 in 2003, which is higher than the state and lower than the nation (Sonoran Institute EPS 2003). Current earnings per job are not reflected in the historical information considering the new oil and gas boom really began in earnest in 2000 to 2001 and a new wave is just now occurring (Jacquet Winter 2006).

Per capita income, adjusted for inflation, increased from $18,366 in 1970 to $30,574 in 2003 for the three-county region. Per capita income for Sweetwater County was $29,125 in 2000, up 22% from the 1990 level. In Lincoln County, per capita income was $20,980 in 2000, up 10% from the 1990 figure. Uinta County per capita income was $22,042, up 13% from the 1990 level. Sublette County per capita income in 2000 was $26,927, up 8% from 1990. A slightly lower standard rate of income occurs within the study area when compared to the State of Wyoming ($32,433). This is most likely due to the lower-wage retail and service sector employment.

The relative increases in income both per job and per capita do not compensate for the cost of living increases in the area. Housing costs as well as fuel costs and some medical services have increased dramatically in the past year. In Wyoming, the Southwest region (Sweetwater, Sublette, Lincoln, and Uinta counties) showed the second highest inflation rate in Wyoming (4.8%) from the 4th quarter of 2005 to the 4th quarter of 2006. This rate is significantly higher than the national rate of 2.5% for the same period (http://eadiv.state.wy.us/wcli/NewsRelease-4Q06.pdf). Mineral extractive counties have been hardest hit by the increase in the cost of living. Housing represents the highest increase in costs throughout the study area, particularly in Sweetwater and Sublette counties. Increased housing costs

range from a 16% increase for single family unit rents to a 56% increase for apartment rents in Lincoln County and from a 64% increase in single family unit rents to a 105% increase in apartment rents in Sweetwater County.

3.10.3.2. Industry Earnings

3.10.3.2.1. Wyoming

Wyoming's mining and minerals sector contributes more to Gross State Product (GSP) than any other sector of the economy (Foulke, Coupal, and Taylor 2001). Minerals (including oil and gas) accounted for 23.7% of Wyoming's GSP, or over $4.5 billion in 2000, and supported approximately 19,387 full-time wage earners, or 5.9% of Wyoming's employment base (Bureau of Economic Analysis 2003). In 2000, government industry provided 23.4% of total income, followed by services (20.0%), retail trade (9.3%), construction (8.5%), and transportation, communication, and public utilities (8.3%). From 1980 to 2000, Wyoming industry income fell for the farm, mining, oil and gas, construction, transportation, communication, public utilities, wholesale trade; and retail trade sectors. The highest income growth occurred in non-farm agricultural services (156.4%; 4.8% average annual growth) and government (27.5%; 1.2% average annual growth) (Bureau of Economic Analysis 2003).

3.10.3.2.2. Lincoln County

In 2000, government provided 23.4% of total income, and mineral extractions provided 14.2% of income. From 1980 to 2000, non-farm agricultural services led industry growth (188.1%; 5.4% average annual growth). Losses occurred in total mineral extraction (-65.4%), and farm income (-60.0%).

3.10.3.2.3. Sweetwater County

In 2000, total mineral extraction provided 31.3% (oil and gas provided 14.1% and mining provided 17.2%) of Sweetwater County industry earnings. Total earnings in Sweetwater County fell by 18.2% (1.0% annual average loss) from 1980 to 2000.

3.10.3.2.4. Uinta County

Services and professionals jobs led industry income (30.0%), followed by government (14.2%). Total mineral extractions provided 11.0% of industry income. Over the 20-year study period (1980–2000), Services and professional jobs led industry growth (47.0%). Losses occurred in total mineral extraction (-15.0%), and farm income (-1.0%).

3.10.3.2.5. Three-County Aggregated

For the three-county aggregated region, in 2003, the number of mining industry firms totaled 96. Professional, technical, and scientific services represented another 145 firms, and construction another 291 firms. Some of these firms provided services to employees affiliated with the mining industry in the forms of goods and services. These represent indirect and induced effects from the mining industry.

3.10.3.2.6. Sublette County

In 2000, total mineral extraction provided 18.1% of industry income (oil and gas provided 16.1% and mining provided 2.0%). From 1980 to 2000, industry income in Sublette County grew by 4.3% (0.2% average annual growth).

3.10.4. Housing

Workforce-related housing is one of the key issues associated with the proposed Moxa Arch Area Infill Gas Development Project. The oil and gas industry's effect on housing demand has had a

significant impact on the availability and cost of both owner-occupied and rental units. Lack of affordable housing has contributed to social problems in the area and has created a transitory workforce whose members have little investment in the local communities.

Workers associated with the Moxa Arch Area Infill Gas Development project would most likely live in the more populated towns of Rock Springs, Green River, Kemmerer/Diamondville, and Evanston, with fewer workers choosing the smaller communities of La Barge, Mountain View, and Lyman. Other towns in the vicinity may attract some project workers, but because of their distance from the MAA drilling area or their lack of amenities, they are not considered as potential high impact areas.

Historical information on housing in Sweetwater, Lincoln, Uinta, and Sublette Counties was obtained from the WDAI (WDAI 2002a), and information on projected housing availability was obtained from the Wyoming Business Council (Wyoming Business Council 2002). Rental rates and costs in the three counties compared to those for the state as a whole were obtained from WDAI (WDAI 2002b).

The Wyoming Housing Database Partnership (WHDP 2005), indicates that housing availability is limited in the study area. Vacancy rates decreased substantially in all four counties in the study area between December 2005 and June/July 2006. Average contract rent for single family homes, apartments, and mobile homes has increased since 2003 in all four counties.

3.10.4.1. Lincoln County

The Census Bureau reports that between 2000 and 2005, total housing units increased 13.64% in Lincoln County compared to a 5.3% increase over the same time in the State of Wyoming. Between 2001 and 2005 the vacancy rate in Lincoln County ranged between 5.5% and 17.0%. In 2006, the vacancy rate dropped from an average of 8.5% in 2005 to 2.7%. Additionally, the number of building permit authorizations decreased from 261 total units in n 2005 to 162 units in 2006 indicating that the housing demand is not being met by increased building in Lincoln County. Housing needs forecasts indicate that as many as 243 new households per year would be required to keep pace with a strong growth scenario. Under this scenario, 2006 building rates would not support the increased demand but rates observe in 2004 and 2005 might support increased demand.

In Lincoln County, Kemmerer/Diamondville and LaBarge are the communities most likely to be affected by the proposed project. According to the Lincoln County Planning Department, the housing market in LaBarge is stabilizing after experiencing a decrease in housing prices during the last several years. Housing in LaBarge is considered available but limited (Woodward 2005). The most recent statistical housing data available for Kemmerer/Diamondville are from the 2000 census, which show 1,530 permanent housing units, of which about 316 were rentals. The vacancy rate for owner-occupied and rental units in Kemmerer was 2.8% and 32.0%, respectively. In Diamondville, these vacancy rates were 1.6% and 14.9%, respectively. However, given the decreased vacancy rate in Lincoln County for 2006, it is likely that these data are no longer accurate and that vacancy rates are substantially lower than reported for 2000.

In Lincoln County, the per unit valuation of a single family unit increased from $151,500 in 2000 to $168,600 in 2006. In the second quarter of 2006, the average rental cost was $431 for apartments (up 56% from the fourth quarter of 2000); $484 for houses (up 16%); $406 for mobile homes (up 28%); and $178 for mobile home lots (down 9%).

Temporary accommodations in Kemmerer/Diamondville include motels (170 rooms) and RV parks and campgrounds (120 campsites).

3.10.4.2. Sweetwater County

Total housing units increased 2.1% in Sublette County between 2000 and 2005 compared to a 5.3% increase over the same time in the State of Wyoming. Between 2001 and 2005 the vacancy rate in Sweetwater County ranged between 0.88% and 8.16%. In 2006, the vacancy rate dropped slightly from an average of 2.4% in 2005 to 1.2%. The number of building permit authorizations decreased from 216 and 260 total units in 2004 and 2005 to 174 units in 2006. When compared to the 2000 to 2003 average of 48 permits per year, the 174 permits in 2006 indicate that the new homes are being built at rates much higher than average in Sweetwater County. However, housing needs forecasts indicate that as many as 397 new households per year would be required to keep pace with a strong growth scenario. Under this scenario, current building rates would not support the increased demand (Western Economic Services 2006).

According to a November 4, 2005, Casper Star Tribune article, housing in Sweetwater County is inadequate for the current demand for two reasons: (1) housing in the county is not readily available, and (2) housing currently on the market is expensive (Gearino 2005). The per unit valuation of a single family unit increased only slightly from $151,300 in 2000 to $153,200 in 2006. However, rental rates in Sweetwater County increased substantially over that same period. In the second quarter of 2006, the average rental cost in Sweetwater County was $684 for apartments (up 105% from the fourth quarter of 2000); $816 for houses (up 64%); $669 for mobile homes (up 67%); and $238 for mobile home lots (up 21%). To help meet the demand for new housing, the Sweetwater Economic Development Association has made housing development a priority.

The most recent statistical housing data available for Rock Springs are from the 2000 census, which show 8,359 permanent housing units, of which 2,074 were rentals. The vacancy rate for owner-occupied and rental units was 3.1% and 18.2%, respectively. However, given the decreased vacancy rate for 2006, it is likely that these data are no longer accurate and that vacancy rates are substantially lower than reported for 2000. Temporary accommodations in Rock Springs include hotels/motels (1,496 rooms) and recreational vehicle (RV) parks and campgrounds (206 campsites).

The most recent statistical housing data available for Green River are from the 2000 census, which show 4,426 permanent housing units, of which 1,008 were rentals. The vacancy rate for owner-occupied and rental units was 1.2% and 10.2%, respectively. Temporary accommodations in Green River (including Little America) include motels (345 rooms) and RV parks and campgrounds (50 sites).

3.10.4.3. Uinta County

Total housing units increased 3.7% in Uinta County between 2000 and 2005 compared to a 5.3% increase over the same time in the State of Wyoming. Between 2001 and 2005 the vacancy rate in Uinta County averaged 7% (range between 1.59% and 12.59%). In 2006, the average vacancy rate 1.4%. The number of building permit authorizations decreased from 100 in 2005 to 80 units in 2006. When compared to the 2000 to 2004 average of 62 permits per year, the 80 permits in 2006 indicate that the new homes are being built at rates just slightly higher than average. However, housing needs forecasts indicate that as many as 236 new households per year would be required to keep pace with a strong growth scenario. Under this scenario, current building rates would not support the increased demand (Western Economic Services 2006).

According to the 2000 census, Uinta County had 1,687 renter-occupied units and 1,188 vacant units. No communities in Uinta County had a significant number of second homes. The most recent statistical housing data available for Evanston are from the 2000 census, which show 4,665 permanent housing units, of which about 1,253 were rentals. The vacancy rate for owner-occupied and rental units was 3.5% and 19.0%, respectively. However, given the decreased vacancy rate for 2006, it is

likely that these data are no longer accurate and that vacancy rates are substantially lower than reported for 2000.

The per-unit valuation of a single family unit in Uinta County increased from $103,200 in 2000 to $111,200 in 2006. Rental rates increased over that same period. In the second quarter of 2006, the average rental cost was $434 for apartments (up 29% from the fourth quarter of 2000); $576 for houses (up 19%); $442 for mobile homes (up 23%); and $197 for mobile home lots (up 31%).

3.10.4.4. Sublette County

Total housing units increased 11.0% in Sublette County between 2000 and 2005 compared to a 5.3% increase over the same time in the State of Wyoming. Between 2001 and 2005 the vacancy rate averaged 4.2% (range between 1.7% and 5.4%). In 2006, the average vacancy rate was 1.4%. The number of building permit authorizations decreased from 185 in 2005 to 154 units in 2006. When compared to the 2000 to 2004 average of 81 permits per year, the 154 permits in 2006 indicate that the new units are being built at rates much higher than average. However, housing needs forecasts indicate that as many as 230 new households per year would be required to keep pace with a strong growth scenario. Under this scenario, current building rates would not support the increased demand (Western Economic Services 2006).

In 2002, Sublette County had 3,627 total occupied housing units, of which 652 were rentals. The vacancy rate in 2002 was 31.8%. In 2000, Sublette County had a total of 930 second home units. The median value for homes in Sublette County in 2000 was $112,000. Between 2000 and 2004, the number of new building permits issued annually in the county increased by 72% (Western Economic Services 2006).

3.10.5. Quality of Living

3.10.5.1. Public Facilities and Services

3.10.5.1.1. Lincoln County

The Lincoln County Sheriff has three offices, including one in Kemmerer. The Sheriff's office has 24 full-time employees, of which six are deputies in the Kemmerer office. Kemmerer has a police department with one chief and six officers, with a total of 12 full-time equivalent employees.

Medical services within the county are provided by the South Lincoln Medical Center, a 16-bed acute care facility located in Kemmerer and served by South Lincoln Emergency Medical Service (EMT and ambulance).

Lincoln County School District #1 provides educational services to the Kemmerer area. In October 2005, the total district enrollment was 629 students. This represented an increase of 7 students from October 2004. In Kemmerer, two elementary schools serve 310 students, one middle school serves 87 students, and one high school serves 232 students. LaBarge has one elementary school (57 students) within the Sublette #9 School District (Wyoming Department of Education 2006).

Kemmerer/Diamondville Water and Wastewater Joint Powers Board provide water and sewer service to its residents and businesses. Pacific Power provides electric service to all county areas, and Wyoming Industrial Gas provides natural gas to communities within the county.

Other county services include four branches of the public library, senior services, daycares, and recreation facilities and services, including a recreation center in Kemmerer, golf courses, parks, ball fields, and bike trails.

3.10.5.1.2. Sweetwater County

Sweetwater County is served by the Sweetwater County Sheriff Department, which has four deputies in Green River and two in Rock Springs. Sweetwater County Fire Protection Department has three paid and 23 volunteer firefighters and 10 wildland fire fighters.

Rock Springs police department has 39 sworn police officers and 24 civilian positions. The City of Rock Springs operates the only city holding facility in the State of Wyoming.

The Green River Police Department has a staff of 31 full time employees. The patrol is staffed with 18 officers that work three shifts, providing Green River citizens 24-hour police service 365 days a year. The Investigations Division in Green River employs 10 officers, one supervisor, and one administrative assistant.

The Rock Springs Fire Department staffs and equips three fire stations 24 hours a day. The Green River Fire Department responds to more than 330 calls per year, with two full-time employees and 36 volunteers.

Medical care in Rock Springs is provided by Memorial Hospital Sweetwater County, which has 99 beds. In addition, Rock Springs has a nursing home (100 rooms), 33 doctors, 24 dentists, and an ambulance service. Green River has a VA Medical Outpatient Clinic.

Public education is provided by two school districts that serve Sweetwater County. Sweetwater School District #1 serves Rock Springs with six elementary schools (1,266 students), one junior high school (634 students), and two high schools (2,340 students). Sweetwater District #2 serves Green River with four elementary schools (933 students), one intermediate school (344 students), one middle school (433 students), and one high school (812 students), including an alternative high school (Wyoming Department of Education 2006). Western Wyoming Community College, a two-year junior college, is also located in Rock Springs, with an estimated enrollment of 1,527.

Electricity services are provided by Pacific Power, and water, wastewater treatment, and solid waste disposal are provided by the local municipalities. Water plant capacity in Rock Springs is 32 million gallons. Community services consist of a library in both Rock Springs and Green River, as well as rural libraries. Commercial services include two shopping centers and five convention facilities (with a total capacity of 4,660 persons).

3.10.5.1.3. Uinta County

Uinta County is served by the Uinta County Sheriff Department, which has one Sheriff, one undersheriff, four patrol officers, two investigators, four jailers, and a civil processor.

The Evanston Police Department has 28 sworn police officers and five support members who provide law enforcement services to a community that encompasses about 12 square miles. Three fire departments provide fire protection in the Uinta County area, which includes Mountain View, Evanston, and Lyman.

Medical care in Uinta County and Evanston is provided by the Evanston Regional Hospital. The hospital has 42 licensed beds with 42 active and 16 courtesy physicians and specialists. The Rocky Mountain Care Hospital in Evanston, with 60 beds, provides religious non- medical nursing health care.

Public education is provided by Uinta School District #1, located in Evanston. In October 2005, the district had 2,599 students in four elementary schools (1,078), two junior high schools (644), and one high school (877) (Wyoming Department of Education 2006).

Evanston's utility service providers include PacifiCorp for electricity, Questar for natural gas, and local municipalities or water and sewer districts for water supply and wastewater treatment.

The City of Evanston recently invested in a $9.6 million addition to its water treatment facility, which gives Evanston the ability to supply 18 million gallons of water per day.

The Uinta County Library is located in Evanston, with two branch libraries in Mountain View and Lyman.

3.10.5.1.4. Sublette County

Sublette County is served by the Sublette County Sheriff's Department, which services all of Sublette County and the affected towns within the Sublette County area. The staff includes a sheriff, undersheriff, lieutenant, emergency management coordinator, two patrol sergeants, three detectives, a probation/resource officer, a seasonal forest patrol deputy, five patrol deputies for Big Piney/Marbleton, five patrol deputies for Pinedale, four patrol deputies for the county, a detention sergeant and five detention deputies, a communication sergeant and five communication deputies, an office manager, and three secretaries/clerks.

Sublette County is served by two school districts, including three elementary schools, two middle schools, two high schools, and a private school, with higher education available from Western Community College's distance learning program.

Sublette County has three airports; 26 churches; three libraries; five medical facilities (however, the nearest hospitals are in Jackson and Rock Springs, Wyoming); two museums; two newspapers; and nine post offices (Big Piney, Bondurant, Boulder, Cora, Daniel, Farson, LaBarge, Marbleton, and Pinedale).

Utilities and services are provided by one telephone company, two garbage/refuse services, one cable television provider, three natural gas suppliers, one electricity supplier, and one coal company.

3.10.5.2. Crime

The Wyoming Attorney General, Division of Criminal Investigation (DCI) produces annual reports on crime statistics for the State of Wyoming. Crime data are complied from the Uniform Crime Reporting (UCR) records submitted to the DCI by law enforcement agencies across the state.

According to UCR data, the number of annual total arrests in Wyoming increased by 368 between 1999 and 2004 (State of Wyoming 2004). Arrest totals decreased for the majority of crimes; however, the number of arrests for aggravated assault, burglary, drug offenses, and driving under the influence increased. Overall arrests in Lincoln County decreased from 435 in 1999 to 347 in 2004. In Sweetwater County, reported arrests decreased from 3,039 in 1999 to 2,773 in 2004. In Uinta County arrests decreased from 774 reported in 1999 to 769 reported in 2004. Reported arrests in Sublette County increased from 257 in 1999 to 442 in 2004.

3.10.6. Taxes and Revenues

3.10.6.1. Wyoming

3.10.6.1.1. Mineral Royalties

The minerals industry accounts for a substantial share of revenues to the state and to local governments in Wyoming. Produced minerals are classified as personal property, and mineral producers pay two types of taxes: (1) the county property (ad valorem) tax on production, and (2) the

state severance tax. Producers pay county property (ad valorem) taxes on plants, refineries, mining and wellhead equipment, pipelines, and other facilities used in the mineral production and transportation operations.

For federally owned minerals, the federal government receives a share of the revenues from the mineral production, or annual rentals are paid on mineral leases that are not producing. The same is true for minerals owned by the state government. Additionally, the state receives a share of federal royalty payments for federal minerals through a federal revenue-sharing provision.

A severance tax is an excise tax imposed on the present and continuing privilege of removing, extracting, severing, or producing any mineral in Wyoming. Severance taxes are distributed according to Wyoming Statute (WS) 39-14-801. The Permanent Wyoming Mineral Trust Fund (PWMTF) is a fund that holds 25% of all severance taxes currently received by the state, functioning like a savings account for the state. Natural gas alone contributed more than $34.7 million (46.8%) to the PWMTF. Gas, oil, and associated products contributed more than $45.5 million (61.4%) of all severance taxes added to the PWMTF. The principal of the PWMTF is inviolate but may be loaned to political subdivisions. The interest on the PWMTF goes to the state's general fund for the legislature to allocate to current programs.

A mineral royalty is the amount of money the owner of the mineral resource receives as a payment or royalty from the mineral producer. Wyoming receives a base royalty of 16.7% of the value of production from state-owned minerals. The federal government receives a royalty of 12.5% of the value of production for minerals produced on federal lands. Fifty percent of federal mineral royalties are returned to the state, a portion of which is then distributed to counties and cities. Unlike severance taxes, royalties are based on the value of production and byproducts. Federal royalties are distributed by the State of Wyoming according to WS 9-4-601. Federal royalty distributions to all counties and cities, including those cities in the area potentially affected by the project, are shown in Table 3-32.

Table 3-32. Summary of Mineral Royalties Received by Wyoming and Directly Distributed to Project Affected Cities from 2000-2004 (Thousands of Dollars).

Tax and Distribution Entity	2000	2001	2002	2003	2004
Total Received by Wyoming	309,093	434,676	334,703	447,693	504,474
Amount Distributed to Cities	19,588	21,678	20,007	17,449	16,892
Kemmerer/Diamondville	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Rock Springs	1,010	1,002	994	1,622	1,533
Green River	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Evanston	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable

3.10.6.1.2. Payments in Lieu of Taxes (PILT)

The federal government owns and manages 49% of Wyoming lands. Federal lands are not subject to property taxes that support county governments and education. In 1976, Congress authorized federal land management agencies to share income with states and counties and provided a "Payments in Lieu of Taxes" (PILT) program to help offset lost property tax revenue (31 USC 6901–6907 [Public Law 103-397, October 22, 1994; Public Law 104-333, November 12, 1996; and Public Law 105-83, November 14, 1997]; 43 CFR Part 1880 [65 FR 51229–51234, August 23, 2000, effective September 22, 2000]). PILT payments are administered by the BLM (Coupal, Taylor, and Foulke 2003).

Between 2001 and 2004, PILT payments received by Wyoming increased by 20.0% (Table 3-33). The three-county study area has experienced a similar increase. Lincoln County PILT payments increased 20.0%, Sweetwater County PILT payments increased 20.4%, Uinta County PILT payments increased by 23.9%, and Sublette County PILT payments increased by 20.5%.

Table 3-33. Total PILT Payments and Total Acreage PILT Payments/Acre.

Location	2001	2002	2003	2004	% Increase 2001-2004
Wyoming					
Payment (000's $)	12,194	12,909	14,305	14,628	20.0
Acres (000's)	29,885	29,890	29,878	29,878	
Lincoln county					
Payment (000's $)	617	643	721	742	20.2
Acres (000's)	1,946	1,948	1,948	1,948	
Sweetwater County					
Payment (000's $)	1,321	1,389	1,547	1,591	20.4
Acres (000's)	4,607	4,607	4,607	4,607	
Uinta County					
Payment (000's $)	632	667	761	783	23.9
Acres (000's)	566	566	566	566	
Sublette County					
Payment (000's $)	361	376	411	435	
Acres (000's)	2,432	2,431	2,431	2,431	20.5

Source: (Coupal, Taylor, and Foulke 2003)) and (BLM 2003), in Year 2000 dollars, adjusted for inflation.

3.10.6.1.3. Sales, Use, and Lodging Tax

Wyoming has collected sales and use taxes since 1935. Sales taxes apply to the retail sale of personal property or services within the state. A use tax is levied on the sale of any property outside the state of Wyoming for use, storage, or consumption inside the state of Wyoming. The state's share of the sales tax revenue is distributed to the General Fund.

Wyoming taxing jurisdictions are the State of Wyoming and/or each Wyoming county. Use tax is a complement of sales tax. Effective January 1, 1981, the adoption of an optional sales tax required a change in the use tax rate of equal amount. State use tax is shared between state government and the county of origin on the same distribution basis as sales tax.

Cities, towns, and counties, by voter approval, may impose a lodging excise tax of up to 4% on all sleeping accommodations for guests staying less than 30 days. This tax also extends to mobile accommodations, such as tents, trailers, and campers. All collections (less a 2% state administrative cost during the first year the tax is imposed and 1% thereafter) are distributed to the cities, towns, and counties of origin.

3.10.6.1.4. Property Taxes (Ad Valorem Taxes)

Foulke et al. (2001) believe that mineral revenues will continue to rise and that gas production will drive future revenues higher. Wyoming Department of Revenue reports indicate that in 2002, natural gas production contributed the greatest proportion of taxable value to the state (34.8%), followed by residential land and improvements (18.5%), mining production (15.9%), and oil production (9.7%). In 2004 natural gas production continued to contribute the greatest proportion of taxable value to the state (38.5%), followed by residential land and improvements (17.8%), mining production (15.4%), and oil production (9.1%).

3.10.7. Study Area Taxes and Revenues

3.10.7.1. Availability of Information

Financial resources of the study area refer to government revenue sources in Lincoln, Sweetwater, and Uinta Counties. These statistics help determine the financial impacts of industrial development on the counties potentially affected. All three counties will directly benefit from the increased tax base provided by the proposed oil and gas development. In addition, they could be financially impacted by secondary growth from residential development, increased retail sales, and increased demands on public services and facilities.

3.10.7.2. State Royalties

Total royalties in Wyoming arising from natural gas production on state lands increased nearly 62.0% from 1998 to 2002 (Wyoming Office of State Lands and Investments 2002). Oil royalties rose and fell, but overall increased 5.6% from 1998 to 2002. Between 2002 and 2004, natural gas royalties in Wyoming increased 148.9%, and oil royalties increased 40.7% (Wyoming Office of State Lands and Investments 2004).

In Lincoln County, from 1998 to 2002, royalties from natural gas production on state lands decreased 21.5%, and oil royalties decreased 17.3%. Between 2002 and 2004, natural gas royalties in Lincoln County increased 75.8%, while oil royalties decreased 2.3% (Wyoming Office of State Lands and Investments 2004). The only other mineral royalty paid to Lincoln County in 2001 and 2002 from state lands was for sand and gravel (Wyoming Office of State Lands and Investments 2002). Sweetwater County royalties from natural gas production on state lands increased 17.1% from 1998 to 2002, and oil royalties increased 20.6%. Sweetwater County received most of its royalties from trona mining, but it also received royalties from coal (2000, 2001, 2002), limestone (2000), uranium (2002), and sand and gravel (2001, 2002). Between 2002 and 2004, natural gas royalties in Sweetwater County increased 294%, while oil royalties decreased 3.9% (Wyoming Office of State Lands and Investments 2004).

3.10.7.3. Sales, Use, and Lodging Tax Collections

Wyoming counties, cities, and towns benefit from sales and use tax collections. Each month, the treasurer's office in each county sends the sales tax collections to the Wyoming Department of Revenue, which distributes the money. Currently, two-thirds of the 4% sales tax collections go to the state general fund, and one-third (minus 1% for state administrative purposes) is returned to the cities, towns, and counties. The money returned to the cities and counties is based on where the purchase occurred and the population of the city or county (which is based on the last federal census). Counties that have 1% optional sales taxes or a 1% capital facilities tax keep 100% of the additional 1% collected. The state's share of the sales tax revenue is distributed to the General Fund. County sales tax rates can fluctuate from year to year because county option taxes originate and expire at varying times.

State use tax is imposed on purchases made outside a taxing jurisdiction for first use, storage, or other consumption within that jurisdiction. Thus, the use tax prevents sales tax avoidance or the payment of a lesser tax rate by making purchases outside of the taxing jurisdiction where first use, storage, or other consumption will occur. Wyoming taxing jurisdictions are the State of Wyoming and/or each Wyoming County. Use tax is a complement of sales tax. Effective January 1, 1981, the adoption of an optional sales tax required a change in the use tax rate of equal amount. State use tax is shared between state government and the county of origin on the same distribution basis as sales tax. Therefore, the revised rate and allocation, as mentioned earlier in the sales tax description, applies here as well.

Cities, towns, and counties, by voter approval, may impose a lodging excise tax of up to 4% on all sleeping accommodations for guests staying less than 30 days. This tax extends to mobile accommodations such as tents, trailers, and campers, as well. All collections (less a 2% state administrative cost during the first year the tax is imposed and 1% thereafter) are distributed to the cities, towns, and counties of origin. At least 90% of the tax distributions must be used to promote travel and tourism within the county, city, or town imposing the tax. The amount remaining, not to exceed 10% of the total amount distributed, may be used for general revenue within the governmental entity imposing the tax.

3.10.7.4. Ad Valorem Valuation and Taxes Levied

3.10.7.4.1. Wyoming

From 2001 to 2005, total state and locally assessed real and personal property valuation increased 60.0%. From 2001 to 2005, assessed oil and gas extraction valuation increased 71.4%. Between 2001 and 2005, non-mineral assessments increased 55.7%. These increases show the vibrancy of the growth in the State of Wyoming as well as those counties affected by resource development.

From 2001 to 2005, taxes levied in the State of Wyoming increased from $675 million to over $1 billion. This increase in taxes levied represented an increase of 54.8% and depicts the intensity of the booming mineral industry throughout parts of the state.

3.10.7.4.2. Lincoln County

Although oil and gas extraction was only assessed for the years 2001 to 2003, Lincoln County experienced positive changes in valuations during the 2001 to 2005 period. Total state-assessed oil and gas extraction increased 14% in Lincoln County. Total state and locally assessed valuation for Lincoln County increased 31.2% from 2001 to 2005. Other assessed property increased 32.2%. Lincoln County has less oil and gas production than both Uinta and Sweetwater County, but serves as a hub for service companies involved in the industry.

Lincoln County has also experienced significant growth in taxes levied during the period. In 2005 taxes levied in Lincoln County totaled $46 million, including $605,000 in Kemmerer and $131,000 in Diamondville. Total taxes levied have increased 37 % in Lincoln County and 12.7 % and 9%, respectively, in Kemmerer and Diamondville.

3.10.7.4.3. Sweetwater County

State and locally assessed valuation of all real and personal property in Sweetwater County increased 29.5% from 2001 to 2005, showing the rapid growth in the area. Between 2003 and 2005 total state and locally assessed valuation increased by 56.9%. Locally assessed oil and gas had the greatest overall increase (88.4%). Rock Springs municipal valuations continue to increase substantially, particularly in the past 2 years, which represents a portion of the other property growth of 27.7% for the period.

Sweetwater County experienced a 34.1 % growth in taxes levied during the period. In 2005 taxes levied in Sweetwater County totaled $119 million, including $6.8 million in Rock Springs and $3.7 in Green River.

3.10.7.4.4. Uinta County

Although Uinta County does not produce as much oil and gas as Sweetwater or Sublette, it also serves as a hub for the smaller service industries in the region similar to Lincoln County. Assessed value in oil and gas extraction has increased by 24% over the period, but overall growth in assessed valuation has declined by 11%. Uinta County has not experienced the same amount of growth as Sweetwater or

even Lincoln counties due to the infrastructure that was already built during the last boom period. More oil and gas operations are located out of Sweetwater and Sublette counties.

Uinta County has actually shown a decrease in taxes levied through the period. In 2005 taxes levied in Uinta County totaled $40.4 million, including $3.2 million in Evanston. Total taxes levied declined 26% since 2001 for the county and 3.9% for the city of Evanston.

3.10.7.4.5. Sublette County

The gross valuation of all real and personal property in Sublette County increased 164% during the 1998 to 2002 study period. Sublette County has no mining (mineral, coal, non-metal) properties to consider in either local or state-assessed valuations. Only oil and gas properties are included in state-assessed mineral valuations in Sublette County, and they increased 211% from 1998 to 2002.

3.10.8. Environmental Justice

Under Executive Order 12898 (published in the Federal Register February 11, 1994), federal agencies are required to identify and address disproportionately high or adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations. A specific consideration of equity and fairness in resource decision-making is encompassed in the issue of environmental justice. As required by law and Title VI, all federal actions will consider potentially disproportionate negative impacts on minority or low-income communities. Within the area potentially affected by the proposed project, minimal minority populations are affected. During the EIS process, particular efforts were made to ensure that property owners within the affected areas were informed of the proposed project, the EIS procedures, and the opportunity to provide comments.

Income levels throughout the study area are diverse. The most recent estimate (2002) of per capita personal income shows $17,533 in Lincoln County, $19,575 in Sweetwater County, and $16,994 in Uinta County. Median household income in 2003 was $46,993 in Lincoln County, $52,402 in Sweetwater County, and $48,612 in Uinta County. These numbers are fairly consistent with the economic base of the area, which is mineral resource and agriculturally driven. The most recent poverty status statistics are from 2003 census data. These data showed poverty status to be 9.0% in Lincoln County, 8.6% in Sweetwater County, and 10.6% in Uinta County (U.S. Census Bureau 2003). Because the economic base of the study area is largely rural agriculture and resource extraction, low income areas are dispersed within the study area. People within the poverty status may reside within the study area, but not disproportionately.

Table 3-34 highlights demographic statistics for identifying potential areas of concern. The 2003 Census data was used for the analysis of race and income data was used for analysis of poverty.

None of the alternatives would result in disproportionately high or adverse impacts on minority or low-income communities, because these groups are not present in large numbers in the affected counties and would not increase as a result of the Proposed Action or alternatives. Impacts to environmental justice are not expected to result from implementation of the Proposed Action or alternatives; therefore, no additional analysis will be conducted in Chapter 4 of this document.

Table 3-34. U.S. Census Bureau Community Statistics.

Population	Lincoln County	Sweetwater County	Uinta County	Sublette County
Persons Below Poverty Level (2005)	1,519	3,266	2,114	533
Percent Below Poverty (2003)*	9.5%	8.6%	10.6%	7.7%
Percent White (2004)*	97.9%	95.7 %	97.4%	97.8%
Percent Black (2004)*	0.1%	1.0%	0.1%	0.2%
Percent American Indian (2004)*	0.7%	1.1%	1.0%	1.0%
Percent Asian (2004)*	0.3%	0.9%	0.4%	0.3%
Percent Native Hawaiian or Pacific Islander (2004)	0.0%	0.1%	0.0%	0.0%
Percent Other Race (2004)*	0.9%	1.3%	1.1%	0.6%
Percent Hispanic Origin (of any race) (2004)*	3.1%	10.2%	5.7%	2.2%

Source:(U.S. Census Bureau 2006).
*Percentages are calculated as the percent of the total population in each respective county.

3.11. Land Use

3.11.1. Land Status/Prior Rights

The MAA consists of federal (BLM, Reclamation, USFWS), State of Wyoming, and privately owned lands and minerals (Map 1-2). The majority of the MAA is characterized by a "checkerboard" pattern with alternating sections of private ownership and state/federal ownership. Current land use includes energy production and development (e.g., well pads, pipelines, access roads, and other infrastructure), livestock grazing, private residences, and recreation. A well-established transportation network exists across the project area.

3.11.2. Livestock Grazing and Rangeland Health

The Wyoming BLM manages rangeland following their Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands Administered by the BLM in the state of Wyoming (2004). According to the Department of the Interior's final rule for grazing administration, effective August 21, 1995, the Wyoming BLM State Director is responsible for the development of standards for healthy rangelands and guidelines for livestock grazing management on 18 million acres of Wyoming's public rangelands. The development and application of these standards and guidelines are to achieve the four fundamentals of rangeland health outlined in the grazing regulations (43 CFR 4180.1). Those four fundamentals are: (1) watersheds are functioning properly; (2) water, nutrients, and energy are cycling properly; (3) water quality meets State standards; and (4) habitat for special status species is protected. Standards address the health, productivity, and sustainability of the BLM administered public rangelands and represent the minimum acceptable conditions for the public rangelands. The standards apply to all resource uses on public lands.

Implementation of the Standards and Guidelines began in 1998 and includes assessing the health of grazing allotments and applying management action guidelines to those that do not meet the minimum standards. BLM management implementation is conducted by periodic review of grazing Allotment Management Plans (AMPs) and land condition. Standards are assessed based on six categories, including soils, riparian and wetland vegetation, upland vegetation, native plant diversity, water quality, and air quality (BLM 2004c). Habitats for federally threatened, endangered, candidate, or other special-status species that occur on allotments are also considered (BLM 1998).

The CIAA for livestock grazing is the 17 affected grazing allotments that encompass approximately 1,206,129 acres (Map 3-14). Seventeen livestock grazing allotments managed by the BLM overlap with the MAA; six occur entirely within the Project Area (Map 3-14). Table 3-35 describes the allotments by name, acreage, and animal unit months (AUMs), the amount of land required for forage for one month for a cow/calf pair. The Granger Lease occupies the largest area, covering 49.5% of the MAA. Acreage and AUMs for the Rock Springs allotment were not available, and is therefore not listed in Table 3-35. Table 3-36 conveys results of Standards and Guidelines assessments for each allotment. Currently, about 3% of the Nutria allotment is disturbed by existing oil and gas field development activities within the MAA. About 2% of each of the H.F., Granger Lease, Cow Hollow, and Slate Creek allotments is currently disturbed. About 1% of each of the Carter Lease, Christensen, and Indian Flat allotments is currently disturbed. Less than 1% of each the remaining allotments is currently disturbed. Disturbance to allotments could be higher than the what is reported in the above section because much of the current reclamation is not complying with the standards authorized as part of the 1997 ROD (BLM 1997a).

Carrying capacities of allotments vary from 8 acres per one AUM on the Carter Lease allotment, to 45 acres per AUM for the Austin triangle allotment, with an average of 19 acres per AUM over the 17 allotments (Table 3-35). The number of acres per AUM indicates rangeland productivity; a higher acreage required per AUM reflects poorer forage production amounts or quality. The reasons for lower forage production can include soil types, topography, or other natural factors.

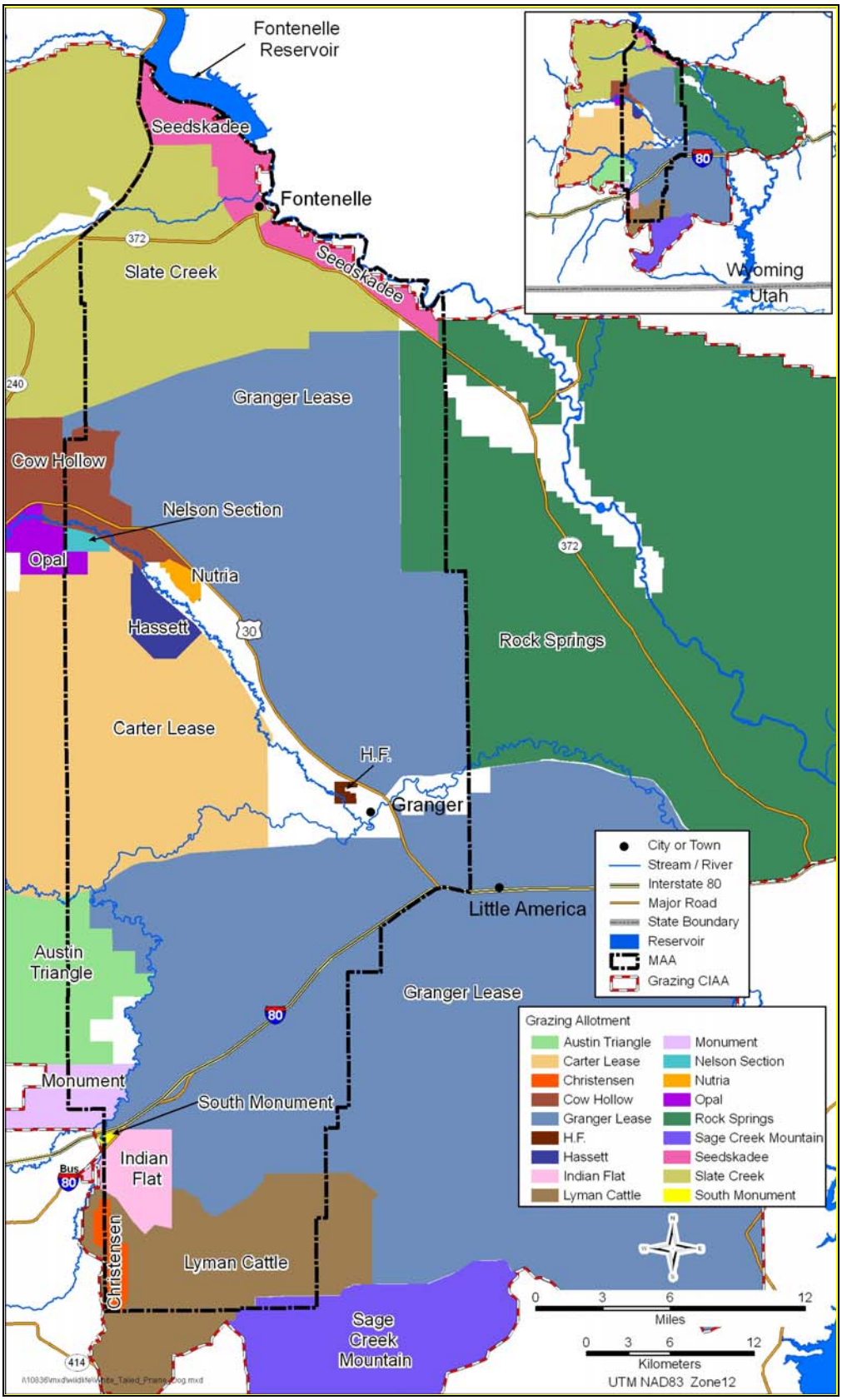
The 1995 Moxa Arch EIS indicated that 55% of the AUMs within the MAA were utilized by sheep, 43% by cattle, and 2% by horses. The majority (66%) of the sheep are on range from December 1 to April 30, with the remainder permitted for spring/summer/fall grazing. Cattle are primarily permitted during the spring/summer/fall period, as are horses. The type of livestock grazed in each allotment is shown in Table 3-36.

3.11.3. Recreation

The CIAA for recreation is the combined area of the CIAAs for big game species and sage-grouse.

Recreation opportunities offered within the KFO area include camping, fishing, hunting, snowmobiling, and cross-country skiing, most of which is available on or near the MAA public lands. The MAA is visited less frequently than adjacent areas such as Fontenelle Reservoir, Flaming Gorge Reservoir, Seedskadee NWR, the Green River corridor, and the mountainous areas to the north.

No known recreational trails cross the MAA; however, seven historic trails cross the Project Area and may draw visitors. Campgrounds that occur within the MAA include the Slate Creek Campground on Slate Creek and the Weeping Rock Campground near Fontenelle Reservoir, which are located in the northern portion of the Project Area. Both include fishing access and picnic areas in addition to camping facilities. BLM data indicate that in 2005, the Slate Creek Campground received 4,700 visits, and the Weeping Rock Campground received 2,300 visits.



Map 3-14. Livestock Grazing Allotments in the MAA and CIAA.

Table 3-35. Grazing Allotments within the MAA.

Allotment Name and Number	Total Allotment Area (acres)	Acres within MAA (% of MAA)	Federal AUMs	State AUMs	Private AUMs	Average Area per AUM (acres)
Austin Triangle 11312	47,030	9,849 (2.1%)	706	10	328	45
Carter Lease 11306	238,798	60,007 (12.6%)	13,184	945	16,699	8
Christensen 11108	2,799	2,198 (<1%)	40	0	78	24
Indian Flat 11324	7,922	7,379 (1.6%)	578	0	0	14
Cow Hollow 11301	18,059	9,122 (1.9%)	687	66	425	15
Granger Lease 11302	470,679	235,407 (49.5%)	13,865	727	15,150	16
H.F. 11315	551	551 (<1%)	36	0	0	15
Hassett 1305	4,696	4,696 (1%)	116	0	172	16
Lyman Cattle 11303 A&B	46,896	27,138 (5.7%)	2,313	45	1,075	14
Monument 11308	8,288	3,413 (<1%)	186	91	467	11
Nelson Section 11321	1,019	999 (<1%)	20	0	80	10
Nutria 11323	1,154	1,154 (<1%)	20	0	80	12
Opal 11322	4,990	630 (<1%)	232	0	0	22
Seedskadee 11112	15,115	15,090 (3.2%)	486	0	0	31
Slate Creek 11113	258,078	55,416 (11.7%)	11,082	615	1,527	20
Sage Creek Mountain	102,353	873 (<1%)	11,844	220	184	8
South Monument 11310	434	247 (<1%)	No data	No data	No data	No data
Totals	**1,224,165**	**434,169 (91%)**	**55,395**	**2,719**	**36,265**	**19**

Note: South Monument not in 2006 BLM list of allotments

Table 3-36. Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management Assessment Results and Management Status for Allotments.

Allotment Name	Livestock Type	S&G Health Assessment*
Austin Triangle	Cattle/Sheep	Met
Carter Lease	Cattle/Sheep	Not meeting
Christensen	Cattle	2007†
Indian Flat	Sheep	2007†
Cow Hollow	Cattle	Met
Granger Lease	Cattle/Sheep	Met
H.F.	Cattle	Met
Hassett	Cattle	Met
Lyman Cattle	Cattle	2006†
Monument	Sheep	2006†
Nelson Section	Cattle	2006†
Nutria	Cattle	2009†
Opal	Cattle	2008†
Seedskadee	Cattle/Horses	2007†
Slate Creek	Cattle/Sheep	Not meeting
Sage Creek Mountain	Cattle/Horses/Sheep	Not meeting
South Monument	No information available	No information available

*- Standards & Guidelines Assessments are only completed on BLM surface lands.
†- health assessment to be completed in year cited
Note: South Monument not in 2006 BLM list of allotments

3.11.3.1. Fishing

Fishing opportunities are associated with perennial streams and reservoirs across southwest Wyoming. These sites are primarily cold-water trout fisheries. Those that cross into the MAA include perennial stretches of the Hams Fork River, Blacks Fork River, and Slate Creek, along with their major tributaries. The Green River and Fontenelle Reservoir on the northern boundary of the MAA provide additional fishing opportunities. These waters are considered part of the Green River Fisheries Region for management purposes. Sport fish species found in portions of the Project Area include brown trout (*Salmo trutta*), rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus* spp.), brook trout (*Salvelinus fontinalis*), mountain whitefish (*Prosopium williamsoni*), channel catfish (*Ictalurus punctatus*), smallmouth bass (*Micropterus dolomieui*), and kokanee salmon (*Oncorhynchus nerka*).

3.11.3.2. Hunting

The four major big game ungulates hunted in southwestern Wyoming are mule deer, pronghorn, moose, and elk. Greater sage-grouse is the most popular upland bird game species hunted in the MAA. Herd units, along with population estimates and objectives for game species within the MAA, are presented in the wildlife and big game sections earlier in this document. Seasons are generally September through November for pronghorn, October through November for mule deer, September through October for greater sage-grouse, and September through October for moose. The MAA includes sections of three mule deer hunt areas (numbers 132, 134, and 135), three pronghorn hunt areas (numbers 93, 94, and 95), and three moose hunt areas (numbers 33, 35, and 40). Elk are relatively rare in the MAA and surrounding CIAA, as suitable habitat is not available. WGFD reports from 2005 indicated that the average pooled total (residents and non-residents) hunter success rate for

the three mule deer hunt areas in the Moxa CIAA ranged between 29.5% and 39.4%, with 14,088 total hunter days (WGFD 2005a). For pronghorn, the average 2005 pooled total success rate for the three hunt areas ranged between 92.9% and 95.1% over 6,411 hunter days. The 2005 moose statistics were only available for two hunt areas (area 33 was closed to hunting) and ranged between a 50% and 64% success rate over 199 hunter days.

Greater sage-grouse is an important game species in Wyoming. WGFD manages greater sage-grouse, along with other upland game birds, in three Management Areas that occur in the MAA: Seedskadee (Area 4), Uinta (Area 5), and Flaming Gorge (Area 6). These correlate closely with big game herd units and are divided by I-80 and US 30. Average success rate in 2005 over the three Moxa Management Areas was 105%, with a total greater sage-grouse harvest of 1,197 (WGFD 2005b). Some evidence suggests that greater sage-grouse populations have steadily declined in the last 50 years (WSGWG 2003; Christiansen 2004; Connelly et al. 2004). Because greater sage-grouse populations are susceptible to over-harvesting, hunting seasons have been closed where habitats are isolated or fragmented. Conservative hunting of sage-grouse that results in harvest rates of less than 10% of the fall population have been recommended, however, there is no direct correlation between hunting and population declines (Christiansen 2004).

Other upland game birds of hunting importance in Wyoming that occur in vicinity of the MAA and CIAA include gray partridge (*Perdix perdix*), chukar (*Alectoris chukar*), ring-necked pheasant (*Phasianus colchicus*), blue grouse (*Dendragapus obscurus*), and ruffed grouse (*Bonasa umbellus*). Waterfowl and other hunted migratory birds expected to be regular visitors to the MAA include mourning dove (*Zenaida macroura*), Virginia rail (*Rallus limicola*), snipe (*Gallinago* spp.), Canada goose (*Branta canadensis*), sandhill crane (*Grus canadensis*), various ducks, and American coot (*Fulica americana*). Small game and furbearers that inhabit the Project Area include badger (*Taxidea taxus*), cottontails (*Sylvilagus* spp.), black-tailed jackrabbit (*Lepus californicus*), bobcat (*Lynx rufus*), weasel (*Mustela frenata*), beaver (*Castor canadensis*), mink (*Mustela vison*), and muskrat (*Ondatra zibethicus*). Of these, cottontails, various duck species, Canada geese, and blue and ruffed grouse appear to have any recreational value (WGFD 2005b).

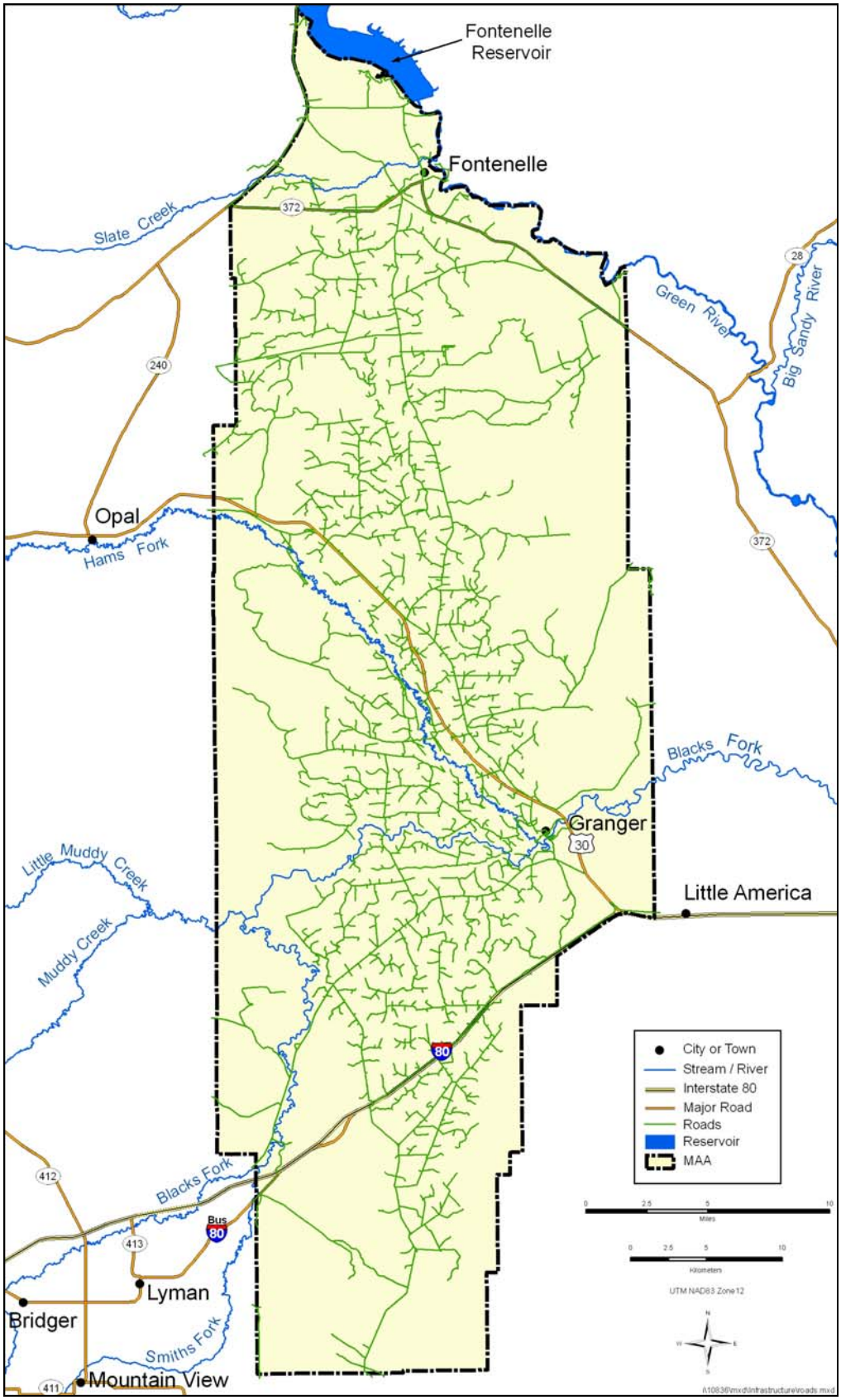
3.11.4. Transportation

The CIAA for transportation is the same as that for socioeconomics, which is the counties (Sweetwater, Lincoln, Uinta, and Sublette) and the communities most likely to be affected by the proposed project (Map 1-1).

Surface transportation in the MAA is provided by an extensive network of collector and resource roads (Map 3-15). The regional transportation system serving Lincoln, Sweetwater, and Uinta Counties (including the MAA) includes an established system of interstate, state, and county roads. The Union Pacific Railroad maintains rail lines serving all three counties; rail passenger service has been discontinued. Commercial air service is provided to Rock Springs, and general aviation services are available at Rock Springs, Evanston, Kemmerer, and Fort Bridger airports.

Several paved all-weather roads provide access to the MAA. Primary access from Green River and Rock Springs is from I-80 and US 30. Access from Evanston and the Bridger Valley is via I-80. Primary access from Kemmerer and Diamondville is from US 30 and US 189. Wyoming Secondary Highways WY 372, WY 240, and WY 374 also provide access to portions of the MAA.

The service levels of the highways providing access to the analysis area are within tolerable standards (e.g., highways design, volumes of traffic, etc.) of the WYDOT. Sufficient unused capacity exists on the highways providing access to the analysis area (with the exception of I-80), which indicates that traffic volumes could nearly double before tolerable standards would be exceeded. Table 3-37 provides information on current traffic volumes for the highways identified.



Map 3-15. Transportation Network in the MAA.

Table 3-37. Current Traffic and Accident Information.

Highway Segment (miles within MAA)	2005 ADT All Vehicles Wtd. Avg./Peak	2004 Accidents/Million Vehicle Miles Traveled	2004 Average Accident Rate (by Hwy Class)
I-80 (MP 6.26-107.09	13,146/97,262	1.03	1.0
U.S. 30 (MP 55.13-100.03)	1,983/9,450	0.61	1.28
U.S. 189 (MP 0.0-66.86)	1,232/6,930	1.44	1.5
WY 372 (MP 0.114- 48.59)	1,207/NA	0.7	1.51
WY 240 (MP 0.0-12.29)	399/1,971	0.0	1.51

MP = Mile Post
Sources: (Adkison 2006); (Carpenter 2006)

Within the MAA, an extensive system of private and public collector, local, and resource roads exists. County roads within the MAA are maintained by individual county road and bridge departments, and resource roads are typically maintained by the Operators.

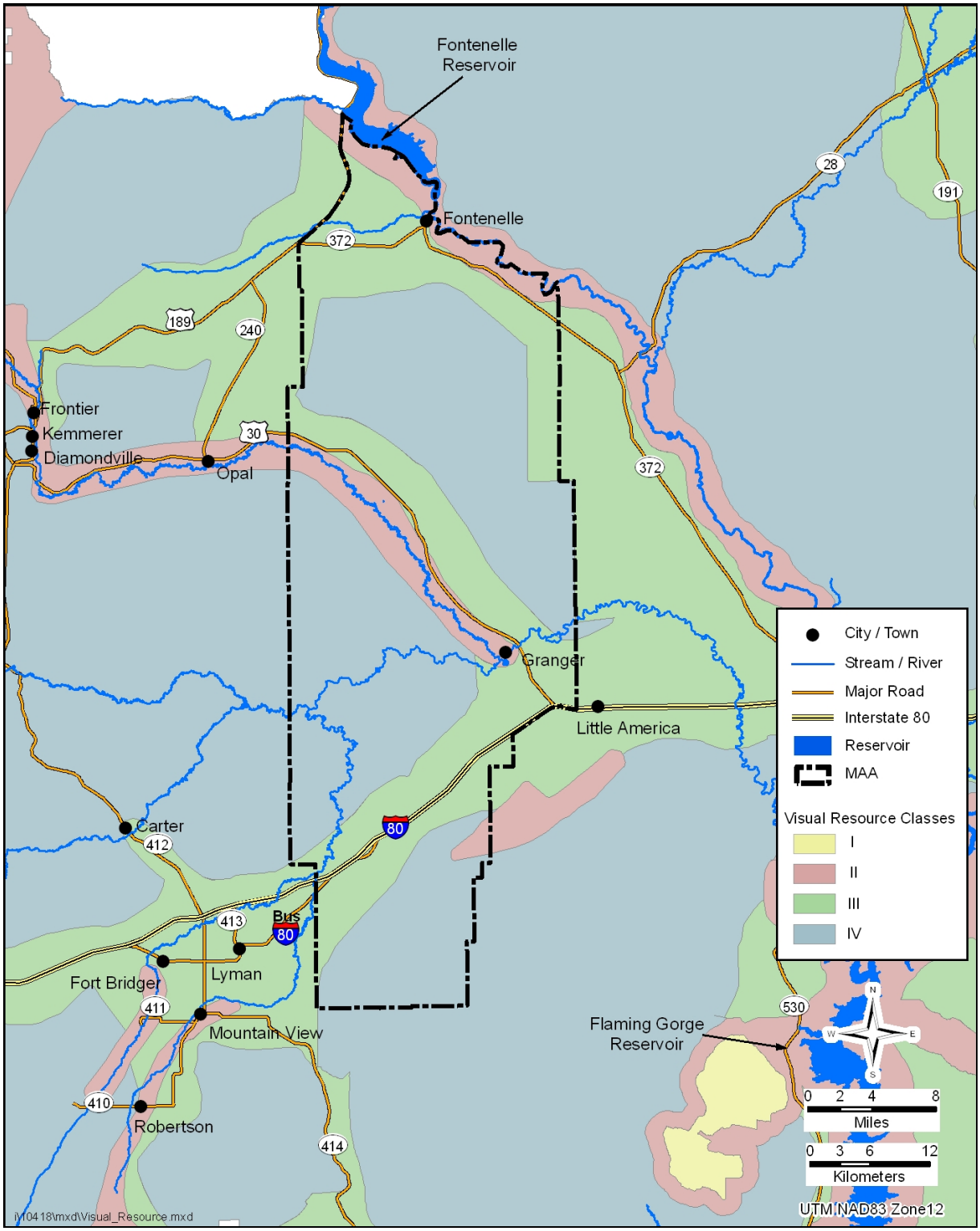
The analysis area has been in various stages of development for the past 40 years. Therefore, the internal road network is developed. As of August 2005, approximately 1,047 miles of internal road existed, which includes 73 miles of highway (IntraSearch 2005).

The road and bridge department of the county in which the roads are located maintains county roads within the analysis area. Lincoln County road and bridge superintendents indicate that increased maintenance has been required in the MAA within the last 10 years (Turner 2006). Sweetwater County road and bridge superintendents have not reported any increased maintenance required on county roads (Gibbons 2006). Uinta County road and bridge superintendents have reported increased maintenance requirements within the past 10 years (Brisko 2006).

3.12. Visual Resources

The BLM manages visual resources on public lands using the Visual Resource Management (VRM) System. VRM evaluates visual resources to determine the appropriate levels of management and analyzes potential visual impacts from surface-disturbing activities. VRM classifies land based on visual appeal, public concern for scenic quality, and visibility from travel routes or observation points. The VRM classes are used to identify the degree of acceptable visual change within a characteristic landscape. Classes are based on the physical and sociological characteristics of a given homogenous area and serve as a management objective. Class I land has the most visual value and is managed to preserve the existing characteristics of the landscape, while Class IV has the lowest value and allows for a high level of change. Projects of all types within established VRM class areas are generally required to conform to objectives and characteristics of the classification, or the project will be modified to meet the class objective. Short-term modifications in portions of VRM class areas may be approved if site-specific analysis determines that impacts would be within an acceptable threshold.

The BLM has categorized the MAA into VRM Class II, Class III, and Class IV areas (Map 3-16). Class II areas should retain the existing character of the landscape. Activities should not attract attention of the casual observer, and changes to the landscape should mimic the form, line, color, and texture of the natural landscape. Class III areas should partially retain the existing character of the landscape. Activities should not dominate the view, and changes should repeat the basic elements found in the predominant natural landscape features. Class IV areas allow major modifications to the existing character of the landscape. Activities may dominate the view and be the major focus of viewer attention. However, management of Class IV areas should attempt to minimize the impact of activities through careful location, minimal disturbance, and repeating the basic elements.



Map 3-16. Visual Resource Management Classifications in the MAA.

The natural landscape of MAA is gently rolling to flat topography, vegetated with desert shrub and riparian species. Parts of the landscape have been modified by ranches, rural communities, oil and gas development facilities, roads, railroads, fences, billboards, power lines, and communication towers. VRM Class II areas, which have the most visual resource value in the MAA, are found at the northern boundary of the Project Area along Fontenelle Reservoir and Green River. Class II areas are also found along Hams Fork River and in an area south of I-80. Class III areas are found in highly visible areas along travel routes, including I-80, US 30, and SH 372. The remainder of the Project Area is classified as Class IV.

3.13. Hazardous Materials

Hazardous materials present in the MAA include those used and produced in association with natural gas drilling, completion, and production; these substances and their current management protocol are discussed in detail in the Hazardous Materials Management Summary (Appendix B). Hazardous materials anticipated to be used during the proposed project generally include drilling materials, cementing and plugging materials, fracturing materials, production products, fuels, pipeline materials, emissions, compressor station materials, and other miscellaneous materials.

The BLM, Wyoming Department of Environmental Quality (WDEQ), Environmental Protection Agency (EPA), OSHA, U.S. Department of Transportation (USDOT), and WOGCC each regulate certain safety aspects of oil and gas development. The primary federal regulations related to health and safety requirements for oil and gas operations are specified under 43 CFR Ch. II, subpart 3162.5. These regulations require the prior approval of a drilling and operations plan by the BLM that addresses the procedures to be employed for protection of environmental quality, including safety precautions, control and removal of waste, spill prevention, fire prevention, and fire fighting procedures.

CHAPTER 4 ENVIRONMENTAL CONSEQUENCES

4.1. Introduction

The purpose of this chapter is to determine the potential for significant impact of the "federal action" on the "human environment." The CEQ regulations for implementing the NEPA state that the "human environment" shall be interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment [40 CFR §1508.14]. The "federal action" is the BLM's selection of an alternative plan on which future land use actions would be based.

4.1.1. Impact Analysis

Analysis of the alternatives focuses on identifying types of impacts and estimating their potential significance. Throughout this chapter the terms "impact" and "effect" are synonymous. An overview of the types of impacts is presented below. Cumulative impacts are defined and discussed separately in Chapter 5.

> Direct Impacts: These are effects that are caused by the action and occur at the same time and place. Examples include the elimination of original land use due to the building of a structure. Direct impacts may cause indirect impacts, such as ground disturbance resulting in resuspension of dust.
>
> Indirect Impacts: These are effects that are caused by the action but occur later in time or are farther removed in distance; they are still reasonably foreseeable and related to the action by a chain of cause and effect. Indirect impacts may reach beyond the natural and physical environment (e.g., environmental impact) to include growth-inducing effects and other effects related to induced changes to resources users (e.g., non-environmental impact).
>
> Significant Impacts: Both direct and indirect impacts may be significant. "Significant" requires consideration of both the context and intensity of the impact. This means that an action must be analyzed in several contexts – such as the immediate vicinity, affected interests, and the locality. Both short-term and long-term effects are relevant. Intensity refers to the severity of impact. Thus, significant impacts are of greater intensity than negligible, minor, or substantial impacts.
>
> Residual Impacts: These are foreseeable impacts after the LOP and after proposed mitigation measures are applied.

The BLM manages public lands for multiple uses in accordance with the FLPMA. Land use decisions are made to protect the resources while allowing for multiple-use of those resources, such as livestock grazing, energy development, and recreation. Where conflicts exist between resources uses, or where a land use activity may result in irreversible or irretrievable impacts to the environment, the BLM may restrict or prohibit some land uses in specific areas. To ensure that the BLM meets its multiple-use mandate in land management actions, the impacts of the alternatives on resource users are identified and assessed as part of the planning process. The projected impacts on land use activities and the associated environmental impacts of land uses are characterized and evaluated for each of the alternatives.

4.1.2. Significance Criteria

Significance criteria are developed to gauge the magnitude of impact that an action would have on the human environment. An adverse impact on resources as a result of human activities would be

considered potentially significant if its magnitude required special mitigation or if the impact persisted indefinitely.

The concept of significance encompasses several factors, including the degree of change from existing conditions and the likelihood of the change to occur. The context and intensity of the impact are also considered. Context refers to the environmental circumstances at the location of the impact. Intensity refers to the severity or extent of an impact, including the potential for violation of laws or regulations and the recovery or resilience of the resource.

Determining significance is complex, in that impacts are dynamic and may change during the planning period. Significance can be real and supportable by fact, or perceived and perhaps not fully supportable even with rigorous study. For this analysis, the approach to establishing significance criteria was based on legal issues (i.e., government regulatory standards), public input, available scientific and environmental documentation, and professional judgment of resource specialists.

4.1.3. Best Management Practices/Mitigation Measures

BMPs and mitigation measures are developed based on BLM requirements and on compensation for potential impacts to the natural and physical or the relationship between people and that environment. All proposed BMPs and mitigation measures for resources are presented in Appendix A of the EIS. All alternatives will comply with the Kemmerer RMP.

4.2. Air Quality

Because of the highly technical nature of air quality modeling and impacts assessment and the quantity of tables and figures required to make informed decisions regarding the impacts of each of the project alternatives, the following sections related to air quality only summarize the results of the modeling efforts. A detailed technical support document containing all of the model assumptions, results, tables, and figures is located in Appendix C in Volume 2 of this DEIS.

4.2.1. Introduction

The Project's location in southwest-central Wyoming required the examination of Project and cumulative source impacts in Wyoming, northwestern Colorado, northeastern Utah, and southeastern Idaho within a defined air quality modeling domain (Map 3-1). The methodologies utilized in the analysis were originally defined in an air quality impact assessment protocol (Protocol) prepared with input from the BLM and project stakeholders, including the EPA, NPS, USDA Forest Service, and Wyoming Department of Environmental Quality Air Quality Division (WDEQ-AQD). The analysis area includes the area surrounding MAA and all or a portion of the Bridger, Fitzpatrick, Popo Agie, Teton, Flattops, Rawah, Mount Zirkle, and Washakie Wilderness Areas; Dinosaur National Monument, the Wind River Roadless Area; and Grand Teton and Rocky Mountain National Parks.

Impacts analyzed include those on air quality and air quality related values (AQRVs) resulting from air emissions from: 1) project sources within the MAA, 2) non-project state-permitted and reasonably foreseeable future action (RFFA) sources within the modeling domain, and 3) non-project reasonably foreseeable development (RFD) within the modeling domain. The Project source emissions inventory was performed in accordance with the Protocol and following WDEQ-AQD oil and gas inventory guidance (WDEQ 2001a). Non-project sources were inventoried as part of a cooperative effort between the BLM Wyoming State Office and the Project proponents. Data from Wyoming, Colorado, Idaho and Utah air agencies were also obtained for the non-project sources. The following ten tasks were performed for air quality and AQRVs impact assessment:

- Project Air Emissions Inventory. Development of an air pollutant emissions inventory for the Project.
- Regional Air Emissions Inventory. Development of an air pollutant emissions inventory for other regional sources not represented by background air quality measurements, including state-permitted sources, RFFA, and RFD.
- Project Near-Field Analysis. Assessment of near-field air quality concentration impacts resulting from activities proposed within the MAA.
- Regional Near-Field Analysis. Assessment of near-field air quality concentration impacts resulting from activities proposed within the MAA in combination with other existing and proposed regional compressor stations.
- In-Field Cumulative Analysis. Assessment of concentration impacts within the MAA resulting from the project and other regional sources inventoried under the second bullet of this list.
- Mid-Field Cumulative Analysis. Assessment of mid-field visibility impacts to regional communities resulting from the Project and other regional sources.
- Far-Field Direct Project Impact Analysis. Assessment of far-field air quality concentration and AQRV impacts resulting from proposed Project activities.
- Far-Field Direct Project Impact Analysis. Assessment of far-field ozone concentration impacts resulting from proposed Project activities.
- Far-Field Cumulative Impact Analysis. Assessment of far-field air quality concentration and AQRV impacts resulting from activities proposed within the MAA combined with other regional sources inventoried under the second bullet of this list.
- Far-Field Cumulative Impact Analysis. Assessment of far-field ozone impacts resulting from activities proposed within the MAA combined with other regional sources inventoried under the second bullet of this list.

The following sections discuss development of the emissions inventory, near-field impacts, far-field impacts and ozone impacts. Appendix C provides a detailed assessment of air quality impacts.

4.2.1.1. Emissions

4.2.1.1.1. Project Emissions

All project emission calculations were completed in accordance with WDEQ-AQD oil and gas guidance (WDEQ 2001a) in effect at the time the inventory was conducted, stack test data, EPA's AP-42, or other accepted engineering methods.

Calculated project emissions included construction, production and total field emissions. Construction emissions were based on well construction, drilling, drilling traffic, completion traffic, and completion flaring. Well construction emissions were based on the number of wells constructed per year and the type of well constructed. Drilling, drilling traffic, completion traffic, and completion flaring were based on the number of wells developed per year. As a conservative assumption, completion flaring operations were assumed to occur at all of the wells under construction and compression was included. Production emissions were calculated based on the total number of producing wells in the field. Total producing wells were equal to the difference in number of wells proposed and the number of wells constructed per year.

4.2.1.1.2. Cumulative Emissions Inventory

An emissions inventory of industrial sources within the Project’s regional modeling domain was prepared for use in the cumulative air quality analysis. The modeling domain included portions of Wyoming, Colorado, Utah, and Idaho (Map 3-1). Industrial sources and oil and gas wells permitted

within a defined time frame (January 1, 2001 through June 30, 2006) through state air quality regulatory agencies and state oil and gas permitting agencies were first researched. The subset of these sources which had begun operation as of the inventory end-date was classified as state-permitted sources, and those not yet in operation were classified as RFFA sources. Also included in the regional inventory were industrial sources proposed under NEPA in the states of Wyoming and Colorado. The developed portions of these projects were assumed to be either included in monitored ambient background or included in the state-permitted source inventory. The underdeveloped portions of projects proposed under NEPA were classified as RFD sources.

RFD information was obtained from final NEPA air quality analysis documents that were submitted to BLM for planned project development. Undeveloped portions of these authorized projects were obtained from BLM records tracking project development to determine total wells or other equipment yet undeveloped. For instance, for an authorized gas field development area for which 2,000 wells were projected but only 250 wells had been developed as of the inventory end-date of this study, 250 wells would be included under permitted source inventory and the remaining 1,750 would be considered RFD. RFD information from not-yet-authorized projects was obtained from contractors working on ongoing air quality analyses for NEPA projects.

Full development of proposed projects inventoried as RFD may or may not coincide with full development of the Project. As a result, the inclusion of RFD in the cumulative analysis may result in overly conservative impact estimates. To ensure "reasonable, but conservative" analysis results for all stages of Project development, the cumulative modeling analysis was performed both with and without RFD sources. A map showing NEPA RFD project areas that were examined in this study, as defined in the paragraph above is presented in Map 5-1. All development areas were reviewed for inclusion, and those projects with significant pollutant emissions during production activities were included as RFD. To ensure a timely, complete modeling analysis, only development authorized through the inventory end-date of June 30, 2006, or quantified as of the beginning of the modeling analysis, was included in the Project analysis.

4.2.1.2. Near-field Impacts

4.2.1.2.1. Criteria Pollutants

The EPA's proposed guideline dispersion model, AERMOD, was used to model the near-field concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2. AERMOD was run using one year of AERMET preprocessed MAA meteorology data following all regulatory default switch settings. Because PM_{10}, $PM_{2.5}$, NO_2, and SO_2 emissions would be present during both the resource road/well pad construction phase of field development and the production phase, these emissions sources were modeled under both scenarios to determine compliance with the appropriate standards. CO and NOx emissions primarily from compressor stations would be greatest during well production.

4.2.1.2.2. Hazardous Air Pollutants

AERMOD was also used to determine hazardous air pollutant (HAP) impacts in the immediate vicinity of the MAA for short-term (acute, 1 hour) exposure assessment and at Granger, Wyoming for calculation of potential long-term (chronic, 1 year) exposure assessment. Sources of HAPs include well-site fugitive emissions (BTEX and n-hexane), completion flaring and venting (BTEX and n-hexane), and compressor station combustion emissions (formaldehyde). Because maximum field-wide annual emissions of HAPs occur during the production phase, only HAP emissions from production were analyzed for long-term risk assessment.

Short-term exposure assessments were performed for production HAP emissions using various well densities (based on each alternative), and for an individual well construction completion (venting and flaring) event. Reference Exposure Levels (RELs) or chronic Reference Concentrations (RfCs) were

used to assess potential impacts. RELs are defined as concentrations at or below levels from which no adverse health effects are expected. RfCs are defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. RfCs exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2002). Because no acute RELs are available for ethylbenzene and n-hexane, Immediately Dangerous to Life or Health (IDLH) values were used for acute exposure. REL and IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database. RfCs are developed by EPA and were also obtained from EPA's Air Toxics Database. Model results are only used for comparison purposes to these standards.

Long-term exposures to emissions of suspected carcinogens (benzene and formaldehyde) were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from these pollutants for comparison purposes only, and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URFs) for carcinogenic constituents

Estimated cancer risks were evaluated based on the Superfund National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1993), where a cancer risk range of 1 x 10-6 to 1 x 10-4 is generally acceptable. Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home. For each constituent, the cancer risk is computed by multiplying the maximum predicted annual concentration by the URF and by the overall exposure adjustment factor. The cancer risks for both constituents are then summed to provide an estimate of the total inhalation cancer risk.

4.2.1.3. Far-Field Impacts

Far-field impact analyses were performed using the CALMET/CALPUFF modeling system (Version 6.0, dated April 14, 2006) to predict air quality impacts from the Project and cumulative sources at far-field PSD Class I and sensitive Class II areas within the far-field modeling domain (Map 3-1). The modeling system was used to generate meteorological fields and calculate ambient concentrations and AQRV impacts for 3 years: 2001, 2002 and 2003. CALMET was used to develop wind fields and other meteorological data for the study area within the modeling domain.

A separate analysis was performed to assess the effects of the Project's and cumulative sources' NO_X, VOC, and CO emissions on ozone concentrations.

The Class I and sensitive Class II receptor areas analyzed in the far-field modeling are:

- Bridger Wilderness Area (Class I);
- Fitzpatrick Wilderness Area (Class I);
- Grand Teton National Park (Class I);
- Mount Zirkel Wilderness Area (Class I);
- Teton Wilderness Area (Class I);
- Washakie Wilderness Area (Class I);
- Bridger Antelope Trap (Class II);
- Bridger Butte (Class II);
- Dinosaur National Monument (Federal Class II, Colorado Class I);
- Flaming Gorge National Recreation Area (Class II);
- Fontenelle Reservoir (Class II);

- Gros Ventre Wilderness (Class II);
- Popo Agie Wilderness Area (Class II);
- Seedskadee National Wildlife Refuge (Class II); and
- Wind River Roadless Area (Class II).

Predicted pollutant concentrations at these areas were compared to applicable national and state ambient air quality standards and PSD Class I and Class II increments and were used to assess potential impacts to AQRVs, which include visibility (regional haze) and acid (sulfur [S] and nitrogen [N]) deposition. In addition, analyses were performed for seven lakes designated as acid sensitive located within Class I and Class II areas to assess potential lake acidification from acid deposition impacts. These lakes are:

- Deep Lake in the Bridger Wilderness Area;
- Black Joe Lake in the Bridger Wilderness Area;
- Hobbs Lake in the Bridger Wilderness Area;
- Upper Frozen Lake in the Bridger Wilderness Area;
- Lazy Boy Lake in the Bridger Wilderness Area;
- Ross Lake in the Fitzpatrick Wilderness Area; and
- Lower Saddlebag Lake in the Popo Agie Wilderness Area.

4.2.1.3.1. Dispersion Model Input and Options

The CALPUFF model was used to model Project-specific and cumulative emissions of NO_x, SO_2, fine particulate matter (PMF), and coarse particulate matter (PMC). CALPUFF was run using the EPA-recommended default control file switch settings (Atkinson and Fox 2006) for almost all parameters. Deviations from EPA-recommended defaults are discussed in Appendix C. Chemical transformations were modeled using the MESOPUFF II chemistry mechanism for conversion of SO_2 to sulfate (SO_4) and NO_x to nitric acid (HNO_3) and nitrate (NO_3). Each of these pollutant species was included in the CALPUFF model runs. NO_x, HNO_3, and SO_2 were modeled with gaseous deposition, and SO_4, NO_3, PMF ($PM_{2.5}$), and PMC ($PM_{2.5-10}$) were modeled using particle deposition. Total PM_{10} impacts were determined in the post-processing of modeled impacts.

4.2.1.3.2. Post-Processing Procedures and Background Air Quality Data

For criteria pollutants, ambient air concentration data collected at monitoring sites in the region provide a measure of background conditions in existence during the most recent available time period. Regional monitoring-based background values for criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NOx, and SO_2) were collected at monitoring sites in Wyoming and northwestern Colorado. Ambient air background concentrations were added to modeled pollutant concentrations to arrive at total ambient air quality impacts for comparison to National Ambient Air Quality Standards (NAAQS), Wyoming Ambient Air Quality Standards (WAAQS), Colorado Ambient Air Quality Standards (CAAQS), and Utah Ambient Air Quality Standards (UAAQS). These background values are based on an e-mail from Darla Potter of WDEQ to Michele Easley of BLM dated August 8, 2006.

The visibility analysis differed from previous Wyoming NEPA cumulative air quality impact studies in its update of visibility background to include the most current data available. It also used representative monitoring data collected from the Interagency Modeling of Protected Visual Environment (IMPROVE) network for the time period (2000 to 2004) that coincides with the time period that will be used to establish "baseline conditions" under the EPA Regional Haze Rule (EPA, 2003a). Monitored visibility background data that have undergone QA/QC are currently available through December 31, 2004.

The most recent lake chemistry background acid neutralizing capacity (ANC) data were obtained from the Federal Land Managers (FLMs) for each sensitive lake in the study area. The 10th percentile lowest ANC values were calculated for each lake following procedures provided from the USDA Forest Service.

4.2.1.3.3. Class I Area Far-Field Air Quality and AQRV Impact Assessment

CALPUFF modeling was performed to compute direct Project impacts and for estimating cumulative impacts from the Project and other regional emission sources. The analyzed alternatives represent maximum emissions scenarios that included the last year of field development, at the maximum annual construction activity rate, combined with nearly full-field production. Regional emission inventories for existing state-permitted RFFA and RFD sources were modeled in combination with each Project alternative to estimate cumulative impacts. Also, because the RFD sources are highly speculative, a scenario that consists of the Project alternatives plus all cumulative emissions less the RFD sources is also analyzed.

For each far-field sensitive area, CALPUFF-modeled concentration impacts were post-processed with POSTUTIL and CALPOST to derive: 1) concentrations for comparison to ambient standards (WAAQS, CAAQS, UAAQS, and NAAQS) and PSD Class I and II Increments; 2) deposition rates for comparison to S and N deposition thresholds and to calculate changes to acid neutralizing capacity (ANC) at sensitive lakes; and 3) light extinction changes for comparison to visibility impact thresholds.

4.2.1.3.4. Sulfur and Nitrogen Deposition

Maximum predicted S and N deposition impacts were estimated for each Project alternative and cumulative source scenarios. The POSTUTIL utility was used to estimate total S and N fluxes from CALPUFF predicted wet and dry fluxes of SO_2, SO_4, NO_x, NO_3, and HNO_3. Predicted direct Project impacts were compared to the NPS Deposition Analysis Thresholds (DATs) for total N and S deposition in the western U.S., which are defined as 0.005 kg/ha-yr for both N and S. Total deposition impacts from Project alternative and regional sources and background values were also compared to USDA Forest Service levels of concern, defined as 5 kg/ha-yr for S and 3 kg/ha-yr for N (Fox et al. 1989). It is understood that the USDA Forest Service no longer considers these levels to be protective; however, in the absence of alternative FLM-approved values, comparisons with these values were made.

4.2.1.3.5. Acid Neutralizing Capacity Calculations for Sensitive Lakes

The CALPUFF-estimated annual deposition fluxes of S and N at sensitive lake receptors were used to estimate the change in ANC. The change in ANC was calculated following the January 2000, USDA Forest Service Rocky Mountain Region's Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide (USDA Forest Service 2000). The predicted changes in ANC are compared with the USDA Forest Service's Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 microequivalents per liter (μeq/l) and 1 μeq/l for lakes with background ANC values of 25 μeq/l or less. Of the lakes in the study area identified by the USDA Forest Service as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive as they have ANC values of less than 25 μeq/l (6 and 10.8 μeq/l, respectively) (Appendix C, Table 4-9).

4.2.1.3.6. Visibility

The CALPUFF model-predicted concentration impacts at far-field PSD Class I receptors were post-processed with CALPOST to estimate potential impacts to visibility (regional haze) for each analyzed alternative and cumulative sources for comparison to visibility impact thresholds. CALPOST estimated visibility impacts from predicted concentrations of PMC, PMF, SO_4, and NO_3 using the

original IMPROVE reconstructed mass extinction equation (Malm, et al. 2000) as recommended by FLAG (2000) and EPA (2003a, b).

Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in FLAG (2000) report results as a percent change in light extinction over Natural Background Conditions. The thresholds of concern are defined as 5% and 10% changes over the reference background visibility for project sources alone and cumulative source impacts, respectively. Visibility impacts have also been expressed as a change in deciview (dv) over Natural Background where a 1.0 and 0.5 change in dv is essentially numerically equivalent to a 10% and 5% change in extinction over Natural Background. The BLM considers a 1.0 dv change as a significant adverse impact; however, there are no applicable local, state, tribal, or federal regulatory visibility standards. Note that a 10% change in extinction and a 1.0 change in dv over natural conditions are almost equivalent metrics.

Five visibility assessment methods (1, 2, 3a, 3b, and 4) were used to analyze the potential visibility impacts due to the Project alone for its various alternatives and the Project plus the cumulative emissions, as discussed in Appendix C. These methods differ on which background Natural Conditions are used (FLAG, IMPROVE or EPA Default) and whether hourly (MVISBK=2) or monthly (MVISBK=6) relative humidity adjustment factors [f(RH)] are used.

4.2.1.3.7. Ozone

The ozone issue in southwestern Wyoming is complicated by the fact that elevated ozone levels have been recorded in the winter, which is in contrast to most areas whose highest ozone events occur during the summer. Consequently, the concept of an "ozone season" is difficult to define for the region. Thus, an entire year was simulated in order to capture all potential high ozone conditions in the region. A photochemical grid model was used to model 8-hour ozone concentrations resulting from the Proposed Action and alternatives and for cumulative sources.

There are two main photochemical grid models that are currently being used to address 8-hour ozone issues:

- The Community Multi-scale Air Quality (CMAQ) modeling system (Byun and Ching, 1999) developed by EPA that is publicly available with no fee from the CMAS Center (http://www.cmascenter.org/); and
- The Comprehensive Air-quality Model with extensions (CAMx) that was developed by ENVIRON (2006) that can also be downloaded for free (www.camx.com).

Both CMAQ and CAMx are current state-of-science models capable of simulating ozone formation due to new sources, such as those being considered in this application. For this study, the CAMx model was selected for the following reasons:

- CAMx includes algorithms for enhancing photolysis rates due to the presence of snow on the ground, which is important because some of the highest ozone measurements recorded in southwestern Wyoming have occurred in the winter when snow is present;
- CALMET meteorological data can be processed for input to CAMx, whereas CMAQ is designed to run solely off meteorological data from MM5 or WRF – the MM5 and WRF prognostic models have difficulty in simulating stagnant conditions because they try to "organize" the simulated flows, and therefore overestimate wind speeds during periods of light winds. On the other hand, if stagnant observations are input into CALMET they will be reflected in the CALMET wind fields;
- CAMx incorporates two-way grid nesting that allows concentrations to feed back and forth between coarse and fine grids, whereas CMAQ only supports one-way grid nesting that just

allows concentrations to flow from the coarser to the finer grids, but not vice versa. Thus, CAMx will be able to estimate ozone impacts over a larger area more cost-effectively;

- CAMx includes a flexi-nesting feature that allows for the run time interpolation of coarse grid data to finer grids that is not available in CMAQ; and
- CAMx is easier to use and more flexible.

A detailed description of the model development, the emissions used, and the modeled results are contained in Appendix C, Section 5. The impact of the Proposed Action and alternatives and other new sources in the region (cumulative emissions) on ozone concentrations were analyzed using the following methods. Detailed descriptions of these methods are contained in Section 5.4 of Appendix C.

- The first approach follows EPA's guidance for projecting future year ozone concentrations for determining attainment of the ozone NAAQS.
- The second approach uses the modeled absolute model predictions and compares the modeled fourth highest 8-hour ozone concentration estimates with the 8-hour ozone NAAQS.

4.2.2. Significance Criteria

4.2.2.1. Near-Field Pollutants

4.2.2.1.1. Criteria Pollutants

Potential impacts to air quality would be significant in the near-field if potential concentrations of criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2) exceed the applicable WAAQS or NAAQS standards.

4.2.2.1.2. Hazardous Air Pollutants

Potential impacts to air quality would be significant if potential HAP concentrations exceeded applicable RELs or RfCs.

4.2.2.2. Far Field Pollutants

4.2.2.2.1. Criteria Pollutants

Potential impacts to air quality would be significant in the far-field if potential concentrations of criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2) exceed the applicable PSD increment.

4.2.2.2.2. Sulfur and Nitrogen Deposition

Potential impacts would be significant if deposition exceeded the USFS levels of concern (LOC) for total N and S deposition.

4.2.2.2.3. Acid Neutralizing Capacity for Sensitive Lakes

Potential impacts would be significant if potential decreases in ANC values exceeded the USFS Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 μeq/l and 1 μeq/l for lakes with background ANC values of 25 μeq/l or less.

4.2.2.2.4. Visibility

Potential impacts would be significant if the visibility impacts at any Class I area exceeds the applicable LOC, as estimated by the BLM method.

4.2.2.3. Ozone

Potential impacts would be significant if modeled concentrations exceed threshold set for any of the analysis methods described in section 4.2.1.3.7.

4.2.3. Direct and Indirect Impacts

4.2.3.1. Near-field Impacts

4.2.3.1.1. Criteria Pollutants

Construction Emissions

When the maximum modeled concentrations of criteria pollutants for construction emissions were added to representative background concentrations, it was demonstrated that all criteria pollutant concentrations for all alternatives comply with the WAAQS and NAAQS.

The total 24-hour $PM_{2.5}$ value of 32 µg/m³ was closest to the NAAQS standard of 35 µg/m³, with half of the total value representing the background concentration. All other total criteria pollutant values were well below standards.

Project Emissions

Maximum predicted pollutant concentrations from project sources were also shown to be below the PSD Class II Increment for all pollutants. In addition, when these impacts are combined with representative background concentrations, they are below the applicable WAAQS and NAAQS.

The total 24-hour $PM_{2.5}$ value for all alternatives was 34 µg/m^3, only slightly below the NAAQS standard of 35 µg/m^3, with background contributing approximately one-half of the total value. The total 24-hour PM_{10} value for all alternatives was 149 µg/m^3, only slightly below the WAAQS/NAAQS standard of 150 µg/m³, with background contributing approximately one-third of the total value. All other PM values for all alternatives were well below standards.

NO_2 and CO total values were all well below standards for all alternatives. Annual NO_2 values for the Alternative C (60 µg/m^3) were approximately twice those of the Proposed Action (34 µg/m^3), with all values being less than the WAAQS/NAAQS annual standard of 100 µg/m^3. CO values were all an order of magnitude lower than the standards for both 1 hour and 8 hour averaging times for all alternatives, with Alternative C being approximately 20% higher than the Proposed Action. Alternative A values were less than the Proposed Action while Alternative B would be expected to have potential levels between those estimated for the No Action and Alternative C.

Hazardous Air Pollutants

Modeling indicated that from all operations short-term HAP concentration would be one to two orders of magnitude below the REL or IDLH values for all scenarios and that the maximum predicted long-term (annual) HAP impacts at the nearest residence locations in Granger would be one to four orders of magnitude below the RfC for all scenarios. In addition, formaldehyde impacts at Granger are shown to be below the RfC thresholds when Project source impacts are combined with regional source impacts.

Under the MLE scenario, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is below 1×10^{-6} for all alternatives. For formaldehyde, the risk is 3.5×10^{-7} for all alternatives. For benzene, the risk ranges from 5.2×10^{-8} for Alternative C to 3.7×10^{-8} for the Proposed Action, to 2.2×10^{-8} for Alternative A/No Action. It is likely that Alternative B would have benzene values between those predicted for the Proposed Action and Alternative C.

Under the MEI analyses, for each modeling scenario, the risk for formaldehyde is 3.1 x 10^{-6}. For benzene, the risk ranges from 4.7 x 10^{-7} for Alternative C to 3.4 x 10^{-7} for the Proposed Action, to 2.0 x 10^{-7} for Alternative A/No Action. Alternative B would have values no greater than those predicted for Alternative C.

4.2.3.2. Far-field Impacts

4.2.3.2.1. Criteria Pollutants

The maximum predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ at any receptor within the PSD Class I areas for each modeled Project alternative are shown in Appendix C, Table 4-11. The highest estimated concentration impacts at any Class I area and any Project alternative occurs for Alternative C at the Bridger Wilderness Area (Bridger). Most of these impacts are 1% or less than the PSD Class I area increments. The largest impact is for 24-hour PM_{10} where Alternative C values are estimates at approximately 6% of the PSD Class I area increment at Bridger. The far-field results demonstrate that the maximum air quality impacts for the Proposed Action and alternatives would not be expected to exceed any PSD Class I increment at any Class I area.

Appendix C, Table 4-12 also displays the maximum estimated PSD pollutant concentrations at Class I areas due to the various alternatives plus the cumulative emissions inventory and compares them to the PSD Class I increments. The highest modeled impacts would occur in the Bridger Wilderness Area as a result of the cumulative emissions plus the project emissions for Alternative C. These impacts include:

- Less than 1% of the PSD Class I increments for annual, 24-hour and 3-hour SO_2 concentrations;
- Less than 3% and 20% of the PSD Class I area increments for annual and 24-hour PM_{10}, respectively; and
- Less than 8% of the PSD Class I area increment for annual NO_2.

The estimated air quality impacts due to any of the alternatives plus the cumulative emissions would not exceed any PSD Class I area increment at any Class I area.

The CALPUFF-estimated maximum concentration of any alternative and the cumulative emissions at any Class I area were combined with the existing maximum background concentrations (Appendix C, Table 4-5) in the region to obtain a total estimated concentration that is compared against the NAAQS, WAAQS, UAAQS, and CAAQS (Appendix C, Table 4-13). The maximum CALPUFF-estimate impact due to any alternative plus the cumulative sources always occurs at the Bridger Class I Area and always occurs for Alternative C. When the Project plus the cumulative potential impacts at any Class I area are added to the maximum background concentrations to obtain a total concentration, no federal or state ambient air quality standards are exceeded.

In summary, the modeling results indicate that, for the Proposed Action and alternatives, neither direct impacts nor cumulative source impacts would exceed any air quality standards (WAAQS, UAAQS, CAAQS, and NAAQS) or PSD Class I area increments. The PSD demonstrations are for informational purposes only and do not constitute a regulatory PSD increment consumption analysis.

4.2.3.2.2. Sulfur and Nitrogen Deposition

Modeling results for the Project and the Proposed Action and No Action alternatives indicate that there is no direct Project total N or S deposition impacts above the NPS western DAT (0.005 kg/ha/yr) at any Class I area (Appendix C, Table 4-14). For Alternative C, the maximum nitrogen deposition at the Bridger Class I area just barely exceeds (0.006-0.007 kg/ha/yr) the NPS DAT (0.005 kg/ha/yr) for

the three years of modeling (Appendix C, Table 4-14b), but at the other Class I areas they are below the DATs.

For the Project alternatives plus the cumulative emissions, the estimated S deposition is well below the NPS DAT for all three years of modeling and all Class I areas (Appendix C, Table 4-15). The total N deposition at several of the Class I areas caused by the combination of the alternatives and cumulative emissions exceeds the NPS DAT. The maximum estimated annual N at any Class I area for the Project plus cumulative emissions occurs at the Bridger Class I area for 2001 with values of 0.031, 0.034 and 0.029 kg/ha/yr are estimated for the Proposed Action , Alternative C, and Alternative A/No Action, respectively. Values for Alternative B would likely fall in the range of conditions between the Proposed Action and Alternative C. Although these maximum N deposition impacts are above the NPS DAT, they are approximately a factor of 100 lower than the Forest Service 3.0 kg/ha/yr level of concern.

4.2.3.2.3. Acid Neutralizing Capacity Calculations for Sensitive Lakes

ANC calculations were performed for each of the alternatives plus cumulative emission (Appendix C, Table 4-16). The maximum changes in ANC are estimated to range from 0.4% to 1.4% so the deposition impacts from direct project and cumulative emissions would not contribute significantly to an increase in acidification at any of the five sensitive lakes with background 10% ANC values > 25 μeq/l. The Upper Frozen Lake in the Bridger Wilderness Area is the only lake starting with 10% ANC < 25 μeq/l for which we have ANC calculations, and a change in ANC greater than 1% may be a cause for concern. For the Upper Frozen Lake, where a change in ANC greater than 1% is of concern, the change in ANC due to the cumulative emissions plus project emissions are 13.4% for the Proposed Action, 15.2% for Alternative C, and 12.0% for Alternative A/No Action. Alternative B would not have ANC values greater than those predicted for Alterative C. Thus, the project emissions plus the cumulative emissions may impact ANC at the Upper Frozen Lake for all alternatives.

4.2.3.2.4. Visibility

The BLM considers a 1.0 change in dv (10% change in extinction) to be a significant impact. Due to the Project alone, only Alternative A/No Action has no days exceeding this threshold. Estimates for the Proposed Action indicate that between 1 and 3 days across 3 years at Bridger (0.09% to 0.3% of the time) exceed this threshold using the 4 methods. Similar results for Alternative C range from 2 to 23 days (0.2% to 2.0% of the time). Impacts for Alternative B would be no greater than those predicted for Alternative C.

4.2.3.3. Ozone

Table 4-1 summarizes the potential ozone concentrations. Using these projection techniques the potential maximum 8-hour ozone concentrations for the Proposed Action would be below the 8-hour ozone NAAQS.

Table 4-1. Maximum projected 8-hour ozone concentrations near the Project and in the 4 km grid domain due to Base Case emissions plus the Cumulative Emissions and comparisons with the NAAQS.

Domain	8-Hour Ozone NAAQS (ppb)	Projected Maximum 8-Hour Ozone (ppb)	
		EPA Guidance Approach	Absolute Model Predictions
Near the Project	85	76.6	77.8
4 km Domain	85	77.6	83.8

Alternative A/No Action has emissions that are much lower than the Proposed Action with NOx and VOC emissions that are 26% and 7% of the Proposed Action, respectively. Thus the No Action alternative would have lower ozone than the Proposed Action alternative so would also not jeopardize compliance with the 8-hour ozone NAAQS.

Alternatives B and C have NOx and VOC emissions that are, respectively, 1.96 and 2.30 times the Proposed Action alternative emissions. The maximum ozone increment near the Project due to the Proposed Action alternative was 2.5 ppb. Assuming the larger of the NOx/VOC emissions increase for Alternatives B and C (2.30) gives an estimate of the ozone increment of 5.75 ppb (2.3 x 2.5). When added to the 75 ppb maximum background we get a conservative estimate of a maximum 8-hour ozone concentrations of 80.8 ppb, which is still below the 8-hour ozone NAAQS. Although ozone formation is non-linear so the 2.30 factor is uncertain, it is likely a conservative estimate of the effects of emissions from Alternatives B and C on ozone concentrations in the area and still leads to ozone that is well below the 8-hour ozone NAAQS.

4.2.4. Residual Impacts

Because emissions will cease after the LOP, no residual air quality impacts are expected. However, in areas where deposition occurs there would be some residual impacts.

4.2.5. Mitigation

ANC values for Upper Frozen Lake exceed the significance threshold. Mitigation would likely do little to immediately reduce the potential ANC issues in Upper Frozen Lake. All alternatives, including the No Action are well above the significance threshold and implementation of mitigation in the MAA would do little to reverse this. However, operators should phase in cleaner drilling rigs and equipment to reduce the emissions from oil and gas development activities.

4.3. Geology and Mineral Resources

4.3.1. Surface Geology and Topography

4.3.1.1. Introduction

Impacts to topography and surface geology would be caused by surface disturbance resulting from well pad, access road, pipeline, and associated facilities construction. Impacts would be similar across all alternatives, differing in the amounts of disturbed acreage. The low relief over much of the MAA, avoidance of streams and riparian areas, and BLM guidelines discouraging construction in slopes exceeding 25% (BLM 1990) would reduce the levels of cut-and-fill construction required and the resultant impacts on topography.

4.3.1.2. Significance Criteria

Impacts to topography would be considered significant if surface-disturbing activities caused permanent alterations to local drainages that resulted in major changes to runoff patterns. In particular, drainage alterations with the potential for negative impacts to wetland or riparian communities in or downstream of the MAA would be considered significant.

4.3.1.3. Direct and Indirect Impacts

Impacts to topography are assumed to be proportional to the degree of surface disturbance of each alternative.

4.3.1.3.1. Proposed Action

Implementation of the Proposed Action would result in short-term disturbance to surface geology of 18,650 acres (3.92% of the MAA, Table 2-2). Approximately 12,300 acres of short-term disturbance would occur within the core area (2.59% of the MAA, 5.78% of the core), and 6,350 acres of short-term disturbance would occur within the flank (1.33% of the MAA, 2.41% of the flank). Approximately 6,990 acres of short-term disturbance would occur on federally administered lands. New long-term surface disturbance would occur on approximately 5,997 acres (1.26% of the MAA), of which approximately 2,265 acres would occur on federally administered lands. When combined with existing disturbance related to oil and gas development in the MAA, a total of 14,070 acres would be disturbed over the life of the project (LOP).

4.3.1.3.2. Alternative A

Implementation of Alternative A/No Action would limit surface-disturbing activities within the MAA to those previously approved and would result in short-term surface disturbance of 10,921 acres (2.30% of the MAA, Table 2-3). Approximately 5,971 acres of short-term disturbance would occur within the core area (1.25% of the MAA, 2.80% of the core), and 4,287 acres of short-term disturbance would occur within the flank (0.90% of the MAA, 1.63% of the flank). Approximately 5,129 acres of short-term disturbance would occur on federally administered lands. New long-term surface disturbance would occur on approximately 2,848 acres (0.60% of the MAA), of which approximately 1,424 acres would occur on federally administered lands. When combined with existing disturbance in the MAA, a total of 10,921 acres would be disturbed over the LOP.

4.3.1.3.3. Alternative B

Long-term impacts to topography and surface geology resulting from Alternative B would be similar to Alternative A/No Action. Although the total number of wells that could be drilled and overall surface disturbance over the LOP would be the same as Alternative C, the long-term surface disturbance after successful interim reclamation would remain below the 10,921 acres predicted for the No Action. Short-term disturbance prior to successful interim reclamation could be as high as Alternative C over the life of the project (approximately 33,235 acres within the core area and 12,338 acres within the flank) with no more than 10,921 acres disturbed at any given time.

To achieve a reduction in surface disturbance the operators could employ a variety of development and reclamation techniques including drilling multiple wells from a single well pad; centralizing production facilities; minimizing topsoil removal during construction; and co-locating powerlines, flowlines, and roads in common utility corridors.

Directionally drilling new wells from existing pads on federal lands would reduce some of the surface disturbance associated with drilling up to 5,165 new wells. However, these impacts would only be reduced on federally administered lands and/or minerals and overall reductions in surface disturbance for the project would be expected to be minimal. However, if operators used directional drilling technology on private and state lands, the reduction in surface disturbance would be much greater. Table 4-2 describes the expected reduction in surface disturbance that would occur if wells in the federal mineral estate were drilled directionally. If 100% of all new wells on federally administered lands/minerals were drilled directionally from existing well pads, overall surface disturbance could be reduced by as much as 14,564 acres.

Centralizing production facilities could be utilized in some portions of the Moxa Arch; especially in areas with higher drilling densities (i.e., downhole and pad spacing of less than 80 acres). Centralizing facilities could also potentially reduce disturbance associated with roads if they were reclaimed back to two-tracks and used only to access the wellhead when necessary for maintenance activities.

Table 4-2. Estimated reduction in oil and gas related surface disturbances that would result from directionally drilling specified percentages of 1,995 federally administered wells in the core from currently existing well pads. Estimates for 0% are the same as for Alternative C.

% Of Wells Drilled Directionally from Existing Pads	Total Short-term Disturbance on Federal Lands	Reduction of Disturbance
0	24,637	0
10	23,180	1,456
25	20,996	3,641
50	17,355	7,282
75	13,714	10,923
90	11,530	13,107
100	10,073	14,564

Co-location of roads and pipelines in common rights-of-way would also reduce disturbance across the entire MAA. Reduction in long-term disturbances that might be associated with gathering pipelines as a result of using common rights-of-way with roads would reduce surface disturbance approximately 350 acres in the MAA when compared with the Proposed Action.

4.3.1.3.4. Alternative C

Implementation of Alternative C would result in short-term surface disturbance of 45,573 acres (9.58% of the MAA, Table 2-4). Approximately 33,235 acres of short-term disturbance would occur within the core area (6.98% of the MAA, 15.61% of the core), and 12,338 acres of short-term disturbance would occur within the flank (2.59% of the MAA, 4.69% of the flank). Approximately 24,637 acres of short-term disturbance would occur on federally administered lands. New long-term surface disturbance would occur on approximately 15,357 acres (3.23% of the MAA), of which approximately 8,339 acres would occur on federally administered lands. When combined with existing disturbance in the MAA, a total of 23,430 acres would be disturbed over the LOP.

4.3.1.4. Residual Impacts

The final reclamation recontouring requirement indicates that there would be no significant residual impacts to topography from any alternative. Appendix E contains information related to reclamation procedures that would be used.

4.3.2. Geohazards

4.3.2.1. Introduction

Potential geohazards in the vicinity of the MAA include landslide and slump features, seismic activity, and the presence of mined-out areas. As discussed in Chapter 3, the MAA is considered to have a generally low risk for geologic hazards.

Impacts to project facilities and personnel from geohazards could conceivably result from landslides or slumps or from earthquake activity. Implementation of the Proposed Action or any alternative is not anticipated to trigger any geologic hazard.

4.3.2.2. Significance Criteria

Geohazards associated with implementation of the Proposed Action or an alternative action would be considered significant if there were a high potential for damage to project facilities or for risk of

serious injury or death to workers. Geohazard impacts would also be considered significant if they could be triggered by implementation of oil and gas development activities.

4.3.2.3. Direct and Indirect Impacts

Regardless of alternative, landslide risks would generally be restricted to steep slopes and bluffs adjacent to perennial streams and along the sides of residual mesas. The risk of such effects is considered to be low, based on avoidance of construction on slopes exceeding 25%, avoidance of perennial water bodies, and the absence of major mapped landslides in the MAA.

The MAA is situated within a low-risk seismic zone. The three earthquakes historically mapped within the MAA have all been of very low intensity, and the MAA does not overlie known or suspected faults capable of generating large seismic events. No impacts to geohazards have been identified for any project alternative.

4.3.2.4. Residual Impacts

No residual geohazard impacts have been identified.

4.3.3. Paleontological Resources

4.3.3.1. Introduction

The BLM uses the PFYC system to rate the potential for recovery of scientifically important fossils. In the MAA, both the Bridger Formation and Laney Member of the Green River Formation are rated 5, which is the highest possible ranking. Impacts to paleontological resources would result from construction-associated excavations into MAA bedrock formations.

4.3.3.2. Significance Criteria

Impacts that would have the potential to damage or destroy fossils of scientific importance would be considered significant. Scientifically important fossils generally include most well-preserved and complete vertebrate skeletons, but they could also include invertebrate fossils that provide important taxonomic, stratigraphic, or paleoecologic information.

4.3.3.3. Direct and Indirect Impacts

Excavations that affect only Quaternary-age deposits would not result in potential loss or recovery of scientifically important fossils. Direct impacts could be either negative, involving the destruction of important fossils, or beneficial, involving the discovery of important fossils that would otherwise have gone undetected. Increased human presence during the excavation process could lead to illegal collection of fossils. Indirect impacts would include long-term academic access to scientifically important fossils that may be uncovered during construction.

Because the entire MAA bedrock surface carries a PFYC ranking of 5 (highest), impacts are considered to be proportional to the level of surface disturbance for each alternative and are not separately analyzed.

4.3.3.4. Residual Impacts

Residual impacts to paleontological resources have not been identified.

4.3.4. Mineral Resources

4.3.4.1. Introduction

The Moxa Arch is a prolific producer of natural gas and is situated immediately adjacent to the world's largest trona reserve. The eastern portion of the MAA is located within areas considered potentially exploitable for trona. A portion of the MAA overlies the MMTA; therefore, the potential for conflict between natural gas and trona development exists. Oil and gas leasing and development are in conformance with the Kemmerer RMP.

Projected and existing production data were obtained from the Proponents for the analyses presented for mineral resource sections. These data were limited to estimates for the Proposed Action. Following development of a production schedule for the Proposed Action alternative, modifications were made to generate production schedules for the other alternatives. The alternative production schedules were based on a field-wide type decline curve provided by the operators (EOG Resources 2006). These alternative production schedules are considered to be reasonable and have been approved by the BLM's Wyoming State Reservoir Management Group (Chase 2006).

Impacts to mineral resources would include extraction and depletion of as much of the remaining gas reserve within the MAA as is economically feasible during the LOP. Impacts to other mineral resources under current and foreseeable economic conditions are limited to conflicts between oil and gas development and underground trona mining.

A portion of the MAA comprising approximately 33,200 acres overlies the MMTA. In proportion to the area of surface ownership in the entire MAA (which closely approximates mineral ownership), slightly more non-federal wells (54% of MMTA acreage) and slightly fewer federal wells (43% of MMTA acreage) would be affected by the MMTA drilling restriction. The MMTA restriction would apply to approximately 0.7% of the MAA core and to approximately 12% of the MAA flank.

4.3.4.2. Significance Criteria

Impacts to mineral resources would be considered significant in the event that:

- Conflicts with other resources or values result in the inability to extract the vast majority of the maximum technically-recoverable portion of the natural gas resource or trona resource,
- Conflicts with other resources or values, or mitigation measures imposed for the protection of other resources or values, resulted in production costs exceeding the economic viability of producing the resource, or
- Access to economically recoverable resources were restricted or prohibited.

4.3.4.3. Direct and Indirect Impacts

Implementation of any of the alternatives would result in varying levels of depletion of the non-renewable natural gas resource. The restrictions on gas development over portions of the MAA resulting from conflicts with trona mining would be considered a significant negative impact to resource recovery.

Impacts to other mineral resources and indirect impacts to mineral resources have not been identified. Summaries of oil and gas development by surface ownership for each alternative are indicated in Tables 2-3, 2-4, and 2-5.

4.3.4.3.1. Proposed Action

Implementation of the Proposed Action would result in the drilling of 1,861 new wells. Of this total, 1,226 are expected to be drilled in the MAA core (310 federal wells and 916 non-federal wells), and the remaining 635 will be drilled in the flank (385 federal and 250 non-federal wells). The Proposed Action is expected to recover at least 1,800 BCF of natural gas (710 BCF from federal wells and 1,090 BCF from non-federal wells) and 12.5 million barrels of condensate. The Proposed Action would recover approximately 60% of the estimated technically recoverable resource for the MAA. Figure 4-1 illustrates the anticipated decline in production over the life of the project for each alternative.

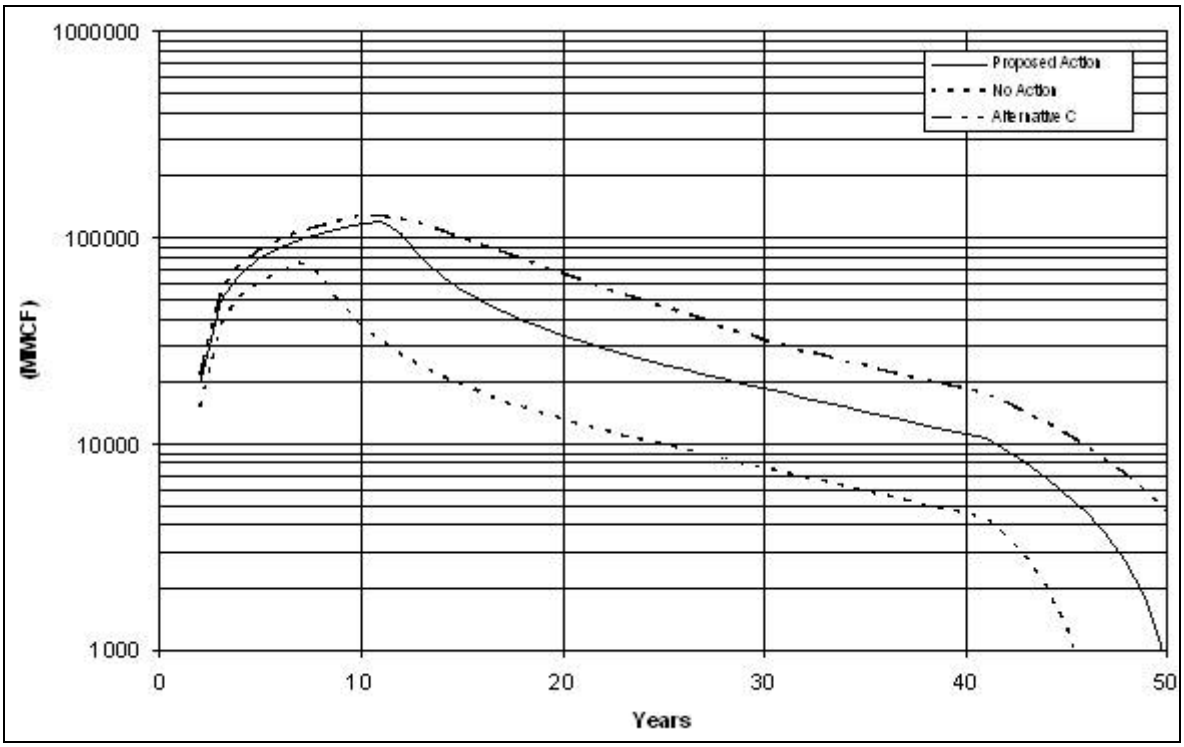


Figure 4-1. Estimated Recoverable Gas Resources in the MAA under Each Alternative. Recoverable Gas for Alternative B would be Identical to Alternative C.

4.3.4.3.2. Alternative A

Under Alternative A/No Action, 670 new wells would be drilled, as authorized under the 1997 Moxa Arch EIS ROD. Although the increased well density would result in additional gas recovery, a reduction in per well recoveries would occur as smaller volumes per well are drained. Per well recoveries would also be greater than those calculated for the Proposed Action (0.967 BCF). For this analysis, an average per well recovery of 1.1 BCF has been estimated. Alternative A is projected to recover approximately 737 BCF of natural gas and 5.1 millions barrels of condensate over a time period similar to that of the Proposed Action. Alternative A would involve recovery of approximately 24.5% of the estimated technically recoverable resource for the MAA. No impacts to trona recovery would occur due to the current MMTA restrictions.

4.3.4.3.3. Alternative B

Implementation of Alternative B would recover the same amount of the natural gas resource as Alternative C even if directional drilling technologies were applied to minimize surface disturbance. In the Moxa Arch, directionally drilled wells recover the same amount of the gas resource as vertically drilled wells (personal communication, Matthew Warren, BLM Petroleum Engineer). Continued enforcement of the MMTA drilling restriction would remove approximately 246 wells from the total

of 5,165. However, if MMTA restrictions are lifted or relaxed over the 25-year drilling phase, those wells could become available for drilling. If this were to occur, trona recovery could be impacted.

4.3.4.3.4. Alternative C

Under Alternative C, 5,165 wells would be drilled, including 3,763 in the core and 1,402 in the flank. Well density would increase to approximately one well per 44 acres in the core and one well per 173 acres in the flank. Total gas recovery would increase, while per well recoveries would be less than those calculated for the Proposed Action. Based on rig availability estimates, the 5,165 wells will be drilled over an approximate 25-year period. Continued enforcement of the MMTA drilling restriction would remove approximately 246 wells and well pads from the total of 5,165. However, if MMTA restrictions are lifted or relaxed over the 25-year drilling phase, those wells could become available for drilling. If this were to occur, trona recovery could be impacted.

The recoverable natural gas under Alternative C would be approximately 2,560 BCF and approximately 18 million barrels of condensate. Average per well recoveries would drop to approximately 0.5 BCF. For the production schedule, a lower initial production rate and steeper decline rate was assumed for wells drilled later (after year 10) in the estimated 25-year drilling period. Alternative C would recover approximately 85% of the estimated technically recoverable resource for the MAA.

4.3.4.4. Mitigation

Restriction on oil and gas development within the MMTA is the principal negative impact to oil and gas resources. No mitigation measures that would allow concurrent gas recovery from within the MMTA have been identified.

On a case-by-case basis, technologies such as directional drilling, horizontal drilling, mat drilling, and others would be evaluated to reduce surface disturbance impacts.

4.3.4.5. Residual Impacts

Residual impacts associated with mineral resource development would be the result of leaving technically recoverable mineral resources in the ground. Economics drives the recoverable reserves and other alternatives may become economical when technologies change.

4.3.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Impacts to geologic, mineral, and paleontologic resources are principally limited to direct impacts. No residual impacts have been identified. Impacts to topography and paleontology would be proportional to the levels of surface disturbance for each alternative and would be less than significant for all alternatives. Provided that required mitigation occurs, the potential for impacts from geohazards associated with implementation of any alternative is considered to be very low and less than significant. Information on specific proposed mitigation measures is provided in Appendix A. Impacts to mineral resources, which would be limited to the depletion of natural gas resources, are dependent on the number of wells allowed under each alternative. Continued enforcement of the ban on oil and gas development within the MMTA, which applies to all alternatives, would have effects on gas recovery proportional to the number of wells proposed in the MMTA for each alternative. Because Alternatives B and C are the only alternatives with potential wells that could occur in the MMTA, they are the only alternatives that could have significant impacts to minerals.

4.4. Soils

4.4.1. Introduction

Potential impacts to MAA soils from access road, well pad, pipeline, and ancillary facilities construction and operation would result from the exposure and disturbance of in-place soils and both short-term and long-term loss of soil productivity. Anticipated soil exposure to the elements and disturbance is based on construction and operational requirements to blade/level, excavate/move, or loosen and/or compact soil materials, as well as to disturb existing steep slopes and create steep slopes of disturbed surfaces.

Adverse impacts could limit potential reclamation success for any post-construction, affected soil due to instability (soil movement and loss by erosion), long term soils compaction, loss of soil materials (erosion), loss of sub-surface biological components, undesirable mixing of soil horizons, and suitability of growth media represented by replaced or disturbed-in-place soil materials. However, these impacts, when coupled with additional inherent limitations to successful reclamation that characterize those problematic/sensitive soils that are present within the MAA, would pose even greater challenges to successful reclamation. Appendix E contains information related to reclamation procedures that would be used.

Field development in the MAA would result in disturbance of both sensitive and non-sensitive soil types. The estimated area of disturbance for each of the sensitive/problematic soil types in the MAA for three of the four alternatives is provided in Table 4-3. Surface disturbance estimates for Alternative B are not included in Table 4-3 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. Acres of impact for the alternatives are in addition to existing disturbance in the MAA. The poor quality and limited quantity of topsoil and the high erodibility and potential for accelerated erosion of the materials comprising the sensitive soil types pose the greatest challenges to successful soil stabilization, reclamation, and restoration of protective and productive vegetative cover following construction, for both interim and final reclamation efforts (BLM 1995b).

In addition to natural limiting factors inherent to the sensitive soil types, additional limitations on post-construction and reclamation success may result from accidental releases of contaminants, including hydrocarbons and other hazardous chemicals, which may limit revegetation establishment and success and may indirectly contribute to surface water contamination via runoff from contaminated soil surfaces.

4.4.2. Significance Criteria

Impacts to soils would be significant if one or more of the following occurred:

- Non-compliance with the Kemmerer RMP.
- Non-compliance with Wyoming BLM Standards for Healthy Rangeland, Standard 1.
- Location and construction of project facilities on Sensitive Soils without the commitment to apply appropriate and adequate design and control measures to stabilize affected soils and to revegetate those portions of disturbed areas caused by construction that are no longer needed for operations.
- Accelerated soil erosion of disturbed areas.
- Failure to re-establish a native vegetative cover equal to 80% cover of comparable, adjacent undisturbed lands within the timeframes specified in Appendix E and in the appropriate Onshore Oil and Gas Order.

Table 4-3. Anticipated Disturbance Acreages for Sensitive and Non-sensitive Soils Types.

Disturbance Type	Core/ Flank	Sand Dune Soils*	Steep Slopes >25% >200 ft	Badland Soils	Saline/ Sodic Bottomland Soils*	Wetland Soils	Floodplain Soils	Non-sensitive Soils
Alternative A								
Construction and Field Development	Core	981	7	402	710	34	145	3,691
	Flank	515	19	188	602	41	87	2,833
Post Interim Reclamation	Core	272	2	112	197	9	40	1,024
	Flank	143	5	52	167	11	24	786
Proposed Action								
Construction and Field Development	Core	1,827	43	798	1,339	158	541	7,662
	Flank	681	28	571	244	66	136	4,551
After Interim Reclamation	Core	589	14	257	431	51	173	2,470
	Flank	218	9	183	78	21	44	1,456
Alternative C								
Construction and Field Development	Core	5,079	108	1,959	3,378	306	998	21,394
	Flank	1,490	52	960	646	121	270	8,802
After Interim Reclamation	Core	1,716	36	655	1,141	103	335	7,225
	Flank	500	17	322	217	41	90	2,951

* Impacts for sand dune soils might be overestimated because they are generally avoided due to significant cultural resource issues. When this occurs, development will occur in other soil types and could potentially raise impacts to those soil types.

4.4.3. Direct and Indirect Impacts

Implementation of any of the four alternatives would result in disturbance of both sensitive and non-sensitive soil types. The estimated area of disturbance for each of the sensitive/problematic soil types in the MAA for each of the four alternatives is provided in Table 4-3. Construction and field development impacts are quantified as acres disturbed from construction of well pads, roads, pipelines, and related facilities. Post interim reclamation or residual impacts are quantified as acres of disturbance that remain after interim reclamation of pipelines and those portions of roads, well pads, and other related facilities that would not be used during operations. Locations of roads, wells, pipelines, and other facilities have not yet been identified; therefore, site-specific impacts on soils are not assessed in this analysis. The poor quality and limited quantity of topsoil and the high erodibility and potential for accelerated erosion of the materials comprising the sensitive soil types pose the greatest challenges to successful soil stabilization, reclamation, and restoration of protective and productive vegetative cover following construction for both interim and final reclamation efforts (BLM 1995).

4.4.3.1. Proposed Action

The Proposed Action would result the direct impact of 18,645 acres of soil resources during construction and field development. Of this area approximately 12,213 acres of disturbance would occur in non-sensitive soils (Table 4-3), and approximately 6,432 acres of new disturbance would occur in sensitive soils that pose unique limitations to successful implementation of reclamation measures and long-term maintenance of protective and productive vegetative cover (Table 4-3). Implementation of an interim reclamation program, would attempt to reduce disturbance to approximately 3,926 acres in non-sensitive soils (Table 4-3), and 2,068 acres in sensitive soils.

4.4.3.2. Alternative A

Alternative A/No Action will result in the direct impact of 10,255 acres of additional soil resources during the construction and field development. Of this area approximately 6,524 acres would occur in non-sensitive soils, and 3,731 acres of the new disturbance would occur in sensitive soils (Table 4-3) during construction and field development. After interim reclamation, disturbance would be reduced to approximately 1,810 acres in non-sensitive soils (Table 4-3), and 1,034 acres in sensitive soils. Operator committed mitigation identified in the 1997 ROD (BLM 1997a) could reduce these disturbance estimates to approximately 1,500 acres in non-sensitive soils and 800 acres in sensitive soils. Although impacts to soils within the MAA are anticipated, the continued application of BLM-required mitigation measures outlined in Sections II, III, and IV of the 1997 ROD (BLM 1997a) would minimize impacts.

4.4.3.3. Alternative B

In order to remain under the 10, 921 acre surface disturbance cap, there will be an emphasis on successful reclamation under Alternative B. This would reduce impacts to sensitive soils that pose unique limitations to successful reclamation and long-term maintenance of protective and productive vegetative cover. However, this would likely increase short-term and long-term disturbance in non-sensitive soil types across the MAA. Short-term impacts in non-sensitive soils would likely be greater for Alternative B than for Alternative C because of the increased emphasis on reclamation.

To achieve a reduction in surface disturbance the operators could employ a variety of development and reclamation techniques including drilling multiple wells from a single well pad; centralizing production facilities; minimizing topsoil removal during construction; and co-locating powerlines, flowlines, and roads in common utility corridors. Minimizing topsoil removal would keep soil microbial and faunal communities relatively intact and increase potential success of reclamation activities.

Technologies to reduce topsoil removal (i.e., mat drilling) could be investigated for use in the MAA per the operators Proposed Action. This technique could also be used during final reclamation and abandonment. If operators could minimize or eliminate topsoil removal during final reclamation activities, the long-term impacts to soils in the MAA would be greatly reduced. Directionally drilling new wells from existing pads on federal lands would reduce some of the surface disturbance associated with drilling up to 5,165 new wells (Table 4-2).

Burying gathering pipelines in or adjacent to access roads and use of common ROWs and utility corridors would reduce surface disturbance to sensitive and non-sensitive soils in the project area. Overall, 350 acres of surface disturbance, most in non-sensitive soils, would be expected from implementation of this alternative on federally-administered lands and minerals.

4.4.3.4. Alternative C

Of the anticipated 45,563 acres of disturbance in the MAA during construction and field development, approximately 30,196 acres would occur in non-sensitive soils, and 15,367 acres of the new disturbance would occur in sensitive soils that pose unique limitations to successful implementation of reclamation measures and long-term maintenance of protective and productive vegetative cover (Table 4-3). After interim reclamation, disturbance would be reduced to approximately 10,176 acres in non-sensitive soils (Table 4-3), and 5,173 acres in sensitive soils.

4.4.4. Mitigation

Additional mitigation information is provided in Appendix A. Sensitive soils should be avoided where possible, due to high potentials for post-disturbance, accelerated erosion, and poor reclamation

potential. Appendix E contains information related to reclamation procedures that would be used in addition to the Operators' proposed reclamation strategy. The limited quantities and quality of topsoil and the high potential for accelerated erosion on surfaces of these soil types would pose limiting conditions to successful reclamation. To preclude significant impacts in these soil types, roads, well sites, and pipelines should not be located in areas with slopes greater than 25%, in badland soils, or in sand dune soils. Where avoidance is not feasible, site-specific construction should incorporate special soil stabilization and erosion control measures as part of the application of mandated BMPs (BLM 1997a). Operators need to work to limiting the amount of time well pads and soils are disturbed. This would include evaporation pit drying time reductions methods, use of larger topsoil stockpiles (increases the initial disturbance area), seed topsoil piles, use of micro inoculants, use of irrigation methods during drought conditions, use of mat drilling technology to reduce impacts to soils, utilize smallest area necessary to drill wells etc.

Avoiding stripping of topsoils during final reclamation would minimize impacts to soils in the MAA. This could be accomplished if operators recontoured and reclaimed the portions of the well pads that would not be used during operations and maintenance activities.

Floodplain and wetlands soil types should also be avoided where possible to prevent significant impacts to these soil types and to minimize potential future impacts to any facilities constructed in these areas.

Other sensitive soil types should also be avoided, but the application of site-specific engineering design and features could be used to minimize impacts below significance criteria.

4.4.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

During project construction, implementation of the Alternative A/No Action Alternative and its approved, ongoing development would initially affect 10,255 acres of the MAA. Interim reclamation efforts during well production and road maintenance would reduce disturbance acreage to a residual of 2,844 acres.

Implementation of either the Proposed Action would initially affect 18,645 acres (3.9%) of the MAA. Interim reclamation efforts during well production and road maintenance would reduce disturbance acreage to a residual of 5,994 acres.

Implementation of Alternative B could initially affect up to 45,563 acres (9.6%) of the MAA depending on the reclamation success rate. Interim reclamation efforts during well production would reduce disturbance acreage to a residual of 2,844 acres.

Implementation of Alternative C would initially affect 45,563 acres (9.6%) of the MAA. Interim reclamation efforts during well production and road maintenance would reduce disturbance acreage to a residual of 15,349 acres. The application of additional BMPs, mandated as part of Alternative A, would effectively reduce the residual acreage and support successful final reclamation efforts and avoidance of significant impacts.

4.5. Water Resources

4.5.1. Surface Water

4.5.1.1. Introduction

The majority of surface disturbance would occur within the Blacks Fork Watershed, particularly the Sevenmile Gulch, Lower Hams Fork, Dry Muddy Creek, Lower Blacks Fork, and Middle Blacks Fork hydrologic units. Proportionally, the Shute Creek, Sevenmile Gulch, and Middle Blacks Fork hydrologic units have the greatest percentage of their total surface areas within the MAA (72%, 95%, and 81%, respectively); therefore, these units would be most impacted by actions in the MAA.

4.5.1.2. Significance Criteria

Project impacts would be considered significant if they resulted in a violation of RMP objectives, downstream water rights, and/or water quality standards for salinity. Changes to water quality would be significant if WDEQ water quality class or WGFD class objectives were not met; the project did not comply with the federal CWA or state water quality standards; and/or increased salinity loading resulted in non-compliance of the Salinity Control Act. Currently, waters in the Wyoming portion of the Colorado Basin are rated good to very good for salinity, and no waters are listed for salinity-related impacts. Impacts to surface water resources would be considered significant if:

- Water quality is degraded beyond the designated use of the receiving water body or other violations of federal or state water quality standards occur, or a water body listed on the State 303d list of Impaired or Threatened Waterbodies is negatively impacted.
- Salt loading to the Colorado River System increases above background conditions.
- There is a net loss of wetlands or wetland function (EO 11990).
- Project-related activities degrade wetland/riparian areas such that, as a minimum physical state, PFC is not being maintained.
- Stream flow characteristics are altered such that established users are affected.
- Erosion and runoff alters the physical characteristics of streams or drainages, beyond what would be expected with natural processes.

4.5.1.3. Direct and Indirect Impacts

Impacts to surface waters could occur as a result of usage and changes to quality. Potential impacts could include increased levels of water flow and runoff, increased sediment yields and corresponding changes to salinity and turbidity, accidental spills, and increased water consumption and resulting water depletions.

The magnitude of impacts to surface waters would depend on the proximity of the disturbance to drainage channels (minimum 500 feet, per Kemmerer RMP directives); slope, aspect, and gradient; degree and area of soil disturbance and vegetation density; soil character; duration of activities; and length of time between impacts and implementation of mitigation measures. Impacts would likely be greatest shortly after the start of construction and would decrease in time due to natural stabilization, reclamation, and revegetation efforts. Removal of vegetation and soil disturbance would potentially increase erosion and sedimentation of surface waters in the MAA and downstream.

The degree of potential impact to individual watersheds depends on the total acreage of the watershed and the percentage of that watershed that falls within the MAA (Table 3-12). Impacts were calculated by determining the acreage of well pads, pipelines, and roads that fall within a watershed. Table 4-4

shows the acres of surface disturbance in the four major watersheds that overlap the MAA and the percentage of the overall watershed area affected before and after interim reclamation. Surface disturbance estimates for Alternative B are not included in Table 4-4 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. Drilling and completion disturbances could be similar to those reported for Alternative C while the disturbance after interim reclamation will likely be more similar to Alternative A/No Action.

Table 4-4. Acres of Surface Disturbance Within the Four Major Watersheds that Overlap the MAA and Percent of the Watershed Affected.

Development Phase	Acres/ %	Upper Green	Upper Green-Slate Creek	Blacks Fork	Muddy Creek
Alternative A					
Drilling and Completion	Acres	0	4,495	5,762	0
	%	0	0.47	0.33	0
After Interim Reclamation	Acres	0	1,248	1,600	0
	%	0	0.13	0.09	0
Proposed Action					
Drilling and Completion	Acres	160	4109	14332	48
	%	0.01	0.4	0.8	0.01
After Interim Reclamation	Acres	51	1325	4603	15
	%	< 0.01	0.1	0.3	< 0.01
Alternative C					
Drilling and Completion	Acres	251	11767	33470	85
	%	0.01	1.2	1.9	0.01
After Interim Reclamation	Acres	84	3929	11194	28
	%	0.01	0.4	0.6	0.01

4.5.1.3.1. Proposed Action

The Proposed Action would impact approximately 2.9% of Shute Creek, 3.0% of Sevenmile Gulch, and 4.0% of the Middle Blacks Fork hydrologic units (Table 4-5). Surface impacts to all other hydrologic units would be less than 2.0%. Reclamation efforts would reduce surface impacts to approximately 1.3% or less in all affected watersheds. Appendix E contains information related to reclamation procedures that would be used.

Surface Water Use

Assuming a maximum of 2.0 acre-feet of surface water per well would be required for drilling, completion, hydrostatic testing, and dust control activities, approximately 3,722 acre-feet of water would be required over the life of the Proposed Action. No more than approximately 374 acre-feet would be required in any year under the Proposed Action. Water used for drilling purposes (for all alternatives) will be obtained from the Blacks Fork, Hams Fork, and Green Rivers as a result of water appropriation permits obtained from the State of Wyoming (State Engineer's Office) and from commercial or privately owned water source wells. This level of water removal from the three river systems is not likely to have a noticeable or measurable impact to stream flows.

Table 4-5. Acres of Surface Disturbance within 15 Watersheds (5th Order) that Overlap the MAA. Disturbances for Alternative B cannot be calculated but would likely have long-term impacts after interim reclamation similar to those estimated for Alternative A.

		Upper Green		Upper Green-Slate Creek			Blacks Fork									Muddy Creek
		Fontenelle Creek	Green River - Delaney Canyon	Slate Creek	Shute Creek	Green River	Sevenmile Gulch	Lower Hams Fork	Dry Muddy Creek	Lower Blacks Fork	Middle Blacks Fork	Upper Blacks Fork	Smiths Fork	Cottonwood Creek	Big Dry Creek	Muddy Creek
Alternative A																
Drilling and Completion	Core	0.00	0.00	83.13	2165.42	69.35	759.35	349.74	102.18	724.79	1314.44	0.00	40.33	54.92	307.38	0.00
	Flank	0.00	0.00	311.73	1820.93	44.69	597.27	428.70	180.18	189.64	238.01	0.00	140.36	283.10	52.18	0.00
After Interim Reclamation	Core	0.00	0.00	23.08	601.11	19.25	210.79	97.09	28.36	201.20	364.88	0.00	11.19	15.24	85.33	0.00
	Flank	0.00	0.00	86.53	505.48	12.41	165.80	119.00	50.02	52.64	66.07	0.00	38.96	78.59	14.48	0.00
Proposed Action																
Drilling and Completion	Core	0.00	0.00	81.69	2518.00	148.41	1673.95	1783.34	439.21	1499.76	3700.00	0.00	53.15	60.28	412.34	0.00
	Flank	3.56	156.85	261.22	894.04	206.07	517.26	864.00	357.30	232.17	1540.86	21.15	284.05	494.72	398.42	48.38
After Interim Reclamation	Core	0.00	0.00	27.63	813.97	48.09	540.78	572.90	141.47	482.06	1189.91	0.00	17.02	19.35	132.49	0.00
	Flank	1.14	50.19	83.59	286.09	65.94	165.52	276.48	114.34	74.30	493.08	6.77	90.90	158.31	127.49	15.48
Alternative C*																
Drilling and Completion	Core	0.00	0.00	781.06	7302.25	1138.28	5375.06	4100.33	1212.41	3179.34*	9186.17*	0.00	75.09	99.08	776.70	0.00
	Flank	3.27	248.02	537.91	1693.69	313.44	1704.03*	1368.31	596.41	1520.29*	2332.62*	31.62	432.10	788.24	691.95	84.59
After Interim Reclamation	Core	0.00	0.00	259.65	2435.87	380.71	1794.36	1371.27	405.08	1062.62*	3070.55*	0.00	25.16	33.13	259.58	0.00
	Flank	1.10	83.14	180.32	567.77	105.08	571.24*	458.70	199.93	509.64*	781.96*	10.60	144.85	264.24	231.96	28.36

* Portion of impacts are within the MMTA

Surface Water Quality

No significant increases in salt loading would be expected due to the small quantities of sedimentation expected with implementation of control measures. Significant degradation of water quality in water bodies listed on the State of Wyoming 303d list of Impaired or Threatened Waterbodies is not anticipated under any alternative. Effective surface runoff, erosion, and sedimentation control measures, as well as compliance with section 404 of the CWA, would provide for adequate water quality protection under all alternatives. Impacts to surface water quality for all alternatives would be identical to the Proposed Action and will not be further discussed for project alternatives.

4.5.1.3.2. Alternative A

Under Alternative A/No Action, no additional activities would affect water resources other than those currently existing or approved for the area. Alternative A would impact approximately 3.6% of Shute Creek, 1.9% of Sevenmile Gulch, and 1.2% of the Middle Blacks Fork hydrologic units. Surface impacts to all other hydrologic units would be less than 1.0%.

Surface Water Use

Approximately 1,340 acre-feet of water would be required over the life of the project for Alternative A. No more than approximately 223 acre-feet would be required in any year under Alternative A.

4.5.1.3.3. Alternative B

Short-term impacts to surface water use and quality could be as high as for Alternative C, assuming the maximum numbers of wells are drilled from individual well pads. However, through the use of various technologies, including directional drilling, the surface impacts to watersheds throughout the MAA could be reduced as described in section 4.3.1.3.3. To remain under the 10, 921 acre surface disturbance cap, there will be an emphasis on successful reclamation. Therefore, long-term impacts would be similar to Alternative A, although the distribution of the wells throughout watersheds would vary.

Surface Water Use

Water use could be as high as described for Alternative C. However, it is likely that less water would be required for drilling and completion activities under Alternative B if technologies designed to minimize surface disturbance (i.e., directional drilling, mat drilling, systems to reuse drilling fluids) are implemented. These technologies would reduce water use by decreasing the amount of dust abatement that would be required and through the use of the same drilling fluids for multiple wells. Increased emphasis on interim reclamation could require more water if operators select to apply water to the soil to improve reclamation success.

4.5.1.3.4. Alternative C

The percentage of impacts to hydrologic units would be higher than for the other alternatives. Alternative C would impact approximately 7.6% of Shute Creek, 9.7% of Sevenmile Gulch, and 8.8% of the Middle Blacks Fork hydrologic unit. Surface area disturbance within all other hydrologic units would be less than 3.5%. Drilling of the additional wells would take place over 25 years, compared to the 10-year drilling duration for the Operators' Proposed Action. Therefore, impacts to surface water under Alternative C would be greater than for the Proposed Action, due to both the increased surface area disturbance and the longer project duration before reclamation.

Surface Water Use

Approximately 10,300 acre-feet of water would be required over the LOP under Alternative C. No more than approximately 414 acre-feet would be required in any year for Alternative C. This alternative would use approximately 6,578 acre-feet more water than the Proposed Action.

4.5.1.4. Mitigation

No additional mitigation is required for impacts to surface water. BLM BMPs, CWA requirements, and Wyoming water quality standards are protective of surface water uses and water quality. Appendix E contains information related to reclamation procedures that would be used in addition to the Operators' proposed reclamation strategy as described in Chapter 2 for the Proposed Action. BMPS that might be implemented to protect surface waters is included in Appendix A.

4.5.1.5. Residual Impacts

Some surface water impacts may continue even after final reclamation at the end of the project because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions. Impacts to sensitive soils where reclamation, and stabilization activities would be hindered would also be long lasting and result in residual impacts to the hydrologic regime. Generally, forbs, brush, and trees reduce surface runoff more effectively than do grasses that establish first after reclamation. The Gold Book (2006) identifies that all access roads that are developed for oil and gas will be removed and reclaimed back to original contours etc. However, many of the main access points to the MAA would likely be retained by local communities and to aid with livestock operations in the future. The MAA would also likely retain numerous improved project roads where vegetation would not be re-established to pre-disturbance conditions and/or where a Travel Management plan has identified a road for retainment for other resource uses. Additionally, if disturbed soils are not reclaimed on private and state lands in the same manner as on federal lands, surface waters could continue to be affected.

4.5.2. Groundwater

4.5.2.1. Introduction

Impacts to groundwater supplies could occur as a result of usage and changes to quality. Potential impacts to groundwater include leakage of fluids from reserve pits, mixing water from aquifers of differing qualities, accidental spills in areas with a shallow groundwater table, and withdrawal from groundwater reservoirs for drilling, completion, and production activities.

Groundwater quality may be affected by mixing water from aquifers of differing qualities. However, the magnitude of mixing would be relatively small, due to the short duration of drilling time and the effects of casing and cementing efforts. Casing practices required by the BLM and the WOGCC limit the potential for movement of any materials outside the well casing and across aquifers. Well completion must be accomplished in compliance with Onshore Oil and Gas Order No. 2 guidelines. Any accidental contamination would be mitigated through an EPA groundwater clean-up program.

4.5.2.2. Significance Criteria

Impacts to groundwater would be significant if the quality did not meet WDEQ groundwater standards for domestic, agriculture, or livestock use. Changes in water quantity would be significant if endangered fish or the water rights of downstream water users were affected. Impacts would also be significant if decreases in groundwater levels limited or prevented use of existing permitted water wells in the area.

4.5.2.3. Direct and Indirect Impacts

Groundwater used for construction, drilling, and operations would come from permitted wells only. Some local depletion from these wells and the surrounding groundwater table might occur under all alternatives. Relative use of groundwater is expected to be proportional to the number of wells drilled for each alternative.

Leakage of fluids from reserve pits and related impacts would be minimal from lined pits. Potential for impacts would be greater for unlined pits; however, impacts from leakage from unlined pits would be unlikely given restrictions regarding design and location of such pits. Potential impacts of pit leakage would be minimal and the same for all alternatives.

Water wells used for the project would be deeper than most domestic and livestock wells in the area. Therefore, impacts to domestic and livestock wells would not be likely. Some groundwater contamination might occur during drilling activities as water from different aquifers is mixed. However, under current casing and cementing policies, this impact is expected to be minimal and the same for all alternatives.

4.5.2.4. Mitigation

For all alternatives, oil and gas wells will be cased below freshwater zones (less than 5,000 mg/L of total dissolved solids) and cemented to prevent the contamination of aquifers. Exploration holes will be properly plugged to prevent groundwater contamination.

4.5.2.5. Residual Impacts

With implementation of mitigation measures and casing standards, no significant residual impacts to groundwater resources are expected. If comparable measures and guidelines are not used on both state and private lands, the impacts could be more significant.

4.5.3. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

It is anticipated that no alternative would have significant impacts to water resources, due to RMP requirements, BMPs, and CWA requirements. Surface water and groundwater would be affected by surface disturbance in the MAA. Water in the MAA is impacted by an increase in surface runoff, sedimentation, and water use. As surface disturbance and the number of wells increase, the impacts to surface waters and groundwater quality and quantity also increase. Therefore, of the four alternatives, Alternative C would have the highest level of impact on water resources, and Alternative A/No Action would have the least impact on water resources. Impacts would be moderate for both the Proposed Action and Alternative B; however, the reduced surface disturbance and increased reclamation efforts implemented with Alternative B would likely reduce overall impacts to surface water as compared to the Proposed Action.

4.6. Noise

4.6.1. Introduction

Noise sensitive receptors in the MAA include residents, visitors participating in recreational activities, and wildlife. Most area residences are sufficiently distant from noise sources, but continuous high noise levels from traffic, construction, and operations may affect wildlife movement, breeding success, and stress levels.

4.6.2. Significance Criteria

To avoid adverse environmental impacts, the EPA standard for noise levels is 55 decibels (dBA). Due to the lack of research documenting the effects of noise levels on wildlife, noise impacts will be considered significant if they exceed the EPA maximum acceptable noise level of 55 dBA except for

raptors. Sage-grouse and raptors have been shown to be sensitive to noise impacts at levels above 49 dBA (WGFD 2004).

4.6.3. Direct and Indirect Impacts

Most noise impacts will be short-term impacts from project construction. The loudest project-related noise source — drilling and flaring operations — would produce temporary noise levels of up to 115 dBA at the source. This would be reduced to 55 dBA at 3,500 feet from the source (BLM 1991, 1995a). All project-related noise is expected be less than 55 dBA for residents and recreators who are not directly adjacent to the source. Following well-drilling activities, noises would be reduced during normal operations. Some on-going impacts will occur due to traffic on access roads and activity at ancillary facilities and compressor sites. Human, equipment, and vehicular activity and the associated noise impacts would be more frequent and intensive as the well density and project duration increases.

4.6.3.1. Proposed Action

Under the Proposed Action, noise would exceed the 55 dBA threshold at certain locations in the MAA during drilling and completion phases. An increase in well construction, drilling, traffic, and compressor stations in the area would result in higher overall noise impacts. High levels of noise impacts would be temporary during drilling and construction and would decrease during the production phase and reclamation.

Drilling, field development, and field operations workers would be the only groups directly affected by Proposed Action-related noise disturbances for more than a brief period of time. These groups are subject to OSHA regulations regarding industrial noise protection. Grazing operators and area recreators would typically be affected by noise impacts only for brief periods while passing by sites where drilling, field development, and field operations occur.

One additional, natural gas compression facility is anticipated to be developed in coordination with the project area development, which would be a source of long-term noise impacts. These impacts would exceed the 55 dBA maximum standard at the compression site, but noise levels would be attenuated to below acceptable levels less than one mile from the compression site.

Drilling noise would occur during the 10 years following project approval. Production noise would continue for approximately 40 years during the life of the wells after drilling is completed. Noise from traffic would continue until reclamation activities are completed.

4.6.3.2. Alternative A

Under Alternative A/No Action, noise impacts would be those approved for the existing Moxa Arch developments in the 1997 ROD. Once all approved wells have been drilled, noise levels would be limited to production related sources, such as traffic, compressor stations, and reclamation equipment. Drilling noise would be completed over the next 6 years. Production noise would continue for approximately 40 years during the life of the wells after drilling is completed. Noise from traffic would continue until reclamation activities are completed. The 1997 ROD found noise impacts to be less than significant.

4.6.3.3. Alternative B

Under Alternative B, efforts to reduce surface disturbance may decrease sources for noise impacts. Noise from drilling would be limited by the number of wells authorized in a given year. Centralizing production facilities and drilling multiple wells from each pad would reduce the number of areas that would be subjected to high noise levels. However, in areas where directional drilling is used, noise

impacts could occur over a longer period because multiple wells would be drilled from the same pad and drilling time would increase. Additionally, because more wells are authorized for Alternative B, the duration of noise impacts would be longer than for the Proposed Action. The reduction in number of areas subjected to high noise would be most beneficial in big game winter range areas and within 1 mile of sage-grouse leks.

4.6.3.4. Alternative C

Noise levels from Alternative C would be similar to those of the Proposed Action; however, the drilling phase would be 25 years rather than 10 years. Alternative C allows for 3,304 more wells than the Proposed Action. Therefore, more individual sources of noise in the MAA would occur under Alternative C, and those noise impacts would continue for an additional 15 years.

4.6.4. Mitigation

Noise reduction techniques should be evaluated on a site-by-site basis during the APD process to minimize impacts to resources.

A recent study of field automation completed by BP on behalf of other MAA operators showed that remote monitoring of wells could reduce field visits by 50%. Field automation should be applied to decrease traffic in the MAA during operations, resulting in reduced noise impacts over the LOP.

4.6.5. Residual Impacts

Following well drilling activities, noise would be reduced during normal pumping operations. There would be no residual noise impacts after the LOP.

4.6.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Construction and development activities under the Proposed Action would be sufficiently distant from residences that would likely be affected by noise impacts. Noise generated from construction operations during peak activity periods could exceed 55 dBA at certain locations and cause significant impacts; however, these impacts would be temporary and would attenuate as distance from the source increases. It is anticipated that most noise impacts would be temporary during drilling and flaring operations and would likely not cause long-term significant impacts over the LOP for any alternative.

4.7. Vegetation and Wetlands

4.7.1. Plant Communities

4.7.1.1. Introduction

Vegetation removal creates short- and long-term impacts, including the modification of vegetation structure, plant species composition, and aerial extent of cover types; increased soil exposure; loss of wildlife habitat; reduced plant diversity; and loss of livestock forage. Indirect impacts include the increased potential for non-native/noxious plant establishment and introduction, accelerated wind and water erosion, changes in water runoff in habitats due to road/facility construction, soil impacts that affect plant growth (soil erosion or siltation), reduction of wildlife habitat, shifts in species composition and/or changes in vegetative density, and changes in visual aesthetics.

Continued oil and gas development in the MAA would require clearing vegetation during the construction phase. These activities, along with higher traffic volume, increase the potential for noxious/non-native plant introduction and the spread of existing invasive plant species.

4.7.1.2. Significance Criteria

Impacts to vegetation communities would be significant if there were a long-term reduction in vegetation productivity, a permanent change in species composition, a net loss of wetlands, or an increase in noxious weeds and other non-native species that contributes to unsuccessful revegetation. This includes the introduction of noxious or invasive plants into areas that were previously free of weeds or an increase in noxious or invasive species where they already exist.

Impacts to vegetation would also be significant if they violate federal, state, and local agency rules and regulations, or Kemmerer RMP management guidelines, such as:

- A violation of Section 404 of the CWA, EO 11988 (floodplain management), or EO 11990 (protection of wetlands) that would impact riparian vegetation, wetlands, and other waters of the U.S., or a decreased PFC rating of streams within or downstream of the MAA. Because wetland and riparian areas would generally be avoided, significant impacts would not be expected for any of the alternatives.
- Lack of protection for federally listed and BLM sensitive plant species.
- Non-compliance with reclamation activities required under EO 13112 (invasive species).
- Non-compliance with the BLM Standards for Healthy Public Rangelands (Standard 2 for wetland and riparian vegetation, Standard 3 for upland vegetation, and Standard 4 for sensitive species habitat).
- Short-term disturbance of a vegetation cover type that exceeds 10% of its total cover.
- Introduction and establishment of noxious or invasive plants that results in increased populations of noxious plant species.

4.7.1.3. Direct and Indirect Impacts

The estimated area of disturbance for each of the vegetation types in the MAA is provided in Table 4-6. Surface disturbance estimates for Alternative B are not included in Table 4-6 because it cannot be determined how wells would be distributed across the MAA under this alternative. Acres of impact for the alternatives are in addition to existing disturbance in the MAA. The No Action/Low Development Alternative includes additional well development that was evaluated in the 1995 EIS but has not yet been completed.

For all alternatives, disturbance to desert shrub/sagebrush and alkali scrub plant communities throughout the MAA would occur. Due to long recovery rates for the shrub species in these habitats, reclamation would primarily result in herbaceous plant recovery initially, replacing shrublands with grassland-type cover and structure. These impacts would likely occur for up to 30 years beyond the LOP.

Table 4-6. Estimated disturbance to vegetation types across alternatives in the MAA (in acres).

Disturbance Type	Core/ Flank	Wyoming Big Sagebrush	Vegetated Sand Dunes	Alkali Scrub	Barrens	Riparian/ Wetlands	Agriculture Cropland	Juniper Woodland
Alternative A								
Drilling and Completion	Core	3,428	981	899	532	65	67	-
	Flank	2,736	515	659	207	60	104	-
After Interim Reclamation	Core	952	272	250	148	18	19	-
	Flank	759	143	183	58	17	29	-
Proposed Action								
Drilling and Completion	Core	7,398	1,744	1,715	959	253	301	-
	Flank	4,400	632	362	669	148	64	5
After Interim Reclamation	Core	2,385	563	552	308	81	96	-
	Flank	1,408	202	116	214	47	21	2
Alternative C *								
Drilling and Completion	Core	20,629	4,936	4,271	2,402	471	516	-
	Flank	8,536	1,422	891	1,127	250	116	4
After Interim Reclamation	Core	6,967	1,668	1,442	810	158	173	-
	Flank	2,862	477	229	378	84	39	1

* Includes development within the MMTA

Noxious weeds and invasive plants can be introduced and become established in areas disturbed by construction, vehicle traffic, road maintenance, and topsoil removal. Therefore, all alternatives would increase the potential for introduction of noxious/invasive plants. Establishment of noxious weeds leads to displacement of native species and shifts in plant community composition and ecosystem functioning. The resulting changes in the plant community can alter wildlife habitat, wildlife and livestock forage, and the fire regime. Additionally, sites dominated by weeds often have a different visual character that may contrast with the surrounding native vegetation. Potential impacts from noxious weeds would be roughly proportional to the amount of disturbance for each alternative and will not be analyzed further.

4.7.1.3.1. Proposed Action

The Proposed Action would result in an estimated 18,650 acres (3.9% of the MAA) of short-term disturbance to vegetation (12,370 acres in the core, and 6,280 acres in the flank). Interim reclamation during the 10-year construction and drilling phase would reduce vegetation disturbance to 5,995 acres. This level of disturbance would be present for approximately 30–40 years prior to final reclamation of these areas. However, interim reclamation would not reduce disturbance to sagebrush or other shrub species because of the time it takes to reestablish those species. Impacts to sagebrush and shrub communities could occur for up to 30 years after the LOP.

The extent of surface disturbance at any particular time depends on the amount of disturbance and the rate of ongoing reclamation. Although most impacts would be short-term, with implementation of reclamation and revegetation plans, some plant species would take several years to re-establish to pre-disturbance conditions. Therefore, the surface disturbance from the Proposed Action would result in significant impacts to vegetation in the MAA.

The most impacted vegetation community during the drilling and completion phase under the Proposed Action would be Wyoming big sagebrush, with a disturbance of 11,798 acres (7,398 acres in the core, and 4,400 acres in the flank). Because of the large area (312,400, acres) covered by desert shrub/sagebrush, only 3.7% of the community would be impacted by new disturbance. The second most impacted vegetation community would be vegetated sand dunes, with 2,376 acres or 3.9% of its total land cover (1,744 acres in the core, and 632 acres in the flank). The third most impacted community would be alkali scrub, with a total disturbance of 2,077 acres or 4.3% of its total availability (1,715 acres in the core, and 362 acres in the flank). Disturbance to the remaining four vegetation communities would account for 2,399 acres (1,513 acres in the core, and 886 acres in the flank).

4.7.1.3.2. Alternative A

Under Alternative A/No Action, no additional impacts to vegetation other than those previously approved for the MAA would occur. Under current development, total disturbance to vegetation in the short term would be approximately 10,258, acres (2.16% of the MAA) (5,971 acres in the core, and 4,287 acres in the flank). After interim reclamation, disturbance to vegetation would be reduced to 2,848 acres. However, interim reclamation would not reduce disturbance to sagebrush or other shrub species because of the time it takes to reestablish those species. Impacts to sagebrush and shrub communities could occur for up to 30 years after the LOP.

The most impacted vegetation community under Alternative A would be Wyoming big sagebrush, with disturbance to 6,164 acres or 2.0% of its total land cover (3,428 acres in the core, and 2,736 acres in the flank). Vegetated sand dunes would be the second most impacted vegetation community, with disturbance to 1,496 acres or 2.4% of its total land cover (981 acres in the core, and 515 acres in the flank). Alkali scrub would be the third most impacted community, with disturbance to 1,558 acres or 3.2% of its availability (899 acres in the core, and 659 acres in the flank). Disturbance to the remaining four vegetation communities would account for 1,035 acres of disturbance (664 acres in the core, and 371 acres in the flank).

4.7.1.3.3. Alternative B

Under Alternative B, maximum well numbers and short-term disturbance estimates could be as high as those for Alternative C (Table 2-5). However, disturbance to vegetation communities would be reduced in order to remain under the surface disturbance limit of 10,920 acres. However, long-term impacts of Alternative B would be greater than those for Alternative A because of the time it would take to reestablish shrub species on reclaimed well pads and pipeline ROWs. While short-term recovery of grasses and forbs might occur relatively quickly and meet the required reclamation standards, the overall disturbance to shrub species would likely be similar to that predicted for the Proposed Action or Alternative C. Short-term disturbance to vegetation could be reduced through implementation of various technologies and development techniques. Techniques that could be selected by the operators to reduce impacts to vegetation include the following:

- Drilling multiple wells from a single pad to avoid sensitive areas and decrease surface disturbance. This would reduce surface disturbance and associated disturbance to vegetation. As described earlier for surface geology and topography, reduction of up to14,564 acres of short-term surface disturbance and associated vegetation could be achieved from drilling new wells from existing well pads on federally administered lands in the core of the MAA. The majority of the reduction would be expected in sagebrush and alkali scrub vegetation communities.
- Using common utility or ROW corridors. Total reduction in surface disturbance would be the same as described for surface geology and topography. Most of the reduction would be expected in sagebrush and alkali scrub communities. However, this technique would like have the greatest utility in sensitive soils where reclamation of the vegetation reliant on those soils is most difficult.
- Centralizing production facilities. This could reduce impacts to vegetation where centralized production is possible. It could also decrease traffic in the MAA and reduce the likelihood that weeds would spread.

An emphasis would be placed on successful reclamation of disturbed vegetation under this alternative in order to remain under the surface disturbance cap. Plant communities existing on sensitive soil types that are difficult to revegetate would likely be avoided more than they would be for other alternatives. However, successful interim reclamation would not reduce the long-term disturbance to sagebrush communities and other shrub-dominated communities because of the time it takes to reestablish those species to pre-disturbance sizes. Therefore, the short-term and long-term impacts to sagebrush communities could be the same as Alternative C over the LOP.

The extent of surface disturbance at any particular time depends on the amount of disturbance and the rate of ongoing reclamation. Although most impacts would be short-term, with implementation of reclamation and revegetation plans, some plant species would take several years to re-establish to pre-disturbance conditions.

4.7.1.3.4. Alternative C

Alternative C would result in a total of 45,571 acres (9.6% of the MAA) of short-term disturbance to vegetation (33,225 acres in the core, and 12,346 acres in the flank). Interim reclamation during the drilling and construction phase would reduce disturbance to 15,288 acres (11,218 acres in the core, and 4,070 acres in the flank).

Disturbance to vegetation communities would be the highest under this alternative. The most impacted vegetation community in Alternative C would be Wyoming big sagebrush, with 29,165 disturbed acres or 9.3% of its total land cover (20,629 acres in the core, and 8,536 acres in the flank). Although this does not exceed the 10% significance threshold, the total acreage disturbed is high enough that impacts would be significant. The second most impacted community would be vegetated

sand dunes, with a total of 6,358 acres disturbed or 10.4% of its total land cover (4,936 acres in the core, and 1,422 acres in the flank). The third most impacted community would be alkali scrub, with 5,162 acres disturbed or 10.7% of its total land cover (4,271 acres in the core, and 891 acres in the flank). Disturbance to the remaining four vegetation communities would total approximately 4,886 acres (3,389 acres in the core, and 1,497 acres in the flank).

4.7.1.4. Mitigation

Increasing the amount of field automation used in the MAA would reduce traffic, and would thereby reduce the impacts on vegetation from fugitive dust. Additionally, it would likely reduce the spread of noxious weeds in the MAA. The Moxa Arch Field Automation Traffic Data Analysis study recently completed by BP, shows that utilizing transmitted instrumentation readings could reduce the number of round trips to standard well sites by 50%.

Operators should evaluate technologies such as mat drilling or vegetation mowing to minimize disturbance to soils and vegetation.

4.7.1.5. Residual Impacts

The alternatives would potentially leave some residual impacts on the landscape even after final reclamation because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions. The timeframe for re-establishment of sagebrush communities could take up to 30 years beyond the date of final well abandonment. The Project Area would also likely retain numerous improved project roads where vegetation would not be re-established to pre-disturbance conditions. If noxious weeds are not controlled on private and state lands, the vegetation on adjacent federal lands may be affected as seeds carry over and establish themselves in revegetation areas.

4.7.2. Cryptobiotic Soil Crusts

4.7.2.1. Introduction

Cryptobiotic crusts are present in limited locations in the MAA. Continued oil and gas development in the MAA requires topsoil clearing during the construction phase, which would result in disturbances to soil crusts if they are present.

Potential impacts to cryptobiotic soil crusts would be caused by surface disturbance resulting from well pad, access road, pipeline, and associated facilities construction. This type of disturbance generally results in loss of species diversity, biomass, and surface cover of cryptobiotic crust components. Impacts include decreased cryptobiotic crust productivity, accelerated invasion of exotic plants, changes in the fire regime, changes in soil structure and function, reduction in water infiltration, and increased soil erosion (Belnap et al. 2001).

4.7.2.2. Significance Criteria

Impacts to cryptobiotic soil crusts would be considered significant if surface-disturbing activities caused long-term reduction in intact crust cover, resulting in major changes to crust species composition and ecological functioning.

4.7.2.3. Direct and Indirect Impacts

All alternatives would cause similar impacts to disturbed cryptobiotic crusts. Due to the very long recovery rates for crusts and the lack of reclamation techniques, any disturbance would result in long-

term or permanent impacts. The level of impact would be proportional to the acres disturbed for each alternative.

4.7.2.4. Mitigation

Impacts to cryptobiotic crusts should be avoided to the extent possible during the APD process. If crusts are observed during on-site visits to proposed well pad locations, measures should be taken to avoid impacting those crusts.

4.7.2.5. Residual Impacts

Recovery of disturbed cryptobiotic crusts may take from 20 to 250 years, assuming the area is not disturbed again (Belnap et al. 2001). Extent, type, and intensity of disturbance are critical factors in determining recovery rates. Limiting the size of the disturbed area increases the rate of recovery.

4.7.3. Riparian and Wetland Areas

4.7.3.1. Introduction

Most of the 8,700 acres of riparian and wetland areas in the MAA are associated with perennial drainages and water bodies, although minor coverage is associated with isolated ponds, seeps, and springs. Wetland types identified in the MAA include lowland alkali scrub, riparian forest/shrub, wet meadow, playas, marsh, aquatic bed/open water, and riverine (Cowardin et al. 1979; PIC Technologies 1996).

In some cases, roads and pipelines may cross drainages, possibly impacting wetland/riparian vegetation. Any impacts from these crossings would require a Section 404 permit and would be analyzed by the USACE permit process. These unavoidable impacts should be minimized and mitigated.

Some impacts to wetlands and riparian habitat could occur as surface runoff and sedimentation increase during construction and drilling.

4.7.3.2. Significance Criteria

Impacts to riparian vegetation, wetlands, and other waters of the U.S. would be significant if a violation of Section 404 of the CWA, EO 11988 (floodplain management), or EO 11990 (protection of wetlands) occurred. Impacts to riparian areas would be significant if they decreased the PFC rating of streams within or downstream of the MAA. Because wetland and riparian areas would generally be avoided, significant impacts would not be expected for any of the alternatives.

4.7.3.3. Direct and Indirect Impacts

For the most part, impacts to wetlands and riparian vegetation would be avoided by complying with the 500-foot buffer required by BLM stipulations. All wells will remain outside the 500-foot buffer. This 500-foot buffer would effectively reduce the disturbance to wetland/riparian areas below the levels presented in Table 4-6. However, road and pipeline crossings could still impact wetland/riparian habitats. The majority of major pipeline crossings within the project area on federal surface are drilled reducing the direct impacts resulting from instream work. Many of the streams systems within the MAA are intermittent or ephemeral and would require the installation of culverts designed to hold 50 year flow events. Most perennial water sources have existing crossings (i.e. bridges) that would continue to be used throughout the development of the project. It is unlikely that additional bridge construction would be required within the MAA. It is anticipated that Alternative C

would have the greatest impact, due to the greater number of wells, but it is not possible to quantify and compare impacts for each alternative.

4.7.3.4. Mitigation

BLM stipulations restrict construction within 500 feet from stream corridors on federal lands. Potential stream crossings could not be estimated at this time, but they would be analyzed on a project-specific basis during the APD process and through CWA permitting, if necessary. Continued implementation of these stipulations would adequately protect fisheries and aquatic ecosystems.

Any unavoidable impacts to riparian areas or wetlands would be mitigated and would be determined during the Section 404 permitting process. Continued implementation of a 500-foot buffer around all wetland/riparian habitats should reduce impacts that would result from well pad construction.

4.7.3.5. Residual Impacts

No residual impacts to wetlands are likely to occur with successful mitigation.

4.7.4. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Removal of vegetation results in increased soil exposure, loss of wildlife habitat, reduced plant diversity, and loss of livestock forage. The disturbed surface area increases potential for non-native/noxious plant establishment, accelerates erosion, and changes the visual aesthetics of the area. Mitigation measures will reduce long-term vegetation impacts by re-establishing vegetative cover and controlling erosion and invasive species. Because some native vegetation takes over 30 years to return to pre-disturbance conditions, residual impacts from vegetation removal are likely to continue after the LOP. Sensitive areas, such as wetlands, will be avoided to the extent practicable. Where impacts to wetlands are unavoidable, mitigation through the Section 404 process would reduce impacts.

Compared to Alternative A/No Action, the Proposed Action would increase disturbance to vegetation communities by 7,061 acres in the short term, and by 2,778 acres after interim reclamation. Alternative C would increase short-term vegetation disturbance by approximately 26,921 acres compared to the Operators' Proposed Action. Drilling of the additional wells would take place over 25 years, compared to the 10-year drilling duration for the Operators' Proposed Action. Therefore, reclamation of disturbed areas would take longer to reach pre-disturbance conditions. A significant overall increase in grassland-type cover and structure while shrub species recover would occur. Impacts to vegetation under Alternative C could be substantial; impacts under all other alternatives are not anticipated to be significant.

4.8. Fisheries and Wildlife

4.8.1. Fisheries and Aquatic Ecosystems

4.8.1.1. Introduction

Sedimentation, localized impacts of road and pipeline crossing, water depletions, and spread of noxious weeds, such as tamarisk, could impact fisheries and aquatic habitat. Additionally, accidental spills or other impacts to water quality could cause direct mortality of aquatic organisms, including fish. Water depletions associated with field development activities could also impact fisheries.

4.8.1.2. Significance Criteria

Impacts to fisheries would be significant if the following occurred:

- Substantial loss of habitat function or disruption of life history requirements for a species or population segment.
- Actions that result in substantial disruption, irreplaceable loss, or abandonment of vital and high value riparian habitats and aquatic resources (Table 4-7), as defined by the WGFD (WGFD 2004).

Table 4-7. WGFD Impact Thresholds for Priority Wildlife Species and Habitat from Oil and Gas Development Activities. Adapted from WGFD 2004, Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats.

Species and Habitat	Value	Impact Threshold	
		Number of Wells per Section	**Cumulative Ground Disturbance Per Section (acres)**
Mule Deer and Pronghorn Crucial Winter Ranges	Vital	>16 (*extreme impact*) 5-16 (*high impact*) 1-4 (*moderate impact*)	>80 (*extreme impact*) 20-80 (*high impact*) <20 (*moderate impact*)
Elk Crucial Winter Range and Parturition Areas	Vital	>4 (*extreme impact*) 1-4 (*high impact*)	>60(*extreme impact*) up to 60 (*high impact*)
Big Game Migration Corridors	Priority	>4 wells/section (*extreme impact*)	Development causing further constriction within narrow corridors (<0.5 mi wide) should be avoided.
Riparian Corridors	High	>16 (*extreme impact*) 5-16 (*high impact*) 1-4 (*moderate impact*)	No net loss of function
Aquatic Resources	Priority*	>16 (*extreme impact*) 5-16 (*high impact*) 1-4 (*moderate impact*)	Avoid to the extent reasonable
Raptor Nesting Areas	Vital	Development activity within buffers and time frames developed with state and federal agencies should be avoided.	
Native Non-game Birds	High	From April 1 through June 30, greater than 49 dBA noise levels within breeding habitat considered an impact, effects greatest for night work.	

*Muddy Creek and Smiths Fork watersheds are categorized as "Priority." Other watersheds vary in value.

4.8.1.3. Direct and Indirect Impacts

The BLM requires 500-foot buffers around all perennial water bodies and wetlands in the MAA. This level of protection would adequately protect fisheries and aquatic communities in and downstream of the Project Area. Some impacts might occur as a result of sedimentation as discussed in the Water Resources section. However, BMPs that would be applied to control sediments would likely be adequate to protect aquatic systems under all alternatives. Any new crossings that are constructed could change channel geomorphology and hydrology and have direct and indirect impacts on aquatic

ecosystems. Potential impacts to aquatic resources and fisheries are expected to be the same for the Proposed Action and the alternatives.

4.8.1.4. Mitigation

Construction should remain outside a 500-foot buffer around all streams and wetlands on federal lands.

For all new or expanded crossings on federal lands operators would provide BLM with an estimate of the wetland and riparian habitats that would be removed or modified as well as a list of BMPs that would be used to avoid impacts to those wetland and riparian habitats. Potential stream crossings could not be estimated at this time, but they would be analyzed on a project-specific basis during the APD process and through CWA permitting.

4.8.1.5. Residual Impacts

Residual impacts to downstream fish habitat could occur if pipelines or other equipment crossings were placed such that they disturb the flow of water or stream bottoms. Hydrology and geomorphology changes upstream and downstream from crossings may occur under all alternatives and could have residual impacts to aquatic ecosystems after the LOP.

4.8.2. Raptors

4.8.2.1. Introduction

Raptor nesting and foraging habitat is found throughout most of the MAA. Federally listed and BLM sensitive raptors are discussed in Section 4.9. All raptor species and their active nests are protected under the MBTA.

Habitat value and impact thresholds for raptor breeding areas and non-game birds are presented in Table 4-8. In general, birds are more sensitive to indirect impacts, such as unexpected noises, and the WGFD has determined that noise levels greater than 49 dBA within breeding habitat from April 1 through June 30 are a negative impact to non-game birds, especially at night (WGFD 2004).

A 0.5-mile buffer and a 1-mile buffer around the 106 known raptor nests in the MAA were used to assess potential impacts of the project alternatives on breeding raptors and their home ranges. Potential effects to these buffers, without protection measures, are shown in Table 4-8. However, active raptor nests would have disturbance-free buffers placed around them by the BLM AO during breeding activity seasons to prevent any impacts. Surface disturbance estimates for Alternative B are not included in Table 4-8 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. However, the long term disturbance would be identical to Alternative A/No Action while the short term impacts could be as high as Alternative C.

Table 4-8. Potential Impacts to Raptor Breeding and Home Range Areas in the MAA.

Activity	Core/ Flank	Disturbance within 0.5 mi of known nests (acres)	Disturbance within 1.0 mi of known nests (acres)
Proposed Action			
Drilling and Completion	Core	1380	4480
	Flank	600	1930
After Interim Reclamation	Core	444	1434
	Flank	192	618
Alternative A			
Drilling and Completion	Core	670	2036
	Flank	444	1470
After Interim Reclamation	Core	186	565
	Flank	123	408
Alternative C			
Drilling and Completion	Core	3390	11255
	Flank	1108	3564
After Interim Reclamation	Core	1144	3773
	Flank	371	1195

4.8.2.2. Significance Criteria

Impacts to raptor species would be significant if the following occurred:

- Activities contributed to unlawful 'take' of any migratory bird, including raptors, as defined by the MBTA.
- Actions resulted in an irreplaceable loss, or abandonment of vital and high value habitats as defined by WGFD (WGFD 2004).
- Surface disturbance from drilling and completion activities of more than 5% of area within 0.5 mile buffer around 106 known raptor nests as a measure of potential forage loss around nesting areas.

4.8.2.3. Direct and Indirect Impacts

4.8.2.3.1. Impacts Common to All Alternatives

All alternatives would have some potential for noise impacts above 49 dBA within breeding habitat (WGFD 2004). Impacts to raptors from noise would be identical to the impacts described in the Noise section earlier in Chapter 4.

In addition, development within specific distances from various species of raptors has been identified to result in the abandonment or failure of nesting raptor species. Within the MAA all species with the exception of Bald Eagle and Ferruginous Hawk have restrictions on the timing of development between February 1 and July 31 which applies to all surface disturbing activities as well as drilling, and completion activities within a ½ mile from active nests. Bald Eagle and Ferruginous Hawks have timing restrictions applied to development within 1 mile of an active nest.

4.8.2.3.2. Proposed Action

Drilling and completion activities in nesting areas could impact up to 1,980 acres or 4.3% of the 45,874 acres of habitat within ½ mile of known nests and 6,410 acres within 1-mile of known nests.

Estimated long-term impacts (following interim reclamation) would cover 636 acres within 0.5 mile and 2,052 acres within 1-mile of known nests. However, BLM stipulations for raptors would establish restrictive buffers and adjust construction scheduling to minimize these impacts.

4.8.2.3.3. Alternative A

Without protection measures, impacts to nesting areas under Alternative A/No Action could affect up to 1,114 acres or 2.3% of estimated breeding and home range habitat within ½ mile of known nests during drilling and completion. Approximately 3.506 acres within 1-mile of known nests would be impacted by short term disturbance. Long-term impacts (following interim reclamation) would be estimated to be 309 acres within ½ mile of known nests and 973 acres within 1-mile of known nests. However, per the 1997 ROD, BLM stipulations for raptors would establish restrictive buffers and adjust construction scheduling to minimize these impacts.

4.8.2.3.4. Alternative B

The total number of proposed wells and the overall short-term disturbance over the LOP would be identical to Alternative C. However, the overall surface disturbance at any one time would remain at or below the 10,921 acres predicted for Alternative A/No Action. The Operators would employ development and reclamation techniques to reduce surface disturbance, which would also benefit raptors. These techniques include drilling multiple wells from a single well pad (Table 4-2); centralizing production facilities; minimizing topsoil removal during construction; and co-locating powerlines, flowlines, and roads in common utility corridors. The higher number of wells that would be allowed under Alternative B would create impacts that would be greater than Alternative A/No Action. However, over the LOP, successful reclamation required to remain under the 10,921 acre disturbance level would help to reduce impacts to a level below that which would be anticipated for Alternative C. Short-term impacts could be significant under Alternative B if techniques such as directional drilling from existing pads are not used.

4.8.2.3.5. Alternative C

Drilling and completion activities in raptor nesting areas could impact up to 4,498 acres or 9.8% of the 45,874 acres of estimated breeding and home range habitat within ½ mile of known nests. Approximately 14,819 acres of short-term impacts would occur within 1-mile of known nests. Short-term impacts would be significant for raptors under Alternative C. Estimated long-term impacts (following interim reclamation) would cover 1,515 acres within ½ mile and 4,968 acres within 1-mile. However, BLM stipulations for raptors would establish restrictive buffers and adjust construction scheduling to minimize these impacts.

4.8.2.4. Mitigation

Raptor mitigation measures and BLM stipulations would be similar for all alternatives. The following seasonal and spatial mitigation measures are included for reference. However, the Kemmerer RMP would take precedence in determining the seasonal and spatial restrictions for development. BLM-established stipulations for all raptor nests would apply on a project-specific basis and would restrict activities depending on species and season. Raptor nest surveys would be conducted in suitable habitat within a minimum 0.5-mile radius of activities proposed to take place between February 1 and July 31. Where active nests are identified, surface-disturbing activity would be seasonally restricted within a 0.5-mile radius between these dates. Seasonal restrictions apply within a 1-mile radius of active bald eagle and ferruginous hawk nests between February 1 and August 15, as well as a 1-mile radius for bald eagle roosts between November 1 and April 1. A nest site should be considered active if it has been used within the past 3 years.

Seasonal restrictions would be evaluated on a case-by-case basis, and may be relaxed or waived at the discretion of the BLM. With these stipulations, the estimated impacts to raptor nests would be reduced and/or eliminated.

Additional measures that would help to mitigate impacts to raptors would include:

- Installing raptor perch avoidance structures, burying distribution power lines and/or gathering pipelines, and locating wellheads below ground surface would discourage raptor perching in the MAA. These BMPs are intended to reduce potential predation of BLM sensitive species by raptors and reduce potential for electrocution of raptors.
- Implementing noise reduction techniques and designs would reduce stress on wildlife from high noise levels. This may include remote monitoring which would reduce field visits during operations.
- Drilling multiple wells from a single pad, collocating power lines and gathering pipelines in roads, centralizing production facilities, and minimizing topsoil removal would result in less surface disturbance and would reduce impacts to wildlife habitat. These impacts would be the same as described in the surface geology and topography section earlier in Chapter 4.

Reducing raptor perch areas would potentially protect sensitive wildlife such as sage-grouse and prairie dogs. This measure may reduce predation by golden eagles, great-horned owls, and ravens, but it would not deter some other predators (coyote, badger, red fox, and bullsnake). However, reduction of available perch areas could adversely impact raptors by reducing foraging opportunities.

4.8.2.5. Residual Impacts

Mitigation measures will reduce long-term impacts by re-establishing vegetative cover. Because some native vegetation takes over 30 years to return to pre-disturbance conditions, residual impacts to habitat from vegetation removal are likely to continue after the LOP.

4.8.3. Big Game

4.8.3.1. Introduction

Pronghorn, mule deer, elk, and moose are the big game species that occur in the MAA and are managed by the WGFD. Impacts may occur to big game seasonal ranges and migration corridors, which may affect big game populations. However, the population levels for some big game herds naturally fluctuate over time.

Fragmentation from roads and other infrastructure can affect big game and other wildlife when patch size and interior habitat availability decrease. Greater separation between suitable habitat patches can prevent dispersal and gene sharing among populations, especially smaller species, thus decreasing population viability and/or creating overcrowded habitats. As an example, a major source of pronghorn habitat fragmentation is fences with bottom wires too low for the animals to pass under, usually placed along roadways (Sawyer 2005). Creation of roads often includes addition of “edge” habitats that are less valuable to native wildlife and can harbor invasive plant and animal species that threaten the viability of interior habitats.

Modification of the behavioral or physiological state and reproductive success of some affected animals may occur as they expend more effort to avoid humans or equipment. Wildlife responses to new development will vary by species and will range from abandonment of a particular habitat to habituating to the disturbances over time (Langbein and Putman 1992). Wildlife responses to either vehicular or human disturbances also vary by factors, including type, timing, location, frequency, and predictability of disturbance (Miller 1998). Miller’s report states that wildlife can habituate to disturbances primarily if the disturbances are predictable and are perceived as non-threatening (e.g., vehicles on a well-traveled road). Another study from Wyoming reported that elk have become adapted to human activities that are repetitive or constant, such as traffic, but are displaced by people

on foot (Ward 1984). The greatest effects to wildlife would occur in areas that currently have little human presence. More roads added to an area usually attract more people to an area and can present opportunities for increased illegal and legal hunting or animal harassment.

The WGFD analysis of impact thresholds for wildlife species from oil and gas development focused on large-scale development projects occurring in sagebrush/steppe ecosystems, which includes many game species that occur in the MAA. As outlined in the WGFD report, in addition to the direct loss of habitat attributed to well pads, accompanying impacts to wildlife can occur due to roads, tanks, equipment staging areas, compressor stations, shops, pipelines, power supplies, traffic, and human activity. WGFD-prioritized big game habitat values and impact thresholds from well pad density are presented in Table 4-7.

All alternatives would require the removal or crushing of sagebrush and other woody vegetation and trampling of forbs and grasses. These vegetation impacts would affect big game breeding and foraging habitats. Direct impacts to big game habitats are shown in Table 4-9. Surface disturbance estimates for Alternative B are not included in Table 4-9 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. These acreages do not take into account BLM wildlife stipulations and mitigation measures to reduce wildlife impacts.

Of the big game species in the MAA, pronghorn are most likely to be affected by additional development because of their year-round use of the entire MAA (Map 3-8). A recent analysis determined that 60% of pronghorn habitat is included in areas of potential oil and gas development in Wyoming (Stalling 2004). A five-year research study partially funded by Shell Oil Company is underway to evaluate the effects of gas field development on pronghorn winter survival, short- and long-term responses, effects to body condition, and habitat fragmentation (Berger, Berger, and Beckman 2006). First year results showed continuing problems related to habitat fragmentation and range limited by snow depths. No significant differences in condition of pronghorns around oil and gas operations were observed. However, first year results are preliminary and might not reflect the total impact of oil and gas development.

Where mule deer come in contact with oil and gas operations there may be increased likelihood for changes in habitat use (Sawyer et al. 2006).

4.8.3.2. Significance Criteria

Impacts to big game species would be significant if the following occurred:

- Actions that result in irreplaceable loss or abandonment of vital and high value habitats, as defined by WGFD (WGFD 2004).
- Greater than 5% increase in disturbance in crucial ranges or greater than 10% increase in disturbance in non-crucial ranges in the MAA.

4.8.3.3. Direct and Indirect Impacts

4.8.3.3.1. Impacts Common to All Alternatives

Habitat fragmentation as a result of an expanded road network in the MAA is difficult to quantify. However, it is anticipated that Alternative C would have the highest habitat fragmentation impact because of the large number of new well pads. Alternative B and the Proposed Action would likely have lower levels of habitat fragmentation but would have a greater impact than would Alternative A/No Action.

Table 4-9. Potential Impacts to Big Game Species in the MAA.

Disturbance Type	Core/ Flank	Pronghorn Range					Mule Deer Range		Elk Range	Moose Range	
		Crucial Severe Winter Relief	Crucial Winter Yearlong	Winter Yearlong	Yearlong	Spring/ Summer/ Fall	Winter Yearlong	Yearlong	Crucial Severe Winter Relief	Yearlong	Winter Yearlong
Acres Available Within the MAA		17,382	153,584	25,874	69,826	209,143	37,971	23,962	35,753	45,214	7,276
Alternative A											
Drilling and Completion	Core	123	605	201	1174	3868	85	364	358	458	11
	Flank	369	590	204	412	2705	453	218	429	274	0
After Interim Reclamation	Core	34	167	56	326	1074	24	101	99	127	3
	Flank	102	164	57	114	751	126	60	119	76	0
Proposed Action											
Drilling and Completion	Core	322	3744	286	1854	6165	151	1387	427	1909	38
	Flank	351	1697	686	1445	2101	1026	151	146	610	84
After Interim Reclamation	Core	103	1205	92	596	1990	48	444	141	612	12
	Flank	112	543	220	462	672	328	48	47	195	27
Alternative C											
Drilling and Completion	Core	905	10322	613	3790	17596	608	2567	3249	3701	100
	Flank	636	3752	1106	2482	4370	1716	273	357	940	262
After Interim Reclamation	Core	305	3481	207	1278	5948	204	862	1103	1239	33
	Flank	213	1258	371	832	1465	576	92	120	315	88

4.8.3.3.2. Proposed Action

Pronghorn

Impacts to pronghorn under the Proposed Action are not anticipated to be significant. However significant impacts could occur if development encroaches on the pronghorn migration corridors that have been identified in the MAA.

Pronghorn use the entire MAA as seasonal range. Impacts to pronghorn crucial severe winter relief habitat from the Proposed Action would cover approximately 673 acres (3.9%) in the short term and 215 acres (1.2%) after interim reclamation (Table 4-9).

A portion of the pronghorn population uses crucial winter yearlong range all year, while other pronghorn depend on this range from December 1 to April 30 for winter survival. Short-term impacts would increase the disturbed habitat by an estimated 5,441 acres (3.5%), and long-term impacts would be increased by an estimated 1,748 acres (1.1%) within the MAA.

Activities in winter yearlong habitat from this alternative would impact 972 acres or 3.8% of available habitat in the short term, and 312 acres (1.2%) in the long term. Yearlong range short-term impacts would cover 3,299 acres (4.7%), and long-term impacts would cover 1,058 (1.5%). Short-term impacts to spring-summer-fall habitat would cover approximately 8,266 acres (4%), and long-term impacts would cover 2,662 acres (1.3%).

This alternative uses an average density of eight wells per section within the MAA core area, which is considered a "high" impact to pronghorn by the WGFD (Table 4-7). Impacts to the 12 pronghorn migration/movement routes in the MAA cannot be estimated at this time; however, the nine routes in the core area are most likely to be affected. WGFD considers greater than four wells per section, or any development causing further constriction, within narrow big game corridors to be an "extreme" impact (WGFD 2004). Only two wells per section are proposed in the flank; this would be considered a moderate impact on crucial pronghorn range.

Mule Deer

The Proposed Action alternative would increase short-term disturbance in available habitat by an estimated 1,538 acres (6.4%), and long-term disturbance by 492 acres (2%) (Table 4-9). Short-term impacts to mule deer winter yearlong range would cover an estimated 1,177 acres or 3% of the available habitat, and long-term impacts would cover 376 acres (1%). BLM-required protections, such as the 500-foot buffer around streams, would reduce impacts to portions of mule deer habitats. No crucial mule deer ranges (winter or yearlong) or migration routes were identified within the MAA. Significant impacts to mule deer habitat would not be expected under the Proposed Action.

Elk

The Proposed Action would impact approximately 573 acres (1.6%) of the crucial severe winter relief elk habitat in the northern portion of the MAA, with 188 impacted acres (less than 1%) remaining after interim reclamation. In the core, development of more than four wells per section in elk crucial winter ranges would be considered an "extreme" impact (Table 4-7). The Proposed Action would have 8-12 wells per section in the core creating an extreme impact under WGFD definitions. The two wells per section in the flank would be considered a "high" impact. Disturbance to elk crucial severe winter relief habitat that would result from the Proposed Action would not exceed the 5% significance threshold.

Moose

Approximately 2,519 acres (5.6%) of available yearlong moose range would be impacted by this alternative (Table 4-9), with 807 acres (1.8%) of long-term impacts after interim reclamation. BLM stipulations would reduce impacts in stream corridors, but disturbances would occur to foraging habitat in other portions of moose habitat. Effects to moose winter yearlong habitat would cover 122 acres (1.7%) of available habitat in the short term, and 39 acres (less than 1%) after interim reclamation.

Four moose migration/movement corridors have been mapped within the MAA; however, because exact drilling pad locations have not yet been determined, impacts are difficult to predict. The known movement corridor south of Granger, where the species crosses US 30, is near the town and likely within the MMTA area; therefore, wells planned for this area should be minimal. However, construction activities near riparian areas at dawn or dusk may affect daily moose movements. Impacts may be greater seasonally as moose travel along the Blacks Fork River to and from winter yearlong habitat. Increased traffic along US 30 could increase the number of animal-vehicle collisions with moose.

4.8.3.3.3. Alternative A

Pronghorn

Disturbance from Alternative A/No Action within the crucial severe winter relief range would cover an estimated 492 acres (2.8%) in the short term, and 136 acres (less than 1%) in the long term (Table 4-9). Within the crucial winter yearlong range, short-term impacts would cover an estimated 1,195 acres (less than 1%), and long-term impacts would cover 331 acres (less than 1%).

Estimated impacts to winter yearlong habitat from this alternative would cover 405 acres or 1.6% of available habitat in the short term, and 113 acres (less than 1%) in the long term. Yearlong range short-term impacts would cover 1,586 acres (2.3%), and long-term impacts would cover 440 acres (less than 1%). Short-term impacts to spring-summer-fall habitat would cover 6,573 acres (3.1%), and long-term impacts would cover 1,825 acres (less than 1%).

This alternative uses an average density of four to eight wells per section within the MAA core area, which is considered a moderate to high impact to pronghorn by the WGFD (Table 4-7). Because final well pad and road alignments have not yet been decided, impacts to the 12 pronghorn migration/movement routes present in the MAA cannot be estimated at this time. The mapped routes in the core area are most likely to be affected, however.

Alternative A would maintain the four zones identified for crucial big game habitats and the cumulative limits on well pads would remain in place. Continued implementation of the No Action would not cause significant impacts to occur for pronghorn.

Mule Deer

Alternative A/No Action would increase short-term disturbance in yearlong range by an estimated 582 acres (2.4%), with long-term effects at 161 acres (less than 1%). Short-term impacts to mule deer winter yearlong range, also in riparian corridors, would cover an estimated 538 acres or 1.4% of available habitat, and long-term impacts would cover 148 acres (less than 1%). BLM-required protections, such as the 500-foot buffer around streams, would reduce impacts to riparian habitats that occur on federal lands within the MAA. No crucial mule deer ranges (winter or yearlong) or migration routes were identified within the MAA. Continued implementation of the No Action would not cause significant impacts to occur for mule deer.

Elk

Alternative A/No Action would impact approximately 787 acres (2.2%) of crucial severe winter relief elk habitat, with a remaining 218 acres (less than 1%) after interim reclamation. This alternative uses

an average density of four to eight wells per section within the MAA core area creating an extreme impact under WGFD recommendations (Table 4-7). In the flank, development would generally consist of fewer than four wells per section, which would be considered a "high" impact to crucial elk habitat. Continued implementation of the No Action would not cause significant impacts to occur for elk.

Moose

Approximately 732 acres (1.6%) of available yearlong range found along the Hams Fork and Blacks Fork Rivers would be impacted by this alternative, with 203 acres (less than 1%) of long-term impacts after interim reclamation. BLM stipulations would reduce impacts in stream corridors, but disturbances would occur to foraging habitat in other portions of moose habitat. Short-term impacts to moose winter yearlong habitat would cover 11 acres (less than 1%) of available habitat, and 3 acres after interim reclamation. Continued implementation of the No Action would not cause significant impacts to occur for moose.

Impacts to the four moose migration/movement corridors would be approximately the same as discussed for the Proposed Action.

4.8.3.3.4. Alternative B

Although the number of wells would be identical to Alternative C, it is likely that surface disturbance and habitat fragmentation would be reduced to stay under the 10,921 acre disturbance cap. Techniques described for Alternative B in Chapter 2 could be utilized to reduce surface disturbance reduce impacts to big game. However, even with this reduction, Alternative B would have impacts to big game species that would be greater than the No Action. Drilling multiple wells from a single pad, collocating power lines and gathering pipelines in roads, centralizing production facilities, and minimizing topsoil removal would reduce impacts to wildlife habitat and reduce traffic in the MAA. Mowing or mat drilling could increase the rate of recovery for sagebrush and other vegetation. Because it is unknown how the operators will develop to remain under the 10,921 acre limit, Alternative B could have significant impacts to all species.

4.8.3.3.5. Alternative C

For all big game species the increased habitat fragmentation that would occur under Alternative C as a result of the increased travel network and high density development could cause significant impacts. While the long-term disturbances associated with Alternative C generally fall below the significant thresholds, the increased road density and habitat fragmentation could change the way the big game species use the MAA and push them into less favorable habitats in the flank or outside of the MAA.

Pronghorn

Surface disturbance in pronghorn crucial severe winter relief habitat under Alternative C would cover approximately 1,541 acres (8.8%) of available habitat in the short term, and 518 acres (3%) in the long term. Within the crucial winter yearlong range, short-term impacts would cover an estimated 14,074 acres (9.2%), and long-term impacts would cover 4,739 acres (3.1%). Impacts to crucial pronghorn ranges would be significant for Alternative C.

Winter yearlong habitat impacts estimated from this alternative would cover 1,719 acres or 6.6% of available habitat in the short term, and 578 acres (2.2%) in the long term. Yearlong range short-term impacts would cover 6,272 acres (9%), and long-term impacts would cover 2,110 acres (3%). Short-term impacts to spring-summer-fall habitat would cover approximately 21,966 acres (10.5%), and long-term impacts would cover 7,413 (3.5%). Significant impacts would occur for spring-summer-fall habitat and could occur for yearlong range if development is more focused in that habitat type than what is assumed for this DEIS.

This alternative uses an average density of 16 wells per section within the MAA core area, which is considered a "high" impact to pronghorn by the WGFD (Table 4-7). Impacts to the 12 pronghorn migration/movement routes in the MAA cannot be estimated at this time; however, the 9 routes in the core area are most likely to be affected. For migration routes, WGFD considers greater than four wells per section or any development causing further constriction within narrow big game corridors to be an "extreme" impact (WGFD 2004). Development of four wells per section in the flank would be considered a "moderate" impact to crucial pronghorn habitat.

Mule Deer

This alternative would increase short-term disturbance in available mule deer habitat by an estimated 2,840 acres (11.9%), with long-term effects of 954 acres (4%). Short-term impacts to mule deer winter yearlong range would cover an estimated 2,324 acres or 6.1% of the available habitat, and long-term impacts would cover 780 acres (2.1%). BLM-required protections, such as the 500-foot buffer around streams, would reduce impacts to portions of mule deer habitats. Significant impacts would occur to mule deer habitat under Alternative C.

Elk

This alternative uses an average density of 16 wells per section within the MAA core area and four wells per section on the flank. WGFD considers greater than four wells per section in elk crucial winter ranges to be an "extreme" impact and between one and four wells to be a "high" impact. This alternative would impact approximately 3,606 acres (10.1%) of crucial severe winter relief elk habitat, with a remaining 1,223 acres (3.4%) of impact after interim reclamation. Impacts to crucial elk ranges would be significant.

Moose

Approximately 4,641 acres (10.3%) of available yearlong moose range found along the Hams Fork and Blacks Fork Rivers would be impacted by this alternative, with 1,554 acres (3.4%) of long-term impacts after interim reclamation. BLM stipulations to avoid drilling within 500 feet of wetland/riparian areas would reduce impacts in stream corridors, but disturbances would occur to foraging habitat in other portions of moose habitat. Effects to moose winter yearlong habitat would cover 362 acres (5%) of available habitat in the short term and 121 acres (1.7%) after interim reclamation. Impacts to moose habitat would be significant.

Impacts to the four moose migration/movement corridors within the MAA would be similar to those discussed for the Proposed Action

4.8.3.4. Mitigation

The use of seasonal development restrictions would be evaluated on a case-by-case basis in crucial winter and crucial severe winter relief habitats and should be consistent with the approved RMP for the KFO.

Any habitat lost to development in the crucial severe winter relief ranges for pronghorn and elk would need to be fully mitigated/replaced to be available to support the existing herds in severe winters. Final well pad and road alignment can be adjusted to reduce the impacts to this crucial range during the APD process. Additional proposed mitigation is presented in Appendix A and includes:

- Implementing noise reduction techniques and designs to reduce stress on wildlife from high noise levels.
- Using remote monitoring and control technologies to reduce the overall human disruptive disturbance associated with the production phase of the development. This would reduce truck traffic in the MAA by up to 50% and the associated risk of truck/wildlife collisions.

4.8.3.5. Residual Impacts

Mitigation measures would reduce long-term wildlife impacts by re-establishing vegetative cover and controlling erosion and invasive species. Because some native vegetation takes over 30 years to return to pre-disturbance conditions, residual impacts to big game habitat from vegetation removal are likely to continue after the LOP.

4.8.4. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

The nature of impacts to wildlife is similar for all alternatives. With increasing surface disturbance, the potential for direct and indirect impacts to wildlife increases. The more well pads, roads, and pipelines within the MAA, the higher the level of fragmentation and decrease in habitat patch size. Raptor nests and big game habitat are protected by seasonal stipulations to protect critical breeding and overwintering periods and reduce impacts associated with surface development. Mitigation measures would reduce long-term impacts by re-establishing vegetative cover and controlling erosion and invasive species. Because some wildlife habitat takes over 30 years to return to pre-disturbance conditions, residual impacts from vegetation removal are likely to continue after the LOP.

4.9. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species

4.9.1. Federally Listed and Candidate Species

4.9.1.1. Introduction

ESA-listed threatened, endangered, or candidate species that are known to occur, or potentially occur, in the MAA include black-footed ferret, Ute ladies'-tresses orchid, and western yellow-billed cuckoo. Impacts to these species from development in the MAA include habitat loss and increased stress from human presence and equipment. Four endangered Colorado River fish species (Colorado pikeminnow, razorback sucker, bonytail, and humpback chub) found downstream of the MAA could be affected by depletions to the Colorado River system. No USFWS-designated critical habitat has been mapped for federally listed species within the MAA.

Direct impacts from project implementation, development, and operations to federally listed species that may be present in the MAA would be similar to those analyzed for general wildlife (Section 4.8). Indirect effects would also be similar to those described for general wildlife, including impacts from additional noise, dust, and human presence. These species may alter their behavior and home range use within the area of potential effect and adjacent areas. Bird species tend to be more sensitive to noise impacts and would benefit from late summer project start dates. All federally listed species that breed in the area are most sensitive to disturbance during the spring season.

No black-footed ferrets are known to occur in the MAA. However, any surface disturbance within the mapped prairie dog complex, which was determined by the USFWS to provided suitable black-footed ferret habitat, could directly impact potential black-footed ferret habitat.

4.9.1.2. Significance Criteria

Impacts to federally listed species would be significant if activities adversely affected or jeopardized threatened, endangered, or candidate species and/or any recovery program.

4.9.1.3. Direct and Indirect Impacts

4.9.1.3.1. Impacts Common to All Alternatives

Significant impacts would not occur to ESA protected species under the Proposed Action or any of the project alternatives. Because BLM-established BMPs and Wyoming Pollutant Discharge Elimination System (WYPDES) Program permits will be followed to prevent alteration of stream flows and reduce soil movement into drainages, no significant additional sediments are expected to enter local stream systems or affect downstream water quality.

BLM stipulations restricting construction within 500 feet of streams and in wet meadows, springs, and seeps would protect potential habitat. Therefore, no effects to the Ute ladies'-tresses orchid or western yellow-billed cuckoo are expected from any of the alternatives. The development of additional road crossings would be avoided unless no existing crossing can reasonably used to gain access to an area of potential development. In this case, impacts to riparian habitat would be assessed on a site-by-site basis. Pipeline crossings within the MAA on federal surface are typically drilled to reduce the impacts to perennial waters.

Colorado River Fishes

Several streams within the MAA are tributaries to the Green River, which flows to the Colorado River. Impacts to streams within the MAA could potentially affect downstream suitable and occupied habitat for listed endangered fish species. These impacts include water depletions, increased sedimentation, and alterations of stream flows. Because BLM-established BMPs will be followed, which prevent alteration of stream flows and reduce soil movement into drainages, no significant additional sediments are expected to enter local stream systems or affect downstream water quality.

Also, if water depletions over 100 acre-feet annually occur, consultation with the USFWS would need to occur and appropriate mitigation decided by that agency. Impacts to Colorado River fishes resulting from water depletions are discussed in the water resource section earlier in this chapter. There is potential for greater than 100 acre-feet in depletions for all alternatives.

4.9.1.3.2. Proposed Action

The Proposed Action would result in short-term impacts to approximately 2,233 acres (4% of available habitat) of prairie dog habitat (Table 4-10), which could also impact black-footed ferret, and 720 acres (1.3%) after interim reclamation. Impacts to riparian habitat, which would impact Ute ladies'-tresses and yellow-billed cuckoo, would cover an estimated 365 acres (4.2% of available habitat) in the short term, and 117 acres (1.3%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

4.9.1.3.3. Alternative A

Alternative A/No Action would result in short-term impacts to approximately 1,898 acres (3.4% of available habitat) of prairie dog habitat, which could also impact black-footed ferret, and 524 acres (less than 1%) after interim reclamation (Table 4-10). Impacts to riparian habitat, which would impact Ute ladies'-tresses and yellow-billed cuckoo habitat would cover an estimated 125 acres (1.5% of available habitat) in the short term, and 35 acres (less than 1%) after interim reclamation (Table 4-10). However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

Table 4-10. Impacts to Prairie Dog Habitat.

Prairie Dog Habitat Available in the MAA		**55,482 Acres**
Disturbance Type	**Core/ Flank**	**Disturbance to habitat (in acres)**
Proposed Action		
Drilling and Completion	Core	1,678
	Flank	555
After Interim Reclamation	Core	542
	Flank	178
Alternative A		
Drilling and Completion	Core	1,080
	Flank	818
After Interim Reclamation	Core	300
	Flank	224
Alternative C		
Drilling and Completion	Core	4,920
	Flank	1,050
After Interim Reclamation	Core	1,663
	Flank	352

4.9.1.3.4. Alternative B

The total number of proposed wells would be similar to Alternative C, however surface disturbance would be maintained below 10,921 acres at any given time. This surface disturbance cap, and the techniques employed to reduce surface disturbance and increase reclamation, would reduce impacts to protected species to levels similar to Alternative A. Reductions in surface disturbance as a result of collocation of production facilities, using common rights-of-ways, and drilling multiple wells from common pads would reduce overall impacts to protected species and their habitats.

4.9.1.3.5. Alternative C

Alternative C would result in short-term impacts to approximately 5,970 acres of prairie dog habitat, which could also impact black-footed ferret, and 2,015 acres (3.6%) after interim reclamation. Impacts to riparian habitat, which could impact Ute ladies'-tresses and yellow-billed cuckoo habitat would cover an estimated 721 acres (8.3%) in the short term and 242 acres (2.8%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

4.9.1.4. Mitigation

Mitigation measures and BLM stipulations would be the same for all alternatives. Noise reduction measures would be as described in the Fisheries and Wildlife section. Qualified biologists would conduct surveys for federally listed species prior to commencement of construction activities. Black-footed ferret presence-absence surveys would be required in prairie dog colonies not included in the USFWS block clearance areas. If populations of Ute ladies'-tresses were discovered, a 500-foot buffer around those populations would be required.

4.9.1.5. Residual Impacts

Residual impacts to federally listed and candidate species would be the same as those for general wildlife.

4.9.2. Wyoming BLM Sensitive Species

4.9.2.1. Introduction

Several BLM-listed sensitive species are known to occur or potentially occur within the MAA. The BLM manages these species in an effort to prevent federal listing. Direct impacts to these species would occur from habitat loss. Indirect impacts would be similar to those discussed for general wildlife. Table 4-11 presents general impacts thresholds used for BLM sensitive species and their habitats.

Table 4-11. WGFD Impact Thresholds for BLM Sensitive Species and Habitat from Oil and Gas Development Activities

Species and Habitat	Impact Threshold	
	No. of Well Pads per Section	**Cumulative Ground Disturbance per Section (acres)**
Sage-grouse Long-eared myotis Trumpeter swan Pygmy rabbit Peregrine falcon Ferruginous hawk Long-billed curlew White-faced ibis	>16 (*extreme impact*) 5-16 (*high impact*) 1-4 (*moderate impact*)	>80 (*extreme impact*) 20-80 (*high impact*) <20 (*moderate impact*)

Adapted from WGFD 2004

4.9.2.1.1. Raptors

Effects to sensitive raptor species (peregrine falcon, ferruginous hawk, and burrowing owl) that may be present within the MAA would be identical to those analyzed for non-sensitive raptors and their nests (section 4.8.2). Impacts to prairie dog habitat (Table 4-9) would directly impact burrowing owl nesting habitat and would indirectly affect other raptors by decreasing foraging habitat. With the exception of burrowing owls seasonal restriction dates cover the timeframes used by sensitive raptors and would be identical to those impacts described for general raptor species. Burrowing owls nest later and could potentially be impacted by disturbances as late as September 15th. In addition, due to the fossorial nature of this species and the fact that new nesting burrows may be chosen from year to year nest locations may be missed during field reviews of project locations.

Because of the recent removal of the bald eagle from the list of endangered and threatened species it will be analyzed as a BLM sensitive species. One bald eagle nest site has been identified in the northern MAA on Fontenelle Reservoir. Nest surveys would likely be required for all raptor species prior to individual project APD processes. Because habitat and nest protections are in place, no direct effects to bald eagles are expected from any of the alternatives. Bald eagles would likely avoid the MAA during the drilling phase and would use other suitable habitat in the region. Therefore, the project may affect individual bald eagles but is not likely to affect viability of the species in the MAA. Impacts in riparian habitats could impact the species and potential nesting and roosting sites. However, direct impacts in riparian areas are expected to be minimal. Indirect impacts to riparian habitats might cause eagles to not use roost sites during development. Increased traffic and potential collisions with wildlife could increase the potential for eagle mortality for birds scavenging along roadways that might be killed or injured by passing vehicles.

4.9.2.1.2. Greater sage-grouse

In 2005, 41 leks were determined to occur within the MAA and were identified as "occupied" (actively used within the last 10 years). As is true for all sagebrush obligate species, loss of mature sagebrush cover, which takes up to 30 years to mature, directly affects year-round habitat for the greater sage-grouse. Installation of more tanks resulting from all alternatives will increase potential perch opportunities for raptors, thereby increasing predation of sage-grouse. Table 4-12 presents potential impacts to greater sage-grouse habitat for all alternatives. These impacts would be expected to occur for up to 30 years beyond the LOP because of the time it takes for sagebrush to mature and return to its pre-disturbance size. Increased traffic during sage-grouse breeding periods could decrease breeding and nesting success (Lyon and Anderson 2003).

Table 4-12. Impacts to Potential Sage-Grouse Wyoming Big Sagebrush Habitat Over the LOP.

Greater Sage-grouse Area within 2 miles of Leks in the MAA		**173,332Acres**
Greater Sage-grouse Available Habitat (Desert Shrub/Sagebrush Vegetation Type) in the MAA		**316,800 Acres**
Disturbance Type	**Core/ Flank**	**Disturbance (in acres)**
Proposed Action		
Lek Buffer	Core	3,884
	Flank	2,433
Available Habitat	Core	7,398
	Flank	4,400
Alternative A – No Action/Low Development		
Lek Buffer	Core	2,872
	Flank	1,757
Available Habitat	Core	4,168
	Flank	3,054
Alternative C – High Field Development		
Lek Buffer	Core	11,638
	Flank	4,505
Available Habitat	Core	20,629
	Flank	8,536

It is likely that significant impacts to leks and breeding and nesting habitat have already occurred in portions of the MAA. Holloran (2005)indicated that 4.7 well pads or more within 2-miles of leks result in decreased use of leks and decreased overall nesting success. Many areas of the MAA already have densities greater than this level. Of the 41 leks in the MAA, all but 8 have more than 5 wells within 2-miles. One of the eight leks is located in the MMTA where oil and gas development is prohibited and the other 7 leks are located in the western and southern portions of the flank.

4.9.2.1.3. Sagebrush Obligate Birds

In addition to the direct loss of mature sagebrush habitat, indirect effects from edge effects and fragmentation can reduce populations of sagebrush obligates. A study conducted in the Pinedale Anticline oil and gas project area determined that breeding bird numbers, primarily sagebrush obligates, decreased by 50% within 100 m of a road due to increased traffic and predators (Ingelfinger 2001). The sagebrush obligates prefer dense sagebrush with heights above surrounding habitats and, therefore, may avoid edge habitats (Ingelfinger 2001). Additionally, fragmentation of nesting habitat could reduce the areas suitable for nesting and maintaining current population levels in the MAA.

Impacts to sagebrush obligates would increase as sagebrush disturbance increases, as analyzed by alternative in Table 4-12. Impacts for Alternative B are not included in Table 4-12 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. As with sage-grouse these impacts would be expected to occur for up to 30 years beyond the LOP because of the time it takes for sagebrush to mature and return to its pre-disturbance size.

4.9.2.1.4. Other Sensitive Birds

Impacts to sensitive birds that use the limited water habitat in the MAA, such as the long-billed curlew, white-faced ibis, and trumpeter swan would be proportional to impacts to wetland and riparian habitats. These species should not be affected if BLM protection measures to protect wetland and riparian habitat are followed. The loggerhead shrike and mountain plover would be impacted by the direct loss of habitat. Effects to suitable mountain plover habitat would be similar to those described for prairie dog habitat (Table 4-10).

The sensitive birds are migratory species; therefore, the degree of direct and indirect impacts varies by season. During reclamation, grass and forb regrowth may establish in one growing season, providing suitable mountain plover habitat. Loggerhead shrikes prefer brushy habitat that would likely take longer to establish, but because the species is widespread, they should be able to recolonize fairly readily.

4.9.2.1.5. BLM Sensitive Mammals

Impacts to pygmy rabbits would be similar to the impacts analyzed for sagebrush habitat, discussed by alternative below. However, pygmy rabbits typically only use old growth/mature sagebrush. Because sagebrush can require up to 30 years to attain a mature height able to support pygmy rabbits, its removal is considered a long-term impact. In addition to sagebrush habitat, impacts to vegetated sand dunes with tall sagebrush and ephemeral channels would also impact pygmy rabbits. Because disturbance of dunes may rarely be fully reclaimed to the original vegetative composition and structure it is felt that the removal will be a long-term impact.

Prairie dogs and most other burrowing mammals would be expected to leave areas once construction begins. However, mortality may occur to these and other burrowing animals (e.g., Idaho pocket gopher, sagebrush vole, Preble's shrew) if grading activities take place in the spring when young are present. Impacts to prairie dog complexes are shown in Table 4-10 and are discussed by alternative below. The long-eared myotis may be most affected by loss of foraging habitat and disturbance near riparian areas, primarily where road crossings would impact riparian habitat. Long-eared myotis mortality could also occur from accidental poisoning at open produced-water pits and tanks.

4.9.2.1.6. BLM Sensitive Amphibians

Impacts to riparian habitat would potentially affect the northern leopard frog and Great Basin spadefoot. Impacts to open water and wetland habitats would potentially impact the boreal chorus frog. With BLM stipulations and mitigation in place to protect riparian and wetland habitat, impacts to amphibians are not anticipated from any of the alternatives. Amphibians may attempt to use open produced-water pits for breeding, which could lead to accidental poisoning. Installation of silt fences around pits may reduce this potential impact.

4.9.2.1.7. BLM Sensitive Fish

Potential impacts to BLM sensitive fishes include water depletions, increased sedimentation, and alterations of stream flows. With BLM stipulations and mitigation in place to protect riparian and wetland habitats, impacts to BLM sensitive fish species are not anticipated from any of the alternatives.

4.9.2.1.8. BLM Sensitive Plants

Trelease's racemose milkvetch and large-fruited bladderpod have not been documented in the MAA, but suitable habitat is present and may be impacted by the project. Other sensitive plant species are unlikely to occur due to lack of suitable habitat, and no impacts to these species are expected. If populations were discovered, adherence to BLM stipulations would prevent impacts to these species.

4.9.2.2. Significance Criteria

BLM sensitive raptors:

- Activities contributed to unlawful 'take' of any migratory bird, including raptors, as defined by the MBTA.
- Actions resulted in an irreplaceable loss, or abandonment of vital and high value habitats as defined by WGFD (WGFD 2004).
- Surface disturbance from drilling and completion activities of more than 5% of area within 1 mile buffer around bald eagle and ferruginous hawk nests as a measure of potential forage loss around nesting areas.

Greater sage-grouse

- Well densities in the MAA greater than or equal to one well pad per 40-acres that could result in decreased use of leks or decreased nesting success and recruitment (Holloran 2005).
- Decreased lek attendance resulting from disturbance within a 2-mile buffer around each lek. Significant impacts would be expected if more than 5 wells are within the 2-mile buffer surrounding any of the 41 leks (Holloran 2005).

Sensitive fish species

- Decrease in baseflows of MAA rivers and streams that would result in loss of habitat.

Other sensitive species

- Disturbance of more than 5% of available habitat

4.9.2.3. Direct and Indirect Impacts

4.9.2.3.1. Proposed Action

Impacts to prairie dog habitat, which would also impact burrowing owl and mountain plover habitat, would cover an estimated 2,233 acres (4% of available habitat) in the short term, and 720 acres (1.3%) after interim reclamation (Table 4-10).

Impacts to sage-grouse habitat would occur over the LOP and would not be substantially reduced after interim reclamation; however, after final abandonment, habitat will begin to recover. Approximately 11,800 acres of disturbance would occur in sage-grouse habitat in the MAA with more than 6,300 acres of disturbance occurring within the 2-mile buffers around leks (Table 4-12). Increasing well density to 8-12 wells per section in the core area proposed under the Operator's Proposed Action would constitute a "high" impact if allowed in sage-grouse breeding habitat (Table 4-11) and could cause significant impacts to occur in some areas. However, the overall impacts across the MAA would not exceed the 40-acre spacing significance threshold. The impacts within the 2-mile sage-grouse lek buffers would be significant. All of the leks in the MAA would be expected to have more than 5 well pads within the 2-mile buffer under the Proposed Action.

Impacts to riparian habitat, which would impact long-billed curlew, white-faced ibis, trumpeter swan, long-eared myotis, northern leopard frog, and Great Basin spadefoot habitat would cover an estimated 365 acres (4.2% of available habitat) in the short term, and 117 acres (1.3%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

Impacts to sagebrush habitat, which would impact sage-grouse as well as sage thrasher, Brewer's sparrow, sage sparrow, and pygmy rabbit habitat would cover an estimated 11,798 acres (less than 1% of available habitat). Additionally, construction of new well pads and their associated roads and ancillary facilities would cause further habitat fragmentation and would likely reduce the number of habitat patches suitable for nesting.

4.9.2.3.2. Alternative A

Impacts to prairie dog habitat, which would also impact burrowing owl and mountain plover habitat, would cover an estimated 1,898 acres (3.4% of available habitat) in the short term, and 524 acres (less than 1%) after interim reclamation.

Approximately 7,200 acres of disturbance would occur in sage-grouse habitat in the MAA with more than 4,600 acres of disturbance occurring within the 2-mile buffers around leks (Table 4-12). Well density increase to an average of four to eight wells per section would constitute a "moderate" impact if allowed in sage-grouse breeding habitat (Table 4-11) and would not exceed the significance threshold of 40-acre spacing for well pads. Continued implementation of the No Action would likely cause additional impacts to leks and brood rearing habitats within the 2-mile buffers around lek locations. Continued implementation of the No Action would be expected to decrease the number of leks in the flank that have fewer than 5 well pads within 2 miles from 8 that exist currently to 4 or 5. The decreased number of leks with fewer than 5 wells within the 2-mile buffer would be a significant impact.

Impacts to riparian habitat, which would impact long-billed curlew, white-faced ibis, trumpeter swan, long-eared myotis, northern leopard frog, and Great Basin spadefoot habitat would cover an estimated 125 acres (1.5% of available habitat) in the short term, and 35 acres (less than 1%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer.

Impacts to sagebrush habitat, which would impact sage-grouse as well as sage thrasher, Brewer's sparrow, sage sparrow, and pygmy rabbit habitat, would cover an estimated 6,164 acres (less than 1% of available desert shrub/sagebrush habitat).

4.9.2.3.3. Alternative B

The total number of proposed wells would be identical to Alternative C. However techniques to decrease surface disturbance and increase reclamation would reduce the overall impacts to sensitive species. Consolidated facilities and drilling multiple wells from common well pads would reduce the overall foot print associated with the development of oil and gas resources as described for the surface geology and topography section as well as the vegetation section. Mowing and mat drilling could improve reclamation of sagebrush and other vegetative habitats. Because it is unknown how the operators will develop to remain under the 10,921 acre threshold for Alternative B, significant impacts could occur to BLM sensitive species; especially sage-grouse and sagebrush obligates. It is likely that under Alternative B significant impacts would occur to leks as more than 5 wells would be expected within 2 miles of all 41 leks in the MAA.

4.9.2.3.4. Alternative C

Impacts to prairie dog habitat, which would also impact burrowing owl and mountain plover habitat, would cover an estimated 5,970 acres (10.8% of available habitat) in the short term, and 2,015 acres (3.6%) after interim reclamation. This would be a significant impact to prairie dogs.

Impacts to sage-grouse habitat would occur over the LOP and would not be substantially reduced after interim reclamation because of the time it takes for sagebrush regrowth. Approximately 29,000 acres of disturbance would occur in sage-grouse habitat in the MAA with more than 16,000 acres of disturbance occurring within the 2-mile buffers around leks (Table 4-12). The addition of 16 wells per

section in the core area proposed under the Operator's Proposed Action would constitute a "high" impact if allowed in sage-grouse breeding habitat (Table 4-11). This level of impact would be significant for sage-grouse per the 40-acre spacing significance threshold. All of the 41 leks would have more than 5 wells within the 2-mile buffer area. Alternative C would have significant impacts for sage-grouse.

Impacts to riparian habitat, which would impact long-billed curlew, white-faced ibis, trumpeter swan, long-eared myotis, northern leopard frog, and Great Basin spadefoot habitat, would cover an estimated 721 acres (8.3%) in the short term, and 242 acres (2.8%) after interim reclamation. However, these impacts do not take into account BLM stipulations, including the 500-foot stream/riparian buffer which would reduce the total acreage that would be disturbed.

Impacts to sagebrush habitat, which would impact sage thrasher, Brewer's sparrow, sage sparrow, and pygmy rabbit habitat, would cover an estimated 29,165 acres (1.7% of available habitat). Habitat fragmentation would be greatest for Alternative C creating fewer patches suitable for sage obligate nesting and life-history requirements. This could cause significant impacts to sage obligates.

4.9.2.4. Mitigation

Mitigation measures and BLM stipulations would be the same for all alternatives. Seasonal stipulations for specific BLM sensitive species are listed in Table 4-13.

Table 4-13. Recommended Seasonal Stipulations for BLM Sensitive Species.

Species	Restriction Dates	Surface Disturbance Restriction
Ferruginous hawk	February 1 – July 31 All Seasons	1 mile around active nests No surface occupancy within 1000 feet of active nest
Peregrine falcon	February 1 – August 15	0.75 mile around active nests
Burrowing Owl	April 1 – September 15	½ mile of known active nest or within colony where active nest was identified within previous 3 years.
Greater sage-grouse	March 1 – May 15 (lek) March 15 – July 15 (nesting) November 15 – April 30 (winter)	Within 0.25 mile of leks Within 2 miles of leks or within habitats identified by biologist during onsite evaluations. In known habitat
Mountain plover	April 10 – July 10	Within potential habitat

<u>BLM Sensitive Raptor Species</u>

Seasonal restrictions would apply within a 1-mile radius of active ferruginous hawk nests and a 0.75-mile radius of active peregrine falcon nests. A nest site would be considered active if it has been used within the past three years. For all other raptors, including burrowing owl, the restriction would apply within 0.5-mile of active nests. Permanent structures would not be allowed within 825 feet of active raptor nests. Permanent structures would not be allowed within 1,000 feet of active ferruginous hawk nests.

<u>Prairie dogs</u>

Any prairie dog colony where burrowing owls have been observed in past 5 years would have seasonal restriction between April 1 and September 15. Biological contractors who conduct Black-footed ferret surveys will be required to report all observations of this species to BLM officials.

Sage-grouse

Despite the BLM-mandated buffer of two miles around active leks, studies indicate that only 45% of sage-grouse nests are likely to occur in this area; therefore, approximately 55% of sage-grouse nests could be affected by project activities outside these buffers and nesting and brood rearing habitats should be protected outside the buffers on a case-by-case basis.

Seasonal buffers and reclamation measures that replace breeding, nesting, or brood rearing habitat could reduce impacts to this species.

All wells within sage-grouse habitat should be remotely monitored and controlled to reduce impacts resulting from traffic.

If more than 5 visible well pads occur within 2-miles of any of the 41 leks, new wells within 2-miles of the lek should be drilled directionally from outside the 2-mile buffer, hidden from sight of the lek, or drilled outside the lekking and brood rearing period providing that facilities are constructed to be hidden beneath the existing vegetative height.

BLM-mandated stipulations for temporal and spatial restrictions of activity in sage-grouse habitat have been developed to reduce adverse effects (Table 4-13). No surface disturbance would occur within 0.25 mile of a lek; other human activities within 0.25 mile of an occupied lek would be avoided between 8:00 pm and 8:00 am from March 1 through May 15; activities that would potentially disturb sage-grouse would be avoided between March 15 and July 15 in suitable nesting and early brood-rearing habitat within two miles of a lek or in suitable nesting and early brood-rearing habitats that have been identified beyond two miles of a lek. On a case-by-case basis in the checkerboard area of the MAA, BLM should consider development of well facilities or pipeline facilities within 0.25 miles of a lek provided that the height of permanent structures not exceed the surrounding vegetation. If directional drilling can be used to develop the federal minerals within 0.25 miles of a lek it should be used. If not, allowing operators to develop within 0.25 miles of a lek could provide BLM greater flexibility in protecting leks on federal surface as operators would not be as likely to move well locations to immediately adjacent sections of private surface where the timing and spatial stipulations do not apply. Field evaluations may be necessary to determine presence of leks and/or nests if existing information is not current or available.

BLM Sensitive Fish Species

BLM stipulations that prohibit construction within 500 feet of streams would protect fish habitat. BMPs to control sedimentation would also protect BLM sensitive fish species. Pipelines will be bored under perennial streams to protect riparian and aquatic habitat. Impacts to BLM sensitive fish would be the same as those presented in section 4.8. Operators should use existing, valid water rights for drilling fluids to minimize reductions to baseflows.

Additional BMPs that would reduce impacts to sensitive species include:

- Installing raptor perch avoidance structures, burying distribution power lines and/or gathering pipelines, and locating wellheads below ground surface would discourage raptor perching in the MAA. These BMPs are intended to reduce potential predation of BLM sensitive species by raptors and reduce potential for electrocution of raptors.
- Implementing noise reduction techniques and designs would reduce stress on wildlife from high noise levels. This may include remote monitoring which would reduce field visits during operations.
- Drilling multiple wells from a single pad, collocating power lines and gathering pipelines in roads, centralizing production facilities, and minimizing topsoil removal would result in less surface disturbance and would reduce impacts to wildlife habitat as previously described.

Using remote monitoring and control technologies to reduce the overall human disruptive disturbance associated with the production phase of the development. This would reduce truck traffic in the MAA by up to 50% and the associated risk of truck/wildlife collisions and decreased sage-grouse breeding and brood rearing habitat.

4.9.2.5. Residual Impacts

Residual impacts to sensitive raptors would be the same as those for general raptors.

Residual impacts to sagebrush obligate sensitive species would be directly proportional to the length of time necessary to reestablish necessary sagebrush habitats. Sagebrush obligate species may be impacted for 30 years or more after final abandonment until density of sagebrush has reestablished.

4.9.3. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Impacts to ESA-listed threatened, endangered, or candidate species, and BLM sensitive species would increase as the density of wells increases. Impacts include direct loss of habitat, as well as indirect impacts from increased fragmentation, noise, and human disruptive activities. Mitigation measures would protect these species and their habitat during breeding season. Residual impacts include continued habitat loss while vegetation matures to pre-construction conditions.

4.10. Cultural and Historical Resources

4.10.1. Introduction

Impacts to cultural and historical resources result directly from increased ground disturbance. Overall indirect impacts, as well as direct impacts, to cultural and historical resources would occur in direct proportion to the volume of new surface disturbance. Because of the existing level of disturbance in the MAA core, avoidance of impacts to cultural/historical resource sites is anticipated to be more difficult in the core than in the flank as a result of ground-disturbing development (Table 4-14). More acres of disturbance would make avoidance of sites more difficult, would increase the need for direct mitigation on sites, and would result in more discoveries and archaeological excavation. Indirectly, development would increase human presence and access in the MAA, which would increase the potential for illegal artifact collection and/or vandalism, as well as impacts to sites, locales, and places considered sacred, sensitive, or of importance to modern-day Native Americans. Vandalism and illegal collection impacts would occur in relative proportion to the amount of human use and the level of development in the MAA.

Table 4-14. Anticipated Impacts to Cultural Resources by Alternative.

Disturbance Type	Core/ Flank	Anticipated Impacts
ALTERNATIVE A		
Drilling and Completion	Core	Direct disturbance to cultural and historical resource sites, vandalism, and illegal collection continue at current rate, coincident with continued development of the MAA at previously approved levels. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance.
	Flank	Flank impacts are anticipated to be the same as for the core, with the added note that the flank has overall lower levels of disturbance and impacts to cultural/historical resources and is not planned for the density of the development intended for the core.
After Interim Reclamation	Core	Reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces level of impact to visual setting at cultural/historical resource sites.
	Flank	Flank impacts are anticipated to be the same as for the core.
PROPOSED ACTION		
Drilling and Completion	Core	Increased direct disturbance to cultural and historical resource sites, vandalism, and illegal collection are expected. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance. Implementation of BMPs will aid in reducing extent of impacts.
	Flank	Flank impacts are anticipated to be the same as for the core, except greater opportunity to avoid impacts through construction design or redesign due to fewer disturbances.
After Interim Reclamation	Core	Same as No Action Alternative; reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces the level of impact to the visual setting of cultural and historical resource sites. Implementation of BMPs will aid in reducing extent of impacts.
	Flank	Flank impacts are anticipated to be the same as for the core.
ALTERNATIVE B		
Drilling and Completion	Core	Increased direct disturbance to cultural and historical resource sites, vandalism, and illegal collection are expected. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance; however, implementation surface disturbance reduction techniques will further aid in reducing extent of impacts, particularly in regard to visibility of development in impact to cultural and historical resource setting and in regard to potential for direct impacts to cultural and historical resources from ground disturbance.
	Flank	Flank impacts are anticipated to be the same as for the core.
After Interim Reclamation	Core	Reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces level of impact to the visual setting of cultural and historical resource sites. Increased emphasis on reclamation success will further aid in reducing extent of impacts, particularly in regard to visibility of development in impact to cultural and historical resource setting and in regard to potential for direct impacts to cultural and historical resources from ground disturbance.
	Flank	Flank impacts are anticipated to be the same as for the core.
ALTERNATIVE C		
Drilling and Completion	Core	More intense direct disturbance to cultural and historical resource sites, more vandalism, and more illegal collection than for any other Alternative are expected. Ability to avoid impacts to cultural sites will reduce with increases in the expanse of area disturbance. Some mitigation from implementation of standard BMPs, as in the Proposed Action, will aid in reducing extent of impacts.
	Flank	Flank impacts are anticipated to be the same as for the core, except that effects to visual setting at cultural/historical site may be contrastingly heightened due to minimal previous flank development.
After Interim Reclamation	Core	Reclamation reduces human presence in the area and chance of opportunistic collection and vandalism. Reclamation reduces level of impact to the visual setting of cultural and historical resource sites. However greater level of ground disturbance and development under Alternative C will result in less correction of impacts as a result of reclamation than other Alternatives.
	Flank	Flanks impacts are anticipated to be the same as for the core.

Adverse impacts to properties considered important to Native American groups, would be significant under all alternatives if not satisfactorily mitigated, as determined through consultation with the SHPO, the Advisory Council on Historic Preservation (ACHP), and other interested parties. Any increase in ground-disturbing activities has an increased potential of impacting significant sites, locales, and places considered sacred, sensitive, or of importance to modern-day Native Americans, including sites with human funerary remains (grave sites). Probability of significant impacts to Native American sensitive sites and TCPs would increase proportionally with the level of ground disturbance estimated for each alternative.

The Kemmerer RMP (BLM 1985) identifies management goals/objectives associated with all cultural and historical resources. These goals and objectives direct cultural and historical resource management pursuant to the NHPA, ARPA, and other statutes. Because of the requirement for compliance with federal statutes, especially with Section 106 of the NHPA and with the ARPA on federal lands, all areas on federal lands (surface or mineral estate) proposed for surface disturbance would be inventoried for cultural and historical resources. These inventories would preserve cultural heritage by protecting most cultural properties from significant damage, increasing cultural/historical resource site databases, and furthering the understanding of history and prehistory.

4.10.2. Significance Criteria

Impacts to cultural and historical resources would be considered significant if they resulted in non-mitigated impacts to National Register-eligible properties (including benchmark sites), diminishment of the aspects of site integrity, loss of scientifically important data or artifacts, a violation of the NHPA and/or ARPA, disturbance of sites that are culturally sensitive to Native American tribes, or if they violated the Kemmerer RMP (BLM 1985) goals/objectives.

In the absence of a Programmatic Agreement and Cultural Resource Management Plan, potential significant impacts to cultural and historical resources could occur under any alternative. These potential impacts arise primarily from the reactive nature of the current management situation for cultural and historical resources.

Impacts would be significant if development decreased the cultural integrity of intact trail segments or if direct disturbance of the physical trace of trail segments occurred.

4.10.3. Direct and Indirect Impacts

For all alternatives, impacts would be proportional to the amount of surface disturbance that would occur. Alternatives that have higher disturbance potential would increase the likelihood of disturbing or destroying cultural resources in the MAA. However, increased surface disturbance would also lead to increased survey and data recovery potential and could increase the knowledge of cultural and historic resources in the MAA and southwest Wyoming.

4.10.3.1. Proposed Action

BMPs that would be implemented in accordance with agency policy would aid in reducing vandalism and collection through reclamation of access routes to areas previously developed, reduction of impacts to integral historic setting of cultural and historical resources, restoration of the natural contour of ground disturbances and the painting of facilities colors that blend with the natural background, and reduction of direct impacts to cultural/historical resource sites by using development designs that minimize the extent or ‘footprint’ of ground disturbance, such as in limiting access road build-up and size and placement of facilities.

4.10.3.2. Alternative A

Prior NEPA documents concluded that there would be no significant adverse impacts to cultural and historical resources as a result of the project. Significant impacts have occurred, such as in discovery situations, and new significant impacts could still occur. Under Alternative A/No Action, fewer new cultural/historical resource inventories would be conducted as development is concluded, and fewer sites would be recorded and added to the cultural/historical resource database. Vandalism and illegal artifact collecting may decrease with reduced human presence in the area at conclusion of development, but would still continue (although at lower levels) for the LOP along eased paths of access created by development and with the continuance of human-serviced operations for production and maintenance. With the conclusion of development and in the absence of new ground disturbance, no additional unanticipated discoveries are likely to occur. Approved development (BLM 1995a) is expected to conclude in six years, after which cultural/historical resource impacts would continue for the LOP under Alternative A. No new impacts to Native American religious or culturally significant sites are anticipated beyond current levels.

4.10.3.3. Alternative B

Under Alternative B, impacts to cultural and historical resources would be greater than those of Alternative A/No Action and less than those of Alternative C. If operators implement techniques such as directional or mat drilling the impacts would likely be less than for the Proposed Action. Vandalism and illegal artifact collection would likely continue to be greatest during drilling and completion, and the duration of these impacts would continue for the LOP. Collocation of roads, power lines, and some pipelines, use of common utility ROW corridors, drilling of multiple wells from single well pads, and centralizing production facilities would reduce the amount of ground disturbance and, therefore, reduce the potential for encroachment on cultural/historical resource sites by development, while simultaneously avoiding cultural/historical resource site locations through project design or redesign. Increased use of buried lines during utility construction and minimization of the footprint of development will further reduce potential for visual disturbance impacts to cultural/historical resource settings.

4.10.3.4. Alternative C

Implementation of Alternative C would result in an increase in potential impacts to cultural and historical resources compared to the other alternatives. Cultural property avoidance may be more difficult under Alternative C compared to other development alternatives, because greater development in both the MAA core and flank area would leave less room to maneuver construction design around known cultural/historical resource sites and would increase cultural/historical resource discoveries and impacts during ground-disturbing activities. Increased development and surface disturbance would also increase the impacts to the visual setting of cultural and historical resources, particularly in the MAA flank, where fewer preexisting disturbances occur. Vandalism and artifact collection would likely be greatest during initial development, but duration of these impacts would continue for the LOP. BMPs would be the same as under the Proposed Action. The pervasiveness of development under Alternative C would necessarily cause a greater operational need for collocating access and utility routes and some other well facilities than under the Proposed Action. However, the extensive development required under Alternative C would likely negate any reduction of repetitive impacts it would achieve in comparison to the Proposed Action. Additionally, under Alternative C, human presence in the MAA would increase and ease of access to more portions of the MAA would be more pervasive, which would increase the opportunity for illegal artifact collection, cultural/historical resource site looting, and vandalism. Vandalism and illegal artifact collection would likely be greatest during development, which would be longer under the increased regime of Alternative C and would continue until project personnel are no longer required for the LOP.

4.10.4. Mitigation

The cultural/historical resource-specific mitigation measures described within this section will be the same under all development alternatives; however, BMPs required under each alternative will have varying effects on direct and indirect impacts, as described above.

Trail segments that have been identified by BLM as having high levels of integrity and convey a sense of their historic period of use (especially segments of the Blacks Fork Cutoff on federal lands in the flank of the MAA) would be managed as VRM Class II.

For trails not managed as VRM Class II, a ¼-mile buffer within which development would not occur would be applied to all traces of national historic trails. This buffer could be reduced if visual impacts can be eliminated.

Additional mitigation measures applied to cultural resources are presented in Appendix A.

4.10.5. Residual Impacts

No significant impacts will remain at cultural and historical resources after mitigation is completed. Residual impacts may only persist at cultural/historical resource sites where unavoidable adverse impacts occur without mitigation.

Unavoidable adverse impacts may occur under all alternatives. Because of the requirement for compliance with Section 106 of the NHPA and with the ARPA on federal lands, adverse impacts are generally avoided or mitigated, with the exception of situations where undocumented NRHP-eligible sites are impacted but not recognized, thereby occurring without mitigation. Unmitigated adverse effects to eligible sites could also occur on State of Wyoming lands and private fee lands, because fewer protections are afforded to cultural and historical resources on lands falling outside BLM jurisdiction. Unexpected discoveries on state and private lands have occurred, and procedures for mitigative treatment of these finds are not in place. Therefore, unavoidable adverse impacts to discovery sites would continue until or unless formal procedures for protecting cultural and historical resources on State of Wyoming or private lands are implemented.

4.10.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

The greatest identifiable threats to cultural and historical resources result directly from increased ground disturbance. Under all alternatives, the overall direct and indirect impacts to cultural and historical resources would mostly occur in direct proportion to the volume of new surface disturbance. More acres of disturbance would make direct cultural property avoidance more difficult and, therefore, would increase the need for mitigation measures for cultural/historical resource sites, both known and newly discovered. Because of the existing level of disturbance in the MAA core, avoidance of impacts to cultural/historical resource sites is anticipated to be more difficult in the core areas than in the flank areas as a result of ground-disturbing development, under all alternatives. The difference in BMPs required among the alternatives affords differing levels of cultural/historical resource protection, with the more extensive BMPs providing better opportunities to avoid effects to resources; cultural/historical resource-specific mitigation measures remain the same under all alternatives. Alternatives with the highest level of proposed ground disturbance have the greatest potential to impact cultural/historical resources.

4.11. Social and Economic Impacts Including Environmental Justice

4.11.1. Introduction

This section is an evaluation of potential social and economic impacts of the proposed project. Evaluation of the impacts associated with the proposed project and alternatives must consider the existing social and economic environment of the local area, including the substantial growth that has occurred there during the past four years. Potential temporary and permanent impacts must also take into account changes in the overall economic picture of the area, including continued oil and gas exploration, expansion, and development, and construction of other proposed industrial and commercial projects.

The economic study area for this analysis includes the counties and communities most likely to be affected, as described in Chapter 3. The impacts of the Proposed Action and alternatives on the economic study area were analyzed using IMPLAN (Minnesota IMPLAN Group 2000), which is an econometric impact assessment input/output (I/O) modeling system. I/O modeling is a mathematical accounting of the flow of dollars and commodities through a region's economy. The IMPLAN database consists of two major parts: 1) a national-level technology matrix; and 2) estimates of sectorial activity for final demand, final payments, industry output, and employment for each county in the U.S., along with state and national totals.

Standard socioeconomic analysis methodology was used to estimate increases in demands on local and regional infrastructure, and state and federal revenue generation (ad valorem, severance, and mineral royalties), based on state and federal historical estimates and rate structures. Impacts from the Project are discussed for both the development (drilling and completion) and production phases (based on current production values Economic impacts are presented in terms of nominal impacts. As presented herein, the nominal value of project activities is the simple calculation of dollars with no adjustments for inflation. No discount rates have been incorporated into revenue projections.

The Moxa Arch Area (MAA) is considered a typical Rocky Mountain oil and gas field with production levels typical of other oil fields in the region. The Moxa Arch formation does not represent a unique field; however, at current production levels the field is economically viable and meets investment criteria. Table 4-15 shows the average annual natural gas production and total production for the Moxa Arch Area compared to the estimated 2030 United States national demand. According to the estimates the total production in the Moxa Arch Area would represent between 2.5 % and 9.9% of total US natural gas consumption for one year (2030). Average annual production would supply less than 1% of the demand in the United States for any year.

Natural gas consumption in the United Sates has grown considerably since 1990 when the US consumed approximately 19.0 trillion cubic feet. Demand for natural gas continues to grow and is projected to increase from 22.0 trillion cubic feet in 2005 to 26.1 trillion cubic feet in 2030 depending on market conditions. Most of this growth is projected to occur before 2020. Price will be a large factor in how growth in natural gas demand occurs, as well as the price of competitive energy sources such as oil (http://www.eia.doe.gov/oiaf/aeo/pdf/trend_4.pdf).

Table 4-15. MAA Natural Gas Production Compared to National Annual Demand. 2007 national natural gas demand estimated as 22 TCF, 2030 national natural gas demand estimated as 26.1 TCF

	Average Annual Production (trillion cubic feet)	% of 2030 National Demand	Peak Annual Production (trillion cubic feet)	% of 2030 National Demand	Total Production (trillion cubic feet)	% of 2030 National Demand
Proposed Action	.036	0.14%	.121	0.46%	1.8	6.9%
No Action	.017	0.07%	.075	0.29%	0.66	2.5%
Alternatives B and C	.040	0.15%	.129	0.49%	2.59	9.9%

Source: Energy Information Administration: Annual Energy Outlook 2007 with Projections to 2030, February 2007: Report #:DOE/EIA-0383(2007)

Natural gas economic activity in the MAA will depend on three primary factors: 1) total number of wells authorized, 2) total number of pads on which wells can be placed, and 3) rate of development. Total monthly per-well operation costs are estimated to range between $2,500 and $5,000, depending on operator and other factors (EOG Resources 2006). An average of $3,500 per-well monthly operating cost will be used for the purpose of this analysis and includes direct labor and overhead, as well as non-labor costs for fuel, chemicals, disposal, surface maintenance, subsurface maintenance, gas, and electricity (EOG Resources 2006). Direct labor and overhead represents approximately 10% of all operating costs, as shown in Table 4-16. Therefore, total annual cost of operation for an average well is $42,000. Total production and operating costs for directionally drilled wells are assumed to be the same as those for vertically drilled wells (personal communication, Matthew Warren, Kemmerer Field Office Petroleum Engineer).

Table 4-16. Average Annual Well Operating Costs (2006 $$).

Annual Per Well Operating Costs	Annual Cost per Well
Annual Production (average)	24,245 MCF to 27,551 MCF over LOP
Direct Labor and Overhead	$4,200
Non-labor	$37,800
Total Annual per Well Costs	$42,000

Source: EOG Resources, Inc. June 2, 2006

4.11.2. Significance Criteria

According to criteria set forth by the Kemmerer RMP (BLM 1985) Green River RMP (BLM 1997b) and land use plans for the State of Wyoming (Wyoming State Land Use Commission 1979), impacts to socioeconomic resources would be considered potentially significant if any of the following were to occur:

- Increased demand for housing that exceeds supply and results from project activities;
- Short- or long-term increases in demand for local government facilities or services that exceed existing capacity and are not offset by adequate revenues from continued exploration and development; or,
- A 10% or greater change in county government or in countywide employment.

4.11.3. Direct and Indirect Impacts

The major socioeconomic issues relevant to all alternatives are:

- The majority of the workforce associated with the Project is likely to come from outside the study area (60%). Transfer of workforce from other job sites to the Project would be minimal.
- Temporary rental and permanent housing availability is limited for all surrounding towns (Rock Springs, Kemmerer, Evanston, and outlying areas). Existing motel units and RV/mobile home spaces are insufficient to accommodate the in-migrating workforce. Housing development is rapidly occurring in the Rock Springs area, and supply should be close to meeting demand by 2009 (Robbins 2006; Crandall 2006; Kaumo 2006).
- School capacity in the region is sufficient to meet current needs. Increases in population of school-age children would impact local schools.
- Although sewer capacity is currently being doubled in Rock Springs, county water and sewer districts are currently incapable of handling large-scale development, and no mechanism is available to improve this situation for the foreseeable future. Roads throughout the counties and municipalities have already been impacted by increased truck traffic from oil and gas operations, and these impacts would be exacerbated by traffic related to the proposed project.
- Additional law enforcement personnel may be required throughout the area, depending on where workers locate. Rock Springs has recently added nine police officers to its force. Although oil and gas Operators require drug tests of their workforce, crime has increased in the area, particularly methamphetamine use.
- Increased employment during the 7- to 25-year drilling period would occur. An estimated 9.9 direct jobs and 2.4 indirect jobs would be created per well (Minnesota IMPLAN Group 2000).
- Increased employment during the 40-year production period would occur. An estimated 15.1 direct jobs and 36.4 indirect jobs would be created for every $100 million in oil and gas production output (Minnesota IMPLAN Group 2000).
- Increased incremental annual income from employment payroll would be generated in the local study area, and associated induced economic effects of local spending by operations workers would occur. Adjusted earnings per job for direct, indirect, and induced employment is estimated at approximately $58,300 (2006$) (Minnesota IMPLAN Group 2000).
- Increased cost of living, especially increases resulting from housing and rental costs, has flattened the effect of the increased annual income in the study area.
- Additional expenditures by the Operators include collection of additional sales and use tax for the state, counties, and communities. Estimated severance taxes, ad valorem production and property taxes, federal mineral royalties, and PILT taxes would accrue to the federal, state, and local governments.

4.11.3.1. Labor

The estimated direct hire labor force is presented in Table 4-17 for all alternatives. Jobs indirectly created or induced as a result of development and operations are presented in terms of annual job equivalents (AJEs). An AJE represents 12 months of employment. For example, one AJE could represent one job for 12 months, or two jobs for 6 months, or three jobs for 4 months. For the purpose of this analysis, a job is defined as 260 worker-days or 1 worker year, and a person-year is 365 days. Therefore, there are approximately 1.4 worker years per person year. An AJE would not necessarily result in a new job; it may simply represent the continuation of an existing job that would otherwise have been terminated had the development not occurred. Average annual starting wages per job are not necessarily the earnings for each job created/maintained. Actual wages are determined on an individual basis by employers and are influenced by market forces.

Table 4-17 depicts the types of jobs that would be ongoing during development and production, but does not necessarily represent the number of actual workers per well. One person could potentially fill several of the employment positions during development and production of a well. All of the wells drilled during a given year will likely be staggered, employing many of the same people during drilling and production activities; therefore, actual employment is somewhat exaggerated in Table 4-17.

Table 4-18 was created to show the annual employment impact for each alternative. Again the numbers shown reflect total number of jobs, but do not reflect total number of workers in the area because many of the jobs will be filled by one worker moving from one rig to the next to perform similar jobs. Actual jobs do not represent number of workers. On average the actual number of workers is estimated to represent a factor of 60 % of the total jobs or 62 people out of a total of 103 jobs created during the development, production and reclamation phases (Jacquet and Kathol 2007). This number was derived from the fact that many of the jobs take from 2 to 5 days to complete, therefore a single worker can work on up to 4 or 5 rigs per month. Table 4-18 shows the number of annual jobs, annual worker years, and estimated actual number of workers for one well, but does not reflect the actual number of people that would be necessary to fill these jobs (Jacquet 2007). In the Moxa, an estimated 9 to 10 wells would be operating at any one time. With this many rigs operating there is likely to be many workers working shifts on several rigs. Based on 62 estimated actual workers per well an estimated total of 620 workers could be employed at any one time during peak drilling activity.

4.11.3.2. Employment Estimate Methodology

The following paragraphs will help to clarify generation of employment estimates and economic statistics in Tables 4-17 through 4-21. The estimates of employment are based on two different methodologies. Tables 4-17 and 4-18 are based on counting heads at the well site and then estimating the number of days that each type of worker would be at the well site. The result is an estimate of worker-days. Tables 4-20 and 4-21 are based on the ratio of employment per dollar of expenditures. For example the latest estimates for Wyoming are one job per $3.7 million of production for the oil and gas extraction sector; one job per $135,986 of expenditures to the oil and gas drilling sector, and one job per $90,813 of expenditures to the oil and gas support activities sector. These ratios may vary by region of the state. With this approach total expenditures are aggregated and then converted to an estimate of employment.

Table 4-17. Estimated Work Force Requirements for All Wells, All Alternatives.[1]

Employment Category	Avg Number of Days	Total workers per well	Worker-Days per Well	Proposed Action Worker-Years for 1,861[2] wells	Alternative A Worker Years for 670 wells	Alternatives B and C Worker Years for 5,165 wells
Well Pad and Access Road Construction	4	4	16	115	42	317
Rig transportation/Setup	5	15	75	537	193	1,490
Drilling [3] Roughnecks (Straight Holes)	15	12	180	1,288	464	3,576
Tool-Pushers and Supervisors	15	9	135	966	348	2,682
Completion Testing - Cementing, Stimulation, Perforating, Logging	2 6 3 1	6 13 5 3	12 78 15 3	86 558 107 21	31 201 39 8	238 1,550 298 60
Pipeline construction	4	6	24	172	62	477
Total Well Construction and Development		**73**	**538**	**3,850**	**1,388**	**10,688**
Production[4,5]		13	305	2,183	786	6,059
Workovers [6](every 10 to 20 years)	10	7	210	1,503	541	4,171
Total Production and Maintenance Activities		**20**	**515**	**3,686**	**1,327**	**10,230**
Total Abandonment and Reclamation	**5**	**10**	**50**	**358**	**128**	**993[7]**
Total		**103**	**1,103**	**7,894**	**2,843**	**21,911**

[1] Assumes all wells are drilled and completed as producers
[2] 260 worker-days = 1 worker year. Implementation of BMPs such as drilling multiple wells from single well pads could change the work force requirements. Detailed analysis of these changes is presented below for alternative B.
[3] Assumes all vertical (straight) wells
[4] Assumes one pumper can visit 20 wells/day, all pads are visited every 3 days, and a productive well life of 40 years.
[5] Assumes six full time production foreman and six full-time field clerks in addition to pumpers.
[6] Assumes three workovers per well.
[7] Actual number for abandonment and reclamation might be slightly higher for Alternative B because of the increased emphasis on reclamation efforts.

Table 4-18. Estimated Annual Work Force Requirements for All Alternatives Expressed in Worker Days.[1]

Employment Category	Avg Number of Days	Total workers per well	Worker-Days per Well	Proposed Action Worker-Years for 186[2] wells	Alternative A Worker Years for 112 wells	Alternatives B and C Worker Years for 205 wells
Well Pad and Access Road Construction	4	4	16	11	7	13
Rig transportation/Setup	5	15	75	54	32	59
Drilling [3] Roughnecks (Straight Holes)	15	12	180	129	77	142
Tool-Pushers and Supervisors	15	9	135	97	58	106
Completion Testing - Cementing, Stimulation, Perforating, Logging	2 6 3 1	6 13 5 3	12 78 15 3	87 56 11 2	5 34 6 2	10 61 12 2
Pipeline construction	4	6	24	17	11	19
Total Well Construction and Development		**73**	**538**	**385**	**232**	**424**
Production[4,5]		13	305	218	132	240
Workovers [6](every 10 to 20 years)	10	7	210	150	91	166
Total Production and Maintenance Activities		**20**	**515**	**368**	**223**	**406**
Total Abandonment and Reclamation	**5**	**10**	**50**	**36**	**21**	**39[7]**
Total		**103**	**1,103**	**789**	**476**	**869**

[1] Assumes all wells are drilled and completed as producers and that workers represents a specific job, but does not necessarily represent a single worker. One worker can fill many jobs.
[2] 260 worker-days = 1 worker year. Implementation of BMPs such as drilling multiple wells from single well pads could change the work force requirements. Detailed analysis of these changes is presented below for alternative B.
[3] Assumes all vertical (straight) wells
[4] Assumes one pumper can visit 20 wells/day, all pads are visited every 3 days, and a productive well life of 40 years.
[5] Assumes six full time production foreman and six full-time field clerks in addition to pumpers.
[6] Assumes three workovers per well.
[7] Actual number for abandonment and reclamation might be slightly higher for Alternative B because of the increased emphasis on reclamation efforts.

The two estimates are not comparable. The Head Counting Method provides a detailed description of on-site employment at the well site. However, it does not consider off-site employment associated with oil and gas development. The Employment/Expenditure Method, on the other hand, provides less detail regarding employment but does consider off-site employment. Off-site employment could result from direct expenditures by operators for goods and services used in drilling oil and gas wells. This could include such things as equipment rentals (surface, down hole, etc.), consumables (fuel, drilling fluids, bits, etc.), tangibles (pipe, facilities equipment, wellhead equipment, etc.), transportation, and miscellaneous expenses. Information from operators in Southwest Wyoming suggests that these off-site expenditures represent about 40 percent of the total cost of a well and generate about one-third of the direct employment. Off-site employment would also include secondary employment associated with oil and gas development. This would include employment associated with expenditures by companies involved in drilling oil and gas well with other firms in the region (Indirect Effects). It would also include expenditures by employees of companies involved in drilling oil and gas wells with other firms in the region (Induced Effects). Because most economic impact models use the Employment/Expenditure Method to estimate employment, the Head Counting Method is not applicable to estimating secondary employment. Overall, previous work in Southwest Wyoming indicates that total off-site employment represents about 50 percent of the total employment associated with oil and gas development.

The units of measurement are also different. The Counting Heads Method measures employment in terms of number of workers. While the Employment/Expenditure Method measures employment in terms of jobs. Because one worker can hold more than one job, the units of measurement are not the same. Another difference is that the employment in Table 4-17 and 4-18 are expressed as worker-days. The Employment/Expenditures Method expresses employment as a twelve month average, but does not consider whether the job was full-time or part-time each month. As a result 12 months of employment does not necessarily equal 260 days of employment. Due to the differences in units of measurement it is not possible to convert from one unit of measurement to the other. While the Head Counting Method is more detailed, it is generally not comparable with published employment estimates because published employment estimates are not generally collected on a worker-day basis. For example, the U.S. Department of Commerce estimates that there were 42,633 jobs in Lincoln, Sublette, and Sweetwater Counties in 2005. However, the number of worker-days for the three counties is unknown.

Double Counting. Because workers will probably work at more than one oil and gas well during the year it is important to estimate worker-days in the Head Counting Method in order to avoid double counting of workers. Because the Employment/Expenditure Method does not count workers at all, but rather counts expenditures and then converts those expenditures to employment estimates, double counting should not be a major issue, at least in terms of jobs, as long as there is no double counting of expenditures. It is important to note however, that the Employment/Expenditure Method estimates employment in terms of jobs and not workers.

Summary. 4-17 and 4-18 provide detailed employment estimates at the well-site, but do not consider off-site employment and is not comparable with published employment data. Table 4-20 and 4-21 provide less detailed employment estimates, but do consider off-site employment and is comparable with published employment data. Because of the differences in the two estimates they are not comparable (Taylor 2007). In the report Tables 4-17 and Table 4-18 represent employment at the well-site expressed in worker-days and Tables 4-20 and 4-21 represent total employment expressed in the number of jobs

4.11.3.3. Economic Activity from Development and Production

Well-cost estimates for the MAA are based on price structure, mechanics, and completion techniques in 2006. Vertical drilling costs include surveys, permits, fees, location and roads, drilling contractor

services and equipment, open-hole logging, mud logging, rentals, casing crews, contract labor and supervision, drilling water, drilling overhead, and transportation and hauling. Completion costs include completion rig and auxiliary services, snubbing unit, contract supervision, professional services, casing crews, pumping services, transportation and hauling, location and roads, completion water, rentals installation labor, and frac flowback. Reclamation costs include contractor services and equipment, monitoring, seed, etc. The costs vary significantly by operator, depth drilled, area drilled, types of facility, and pipeline lengths. Additionally, the specialized equipment and labor associated with directional drilling cause costs to vary (Table 4-19). Table 4-19 shows the range and average costs associated with drilling and completion of a single well and the amount of time it would take on average for the well to be paid out once production begins.

Table 4-19. Moxa Well Drilling and Completion Cost Estimates (2006 $).

	Drilling	**Completion**	**Total**	**Estimated Payout/well @ 2007 spot prices [3]**
High Range[1]	$1.3 million	$900,000	$2.2 million	16 months
Low Range[1]	$550,000	$500,000	$1.05 million	8 months
Average[1]	$850,000	$650,000	$1.5 million	11 months
Directional Well[2]	$948,300	$809,560	$1,757,860	13 months

Source:
[1] EOG 2006
[2] Data contained in this table was derived from estimate for one well in the MAA (Westport Oil and Gas 2005). Matthew Warren, BLM petroleum engineer, indicates that on average, $300,000 to $350,000 in additional costs can be expected for each well that is drilled directionally in the MAA (personal communication).
[3] Well production will vary depending on well location, but average payout is estimated to be 11 months for vertical wells and 13 months for directionally drilled wells based on current gas spot prices.

Average estimated payout for drilling and completion costs in the MAA per conventional well is approximately 11 months based on an estimated spot price for natural gas in 2007 of $7.84/mcf (Henry Hub spot price- Energy Information Administration (DOE) May 1, 2007). For directionally drilled wells the average payout is slightly longer, approximately 13 months, at the same rate. Summaries of expected economic activity and employment from one conventionally drilled well is presented in Tables 4-20 and Table 4-21. Table 4-20 shows total economic activity and employment and earnings from drilling activity, and Table 4-21 shows average annual economic activity by alternative. Table 4-22 shows total economic activity and employment from production activities and Table 4-23 shows average annual economic activity by alternative. The results shown in these tables are derived from the IMPLAN I/O model runs and are estimated in 2006 dollars. Employment represents direct, indirect, and induced (secondary) jobs. The employment figures in these tables are not comparable to the direct worker figures in Tables 4-17 and 4-18 because employment in Tables 4-20 and 4-21 represent all direct, indirect and induced jobs created locally and regionally and do not represent actual direct, indirect, or induced workers but are estimates derived from oil and gas expenditures based on the I/O model methodology.

Direct drilling and completion expenditures of $ 1,615,331, with direct local spending of $1,301,957 for one conventional well, are estimated to generate economic activity (direct, indirect, and induced) of $1,553,452. An estimated 12.4 new direct and secondary jobs would be created during drilling activity, assuming that 40% of the labor force comes from the local area. Employment projections were generated from the average expenditures per job for the oil and gas industry from the I/O model inputs. Average earnings per job are estimated at $55,628. Each well would generate this level of economic activity, which is assumed to remain constant across all alternatives on a per-well basis. The timing of economic activity will depend on the number of approved wells and the rate of development.

Table 4-20. Economic Activity from Gas Drilling and Completion per Vertically Drilled Well (40% Local), Sweetwater, Uinta, and Lincoln Counties, Wyoming, 2006 (2003 $).

Estimated Activity	Conventional Well
Direct Drilling Expenditures [1]	
Total Cost	$ 1,615,331
Local Direct Expenditures	$ 1,301,957
Secondary[2] Expenditures	$ 251,495
Total Local Economic Activity	$ 1,553,452
Employment (Jobs)	
Direct Annual Job Equivalent (AJE)[3]	9.9
Secondary AJE	2.4
Total	12.4
Average Earnings Per Job	$55,628[4]

Source: IMPLAN
[1] Includes proposed labor costs.
[2] Includes indirect and induced
[3] AJEs are jobs indirectly created as a result of the activity. They do not include the direct labor jobs.
[4] This estimated average annual starting wage per job would not necessarily be the actual wage paid for each created job. Actual wages are determined on an individual basis by employers as influenced by market forces.

Table 4-21. Average Annual Economic Activity from Gas Drilling and Completion by Alternative (40% Local Labor) over Life of the Project (2006 $).

Average Annual Estimated Activity	Proposed Action (186 wells)	No Action (126 wells)	Alternatives B & C (205 wells)
Drilling Costs [1]			
Total Annual Cost	$300.4 M	$203.4 M	$331.1 M
Local Direct Expenditures	$242.1 M	$164.0M	$266.8 M
Secondary[2] Expenditures	$ 46.3 M	$ 31.6 M	$ 51.5 M
Total Local Ave. Ann. Economic Activity	$288.5 M	$195.6 M	$318.3 M
Local Employment	1,193	808	1,315
Secondary Employment	1,105	749	1,218
Avg. Ann. Employment (jobs)[3]	2,298	1,557	2,533
Avg. Ann. Earnings	$127.8 M	$86.6 M	$140.9 M
Avg Annual AEPJ	$55,614	$55,620	$55,626

Source: IMPLAN
[1] Includes proposed labor costs.
[2] Includes indirect and induced
[3] Total Annual Employment represents local, regional and national employment derived from the drilling activities. Much of the secondary employment would occur outside the region.
AEPJ – Adjusted Earnings Per Job
M = million

Table 4-21 shows annual average direct drilling and completion expenditures by alternative. Direct drilling and completion costs range from $203.4M for the No Action, to $300.4M for the Proposed Project and Alternative B, and $331.1M for Alternative C. Direct local spending is estimated between $164.0M, $242.1M, and $266.8 million per year per respective alternative, over the life of the project. Local expenditures represent 80% of total expenditures based on information collected on oil and gas activities in the Southwest region of Wyoming and outputs from the IMPLAN I/O model. Total average annual economic activity generated (direct, indirect, and induced) would range between $195.6M for the No Action and $318.3M for Alternative C. Average annual estimated new direct and

secondary jobs of between 1,557 and 2,533 would be created during drilling and completion activity for the alternatives. Average earnings per job are estimated at approximately $55,620 for all alternatives. Each alternative would generate this level of economic activity annually. These average annual estimates are assumed to remain constant across all alternatives on a per-well basis.

The value of natural gas and condensate production is based on revenues less the cost of operation. Table 4-22 illustrates economic activity that would be generated by $100 million of natural gas and condensate production output per well, based on CREG 2005 prices. The value of $100 million in direct natural gas and condensate production would generate economic activity of $107,114,999 (including secondary activity of $7.1 million) and would create 15.1 direct jobs and 36.4 secondary jobs during the production period. Direct and secondary earnings would total $2.7 million, $1.33 million in direct earnings and $1.37 in secondary earnings. Average earnings per job are estimated at $52,605.00.

Table 4-22. Economic Activities from Gas Production Per Well, Sweetwater, Uinta, and Lincoln Counties, Wyoming, 2006.

Estimated Activity	Conventional Well (2006 $)
Economic Impact of $110 million in Natural Gas and Condensate Production [1]	
Direct	$ 110,450,000
Secondary	$ 7,858,516
Total Economic Activity	**$ 118,308,516**
Employment per $110 million in production	
Direct	15.1
Secondary	36.4
Total	51.5
Earnings per $110 million in production	
Direct	$ 1,468,450
Secondary	$ 1,523,810
Total Earnings	$ 2,992,260
Average Earnings per Job per $110 million in production	
Direct	$ 97,248
Secondary	$ 41,863
Average Earnings Per Job	**$ 58,102[2]**

1 Price is $5.02/MCF based on (CREG 2006) the value of production is based on revenues less cost of operation. Price is $33.47/bbl based on (CREG 2006). Assumes natural gas recovery costs include recovery of condensate.
2 This estimated average annual starting wage per job would not necessarily be the actual wage paid for each created job. Actual wages are determined on an individual basis by employers as influenced by market forces.

The value of natural gas and condensate production is based on revenues less the cost of operation. Table 4-22 illustrates economic activity that would be generated by $110 million of natural gas and condensate production output per well, based on CREG 2005 prices. The value of $110 million in direct natural gas and condensate production would generate economic activity of $118,308,516 (including secondary activity of $7.9 million) and would create 15.1 direct jobs and 36.4 secondary jobs during the production period. Direct and secondary earnings would total $3.0 million, $1.47 million in direct earnings and $1.52 million in secondary earnings. Average earnings per job are estimated at $58,102.

Table 4-23 shows average annual economic activity from oil and gas production by Alternative. The Table shows average annual generation of economic outputs (market value of oil and gas sales), employment, and earnings over the life of the project. Average annual economic activity by alternative ranges from $103 M for the No Action to $322 M for Alternative C. Average annual total employment by Alternative ranges from 45 annually for the No Action to140 for Alternative C. Most of the

employment during the production phase is secondary employment and is likely to be regional and national employment rather than local employment. Average annual earnings per job are approximately $58,000.

Table 4-23. Average Annual Economic Activity from Oil and Gas Production.

Economic Impact of Natural Gas and Condensate Production by Alternative (2006$)			
Average Annual	**Proposed Action**	**No Action**	**Alternatives B and C**
Direct Economic Impact	$208,973,611	$96,595,692	$300,569,141
Secondary	$14,837,126	$6,858,294	$21,340,409
Total Economic Activity	**$223,810,737**	**$103,453,987**	**$321,909,550**
Average Annual Employment			
Direct	28.4	13.2	41
Secondary	68.6	31.8	99
Total Employment	97	45	140
Average Annual Earnings			
Direct	$2,778,321	$1,284,255	$3,996,115
Secondary	$2,883,063	$1,332,671	$4,146,766
Total Earnings	$5,661,384	$2,616,926	$8,142,881
Average Earnings Per Job			
	$97,687	$97,292	$97,466
	$42,027	$41,907	$41,887
Average Earnings/Job	$58,365	$58,154	$58,163

4.11.3.4. Housing

Population in the study area is anticipated to increase as a result of increased employment opportunities generated both directly and indirectly by the Project. All three affected counties in the study area are facing a housing shortage, and any additional pressure would exacerbate an already-tight housing market (Robbins 2006; Hanks 2006; Archibald 2006; Harris 2006). Moreover, the increased demand for housing would likely cause housing prices (rental costs and home sales prices) to rise. Housing rental costs increased between 41% and 46% in Sweetwater County from 1998 to 2004. Residential sales prices increased by 34% between 1998 and 2004 in Sweetwater County (Sublette County Socioeconomic Analysis Advisory Committee 2006). Additionally, affluence in the study area is likely to cause an increase in the demand for higher-quality housing, which also would drive the cost of housing upwards. Some town homes and apartment complexes are in the construction or development phases in all affected communities, and these will ease the housing shortage; however, single family housing continues to be unaffordable for any of the gas field workers who would like to provide housing for their families or to move their families to the area in spite of the higher income levels that most of these workers maintain..

4.11.3.5. Quality of Living

Quality of life could be impacted by oil and gas development and production in the area. Potential beneficial effects include increased local economic activity and reduced poverty, and the potential for improved public facilities and services once ad valorem taxes, severance taxes, and other revenues become available to the local counties and communities. The short-term impacts (1 to 2 years) to local communities and other local jurisdictions, however, would be negative, because increased population from the gas development workforce would exacerbate impacts on the already-tight housing market and would increase demands on facilities and services. Increased economic activity could enhance the availability of goods and services, as well as cultural, educational, and recreational opportunities. However, the conversion of large tracts of land to gas development is seen by some as industrialization and a diminishment of the characteristics they value in the region: natural beauty and quiet, vast reaches of unpopulated and undeveloped open space, fresh air, and wildlife.

Because of the population increase anticipated as a result of new oil and gas development and production jobs, along with the record of increasing criminal activity already affecting the CIAA, the Project could potentially exacerbate an already worsening crime rate (see Jeffrey Jacquets December 2005 report entitled "Index Crimes, Arrests, and Incidents in Sublette County 1995 to 2004 Trends and Forecasts"). Although the number of arrests in Sweetwater, Lincoln, and Uinta Counties decreased from 1999 to 2004, crimes related to alcohol and substance abuse, assaults, driving under the influence (DUI) charges, and traffic offenses represented the largest number of crimes in the area. Additional law enforcement personnel may be required to serve the increasing population base related to the proposed project.

For the purpose of this analysis, the rate of development and an average decline curve for individual well production (Chase 2006; EOG Resources 2006; Fetzer 2006) was used to estimate total annual field production; well production life was assumed to be 40 years for all alternatives. Increases in taxes and revenues would provide counties and communities with more discretionary dollars to develop infrastructure and support the population. However, short-term budgetary impacts to local governments would occur, due to population growth and its effects on housing and local infrastructure, services, and facilities. Receipt of taxes generally lags one year behind production; therefore, affected counties and communities would not receive any funds until two years after drilling activities begin. Over the LOP, all counties and communities in the study area would benefit from increased revenues from ad valorem taxes, as shown in Table 4-24. Some state mineral royalties and severance taxes would also be distributed to the counties and communities, based on a state distribution formula. Other tax revenues generated, but not included in the table, would include sales, use, and lodging taxes. These amounts have not been estimated, even though they will represent a significant increase in local revenues throughout the region. Other taxes not estimated include state mineral royalties and PILT payments.

Because development and production would occur within Sweetwater, Lincoln, and Uinta Counties, increases in ad valorem production and property taxes would impact all three counties and affected communities. Ad valorem taxes on production were estimated for this analysis, but because of limited information provided by the Operators, property taxes related to equipment and facilities could not be estimated. These tax revenues could be substantial. In addition, real property values are likely to change as population fluctuates within the study area. Housing costs have escalated during the past several years and with increased demand for housing in the region, these housing cost increases are likely to continue. Population growth will also stimulate additional commercial and residential activity, but indirect property taxes generated by this activity are beyond the scope of this analysis and are not addressed further.

Table 4-24. Estimated Taxes and Revenues Received by Governments from Moxa Arch Area Infill Gas Development Project (LOP) (2006$ using 2005 mill levies).

	Proposed Action	Alternative A - No Action	Alternatives B and C
Ad Valorem[1]	(nominal values)	(nominal values)	(nominal values)
Sweetwater County, WY	$185,979,606	$85,966,973	$267,496,600
Lincoln County, WY	$139,602,007	$64,529,451	$200,791,167
Uinta County, WY	$110,994,250	$51,305,839	$159,644,302
Severance Tax[2]			
State of Wyoming	$398,668,099	$184,279,828	$573,408,897
Mineral Royalties Tax			
Federal	$336,070,701	$155,344,887	$483,374,343
State of Wyoming[3]	$168,035,350	$77,672,444	$241,687,171

[1] Ad valorem tax estimated is for natural gas and condensate production. Due to limited information from the proponent no ad valorem tax was estimated for equipment or facilities. Additional ad valorem taxes would be generated from residential, commercial and industrial properties constructed as a result of project development to serve the new population and increased industry demands.
[2] Severance tax revenue would be returned to local jurisdictions based on a distribution formula generated by the State Treasurer's Office. These revenues would typically go for road construction to the counties and miscellaneous capital expenditures for the local communities. All three counties, the impacted communities of Rock Springs, Kemmerer/Diamondville, and Evanston, as well as any other communities impacted by the proposed project, would receive a portion of the severance taxes.
[3] This represents the Federal Mineral Royalties returned to the state, which is 50% of the total Federal Mineral Royalty.

Sales and Use taxes were not estimated due to limited information provided by the proponent. State mineral royalties and PILT payments were not estimated.

4.11.3.6. Proposed Action

The Project would result in increased population in Sweetwater, Lincoln, and Uinta Counties as a result of job seekers moving to the area. Current employment levels in the study area are estimated at full employment, due to ongoing natural resource development projects. Temporary workers are being transported in and out of the area due to limited housing availability and a shortage of permanent, reliable gas field workers in the labor pool. Continued in-migration of labor is anticipated as a result of the proposed project; without adequate planning at the local level, increases in population would likely have both beneficial and negative effects on communities in the study area.

4.11.3.6.1. Population

It is difficult to estimate population related to the influx of new workers into the area. Because of the current housing shortage, many oil field workers are not bringing their families to the area. If housing availability improves, this situation could change. Based on 2.7 persons per household, new population related directly and indirectly to the Project could be over 3,221 for the Proposed Action during drilling and completion, based on annual average local employment of 1,193. However it has been discussed that the estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that actual workers would represent 60 % of the jobs, therefore the population impact could be estimated based on a workforce of 716 vs. 1,193 and the total population impact would be 1,933 vs 3,221. Population impacts during production would depend on the number of local workers in the area. Total average annual employment generated by production activities ranges from 2 to 326 workers based on the number of wells producing. Assuming 30% of these annual production workers live locally, peak population related to 97 local workers would be 262, based on a household size of 2.7.

4.11.3.6.2. Employment and Income

The Proposed Action would directly provide up to 7,894 worker years (Table 4-25). Employment per year tallied through the LOP totals 22,993 jobs during development and 4,872 jobs during production (Table 4-25). Estimated average annual total employment would be 2,298, of which 1,193 would be local during drilling and completion. Actual workers would be less than this perhaps more in the range of 716. The duration of these impacts and, the number of actual jobs would depend on the rate of development. Employment generated during production ranges between 2 and 326 annually based on the number of wells producing and the level of production, but averages 97 over the 40 year production period.

Table 4-25. Summary of Economic Activity Resulting from Natural Gas Development and Production over the LOP, Moxa Arch Area Infill Gas Development Project, Sweetwater, Lincoln, and Uinta Counties, 2006 (2006 $).

Nominal Value of Economic Activity	Proposed Action	Alternative A	Alternatives B and C
Drilling			
Total Spending	$3,005 billion	$1,222 billion	$8,343 billion
Local Spending	$2,423 billion	$985 million	$6,724 billion
Total Employment for all Years	22,993	9,353	63,814
Average Annual Employment	2,298	1,557	2,533
Local Employment for all Years	11,938	4,856	33,133
Average Annual Local Employment	1,193	808	1,315
Local Earnings	$1,279 billion	$520 million	$3,550 billion
Average Earning per Job	$55,614	$55,620	$55,626
Production			
Natural Gas Production	1.8 trillion CF	832 BCF	2.6 trillion CF
Average Annual	36 BCF	16 BCF	51 BCF
Condensate Production	12.5 million barrels	5.8 million barrels	18.1 million barrels
Average Annual	251,108 barrels	116,072 barrels	361,172 barrels
Value of Total Production	$10.4 billion	$4.7 billion	$15.0 billion
Average Annual Value of Production	$209 million	$96.6 million	$300 million
Total Employment for all Years	4,872	2,252	7,007
Average Annual Employment	97	45	140
Total Earnings	$283 million	$130 million	$407 million
Average Annual Earnings	$5.6 million	$2.6 million	$8.2 million
Average Earning per Job	$58,365	$58,154	$58,163

* See discussion of impacts for Alternative B for detailed analysis regarding changes that might occur to these values compared to Alternative C.

Natural gas development jobs are in high demand and are competing with other service positions and lower-paying jobs, which is causing an increase in wage rates throughout all economic sectors. The Proposed Action would result in beneficial impacts to local employment—both to the workforce directly involved in oil and gas development and to the general service economy—especially during construction and drilling. Because of the status of full employment in the area, the new jobs could be considered both beneficial and detrimental to the region. This situation will continue, and new workers will likely be brought in temporarily to fill the new positions either for gas and service field jobs or secondary jobs. Currently, local businesses are soliciting workers from various parts of the country to fill industrial retail and service positions, that have lost workers to the oil and gas industry due to higher wages (Robbins 2006).

In 2005, the oil and gas extraction mean and median wages in the southwest Wyoming region were $48,629 and $48,846, respectively (Wyoming Department of Employment 2005b). These estimated annual wages are higher than most other sectors of the southwest Wyoming regional economy. Thus, there would likely be beneficial impacts on income and poverty reduction as a result of the Proposed Action.

4.11.3.6.3. Economic Effects

Because up to 1,861 new wells would be drilled under the Proposed Action, up to 1.8 trillion CF of gas and 12.5 million barrels of oil (MBO) would be recovered. Over the LOP, economic activity is estimated at $3.0 billion (nominal value) during drilling and completion (Table 4-25). For every $110 million in production value, an estimated $7.9 million will be generated in secondary output, including total earnings of $3.0 million for direct, indirect, and induced workers (Table 4-22). The LOP total value of production is estimated at $10.4 billion, with an estimated $283 million in earnings for the Proposed Action.

An estimated $185 million (nominal value) in ad valorem taxes would accrue to Sweetwater County, $139 million to Lincoln County, and $111 million to Uinta County over the LOP (Table 4-24). In addition, the Proposed Action is estimated to generate severance tax revenues of $399 million (nominal value) over the LOP, and $336 million (nominal value) in Federal Mineral Royalties, of which $168 million would go to the State of Wyoming.

Under the Proposed Action, local area government operating budgets would likely expand in the long term, increasing the level of services and infrastructure provided to community residents. Annual jobs created, as mentioned above, are estimated to total 22,993 during development and 4,872 during production, with an average wage ranging from $55,628 to $58,102.

In the short term, before revenues from production activity accrue to the local governments, significant social and economic impacts to local governments could occur, due to increased demands on public services and facilities, housing, and social services. In the long term, increased revenues to the state and local governments in the form of ad valorem, severance, mineral royalties, sales and use, and other taxes from direct project activity and secondary activity would be beneficial to the State of Wyoming and its regional governments. In addition, increased employment would occur throughout the area from indirect and induced employment opportunities stemming from the Proposed Action. Significant adverse and beneficial social and economic impacts from the Proposed Action would occur throughout the LOP. Most adverse impacts would occur in the short term (2 to 5 years).

4.11.3.7. Alternative A

The socioeconomic effects of Alternative A/No Action would be similar to those described for the Proposed Action, but they would have a lesser impact in terms of employment, revenue generation, and local jurisdiction infrastructure and housing, due to the lower level of resource recovery and the lower number of wells drilled annually. Tables 4-21 and 4-23 show the economic activity, employment, and earnings related to the No Action alternative.

4.11.3.7.1. Employment and Income

Alternative A would directly provide up to 3,211 worker years (Table 4-17). Employment per year, tallied through the LOP, totals 9,353 jobs during development and 2,252 jobs during production (Table 4-25). Estimated average annual total employment during drilling and completion would be 1,557, of which 808 would be local, with an average wage ranging from $55,620 to $58,154. The duration of these impacts and, therefore, the number of actual jobs would depend on the rate of development. Employment during production would range from 1 to 204 depending on how many wells are producing and at what level, but average employment for the 40 year production period is estimated at 45.

4.11.3.7.2. Population

It is difficult to estimate population related to the influx of new workers in the area. Because of the current housing shortage, many oil field workers are not bringing their families to the area. If housing availability improves, this situation could change. Based on 2.7 persons per household, new population related directly and indirectly to the Project could be over 2,182 for Alternative A during drilling, based on annual average local employment of 808. However it has been discussed that the estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that actual workers would represent 60 % of the jobs, therefore the population impact could be estimated based on a workforce of 485 vs. 808 and the total population impact would be 1,309 vs 2,182. Population impacts during production would depend on the number of local workers in the area. Total average annual employment generated by production activities would range from 2 to 204 workers depending on how many wells are producing and at what level. Assuming 30% of these annual production workers live locally, peak population related to 61 local workers would be 165, based on a household size of 2.7.

4.11.3.7.3. Economic Effects

An estimated 832 BCF of gas and 5.8 MBO would be recovered under this alternative. Over the LOP, Alternative A is estimated to generate up to $1.2 billion (nominal value) (Table 4-25) in total spending, of which $985 million would be spent locally during drilling and completion. For every $110 million in production value, an estimated $7.9 million would be generated in secondary output, including total earnings of $3.0 million for direct, indirect, and induced workers (Table 4-22). Total LOP production value for Alternative A is estimated at $4.7 billion, with estimated earnings of $130 million.

An estimated $86 million in nominal ad valorem taxes would accrue in Sweetwater County, $64 million in Lincoln County, and $51 million in Uinta County over the LOP (Table 4-24). In addition, an estimated $184 million in nominal severance taxes would be generated over the LOP, and $155 million in Federal Mineral Royalties, of which $77.6 million would go to the State of Wyoming. Under this alternative, local area government operating budgets would likely expand in the long term, increasing the level of services and infrastructure provided to community residents.

Beneficial impacts from increased local government revenues would be similar to those under the Proposed Action, but they would generate less money for local government budgets than would the Proposed Action. In summary, Alternative A would have effects similar to the Proposed Action, but on a smaller scale because of fewer number of wells, less production, and a shorter drilling phase. Social and economic adverse and beneficial impacts would still be considered significant.

4.11.3.8. Alternative B

The socioeconomic impacts of Alternative B would be similar to those of Alternative C. The following sections describe those impacts that are not the same as Alternative C. Most of the changes would be related to different costs associated with different development techniques that might be used by the operators, including directional drilling. Because the technologies that will be used by the operators to remain below the disturbance threshold for Alternative B, the following sections are meant to describe the potential impacts of the alternative for disclosure and decision-making purposes only.

4.11.3.8.1. Employment and Income

If all wells for Alternative B are conventionally drilled from individual well pads, the impacts would be identical to those described for Alternative C. However, if wells are drilled directionally the employment and income would be slightly different from Alternative C. Additionally, increased emphasis on reclamation for Alternative M might slightly increase the employment related to reclamation activities compared to Alternative C.

Analysis completed by Westport Oil and Gas (Westport 2005)indicates that drilling a directional well in the MAA takes approximately eight additional days when compared to drilling a vertical well to the same depth and target. Time and labor for completion and operations of a directional drilled well are assumed to be the same as for a vertically drilled well ((Westport 2005), Matthew Warren BLM Kemmerer Field Office Petroleum Engineer, personal communication). For every well that is drilled directionally rather than conventionally, there would be an increased of approximately 1 worker year and increased wages of approximately $55,000. However, because of the specialized workers necessary to complete some phases of directional drilling, wages could be higher than the $55,000 projected for the other alternatives.

4.11.3.8.2. Population

As described in the previous section, for every directionally drilled well, there would be an increase of approximately 1 worker year. Based on this estimate a total of an additional 1,995 worker years could be generated by Alternative B when compared to Alternative C if all wells on federal lands in the core were drilled directionally. However, as discussed in the following section, approximately 913 worker years would be saved through decreased construction, rig transport, and pipeline construction costs resulting in 1,197 more jobs more than Alternative C. The estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that 60% of the jobs would require actual new workers resulting in 718 more jobs than Alternative C. Assuming 30% of the labor would be local, approximately 1 household would be added for every 9-10 wells drilled directionally. Assuming 2.7 persons per household, directionally drilling 1,995 wells (100% of all wells on federal lands in the core for Alternative C) would increase the area population by approximately 539-599 individuals more than Alternative C.

4.11.3.8.3. Economic Effects

Drilling multiple wells from a single pad would have the greatest short-term economic impact to the area because wells would have to be drilled directionally. This would require additional specialized equipment and crews during the drilling phase of the project. Analysis completed by Westport Oil and Gas (Westport 2005) indicates that drilling a directional well in the MAA costs, on average, $300,000 to $350,000 more than drilling a vertical well. Much of this additional cost is associated with drilling labor, specialized outside services, and increased equipment rental and purchase expenses. Westport's analysis indicated that labor associated with drilling a vertical well in the MAA would cost approximately $42,000. When drilled directionally, labor costs would increase to $132,000 as a result of increased drilling time and specialized labor required to complete drilling activities.

Completion costs for a directional well are typically higher than a vertically drilled well (Westport 2005). While labor costs for completion would be expected to be similar for a directionally drilled well, the equipment and materials costs for completion would be higher. Much of the increased completion costs would be associated with the need for a longer length of production casing and increased cementing costs.

Directionally drilled wells also potentially have higher operational costs than vertically drilled wells. In much of the MAA, plunger lift systems are used to reduce liquid loading problems and maximize well flow rates. However, in a directional bore, increased wear on the plunger lift system and tubing can limit the usefulness of this technology and increase operations costs.

Total drilling costs in the MAA would increase as a result of using directional drilling technologies. For comparison with the Alternative C, directionally drilling 100% of wells on federally administered surface (1,995 wells) could increase cost to operators by approximately $600 million over the LOP. However, because multiple wells would likely be drilled from each pad, costs associated with pad construction, rig transportation and set-up, and pipeline construction would likely be reduced on a per well basis. Assuming a 40% decreased in the worker years presented in Table 4-17 for Alternatives B and C, a reduction in approximately 913 worker years would be expected. This would result in a

savings of $50.8 million and would reduce the increased cost to operators to approximately $550 million. Table 4-19 indicates that the total time to payout for a directionally drilled well can be increased by as much as 2 months. Increased number of days to payout would likely decrease the revenues generated for both the operators and the State of Wyoming and counties.

4.11.3.9. Alternative C

The socioeconomic effects of Alternative C would be similar to those described for the Proposed Action, but they would have a greater impact in terms of employment, population, revenue generation, and infrastructure and housing. Tables 4-21 and 4-23 show the economic activity, employment, and earnings related to Alternative C.

4.11.3.9.1. Employment and Income

Alternative C would directly provide up to 21,911 worker years (Table 4-17). Employment per year tallied through the LOP would total 63,814 jobs during development and 7,007 jobs during production (Table 4-25). Estimated average annual total employment would be 2,533, of which 1,315 would be local during development. The duration of these impacts and, therefore, the number of actual jobs would depend on the rate of development. Employment during production would range from 1 to 349 annually depending on the number of producing wells and the level of production, but an average of 140 would be employed annually through the 40 year production phase. Average earnings per job would range from $55,626 during drilling and completion to $58,163 during production.

4.11.3.9.2. Population

It is difficult to estimate population related to the influx of new workers in the area. Because of the current housing shortage, many oil field workers are not bringing their families to the area. If housing availability improves, this situation could change. Based on 2.7 persons per household, new population related directly and indirectly to the Project could be over 3,550 for Alternative C during drilling and completion, based on annual average local employment of 1,315. However the estimated jobs created would not necessarily require one worker per job. A more realistic estimate is that actual workers would represent 60 % of the jobs, therefore the population impact could be estimated based on a workforce of 789 vs. 1,315 and the total population impact would be 2,130 versus 3,550. Total average annual employment generated by production activities ranges from 1 to 349 workers, depending on number of wells producing and level of production. Assuming 30% of these annual production workers live locally, peak population related to 104 local workers would be 283, based on a household size of 2.7.

4.11.3.9.3. Economic Effects

Under Alternative C, changes in economic activity would be expected from the development of up to 5,165 wells and the recovery of up to 2.6 trillion CF of gas and 18.1 MBO (Table 4-25). Over the LOP, Alternative C is expected to generate up to $8.3 billion (nominal value) (Table 4-25) total spending, of which $6.7 billion would be spent locally during development. For every $110 million in production value, an estimated $7.9 million will be generated in secondary output, including total earnings of $3.0 million for direct, indirect, and induced workers (Table 4-22). Total LOP production value for Alternative C is estimated at $15.0 billion, with estimated earnings of $407 million. An estimated $114 million in total nominal ad valorem taxes would accrue in Sweetwater County, $86 million in Lincoln County, and $68 million in Uinta County over the LOP (Table 4-24). In addition, Alternative C is expected to generate total LOP severance tax revenues of $245 million and $207 million in Federal Mineral Royalties, of which $103 million would go to the State of Wyoming.

Under Alternative C, local area government operating budgets would likely expand more than under the Proposed Action, Alternative A, or Alternative B. Alternative C would generate the most overall taxes and revenues compared to all other alternatives.

In summary, this alternative would generate more economic activity related to development and production than all other alternatives because of the high level of resource recovery. Alternative C would have both adverse and beneficial social and economic impacts on the study area. The impacts from Alternative C would be greater than any of the other alternatives, due to the number of new wells drilled and the length of the project drilling, completion, and production phases.

4.11.4. Mitigation

Due to the significance of the socioeconomic issues, particularly in the short term, several potential mitigation measures are proposed for all alternatives:

- Assist local government with funding of public service projects that have been impacted by population growth related to oil and gas development.
- Work with impacted communities to develop and fund "portable" infrastructure enhancements (infrastructure provided by Operators during "boom" peaks and removed by Operators during "bust" times).
- Work with the Wyoming Department of Transportation and/or Sweetwater, Lincoln, and Uinta County Road and Bridge Departments to install appropriate road-side signs outside the MAA that indicate potential hazards (e.g., school bus stops, high-traffic volume turnouts, trucks entering roadway).
- MAA Operators could provide incentives or land for local builders to build housing prior to start-up of MAA drilling activities. The City of Evanston has adequate utility capacity for significant growth. Therefore, these incentives would be best provided in the Evanston area.

4.11.5. Residual Impacts

Residual and unavoidable short-term and long-term adverse socioeconomic impacts would occur as a result of the proposed project. Some short-term impacts could be reduced by implementation of suggested mitigation measures.

4.11.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Both beneficial and adverse socioeconomic impacts are anticipated as a result of (1) the effects of employment and population growth on the region, and (2) the increases in federal, state, and local revenues from direct and indirect production and expenditures. Under the No Action/Low Development Alternative, effects of increased employment, economic activity, and substantial federal, state, local, and county revenues would occur to a lesser degree than for the Proposed Action or alternatives.

Under all alternatives (including the No Action/Low Development), the Project would generate substantial revenues for state, county, and local governments, including area school districts, through state sales tax, federal income tax, ad valorem taxes (production property taxes), severance taxes, federal minerals royalties, and other taxes on facilities and production. Estimated ad valorem taxes, severance taxes, and federal mineral royalties (shown as nominal values) resulting from the Project, through the production phase (LOP), are presented in Table 4-24, including the likely distribution of those funds to the U.S., State of Wyoming, and affected counties, based on current statutes and distribution trends.

4.12. Land Use

4.12.1. Land Status/Prior Rights

Current land uses in the MAA include livestock grazing, natural gas production, wildlife habitat, recreation, and some limited residential use. Ownership of surface and mineral estates would not be expected to change under any alternative and no significant impacts to land status or prior rights would be expected.

4.12.2. Livestock Grazing and Rangeland Health

4.12.2.1. Introduction

Impacts to rangeland health, livestock, grazing allotments, and all resource uses of rangelands would result with implementation of the Proposed Action or any of the action alternatives. In particular, fish, wildlife, and domestic animals depend upon rangeland health for food and habitat. The impacts upon fish, wildlife, and other uses of rangelands are discussed in their respective sections, and impacts upon livestock grazing are discussed in this section. Impacts would occur throughout the LOP and would vary in intensity depending upon vegetation and soil disturbance, reclamation success, weed control, road construction and use (i.e., dust and animal/vehicle collisions), success of rangeland improvements, and additional resources and costs incurred by government officials and grazing permittees. Under the Proposed Action and all alternatives, cattle and sheep grazing would likely continue throughout the duration of the project with stocking rate adjustments and requests for temporary non-use made annually by each livestock operation.

4.12.2.2. Significance Criteria

Impacts to livestock grazing would be significant if project activities precluded livestock grazing use of the MAA for the long term, if there were a reduction in AUMs that would require modification in grazing allotments or other actions that would prevent the realization of grazing management goals, or if project activities resulted in a violation of BLM RMP or other land use plan goals/objectives.

4.12.2.3. Direct and Indirect Impacts

4.12.2.3.1. Impacts Common to All Alternatives

Under the Proposed Action and all alternatives, cattle and sheep grazing would continue throughout the duration of the project. Livestock management impacts include reclamation failures, loss of functions of rangeland improvements, loss of palatability of vegetation from road dust, and livestock losses. Livestock grazing is a primary land use of the Project Area, and over 91% of the MAA is part of a grazing allotment. Impacts would occur throughout the LOP from vegetation and soil disturbance associated with construction activities, reclamation, weed control, road construction and use (i.e., dust and animal/vehicle collisions), and rangeland improvements functionality.

The primary impact to grazing resources would be short-term loss of available forage as a result of construction and production-related disturbance. Available forage would be reduced during drilling and construction phases but would be reclaimed as soon as feasible for the production phase. A long-term loss of forage would occur due to construction of roads and ancillary facilities that remain in place during the LOP. Dust from roads reducing the palatability of adjacent vegetation and the threat of health issues such as dust pneumonia would also be impacts of field development activities, in addition to the effects associated with direct loss of vegetation.

The potential exists for disruptions to livestock management actions. There is also potential for damage to range improvements from the movement of heavy trucks, drilling equipment, and heavy construction equipment. Traffic along roads that pass through active shipping pastures or corrals may interrupt or complicate this work, extending the time and increasing the cost to complete it. Cattle guards and gates may be damaged by drill rigs that are too wide/heavy, leading to added maintenance and unwanted mixing of livestock. Direct loss of livestock is possible if vehicle collisions and the resulting mortality increase with field development.

Disturbance of soils and increased vehicle activity would increase the introduction, establishment, and spread of undesirable non-native/noxious weedy species. This can reduce forage availability and animal weight gains, in addition to affecting trail routes and overall animal health. Proper reclamation of disturbed sites (Appendix E) would help reduce these potential impacts.

4.12.2.3.2. Proposed Action

The Proposed Action would result in an estimated initial disturbance to allotments of about 11,063 acres (1,106 acres per year for the 10 years of drilling) in the core and 6,085 acres (608 acres per year) in the flank. This represents about 3.9% of the total land area of the grazing allotments. Successful interim reclamation would replace forage removed from short-term disturbances. Reclamation of short-term disturbance will probably compensate for a portion of the forage lost. However, this is dependent on commitment by Operators for successful reclamation and weed control. During the LOP, this disturbance would be reduced to about 5,511 total acres, or about 1.3% of the combined land area of the allotments. Potential short-term and long-term impacts to grazing allotments and AUMs within the MAA are presented in Table 4-26. Impacts for Alternative B are not included in Table 4-26 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. Some impacts would occur within the Rock Springs allotment; however, due to the lack of data for this allotment, it is not included in impact analysis.

Long-term impacts would occur where proposed well pads, new roads, and other facilities replace current allotment acreages. Short-term impacts would be expected from staging, storage, and other temporary use facilities for construction/exploration occurring on allotments that would later be reclaimed. Reseeding of allotments with perennial forage grasses would occur within the next growing season. Revegetation of the allotments is dependent on many factors including soil moisture, precipitation, soil type, and a number of other environmental correlates. Revegetation is expected to occur within three years of disturbance and no long-term reduction in quality of current grazing allotments would be expected, as long as an appropriate seed mix is used for interim reclamation of well pads, access roads, and pipelines. The short-term reduction in AUMs from the Proposed Action would not be a significant loss (Feeley 2006).

4.12.2.3.3. Alternative A

Some AUMs would be directly lost each year to short-term oil and gas activities, as shown in Table 4-26. Continued activities under Alternative A/No Action would result in an estimated initial disturbance of 5,686 acres (948 acres per year for the 6 years of drilling) in the core and 4,124 acres (687 acres per year) in the flank, which represents about 2.3% of the total land area of the allotments. These impacts would decrease as interim reclamation continues to take place on an annual basis. During the LOP, disturbance would be reduced to about 3,100 total acres, or about 0.7% of the land area of the allotments. The quality of grazing allotments within the MAA would remain stable as current management practices continue to be implemented.

Table 4-26. Potential Disturbance to Grazing Allotments within the MAA.

Disturbance Type	Core/ Flank	Austin Triangle	Carter Lease	Christ-ensen	Indian Flat	Cow Hollow	Granger Lease	H.F.	Hassett	Lyman Cattle	Monu-ment	Nelson Section	Nutria	Opal	Seeds-kadee	Slate Creek	Sage Creek	South Monument
Alternative A																		
Drilling and Completion	Core	0	444	0	0	12	3998	17	13	347	0	0	12	0	30	813	0	0
	Flank	46	215	108	141	174	2,500	0	134	202	0	0	45	0	54	538	0	13
AUMs Affected		1.0	82.4	4.5	10.1	12.4	203.1	1.1	9.2	39.2	0	0	4.8	0	2.7	67.6	0	unk
After Interim Reclamation	Core	0	123	0	0	3	1,110	5	4	96	0	0	3	0	8	226	0	0
	Flank	13	60	30	39	48	694	0	37	56	0	0	12	0	15	149	0	4
AUMs Affected		0.3	22.9	1.3	2.8	3.4	56.4	0.3	2.6	10.9	0	0	1.3	0	0.3	18.8	0	unk
Long Term % of AUMs Affected		0.1%	0.3%	1.4%	0.5%	0.6%	0.2%	0.8%	0.9%	0.6%	0%	0%	1.4%	0%	0.06%	0.7%	0%	unk
Proposed Action																		
Drilling and Completion	Core	0	1,523	0	0	85	8,083	51	10	452	0	0	27	0	69	763	0	0
	Flank	317	1,083	51	299	160	1943	0	130	705	129	33	16	20	313	419	35	11
AUMs Affected		7.0	325.8	2.1	21.4	16.3	313.3	3.4	8.75	82.6	11.7	0	3.6	0.9	12.3	59.1	4.4	unk
After Interim Reclamation	Core	0	490	0	0	27	2,603	16	3	145	0	0	9	0	22	251	0	0
	Flank	101	347	16	96	51	622	0	41	225	41	11	5	6	100	134	11	3
AUMs Affected		2.2	104.6	0.7	6.9	5.2	100.8	1.1	2.8	26.4	3.7	1.1	1.2	0.3	3.9	19.3	1.4	unk
Long-term % of AUMs Affected		1.0%	1.4%	0.7%	1.3%	0.9%	0.3%	3.0%	1.0%	1.3%	1.2%	1.1%	1.1%	0.9%	0.8%	0.7%	0.2%	unk
Alternative C																		
Drilling and Completion	Core	0	3,918	0	0	174	20,731	97	16	800	0	0	74	0	479	4643	0	0
	Flank	523	1,691	109	388	289	5,024	0	178	1,203	184	50	39	35	565	761	48	14
AUMs Affected		11.6	701.1	4.5	27.7	30.9	804.8	6.5	12.1	143.1	16.7	5	9.4	1.6	7.1	270.2	6.0	unk
After Interim Reclamation	Core	0	1,322	0	0	59	6,997	33	5	270	0	0	25	0	161	1577	0	0
	Flank	175	567	37	130	97	1,684	0	60	403	62	17	13	12	189	255	16	5
AUMs Affected		3.9	236.1	1.5	9.3	10.4	271.3	2.2	4.1	48.1	5.6	1.7	3.2	0.55	7.1	91.6	2.0	Unk
Long-term % of AUMs Affected		1.8%	3.1%	1.7%	1.7%	1.8%	0.9%	6.1%	1.4%	2.4%	1.8%	1.7%	3.1%	1.9%	1.5%	3.2%	0.32%	unk

4.12.2.3.4. Alternative B

Long-term surface disturbance resulting from Alternative B would be the same as that from the No Action/Low Development Alternative; therefore, loss of available grazing and AUMs on the allotments within the MAA would also be the same. Application of techniques to reduce surface disturbance, as defined in Chapter 2, would not significantly reduce direct or indirect impacts to grazing allotments. The increased emphasis on reclamation success under this alternative would further reduce impacts to grazing allotments, and could possibly improve the quantity and quality of available forage for livestock. The reduction in AUMs from Alternative B would not be a significant loss (Feeley 2006) and would not result in economic impacts to the grazing lessees within the MAA.

4.12.2.3.5. Alternative C

Potential short-term and long-term impacts to AUMs on the grazing allotments within the MAA are presented in Table 4-26. Due to increased well density and surface disturbance, direct impacts to AUMs and economic costs to grazing lessees would increase as a result of Alternative C over those of the Proposed Action. Alternative C would result in an initial disturbance of about 30,932 acres (1,237 acres per year for the 25 years of drilling) in the core and 11,857 acres (474 acres per year) in the flank. This represents about 9.9% of the total land area of the allotments. During the LOP, this disturbance would be reduced to about 14,424 total acres, or about 3.3% of the combined land area of the allotments. The reduction in AUMs from Alternative C would not be a significant loss (Feeley 2006) and would not result in economic impacts to the grazing lessees within the MAA.

4.12.2.4. Mitigation

Protection measures that benefit rangelands include those that prevent weed spread or introduction of new noxious weed infestations (see Section 4.7). Other Operator-committed measures include repairing fences damaged or removed for construction and avoiding impacts to range improvements such as stock ponds, guzzlers, and other watering amenities.

Increasing the amount of field automation would reduce traffic in the MAA, and would thereby reduce the impacts on vegetation from fugitive dust. The Moxa Arch Field Automation Traffic Data Analysis study recently completed by BP, shows that utilizing transmitted instrumentation readings could reduce the number of round trips to standard well sites by 50%.

As mitigation for the initial temporary loss of AUMs, use of a reclamation seed mix that fits the needs of affected permittees and complies with BLM standards should continue to be implemented in the MAA (see Reclamation Plan, Appendix E).

4.12.2.5. Residual Impacts

No residual impacts are expected after successful reclamation.

4.12.3. Recreation

4.12.3.1. Introduction

Recreational resources are an important value for residents in the vicinity of the Project Area, as well as a source of income for the state of Wyoming and its cities and towns. One of the goals of the Kemmerer RMP is to assure that these resources are preserved and continue to be available to residents and visitors.

4.12.3.2. Significance Criteria

Impacts to recreation would be considered significant if project development changes the recreational use of the MAA or results in a violation of RMP or other land use plan recreation objectives. Impacts to recreation in most cases are assumed to be proportional to the amount of development for all alternatives (Tables 2-3, 2-4, and 2-5). Dispersed recreation opportunities may be impacted in the MAA for the LOP under all project alternatives, including the No Action/Low Development Alternative.

4.12.3.3. Direct and Indirect Impacts

4.12.3.3.1. Impacts Common to All Alternatives

Impacts to recreational sites and facilities are expected to be minimal for all alternatives. The MAA has two campground facilities within its boundaries. Slate Creek Campground is located on the west side of the Green River, approximately four miles south of the Fontenelle Reservoir, and the Weeping Rock Campground is located on the west side of the Green River, approximately one mile south of the Fontenelle Reservoir. Though both of these facilities occur in the MAA, significant impacts are not expected as development in this flank area is anticipated to be minimal.

The MAA does not currently have a high level of recreational use. As such, direct impacts to recreational opportunities are expected to be minimal. Project-improved roads may promote some increased recreational use (e.g., access for hunting and sightseeing). However, long-term displacement of existing dispersed recreation (if any) due to increased levels of gas field development activity is anticipated. In addition, some potential recreational visitors would likely avoid the MAA because of a perceived reduction in the quality of the recreational experience.

<u>Hunting</u>

Hunting pressure on any species within the MAA is likely to be directly related to wildlife population size, structure, and availability. Under all alternatives, displacement of populations of pronghorn and other hunted species could impact the quality or perceived quality of recreational hunting opportunities in the MAA. Lands adjacent to or in the flank of the MAA would likely absorb some of the displaced hunting pressure, because displaced wildlife would likely move to adjacent lands.

<u>Fishing</u>

BLM-permitted development activities within the KFO area are restricted by a 500-foot buffer along streams and creeks to protect aquatic and riparian resources. This would benefit anglers, as well as water resources, in that no direct effects to fishing resources are expected. Other protection measures designed to keep sedimentation out of water bodies would benefit fish and, therefore, angling resources. Impacts to surface waters that may indirectly affect fishing opportunities include increases/decreases in levels of water flow and runoff, sedimentation (downstream and offsite), salinity changes, and turbidity. Potential visual and noise effects to anglers will depend on the proximity of development activity to fishing access areas and will be analyzed on a case-by-case basis. Fishing access to the Hams Fork and Blacks Fork Rivers may be temporarily affected when project activities are occurring in the immediate area.

<u>Camping</u>

Camping occurs in well-established areas that are not expected to be impacted by oil and gas development activities. Potential visual and noise effects to campers will depend on the proximity of development activity to camping areas and will be analyzed on a case-by-case basis.

<u>Open Recreation (Hiking, Off-highway Vehicles [OHVs], Wildlife Watching)</u>

Because recreation of this type is primarily dispersed throughout the MAA, specific effects are difficult to determine. Roads created for oil and gas resource development may be used by OHVs for

access or other recreational opportunities. During concentrated development activities, some of these recreational pursuits may be temporarily affected by access limitations, noise, and/or visual intrusions. Long-term impacts may include reduced ecologic or aesthetic value of the area for activities such as wildlife watching and hiking. Additionally, some areas may be off-limits due to safety issues, reducing recreation access.

4.12.3.3.2. Proposed Action

Under the Proposed Action, impacts to recreational opportunities are anticipated to increase from levels under the Alternative A as 1,861 new well pads are constructed and the approximate 931 miles of new roads are built. Duration of impacts would be for the 60-year LOP and until areas are adequately reclaimed.

4.12.3.3.3. Alternative A

Current and continuing permitted/approved resource developments in the MAA would not be expected to change the opportunities for access to recreational resources. Disturbance would continue through the LOP of current development projects.

4.12.3.3.4. Alternative B

Impacts to recreation under Alternative B would be similar to that of Alternative C. However, surface disturbance reduction techniques could potentially reduce impacts to recreational resources to that of Alternative A.

4.12.3.3.5. Alternative C

Under Alternative C, impacts to recreational opportunities are anticipated to increase from levels under the Proposed Action, as 5,165 new well pads and approximately 2,583 miles of new roads are constructed. Duration of impacts would be for the 75-year LOP and until areas are adequately reclaimed. The types of impacts are expected to be the same as those described for the Proposed Action.

4.12.3.4. Mitigation

No specific mitigation for recreational resource impacts is anticipated, as disturbance is not expected to be significant. However, any measure that reduces the volume of surface disturbance and human presence, as well as those measures that minimize adverse effects to wildlife, has the potential to reduce impacts to recreation. Additional techniques employed to reduce surface disturbance in Alternative B may reduce impacts to recreational resources. Mitigation measures for wildlife and big game species would likely benefit recreation.

4.12.3.5. Residual Impacts

Residual impacts after final reclamation and the LOP are expected to be minimal and not significant. Recreational hunting opportunities in the MAA and other wildlife-related recreation may still be slightly impacted after the LOP until displaced species return to the area.

4.12.4. Transportation

4.12.4.1. Introduction

Transportation effects of natural gas development and production would include increased traffic on federal and state highways and county roads providing access to the MAA, primarily I-80, US 30, and US 189. Primary access from Green River and Rock Springs is from I-80 and US 30. Access from Evanston and the Bridger Valley is from I-80. Primary access from Kemmerer and Diamondville is

from US 30 and US 189. Wyoming Secondary Highways WY 372, WY 240, and WY 374 also provide access to portions of the MAA. The BLM, cooperating agencies, and the Operators would continue to cooperatively develop long-term transportation management plans for existing and future roads. Total number of trips would increase in proportion to the level of development for each alternative (Table 4-27).

Table 4-27. Total Number of Trips by Alternative.

Trip Type	Proposed Action	Alternative A	Alternatives B and C
Drilling	22,320	12,960	24,620
Cementing and Production casing	11,160	6,480	12,310
Completion and Testing	37,220	21,612	41,000
Operations/Maintenance	2,880	1,672	12,972
Frac Operations	7,812	4,536	8,610
Road and Pad Construction	3,906	2,268	4,305
Total trips for peak year	**85,298**	**49,528**	**103,817**

* Total trips for Alternative B could be reduced through use of techniques such as mat drilling, drilling multiple wells from a single pad, and remote monitoring/control.

4.12.4.2. Significance Criteria

The following criterion is used to determine whether transportation impacts would be significant: increases in traffic levels in the local public transportation system that would cause the level of service to fall below acceptable levels, as defined by the responsible government agency.

4.12.4.3. Direct and Indirect Impacts

4.12.4.3.1. Proposed Action

Table 4-28 shows the estimated number of annual round trips associated with drilling, field development, and well field operations activities in the 10th (peak) year of drilling. Drill rigs and other heavy equipment would be transported to the MAA and remain within the Project Area until relevant work is completed. Materials and supplies would be delivered on an as-needed basis. Drilling and completion crews would commute to the MAA daily. Other contractors and vendors would commute on an intermittent, as-needed basis.

Table 4-28. Proposed Action Traffic Estimates in Peak 10th Year of Drilling.

Trip Type	Vehicle Requirements	Days/well	Well	Annual Round Trips
Drilling	6 vehicles/day	20	186	22,320
Cementing and Production casing	6 vehicles/day	10	186	11,160
Completion and Testing	20 vehicles/day	10 days	186	37,220
Operations/Maintenance	*	*	1861	2,880
Frac Operations	6 vehicles/day	7 days	186	7,812
Road and Pad Construction	3 vehicles/day	7 days	186	3,906

*Assumes each pumper visits 20 wells and that telemetry is installed within 60 days. Each well is visited twice monthly during the 10th year with the exception of newly installed wells that will require daily visits for the first 60 days.

Average annual daily traffic (AADT) estimates were developed based on current drilling activities occurring in the MAA since the 1997 ROD, including drilling activities for typical conventional gas wells, construction of ancillary facilities, performance of routine operations activities and well workovers, and miscellaneous visits. Based on past and current operations, the Proposed Action would generate an estimated AADT of 467 (233 round trips) during the peak drilling year (Year 10). Year 10 will have the same number of wells drilled as year 1, with the continuance of routine maintenance and operations activities for all wells drilled to that point. This would include an AADT of 429 for drilling and field development activities. AADT is calculated on a 365-day basis, and drilling and field development activities would be limited due to weather-related activities. Therefore, average daily traffic would be substantially higher during the active drilling period. Drilling and field development traffic would remain relatively constant through the 10 years of drilling requested under the Proposed Action. Operations traffic would increase through the 10 years of drilling and would remain constant thereafter until the life of the wells begin diminishing during year 30 of production. Under the assumptions used for this assessment, Proposed Action-related AADT would be relatively constant after the peak year, consisting of operations and maintenance, and would average approximately 12 trips per day (20 pumpers per well twice monthly).

Table 4-29 contrasts peak drilling year (Year 10) AADT for federal and state highways providing access to the MAA, with 2005 and projected 2015 AADT on those highways. AADT for individual highways was derived by using the percentage of total AADT for each highway from the BLM approved Expanded Moxa Arch Area Draft EIS, April 1995, and extrapolating the data to the same highways using current estimated AADT data.

Table 4-29. Proposed Action Peak Drilling Year (Year 10) AADT Compared with 2005 AADT and Projected 2015 AADT on Affected Highways.

Highway Segment	2005 AADT	Projected 2015 AADT	Estimated Peak Year Drilling Year AADT	% 2005 AADT	% Projected 2015 AADT
I-80 (mp 6.26-107.09	13,146 (5,877 Trucks)	15,652 (6,696 Trucks)	225	1.7	1.4
U.S. 30 (mp55.13-100.03)	1,983 (928 Trucks)	2,554 (1,684 Trucks)	184	9.2	7.2
U.S. 189 (mp 0.0-66.86)	1,232 (162 Trucks)	1,443 (189 Trucks)	29	2.4	2
WY 372 (mp 0.114- 48.59)	1,207 (321 Trucks)	1,344 (358 Trucks)	20	1.7	1.5
WY 240 (mp 0.0-12.29)	399 (120 Trucks)	484 (121 Trucks)	8	2	1.7

Source: Wyoming Department of Transportation (Adkison 2006; Carpenter 2006)

Given the potential for increased drilling and field development in the area, these traffic forecasts may change. The Proposed Action-related increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways. Wyoming severance tax revenues and the State's share of federal mineral royalty revenues associated with the Proposed Action would offset these costs. The Proposed Action-related increase of traffic on federal and state highways would result in a corresponding increase in the statistical probability of accidents on these highways, although actual accident rates would depend on a variety of factors.

4.12.4.3.2. Alternative A

As part of Alternative A/No Action, the BLM would reject the Operators' proposal and continue with implementation of the 1997 ROD for the previous Moxa Arch EIS. Authorizations for and impacts from previously approved or analyzed development and surface disturbance would continue. Traffic volumes (Table 4-28) would be approximately equal to those described in the Expanded Moxa Arch Gas Development EIS (BLM 1995a).

4.12.4.3.3. Alternative B

Alternative B would have well numbers similar to those of Alternative C, and surface disturbance estimates similar to those of Alternative A. Consolidation of production facilities and drilling multiple wells from single pads would decrease traffic as a result of fewer operations and maintenance trips and fewer construction trips. The level of this decrease would depend on how the operators develop the field. If multiple wells are drilled from single pads, traffic could decrease proportionally to the number of directional wells drilled.

Drilling multiple wells from single pads could increase localized traffic impacts. If wells are drilled directionally the rigs sit on the pads for a longer duration and traffic follows the same route the entire time the rig is on site rather than dispersing among multiple rigs.

4.12.4.3.4. Alternative C

Table 4-30 shows the estimated number of annual round trips associated with drilling, field development, and well field operations activities in the 25th (peak) year of drilling. Drill rigs and other heavy equipment would be transported to the MAA and remain within the Project Area until relevant work is completed. Materials and supplies would be delivered on an as-needed basis. Drilling and completion crews would commute to MAA daily. Other contractors and vendors would commute on an intermittent, as-needed basis.

Table 4-30. Alternative C Traffic Estimates in Peak 25th Year of Drilling.

Trip Type	Vehicle Requirements	Days/well	Well	Annual Round Trips
Drilling	6 vehicles/day	20	205	24,620
Cementing and Production casing	6 vehicles/day	10	205	12,310
Completion and Testing	20 vehicles/day	10	205	41,000
Operations/Maintenance	*	*	5,165	12,972
Frac Operations	6 vehicles/day	7	205	8,610
Road and Pad Construction	3 vehicles/day	7	205	4,305

*Assumes each pumper visits 20 wells and that telemetry is installed within 60 days. Each well is visited twice monthly during the 25th year with the exception of newly installed wells, which will require daily visits for the first 60 days.

Based on past and current operations, Alternative C would generate an estimated AADT of 568 (284 round trips) during the peak drilling year (Year 25). Year 25 will have the same number of wells drilled as year 1 with the continuance of routine maintenance and operations activities for all wells drilled to that point. This would include an AADT of 498 for drilling and field development activities. AADT is calculated on a 365-day basis and drilling and field development activities would be limited due to weather related activities. Therefore, average daily traffic would be substantially higher during the active drilling period. Drilling and field development traffic would remain relatively constant through the 25 years of drilling requested under Alternative C. Operations traffic would increase through the 25 years of drilling and would remain constant thereafter until the life of the wells begin diminishing during the subsequent 15 years. Under the assumptions used for this assessment, Alternative C-related AADT would be relatively constant after the peak year, consisting of operations

and maintenance, and would average approximately 34 trips per day (20 wells per pumper twice monthly).

Table 4-31 contrasts peak drilling year (Year 25) AADT for federal and state highways providing access to the MAA with 2005 and projected 2025 AADT on those highways. Given the potential for increased drilling and field development in the area, these traffic forecasts may change. The Proposed Action-related increase in traffic, particularly truck traffic, would accelerate maintenance requirements on federal and state highways. Wyoming severance tax revenues and the State's share of federal mineral royalty revenues would offset these costs. The increase of traffic on federal and state highways would result in a corresponding increase in the statistical probability of accidents on these highways, although actual accident rates would depend on a variety of factors.

Table 4-31. Alternative C Peak Drilling Year (Year 25) AADT Compared with 2005 AADT and Projected 2025 AADT on Affected Highways.

Highway Segment	2005 AADT	Projected 2025 AADT	Estimated Peak Drilling Year AADT	% 2005 AADT	% Projected 2025 AADT
I-80 (mp 6.26-107.09	13,146 (5,877 Trucks)	18,234 (8,934 Trucks)	275	2.1	1.5
U.S. 30 (mp55.13-100.03)	1,983 (928 Trucks)	2,713 (1,832 Trucks)	224	11.2	8.2
U.S. 189 (mp 0.0-66.86)	1,232 (162 Trucks)	1,652 (228 Trucks)	35	2.8	2.1
WY 372 (mp 0.114- 48.59)	1,207 (321 Trucks)	1,453 (425 Trucks)	24	2.0	1.7
WY 240 (mp 0.0-12.29)	399 (120 Trucks)	579 (160 Trucks)	10	2.5	1.7

4.12.4.4. Mitigation

Operators will be required to participate in and assist with funding of development of an area-wide transportation plan which will include transportation network design, dust control measures, and address other transportation-related issues.

Increasing the amount of field automation would reduce traffic impacts in the MAA. The Moxa Arch Field Automation Traffic Data Analysis study recently completed by BP, shows that utilizing transmitted instrumentation readings could reduce the number of round trips to standard well sites by 50%.

4.12.4.5. Residual Impacts

No residual impacts would be expected after the LOP.

4.12.5. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

4.12.5.1. Livestock and Grazing Allotments

Impacts to livestock and grazing allotments would be greatest for Alternative C, which approximately doubles the amount of disturbance to allotments that would occur under the Proposed Action. Generally, impacts to allotments would be lowest under the No Action/Low Development Alternative.

However, impacts to smaller leases in several of the zones used in the 1997 EIS could be slightly greater under the Alternative A. Alternative B would be expected to have similar levels of surface disturbance as Alternative A Implementation of techniques to reduce total project surface disturbance and increase reclamation success in order to remain under the disturbance cap could reduce the impacts to livestock and grazing allotments. Loss of forage, death or disruption of livestock, and other impacts that might affect livestock or allotments would be approximately proportional to the level of disturbance that would occur in each allotment.

4.12.5.2. Recreation

Impacts to recreational resources in the MAA are not expected to be significant, as the current recreational opportunities in the MAA are minimal. Indirect effects to recreational opportunities associated with wildlife may occur due to the displacement of species during construction and reclamation and continue until these species return to the area. Other dispersed recreational opportunities may also be affected during the LOP, though not significantly. Of all alternatives, Alternative B would most likely have the least amount of impacts to recreational resources. Implementation of mitigation and techniques that reduce surface disturbance and minimize impacts to wildlife have the potential to reduce impacts to recreational resources. Alternative C would have the most impact on recreational opportunities, due to the high levels of disturbance.

4.12.5.3. Transportation

Impacts to transportation would be proportional to the number of well pads that would be constructed in the MAA. Alternative C would generate the greatest increase in traffic because of the higher number of well pads that would be constructed. Alternative A would generate the lowest increase in traffic, with volumes similar to those currently observed in the MAA. Alternative B could generate traffic volumes similar to those of Alternative C. However, implementation of surface disturbance reduction techniques, such as drilling multiple wells from single pads, consolidating production facilities, remote monitoring and remote control of wells, and implementing traffic planning, would minimize the total traffic volume.

4.13. Visual Resources

4.13.1. Introduction

Potential impact areas in the MAA include historic trails; views from surrounding recreation areas; and views from I-80, U.S. 30, Hwy 189, and railroads. For the most part, these are VRM Class II and III areas and are associated with the Hams Fork and Green Rivers and the Fontenelle Reservoir. A majority of the interior of the project area is Class IV and is not typically seen by the public. Visual resource impacts from natural gas development can result from increases in well pad density, miles of road and pipeline, traffic, and ancillary facilities within the MAA. Construction equipment and temporary facilities cause short-term impacts to contrasts in the characteristic line, form, color, and texture of the landscape. Fixed structures cause long-term impacts to the landscape. The severity of impact to sites depends on the existing scenic quality, level of disturbance, reclamation potential, and visibility to viewers. Note that the project is located within “checkerboard” land ownership, and visual impacts are not regulated on private or state lands.

4.13.2. Significance Criteria

Impacts to visual resources in the MAA would be significant if project-related development did not meet the BLM VRM class objectives described in Section 3.12 or caused a change in the overall character of the landscape. The VRM analysis process determines whether the potential visual

impacts from proposed surface-disturbing activities meet the management objectives established for the area, or whether design adjustments will be required. A visual contrast rating process is used for this analysis, which involves comparing the project features with the major features in the existing landscape using the basic design elements of form, line, color, and texture. Site-specific analyses would occur after approval of the project and issuance of the ROD by the BLM and before surface disturbance would be allowed to take place on federal surface or minerals, pursuant to an individual APD or ROW grant.

In addition to VRM management, the Wyoming BLM analyzes impacts to National Historic Trails (NHT) and their associated viewsheds. Visual surveys determine the visibility of structures and ground level visibility from NHTs. To provide a protective corridor for the trail; generally visual intrusion and surface disturbance will be restricted or prohibited within 1,320 feet from either side of an historic trail (may depend on topography and existing surface disturbance), or within the visual horizon of the trail, whichever is closer.

4.13.3. Direct and Indirect Impacts

Table 4-32 shows the acres of impact within the MAA by VRM Class. Impact estimates for Alternative B are not included in Table 4-32 because it cannot be determined how wells would be distributed across the MAA under implementation of this alternative. In general, wells, roads, and pipelines will be evenly distributed throughout the MAA and, therefore, are proportionate to the VRM Class acreages within the MAA. For all alternatives, the greatest amount of surface disturbance will take place in VRM Class IV areas, while the least impact will take place in Class II. However, even low levels of disturbance within Class II areas can be significant, because these areas are more visible to the observer.

Table 4-32. Impacts to VRM Class Areas within the MAA.

Disturbance Type	Core/ Flank	Class II		Class III		Class IV	
		# Wells	Acres	# Wells	Acres	# Wells	Acres
Alternative A							
Drilling and Completion	Core	28	431.5	63	957.4	299	4582.4
	Flank	18	270.2	78	1187.0	185	2830.2
After Interim Reclamation	Core	28	119.8	63	265.8	299	1272.1
	Flank	18	75.0	78	329.5	185	785.7
Proposed Action							
Drilling and Completion	Core	155	1555.6	293	2944.5	785	7870.3
	Flank	66	661.5	184	1842.8	377	3774.8
After Interim Reclamation	Core	155	497.5	293	937.5	785	2510.7
	Flank	66	211.7	184	589.7	377	1207.9
Alternative C*							
Drilling and Completion	Core	359	3164.6	1158	10231.2	2245	19829.4
	Flank	116	1013.9	459	4044.9	828	7286.3
After Interim Reclamation	Core	359	1059.9	1158	3414.7	2245	6623.1
	Flank	116	339.9	459	1355.9	828	2442.6

Acres includes surface disturbance from well pads, roads, pipelines, and additional disturbance
* Includes MMTA

4.13.3.1. Proposed Action

Under the Proposed Action, natural gas field development would increase from existing development in the MAA with the addition of wells, increased miles of roads and traffic, and ancillary facilities. Total surface disturbance area resulting from the Proposed Action would be 2,217 acres in VRM Class II, 4,787 acres in VRM Class III, and 11,645 acres in VRM Class IV. The highest level of visual impact would occur during construction and drilling, which would be a 10-year duration. Visual impacts would continue to a lesser degree over the 40-year life of the wells and for additional time as reclamation continues.

The additional wells in the MAA would increase the likelihood of people seeing a landscape that includes oil and gas structures, areas of bare soil around well pads and other facilities sites, and roads. These would contrast with the natural landscape, especially in areas of continuous vegetation. Locations with the greatest potential for visual contrasts from the Proposed Action would be viewpoints along the major roads passing through the MAA. These roads would likely be traveled by private property owners and recreational visitors, as well as by oil and gas-related personnel. Sensitivity to the level of visual contrast from oil and gas development would likely be highest among recreation users, including hunters, sightseers, and wildlife observers. Visual impacts related to the Proposed Action would be significant and long term, beginning during development and lasting beyond the LOP.

The Operators' commitment to reduce visual impacts through the use of BLM-approved paint colors for production facilities will help to mitigate visual resource impacts. This mitigation would occur for all project alternatives.

4.13.3.2. Alternative A

Under Alternative A/No Action, there would be no new impacts to visual resources beyond existing Moxa Arch developments approved by the 1997 ROD. Disturbance in VRM classes would include 702 acres in VRM Class II areas, 2,144 acres in VRM Class III areas, and 7,413 acres in VRM Class IV areas.

For Alternative A/No Action, the 1996 Moxa EIS and 1997 ROD determined that short-term impacts would exceed the level of contrast permitted in Class II, III, and IV. Application of mitigation measures would reduce contrasts to levels permitted in Class IV areas, and impacts in Class II and III areas would be reduced with mitigation, but not to levels below significance.

4.13.3.3. Alternative B

Under Alternative B, development would be similar to Alternative C. However, additional techniques employed to reduce surface disturbance and increase reclamation would reduce visual impacts. These techniques include drilling multiple wells from single well pads, collocating gathering and power lines with roads, and minimizing vegetation and topsoil removal. Therefore, impacts to visual resources would be reduced to levels similar to Alternative A.

4.13.3.4. Alternative C

Total surface disturbance in VRM Classes would include 4,179 acres in VRM Class II, 14,276 acres in VRM Class III, and 27,116 acres in VRM Class IV. The highest level of visual impact would occur during construction and drilling, which would occur over a 25-year period. Visual impacts would continue to a lesser degree over the 40-year expected production life of the wells following drilling and for additional time as reclamation continues.

With the additional wells and associated infrastructure in Alternative C, visual changes to the characteristic landscape would be more noticeable. While Alternative A has already significantly impacted many of the VRM areas, higher development under Alternative C would be more likely to attract the attention of the casual observer. It could also cause reduced visitation by recreators and would likely increase the significance of the VRM impacts; therefore, it would not meet VRM objectives.

4.13.4. Mitigation

BLM management objectives that protect visual resources include evaluating the visual sensitivity (e.g., VRM classes) of the Project Area and ensuring compatibility of projects with management objectives for visual resources; blending long-term facilities with the natural environment; and restricting visual intrusion and surface disturbance within Class I and II areas and within 0.25 mile of either side of a NHT or within the visual horizon of the trail, whichever is closer. Also, the required 500-foot riparian buffer would prevent wells from being located in portions of VRM Class II areas along rivers.

When final siting decisions are made, design and location strategies would be used to screen features from view in VRM Class II and III areas visible from major roads. Using existing topography to screen roads, pipeline corridors, drill rigs, wellheads, and production facilities is included in agency requirements for visual resources.

Reclamation and road standards, which would be applied for all alternatives, would reduce the amount of bare ground that contrasts with the natural environment, reducing short-term and residual visual impacts of disturbed sites.

4.13.5. Residual Impacts

Residual impacts on the visual resources would occur even after final reclamation at the end of the LOP because of the time it takes for reclaimed areas to return to pre-disturbance vegetation conditions. Shrubland communities and impacted sensitive soils could take as long as 30+ years to recover, depending on factors such as soils, climate, and maintenance. The MAA would also likely retain numerous improved project roads, which would create lasting linear features that detract from the existing character of the area.

4.13.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

As development in the MAA increases, observers would be able to notice a change in the characteristic of the landscape. Structures, roads, and bare ground will interrupt basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape, depending on the number of wells planned for visible areas. Therefore, Alternative C would have the most impact on visual resources, while the Alternative A/No Action would have the least impact. Impacts would be long-term, existing during the LOP and while the natural landscape recovers after reclamation.

4.14. Hazardous Materials/Health and Safety

4.14.1. Introduction

Potential health and safety impacts associated with all alternatives are similar to those associated with existing conditions in the MAA, although the risk of certain types of impacts would increase as the

amount of natural gas development increases. Potential health and safety impacts include occupational hazards associated with oil and gas exploration and development, risk associated with vehicular travel on improved and unimproved roads, and range fires.

4.14.2. Significance Criteria

No specific health and safety standards were identified in the Kemmerer RMP (BLM 1985). General health and safety effects of the alternatives would be considered significant if they resulted in substantially increased risk to the public, results in the "release" (40CFR300.5) of hazardous substances at or above reportable quantities to the environment, and/or fails to comply with all federal, state, or local regulations.

4.14.3. Direct and Indirect Impacts

Direct and indirect impacts of development in the MAA would be proportional to the level of development under each alternative. As these impacts are proportional, additional analysis for each alternative will not be completed. The following are the direct and indirect impacts that would be expected for all project alternatives and the proximity to sensitive resources (i.e. water, wildlife, human receptors).

4.14.3.1. Health and Safety

Potential health and safety effects associated with development in the MAA include hazards associated with natural gas development and operations; risk associated with vehicular travel on county, BLM, and Operator-maintained roads; firearms accidents during hunting season and by casual firearms use such as plinking and target shooting; and natural events such as range fires.

Deep formations in the Church Buttes Unit in the southern third of the MAA have produced hydrogen sulfide (H_2S), a gas that could cause concerns with regard to health and safety. However, the Proposed Action and alternatives are producing the Frontier and Dakota formations and H_2S is not expected to be a problem. Also, operations of the Shute Creek gas plant could create health and safety issues related to the accidental release of H_2S. The Proposed Action and alternatives will not modify the operations of this plant. However, oil and gas activities in the vicinity of the Shute Creek plant should have contingency plans should an accidental upset occur at the plant.

The potential for firearms-related accidents would occur primarily during hunting season. However, the increased activity in the MAA during drilling and field development would likely discourage hunting in the vicinity during that period. Consequently the risk of fire arms-related accidents should be minimal.

Scoping identified concerns with wells placed within one-mile of the Fontenelle Reservoir dam and directional drilling under the dam. If wells are placed in close proximity to the dam, some possibility exists that structural damage could occur.

4.14.3.2. Occupational Hazards

Adherence to relevant safety regulations on the part of the Operators and enforcement by the respective agencies would reduce the probability of accidents. Additionally, given the remote nature of the Project Area and the relatively low use of these lands by others (primarily grazing operators and hunters), occupational hazards associated with the Proposed Action and alternatives would mainly be limited to employees and contractors rather than the public at large.

4.14.3.3. Pipeline Hazards

Increasing the miles of gathering and transmission pipelines within the MAA would increase the chance of a pipeline failure. However, the low probability of failure, the remoteness of the Project Area, and the low level of anticipated non project-related construction and excavation would result in minimal risk to public health and safety. Compliance with signing requirements for pipeline ROWs and Wyoming One call standards would reduce the likelihood of pipeline ruptures caused by excavation equipment, particularly in the vicinity of road crossings or areas likely to be disturbed by road maintenance activities.

4.14.3.4. Hazardous Materials

Drilling, field development, and production activities require use of a variety of chemicals and other materials, some of which would be classified as hazardous. A Hazardous Materials Management Plan is provided as Appendix B, pursuant to BLM Instruction Memoranda Numbers WO-93-344 and WY-94-059, which require that all NEPA documents list and describe any hazardous and/or extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project. Potential impacts associated with hazardous materials include human contact, inhalation, or ingestion; and the effects of exposure, spills, or accidental fires on soils, surface and ground water resources, and wildlife. A Hazard Communication Program, Spill Prevention Control and Countermeasure (SPCC) Plans, and other mitigation measures, would reduce the risk of human contact, spills, and accidental fires, and would provide protocols and employee training to deal with these events should they occur.

4.14.3.5. Fire and Natural Hazards

The risk of fire in the Project Area would increase under the Proposed Action and would be associated with construction activities, industrial development, and the presence of fuels, storage tanks, natural gas pipelines, and gas production equipment. However, this risk would be reduced by the placement of facilities on pads and locations that are graded and devoid of vegetation. In the event of a fire, property damage would likely be limited to construction- or production-related equipment and range resources. Fire suppression equipment, a no smoking policy, shutdown devices, and other safety measures typically incorporated into gas drilling and production activities would help to minimize the risk of fire.

A heightened risk of wildfire would occur where construction activities place welding and other equipment in close proximity to native vegetation. Given the limited public use and presence in the Project Area, the risk to the public would be minimal. There would be a small increase in risk to area fire suppression personnel associated with the Proposed Action and alternatives.

There would be an increased potential for weather-related hazards associated with the Proposed Action and alternatives. Many development locations in the MAA are remote, and rapidly moving storms can impair driving conditions in a fairly short time. Workers may get stranded in remote locations, requiring rescue operations by emergency management personnel. Proper training of development and operations workers, coordination with emergency management agencies, and frequent mapping of development locations can reduce the potential for weather-related impacts.

4.14.4. Mitigation

The Operators should coordinate emergency response planning with the Uinta, Sweetwater, and Lincoln Counties Emergency Management Agency and provide documentation regarding compliance with Federal Hazardous Material Regulations and the Uniform Fire Code.

To avoid the unlikely possibility of structural damage to the Fontenelle Reservoir dam, wells should not be drilled within one mile of the dam.

4.14.5. Residual Impacts

Risk to health and safety of workers, contractors, and other users of the Project Area associated with industrial accidents, transportation accidents, shooting accidents, and natural fire disasters would remain for the LOP and may exist for years after due to chemicals within reserve pits, misinterpretation of laws [i.e. Resource Conservation and Recovery Act (RCRA)] and regulations regarding the handling and disposal for hazardous materials, and unreported chemical spills. However, risks to the public would be small, given the remoteness of the area, the low visitor numbers, and the proposed mitigation measures.

4.14.6. Summary of Direct and Indirect Impacts, Mitigation, and Residual Impacts

Given the remote nature of the Project Area, health and safety risks to the public due to project development activities are expected to be generally low. Occupational hazards would be limited to project employees and contractors, rather than the general public.

The potential for impacts related to the use of hazardous materials would be reduced by implementing a Hazard Communication Program, SPCC Plans, and other mitigation measures. Although a heightened risk of wildfire would occur where construction activities place welding and other equipment in close proximity to native vegetation, risk to the public would be minimal, given the limited public use and presence in the Project Area.

CHAPTER 5 CUMULATIVE IMPACTS ANALYSIS

5.1. Introduction

The National Environmental Policy Act of 1969 (NEPA), as amended, requires an assessment of potential cumulative impacts. Federal regulations (40 Code of Federal Regulations [CFR] 1500 1508) define cumulative impacts as:

> *"...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time."*

Potential cumulative impacts are assessed at the resource level. The cumulative impact analysis area (CIAA) for past, present, and reasonably foreseeable future activities (RFFAs) that may generate cumulative impacts varies depending on the resource under consideration. For example, the CIAA for air quality is regional in nature; therefore, the scope of activities considered is necessarily broad. In contrast, the CIAA for geology and minerals is the area specifically associated with the Proposed Action and alternatives; therefore, the scope of potential cumulative activities considered is much narrower.

This discussion of potential cumulative impacts assumes the successful implementation of the BMPs and mitigation measures discussed in Chapters 2 and 4 of this EIS, as well as compliance with the Kemmerer RMP and all applicable federal, state, and local regulations and permit requirements.

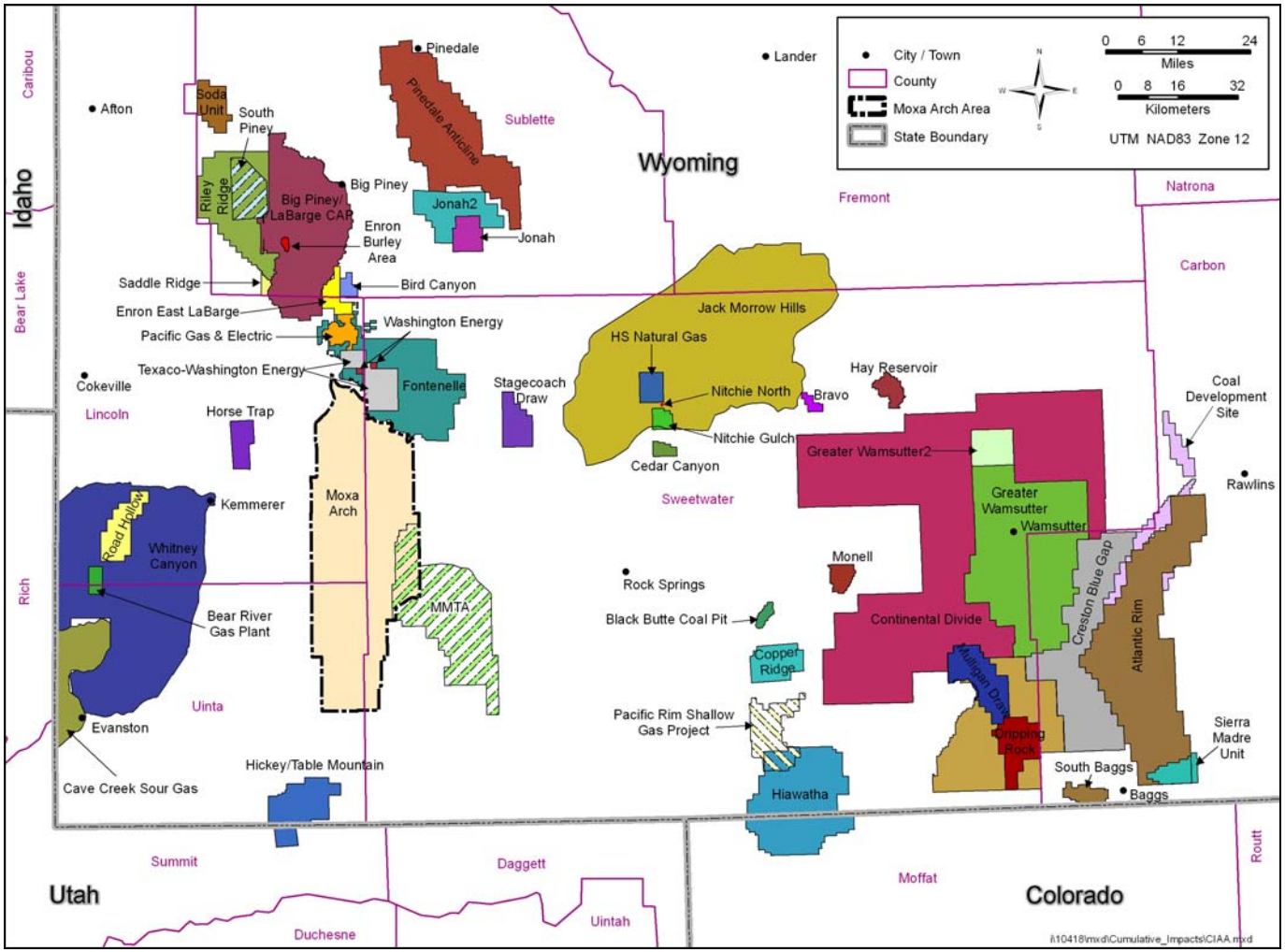
5.2. Past, Present, and Reasonably Foreseeable Future Activities

Past and existing development in the MAA and RFFAs are organized by CIAA and include the Moxa Arch Area CIAA, the watershed CIAA, the wildlife and recreation CIAA, the four-county area CIAA, and the air quality CIAA as described below (Map 5-1).

5.2.1. Moxa Arch Area CIAA

In addition to the current disturbance and anticipated future natural gas development previously discussed in this document, RFFAs in the MAA involve natural gas and liquids pipelines, geophysical exploration projects, trona mining, and wind energy projects. The MAA CIAA (Map 5-1) will be used to analyze cumulative impacts to visual resources, noise, cultural resources, geology, minerals, and paleontological resources.

<u>Overthrust Pipeline Project</u>
Overthrust Pipeline Company is seeking authority to construct and operate a new 36-inch-diameter pipeline that is approximately 27.2 miles long. The proposed pipeline facilities would connect Overthrust's existing pipeline in Uinta County, Wyoming to a Kern River Gas Transmission Company (Kern River) pipeline near Opal in Lincoln County, Wyoming. This new pipeline would begin at Overthrust's existing pipeline in Uinta County, approximately 500 feet west of the Sweetwater-Uinta County line. Portions of this pipeline are proposed to cross the MAA.



Map 5-1. Known Projects Falling within the CIAA Boundaries Used in Cumulative Impacts Determinations. This map reflects the extent of the known projects in the air quality cumulative impacts analysis. Cumulative impacts for other resources will not be analyzed at this scale and are described in more detail in this section.

Overland Pass Pipeline

Overland Pass Pipeline Company, LLC (Overland Pass) proposes to construct a 750-mile-long, 14-inch to 18-inch-diameter underground natural gas liquids (NGL) pipeline that would begin at its existing facilities in Opal, Wyoming and end at its existing facilities in Conway, Kansas. The proposed Overland Pass pipeline route would traverse the lower half of Wyoming in a west-to-east direction and would cross the MAA near the intersection of Sweetwater, Uinta, and Lincoln counties.

Jonah Gas Gathering Projects

Jonah Gas Gathering Company (JGGC) proposes to enhance the ability to gather natural gas produced from the Jonah and Pinedale Anticline natural gas fields for the long term (approximately 30 years). This proposal, which consists of constructing multiple large diameter pipelines, building a new compressor facility, expanding the existing Pioneer Gas Plant, and installing two 230 kV powerlines to supply power to the new compressor facility and plant expansion would allow JGGC to deliver to multiple markets and provide for the sale of developed minerals. The Bridger to Opal pipeline follows the existing JGGC pipelines through the Pinedale and Rock Springs Field Office areas and includes a 36-inch-diameter pipeline that traverses portions of the MAA. Future surface disturbance from the above-mentioned projects are expected to be minimal because their proposed locations are adjacent to existing pipelines.

Geophysical Exploration

Geophysical exploration projects will likely continue in the MAA to better define the gas resource in the Project Area. Typically, geophysical operations are necessarily spread over large areas to ensure that data collected are sufficient to define the mineral resources. Generally, geophysical operations in the MAA use vibroseis buggies or small explosive charges buried under the surface to create the seismic waves necessary to map the underlying geologic formations.

5.2.2. Watershed CIAA

The watershed CIAA is the combined watersheds that drain the MAA, Fontenelle Reservoir, the Green River to the Flaming Gorge Dam, and Flaming Gorge Reservoir (Map 3-3). This area of southwestern Wyoming and northeastern Utah includes oil and gas development; grazing and ranching; recreational development and dispersed recreation use; coal and trona mining; soda ash, fertilizer, and electric power production; and residential, commercial, and industrial development. This CIAA covers approximately 2.5 million acres; includes water, soils, and vegetation resources; and also represents the fisheries CIAA. In addition to the projects described above for the MAA CIAA, RFFAs occurring within the watershed CIAA are listed below.

Horse Trap Natural Gas Project – Lincoln County

Condor Exploration, LLC was authorized in 2001 to drill and develop 24 natural gas wells in the Horse Trap Natural Gas Project Area (HTPA) of southwestern Wyoming over a period of approximately two years. The proposed project was in addition to two active producing wells and the accompanying production-related facilities, roads, and pipelines. The 13,680-acre HTPA is located approximately 13 miles northeast of Kemmerer, Wyoming in Lincoln County and approximately 26 miles from the MAA.

Mechanically Mineable Trona Area (MMTA)

On April 15, 2004, an outreach meeting for the public and industry was held at the BLM Rock Springs Field Office in Rock Springs, Wyoming. A proposed solution to the conflict between oil and gas and trona resource recovery in the Known Sodium Leasing Area (KSLA) was described. In response to this conflict, BLM created a special management area called the Mechanically Mineable Trona Area (MMTA). The preferred course of action is to administer the area exclusively for trona extraction until conventional trona mining is complete. Oil and gas leasing and development are prohibited in

the MMTA. The area overlaps with the MAA; although, much of the development in the MMTA is located approximately southeast of the MAA.

5.2.3. Wildlife and Recreation CIAA

The CIAA for recreation is the combination of the MAA CIAA, watershed CIAA, the herd units for big game species (Maps 3-7 through 3-10), and Game Bird Management Areas for sage-grouse (Map 3-12). This CIAA includes recreation, wildlife, and grazing resources; however, the grazing CIAA only includes the grazing leases that intersect the MAA. Past and historic activities occurring in the region surrounding the MAA include oil and gas exploration, development, and production; dispersed recreation; ranching and grazing; mining; and residential, commercial, and industrial development. The projects and the NEPA documents on which potential cumulative impacts in this CIAA were based are listed below.

Black Butte Coal Pit (DEIS 2006) – Sweetwater County
The existing Black Butte coal mine and Lease-by-Application (LBA) tract are located approximately 28 miles southeast of Rock Springs. Existing operations would support coal mining through the use of processing, maintenance, and other ancillary facilities located in the Black Butte Mine permit area.

The proposed project area is 4,359 acres and includes the 1,399-acre LBA tract (federal surface and minerals); 640 acres of previously leased, federally owned surface and minerals; 160 acres of split estate (federal surface, State of Wyoming-owned minerals); and 2,159 acres of privately owned land (surface and mineral estate owned by Anadarko E&P Company, LP). Total surface disturbance associated with the project is estimated to be 2,253 acres, and the LOP is estimated to be 20 years.

Continental Divide - Creston Natural Gas Development Project (EIS) – Carbon and Sweetwater Counties
BP America Production Company (BP) and a number of other companies propose to further develop natural gas resources within the existing Continental Divide and Creston Blue Gap natural gas fields. In April 2005, Devon Energy Corporation, representing itself and other lease holders, proposed to drill and develop up to 1,250 additional natural gas wells and associated facilities within an area previously approved for up to 275 natural gas wells on up to 250 well pads. The Devon proposal was initiated and named the "Creston/Blue Gap II Natural Gas Project."

In November 2005, BP, representing itself and other leaseholders, proposed to drill and develop up to 7,700 additional wells and associated facilities within a portion of the previously approved (May 2000) Continental Divide/Wamsutter II Natural Gas project area. After reviewing the Continental Divide and Creston Blue Gap II proposals, and in view of their timing, proximity, and similarity of the projects, the BLM determined the two projects should be combined into one project, now known as the "Continental Divide – Creston Gas Development Project." The project area is located approximately 122 miles from the MAA.

Copper Ridge Shallow Gas Exploratory and Development Project – Sweetwater County
This project authorized exploration and possible development of federal oil and gas leases in conjunction with exploration and development of its privately held minerals. The project involves drilling, completing, and operating a maximum of 89 shallow gas wells and related production and water disposal facilities in the Copper Ridge Project Area (CRPA), which is located approximately 72 miles from the MAA. The project area includes approximately 11,565 acres of public land administered by the BLM, 12,108 acres of privately owned land, and 1,280 acres of land owned by the State of Wyoming, for a total of 24,953 acres. The CRPA overlies an area already developed by two existing oil and gas projects: the Brady and the Jackknife Springs Fields.

Fontenelle Natural Gas Infill Drilling Project (EIS) – Sublette County
This project authorized drilling of up to approximately 1,322 infill wells in the Fontenelle II Unit and Lincoln Road Development Area over a 10-year period beginning in 1995.

The project areas are located approximately 30 miles northeast of Kemmerer, Wyoming and 70 miles northwest of Rock Springs, Wyoming and encompass a 179,760-acre natural gas field, where 1,070 existing wells were already active at the time of the project proposal. The project area is approximately 29 miles from the MAA.

Hay Reservoir Unit Natural Gas Infill Development (ROD 2004) – Sweetwater County
This project authorized infill drilling of additional natural gas wells within the existing Hay Reservoir Federal Oil and Gas Unit (HRU), located in Sweetwater County, Wyoming, approximately 30 miles northwest of the town of Wamsutter and 92 miles from the MAA. The project entails constructing, drilling, completing, and producing up to 25 infill natural gas well locations within the project area (Unit), along with the construction, utilization, and maintenance of appurtenant access roads, pipelines, production facilities, and subsequent reclamation.

Vermillion Basin Natural Gas Development and Hiawatha Regional Energy Development Project EIS (DEIS anticipated 2007) – Sweetwater County
Questar Exploration and Production Company and Wexpro Company propose to drill exploratory and development wells on their leasehold acreage within the greater Hiawatha and Canyon Creek gas field area in Sweetwater County, Wyoming and Moffat County, Colorado. The project area includes 157,000 acres located approximately 60 miles southwest of the MAA along the Colorado/Wyoming border.

The Hiawatha project proponents propose to drill as many as 4,208 new wells beyond the number that currently exists in the project area. If approved, proposed wells would be drilled during a 30-year period. If all wells are determined to be technically feasible, as many as 200 wells could be drilled each year. Ongoing development in the Hiawatha project area was authorized by the Vermillion Basin EA.

Jack Morrow Hills (JMH) Coordinated Activity Plan (CAP) (ROD 2006) – Sweetwater County
The Green River RMP was published in October 1997. Because of concerns raised by the public and BLM regarding resource uses and conflicts in the JMH area, the RSFO deferred decisions on fluid mineral leasing, withdrawals for mineral location, and related mining activities until a CAP for the area was completed. The Green River RMP deferred these decisions in a "core" area, which included the eastern portion of the Greater Sand Dunes Area of Critical Environmental Concern (ACEC), the entire Steamboat Mountain ACEC, and the area of overlapping crucial big game habitats surrounding and adjacent to the Greater Sand Dunes and Steamboat Mountain ACECs.

The core area encompasses approximately 90,000 acres; however, the JMH CAP area includes about 622,000 acres surrounding and including the core area. The BLM administers approximately 574,800 acres of the planning area through the RSFO in Rock Springs, Wyoming. Parts of Fremont, Sweetwater, and Sublette counties lie within the planning area, which is approximately 66 miles from the MAA.

5.2.4. Four-County CIAA

The four-county region of Lincoln, Uinta, Sweetwater, and Sublette is used primarily for the analysis of socioeconomic impacts. It includes many of the projects described for the MAA, watershed, and recreation CIAAs. Past and historic activities occurring in the region surrounding the Project Area include oil and gas exploration, development, and production; dispersed recreation; ranching and grazing; mining; and residential, commercial, and industrial development in the communities of

Kemmerer, Rock Springs, Green River, Pinedale, and others. RFFAs in areas adjacent to the MAA primarily involve natural gas development and pipelines. The projects and the NEPA documents on which potential cumulative impacts in this CIAA were based are listed below.

Big Piney/LaBarge Coordinated Activity Plan – Lincoln and Sublette Counties
The approved CAP provided for managing the Big Piney-LaBarge area in a manner that balances multiple uses, sustains long-term yield of resources, and recognizes the area as one that will continue to be developed for its oil and gas resources. Approximately 135,785 acres of public land surface and 196,841 acres of federal mineral estate are within the area, which is located roughly 54 miles from the MAA. The CAP refined and elaborated on decisions made in the Pinedale RMP that pertain specifically to the Big Piney-LaBarge area.

Jonah Infill Drilling Project (JIDP) EIS and ROD (2006) – Sublette County
The JIDP guides the development of natural gas resources in the Jonah planning area, located 60 miles north and east of the MAA in Sublette County, Wyoming. The JIDP Area includes approximately 30,500 acres in Sublette County, Wyoming northeast of the MAA. The EIS authorizes development of natural gas resources on 3,597 new well pads at a pace of 250 wells per year. The LOP is anticipated to be 76 years. Approximately 14,030 to 20,344 acres of surface disturbance is projected during the LOP, with 4,267 to 6,020 acres disturbed after reclamation. Approximately 488 to 710 miles of new roads would be built, with an average daily traffic volume of 312 to 610 round trips to and from JIDP per day.

Monell Enhanced Oil Recovery (EOR) Project (EA-March 2006) – Sweetwater County
This EOR project in the Patrick Draw Field Monell Unit in Sweetwater County, Wyoming. The project area is approximately 70 miles east of the MAA and encompasses approximately 10,120 acres. In total, 146 producing wells have been drilled and developed prior to EOR activity. To date, 123 non-producing wells have been plugged, abandoned, or reclaimed. Of the 23 wells that remain from the original Monell unit, 9 are active oil and gas wells, and 14 are monitoring wells.

Anadarko proposes to drill a maximum of 126 new wells, which would require constructing and upgrading approximately 32 miles of access roads and 95 miles of gathering lines (facility corridors). An estimated 12 miles of new roads would be built on federal land, and 20 miles of roads would be built on private or state land. Drilling is expected to begin in 2006 and continue for 3 to 6 years, with a projected LOP of 20 to 25 years. The overall estimated disturbance on federal land would be approximately 385 acres initially and 89 acres after reclamation.

Pacific Rim Shallow Gas Exploration and Development Project (ROD 2004) – Sweetwater County
This project authorized the drilling of a maximum of 120 wells within the administrative boundary of the BLM RSFO, with a projected LOP of 15 to 20 years. The total project area encompasses approximately 47,597 acres and is located approximately 75 miles southeast of the MAA. Access to the area is via U.S. 430, Sweetwater County Road No. 24, and other existing or newly constructed roads. The project area overlies an area mostly unexplored for natural gas.

Pinedale Anticline Oil and Gas Exploration and Development Project (ROD 2000) – Sublette County
This project was approved in 2000, and it authorized the development of 700 producing well pads within the Pinedale Anticline Project Area over a 15-year period. The Pinedale Anticline Project Area comprises 197,345 acres of federal, state, and private land located within an area that extends from the town of Pinedale, Wyoming, south (25 to 30 miles) to the Jonah Natural Gas Field, west to the Green River, and east to Wyoming Highway 191.

Riley Ridge Natural Gas Development Project (ROD 1984) – Sublette County
This project included the construction, operation, maintenance, and abandonment of a deep gas well field in western Wyoming, gathering lines for the transportation of sour gas within the well field, trunk

lines for shipment of sour gas to the treatment plants, sales gas pipelines for delivery of sales gas to existing gas transmission pipelines, and facilities for the handling and transportation of by-products to markets. The final project represented three individual projects proposed by three operators. The project area is located approximately 61 miles northwest of the MAA.

South Piney Natural Gas Development Project EIS – Sublette County
This project proposes to develop oil and gas leases in the South Piney area of Sublette County, Wyoming. The area of proposed development encompasses approximately 31,230 acres within the Pinedale Field Office Management Area north of the MAA. The companies propose to drill a minimum of 100 to a maximum of 210 natural gas wells within the overall project area.

5.2.5. Air Quality CIAA

The regional CIAA includes the southern half of Wyoming, northern Colorado, and northeast Utah and is used primarily for the analysis of air quality impacts. The regional CIAA includes extensive oil and gas development; grazing and ranching; recreational development and dispersed recreation use; coal and trona mining; soda ash, fertilizer, and electric power production; and residential, commercial, and industrial development. Several highways and Interstate 80 (I-80) must also be considered in the analysis of cumulative air quality impacts.

5.3. Potential Cumulative Impacts by Resource

Table 5-1 presents a description of CIAAs by resource.

5.3.1. Air Quality

For consistency and clarity, cumulative air quality impacts are discussed with the direct and indirect impacts presented in Section 4.2.

5.3.2. Geology, Geohazards, Mineral Resources, and Paleontology

Cumulative impacts that would affect geologic or paleontologic resources are largely related to oil and gas development or mining activities.

5.3.2.1. Geology, Geohazards, and Mineral Resources

The CIAA for topography, geohazards, and mineral resources is confined to the MAA and the KSLA. Cumulative impacts affecting the CIAA are limited to oil and gas development. No trona mining within the MAA has been proposed; although, the presence of the MMTA indicates the possibility in the future. Because impacts to these resources are identical to MAA impacts, there are no additional cumulative impacts beyond those described in Chapter 4.

Table 5-1. CIAAs by Resource, MAA Infill Gas Development Project, Wyoming, 2006.

Resource	CIAA	Map
Air Quality	Air Quality CIAA; CALPUFF model domain (Map 3-1); Project Area and Nearby Class I and sensitive Class II areas	3-1
Geology		
Geohazards	MAA CIAA and Known Sodium Leasing Area (KSLA)	3-2
Paleontology	MAA CIAA	1-1
Mineral Resources	MAA CIAA and KSLA	3-2
Soils	Watershed CIAA	3-3
Water Resources		
Surface Water	Watershed CIAA	3-3
Groundwater	MAA CIAA and adjacent potential draw-down areas	1-1
Noise	MAA CIAA and 1-mile buffer	1-1
Vegetation		
Plant Communities	Watershed CIAA	3-3
Riparian/Wetlands	Watershed CIAA	3-3
Wildlife and Fisheries		
Fisheries	Watershed CIAA	3-3
Raptors	Entire ranges for affected species within the KFO	1-1
Big Game Species	Recreation CIAA plus CIAAs for each species herd unit	1-1, 3-7 through 3-10
Threatened, Endangered, Candidate, Proposed, and BLM-Sensitive Species	Entire ranges for affected species within the KFO, except greater sage-grouse (below); Green and Upper Colorado River area for Endangered Colorado River fish species	1-1
Greater Sage-Grouse	Recreation CIAA within upland Game Bird Management Areas 4, 5, and 6	3-12
Cultural Resources	MAA and trails within the four counties that intersect the MAA	1-1
Socioeconomics	Four county CIAA and communities most likely to be affected by the proposed project	1-1
Land Use		
Grazing	All portions of grazing allotments that occur partially or entirely within the MAA	3-13
Recreation	Recreation CIAA plus CIAAs for big game species and sage grouse	1-1, 3-7 through 3-10, 3-12
Transportation	The MAA and the county roads and state and federal highways in the four-county area that provide access to the site	3-14
Visual Resources	MAA CIAA and a surrounding 1-mile radius	1-1

5.3.2.2. Paleontology

Bedrock formations in the MAA are those deposited in or marginal to Lake Gosiute, which formed during the Eocene and was limited to a large portion of the current Bridger Basin. Accordingly, the CIAA for paleontology is the area of bedrock exposure or the Bridger Basin roughly south of the Pinedale Anticline. Fossil resources that provide information about the history, flora, and fauna of the lake and its environs form a related dataset. As indicated in Section 5.2.1, a number of extensive oil and gas development projects are ongoing or proposed for the southern Bridger Basin. Excavation activity associated with each of these projects has the potential to destroy or uncover fossils of potential scientific importance. Mitigation measures similar or identical to those discussed in Section 4.2 would preserve paleontological resources recovered during federally administered oil and gas development activities.

5.3.3. Soils

Oil and gas development as part of the proposed project would generate temporary construction disturbance and long-term (LOP) disturbance within the soils CIAA but would create little potential for erosion and sedimentation. This is due principally to the absence of long, steep slopes in the MAA and CIAA and the corresponding limited potential for significant soil transport by erosion and sedimentation across project boundaries.

Final reclamation of decommissioned and/or abandoned facilities after oil and gas production, mining, pipeline construction, and other surface disturbances would result in a reduction in project-related disturbance acreages. Remaining disturbance in the CIAA would mostly be associated with roads constructed for oil and gas development that would be retained as part of the federal, state, and county roads network.

5.3.4. Water Resources

The CIAA for surface water resources is the watershed CIAA. Existing and reasonably foreseeable future disturbance would impact approximately 1% to 2% of the CIAA, primarily within the Blacks Fork watershed. The RFFA disturbance could potentially impact the quality and quantity of downgradient receiving water in the CIAA due to additional surface runoff, sedimentation, and water use.

Key water quality impacts to the CIAA would include salt loading to the Colorado River System and increases in total suspended solids (TSS) above existing levels. Currently, waters in the Wyoming portion of the Colorado River System are rated good to very good for salinity, and no waters are listed for salinity-related impacts. Thus, no significant cumulative salinity impacts from the MAA and projects in the CIAA are anticipated. However, combined impacts from the Proposed Action and other projects in the CIAA may increase TSS to above background levels.

Approximately 3,722 acre-feet of water would be required over the life of the Proposed Action, or approximately 374 acre-feet per year. As existing water rights would be used for future development in the MAA and most projects in the CIAA, noticeable changes in downstream discharge are not anticipated.

5.3.5. Noise

The CIAA for noise is the MAA and a surrounding 1-mile buffer. Noise levels cumulatively exceeding 55 dBA may disturb residents and recreators and could displace area wildlife. Disturbance depends on distance from the source and the nature of the ground surface, atmospheric conditions, and topography. Most noise impacts in the CIAA would be short-term and should be less than 55 dBA at

1 mile or less from the source. Some on-going impacts would occur at ancillary facilities and compressor sites and from traffic on access roads.

5.3.6. Vegetation and Wetlands

The CIAA for vegetation resources is the watershed CIAA. Existing activities in this area include historical and ongoing oil and gas development, ranching and grazing, mining, and proposed or reasonably foreseeable future oil and natural gas development. These activities have all contributed to the removal of native vegetation. Significant impacts to vegetation from oil and gas development in the CIAA have occurred as a result of past and ongoing development in the MAA and several other development projects that overlap the CIAA.

According to Gap Analysis Program (GAP) vegetation data (PIC Technologies 1996), the mixed desert shrub and sagebrush community is the dominant vegetation type in the MAA and the CIAA. Regardless of the development alternative selected, the mixed desert shrub and sagebrush community would experience the greatest amount of cumulative disturbance. Disturbance from RFFAs in the CIAA would cause further loss to this plant community. In addition, increased dust accumulation on vegetation would reduce photosynthetic activity and growth and result in long-term alteration of species composition, cover, and productivity. If not mitigated, these impacts could create impacts across the CIAA and include all vegetation cover types.

Reclamation and revegetation efforts would be required for all oil and gas and pipeline projects in the CIAA. These efforts typically involve recontouring and planting native grasses. This often results in increased dominance of herbaceous vegetation and a general decrease in the shrub stratum, at least temporarily. Recovery of habitat functionality for shrubs in treatments generally occurs within 20 to 50 years; whereas, recovery of shrubs in reclamation tends to take longer. Due to limited annual precipitation and poor soil quality in the CIAA, reclamation efforts have been relatively unsuccessful, resulting in long-term impacts to the diversity of native vegetation.

The invasion and establishment of invasive weed species has already resulted in an increase to the local and regional cumulative effects of undesirable plant species in native ecosystems. Invasive species have caused a decrease in habitat quality for wildlife and loss of desirable forage for livestock. Additional disturbance in the MAA and from RFFA in the CIAA would contribute cumulatively to the local and regional invasive weed populations by increasing the vulnerability of soils to invasion and increasing the vectors (i.e., vehicles, construction equipment, and transported topsoil) for the introduction of invasive species.

Riparian and wetland habitats within the CIAA are found along drainages, ponds, and reservoirs. Current impacts to these habitats include roads, livestock grazing, and recreational use. Waters of the U.S, riparian areas, and wetlands would be avoided where possible in the MAA and CIAA. Activities on BLM lands would not occur within 500 feet of surface waters. All activities are required to comply with Section 404 of the CWA and EO11990. Therefore, no significant cumulative impacts to these habitats are expected.

5.3.7. Wildlife and Fisheries

The CIAA for wildlife differs by species. This analysis examines the proportion of the wildlife habitat within respective CIAAs that may be disturbed from all past and present development and RFFAs. Cumulative impacts for wildlife were assessed using estimates of total surface disturbance from past, present, and known future projects within the CIAA. RFFAs within the CIAA that would impact wildlife include exploration and mineral resource extraction, road construction, and livestock grazing.

Surface disturbance and habitat fragmentation currently exist in the MAA, and some species have habituated to human intrusion. Additional disturbance in the CIAA would likely cause new behavioral adaptations, movement, and avoidance of activity areas for some time. Displaced species would be impacted if there were not adequate habitat in the CIAA to support those animals.

The cumulative indirect effects from the Proposed Action or alternatives to most wildlife species would result from the increase in roads and traffic noise. As roads are developed within and adjacent to the Project Area, habitat is fragmented and animal movement is restricted. As wildlife move to other areas to avoid dust and noise from roads, adjacent habitats throughout the CIAA are also impacted. All species would be affected by the cumulative removal of habitat, fragmentation, and reduced vertical habitat structure throughout the area, mostly as a result of MAA and adjacent developments. These direct and indirect impacts could affect population size of wildlife and species diversity in the area.

5.3.7.1. Fisheries and Aquatic Habitat

The CIAA for fisheries is the watershed CIAA. As no significant impacts are expected under any project alternatives, future development in the MAA is not anticipated to add to cumulative impacts.

5.3.7.2. Raptors

The CIAA for raptors varies by species and is the raptor's range within the Kemmerer Field Office (KFO) area. RFFAs within the KFO include Horse Trap, Road Hollow, Whitney Canyon, Bear River Gas Plant, Cave Creek Sour Gas, and Hickey/Table Mountain, which are primarily other oil and gas well developments. Impacts from these RFFAs would be similar to the impacts described in Chapter 4 of this DEIS and include decreased nesting habitat and decreased available prey.

For activities on BLM lands, seasonal restrictions around raptor nests would be enforced. Much of the land within the CIAA for raptors is managed by BLM; however, cumulative impacts to nesting raptors could occur if seasonal restrictions are not enforced on private and state land within the CIAA. Some raptor species may be cumulatively impacted by reduced foraging habitat. Increased energy-related construction and maintenance traffic in the CIAA would result in increased roadkill, leading to increased scavenging and death of raptors.

5.3.7.3. Big Game Mammals

Cumulative impacts were assessed based on seasonal ranges and migration corridors located within the big game CIAAs. Cumulative impacts to big game would generally include short-term and long-term loss of habitat, as well as increased stress due to human/wildlife encounters, potential reductions in birth/survival rates, and possible alterations of migration routes. Increased energy-related traffic in the CIAAs would likely result in an increase in roadkill, and subsequent poaching, of big game. The big game populations could remain below objectives set by WGFD and overall health of populations could be affected. In addition, displaced big game may impact other wildlife or livestock.

5.3.7.3.1. Pronghorn

A majority of the pronghorn CIAA is comprised of seasonal habitat. RFFAs within the pronghorn CIAA include the Horse Trap and MMTA projects. These projects, as well as the MAA, fall within pronghorn seasonal ranges and migration routes. For example, the pronghorn displaced by activities within crucial winter range in the MAA would be further limited by the MMTA project, which also impacts crucial winter range. Cumulative impacts may limit the available pronghorn seasonal habitats within the CIAA, cause a decrease in habitat function, or disrupt the life history requirements of pronghorn.

5.3.7.3.2. Mule Deer

Although mule deer seasonal range within the MAA is limited, range is available throughout much of the CIAA for mule deer. RFFAs within this CIAA may impact mule deer seasonal ranges or migration routes. Because mule deer range within the MAA is limited to riparian areas, BLM protection measures should limit project impacts to this species. Therefore, mule deer displacement by the project would be minimal, and the project is not expected to contribute to cumulative impacts.

5.3.7.3.3. Elk

Elk habitat within the MAA is limited to an area of crucial severe winter relief habitat. No other crucial severe winter relief range is available within the elk CIAA, except a small portion just outside the MAA boundary. Therefore, cumulative impacts to this elk habitat would be significant during harsh winters when herds from outside the MAA move into the relief area. Elk typically only use crucial severe winter relief areas during harsh winters, but potentially could use this range when activities in the CIAA displace elk from their usual winter ranges. Therefore, some cumulative impacts to elk winter range are expected.

5.3.7.3.4. Moose

Moose seasonal range within the MAA is limited to major riparian corridors; however, range is available throughout much of the CIAA for moose. RFFAs within this CIAA may impact moose seasonal ranges or migration routes. Because moose range within the MAA is limited to riparian areas, BLM protection measures should limit project impacts to this species. Therefore, moose displacement by the project would be minimal, and the project would not contribute to cumulative impacts.

5.3.8. Threatened, Endangered, Proposed, and Candidate Species and Wyoming BLM Sensitive Species

The CIAA for affected federally listed species is the species' entire range within the KFO. Cumulative impacts to listed wildlife generally include direct loss of habitat, as well as indirect impacts from increased fragmentation, noise, and human presence. Specific cumulative impacts for listed species that may be impacted are discussed below.

5.3.8.1. Colorado River Fishes

The CIAA for Endangered Colorado River fish species is the Green River Basin downstream from the Project that would be subject to project-related depletions. Cumulative impacts would be the same as described for fisheries and aquatic habitats.

5.3.8.2. Ute Ladies'-tresses Orchid

The CIAA for Ute ladies'-tresses orchid is riparian habitat within the KFO. Cumulative impacts to potential Ute ladies'-tresses habitat on BLM lands within the CIAA are limited due to stipulations that protect riparian habitat and require site-specific surveys for this plant. Cumulative impacts could occur to this plant if activities on private and state lands within the CIAA result in the take of multiple populations.

5.3.8.3. Western Yellow-billed Cuckoo

The CIAA for the western yellow-billed cuckoo is the riparian habitat within the KFO. Riparian habitat in the area is limited, and this species is unlikely to occur regularly in the CIAA. RFFAs in the CIAA could cumulatively impact this bird by decreasing available habitat from road stream crossings

that remove habitat. Cumulative impacts to BLM lands within the CIAA are limited due to stipulations that protect riparian habitat. Cumulative impacts could occur if activities on private and state lands within the CIAA displace this species.

5.3.9. Wyoming BLM Sensitive Species

The CIAA for affected BLM sensitive species, except for greater sage-grouse, is the species' entire range within the KFO area.

5.3.9.1. BLM Sensitive Bird Species

Cumulative impacts to sensitive raptor species would be similar to those described for non-sensitive raptors and their nests. The cumulative loss of prairie dogs and their habitat within the CIAA would impact the prey base for some raptors and nesting habitat for the burrowing owl.

Cumulative impacts to sagebrush obligate birds would occur due to the collective removal of mature sagebrush habitat and increased fragmentation within the CIAA. Sagebrush habitat is currently the dominant vegetation type within the CIAA and would experience the greatest amount of acreage loss from this project and RFFAs. Sagebrush obligate birds displaced by this project and RFFAs would have increasingly limited habitat to move into due to the overall decrease in sagebrush within the CIAA and the slow rate of regrowth. These impacts could reduce populations of sagebrush obligate birds in the area and/or increase the populations of other bird species that are adapted to the altered habitat.

5.3.9.2. Greater Sage-Grouse

The CIAA for greater sage-grouse is the combined area of Upland Game Bird Management Areas 4, 5, and 6 (Map 3-12). RFFAs within the greater sage-grouse CIAA include the several oil and gas projects. Many of these projects fall within known greater sage-grouse lek areas, nesting, and brood-rearing habitat. Activities on BLM lands within the CIAA require buffers around leks to protect the lek and nesting area although some nests fall outside of the 2-mile protective buffer. In addition, sage-grouse lek areas, nesting, and brood-rearing habitat that occur on private or state lands are not subject to these restrictions. Therefore, significant cumulative impacts to greater sage-grouse could occur within the CIAA.

There are several known greater sage-grouse leks within project boundaries and within 2 miles of RFFAs in the CIAA, including the MMTA, Whitney Canyon, and Horse Trap projects. This project would cumulatively increase the leks potentially impacted in the CIAA, and sage-grouse displaced by the project would have a decreasing amount of habitat to move into as RFFAs are developed. Therefore, sage-grouse displacement and nest abandonment from habitat fragmentation, dust, noise, human activities, and long-term loss of sagebrush habitat would be cumulatively significant, leading to lower productivity and potentially a long-term decline in the population of this species.

5.3.9.3. Bald Eagle

Because of the recent removal of the bald eagle from ESA protections, potential impacts are discussed as part of the BLM sensitive species sections. Bald eagles may be affected by reduced foraging habitat in the MAA. RFFAs occur in potential prairie dog habitat and may further reduce available prey. A cumulative reduction of prairie dog colonies in the CIAA could impact individual bald eagles. Increased energy-related construction and maintenance traffic in the MAA would result in increased roadkill, leading to increased scavenging and death of bald eagles.

5.3.9.4. BLM Sensitive Mammals

Cumulative impacts to pygmy rabbit and its habitat would occur if projects within the CIAA removed large stands of mature sagebrush in mixed desert shrub/sagebrush and vegetated sand dune communities. Cumulative loss of habitat is likely over time because much of the sagebrush habitat would be impacted and would not reach the old growth/mature age, which this species prefers.

5.3.9.5. BLM Sensitive Amphibians

The CIAA for amphibians is riparian and open water habitat in the KFO. Cumulative impacts in the CIAA for amphibians would be minimal because these habitats are protected on BLM land and by the CWA.

5.3.9.6. BLM Sensitive Fish

Cumulative impacts would be the same as described for fisheries and aquatic habitats.

5.3.10. Cultural Resources

The CIAA for cultural resources is the MAA and trail segments in the four-county area that intersect the MAA. Cumulative impacts to cultural and historical resources within the MAA would occur as a result of additional non-project-related ground disturbance and vandalism/illegal collection activities primarily associated with energy development in the surrounding region, such as the pipeline development and expansion of Bridger Basin mineral fields.

Since 1995, human presence at formerly remote cultural/historical resource sites has increased. Regulatory agency personnel and consultants have noted illegal artifact collection in the area, evidenced by collector's piles and pits on archaeological sites. Illegal artifact removal has made the evaluation of surficial archaeological sites difficult, due to the absence of diagnostic artifacts and tools (which aid in the determination of site function) and the resultant alteration of site context and setting. Off-road vehicle traffic in the area and across cultural/historical resource sites is also more commonly noted.

Increased surface-disturbing activities and human presence primarily resulting from expanded energy development activities in the CIAA would result in cumulative adverse effects. Furthermore, because many of these impacts are indirect (illegal artifact collecting or digging), they are difficult to minimize or mitigate. Under any project development alternative, significant cumulative effects to cultural and historical resources could occur if undocumented and unrecognized NRHP-eligible sites are impacted and unmitigated.

Development activities within the MAA would also have beneficial cumulative impacts on cultural/historical resources. Generally, the greater the increase in permitted activity, the greater the data acquisition of cultural/historical resource information. The MAA has already produced the greatest body of archaeological site information known in the BLM KFO area, including a majority of the benchmark sites that aid in defining regional prehistoric culture history contexts. Inventory, recordation, and data recovery projects triggered by ground-disturbing actions would continue to increase the cultural/historical resource database, likely improving future cultural/historical resource management decisions. Cumulatively, archaeological investigations in the MAA have made notable positive impacts on knowledge of the region's archaeology.

5.3.11. Socioeconomics

The CIAA for socioeconomics is the four-county region described in Section 5.2.4 above. Lincoln, Uinta, Sweetwater, and Sublette counties all depend on the oil and gas industry for a portion of their economic activity and tax base.

Development from existing activity and RFFAs would have significant adverse and beneficial impacts on the study area. Development activities in the MAA, along with other oil and gas developments, proposed and approved industrial projects (pipelines, coal mines, plant expansions), and commercial and residential projects, would increase employment opportunities, expand the tax base, and improve the counties' ability to maintain and increase services and infrastructure for residents.

Existing projects and RFFAs would not have a long-term positive economic impact on the area, but could have short-term (2 to 5 years) adverse social and economic impacts. Rapid population growth due to increased employment and the impacts associated with inadequate public facilities and services would cause short-term, but significant, negative impacts. Short-term impacts would occur in the areas of housing availability, housing affordability, daycare services, medical care, schools, social services, and law enforcement.

Increased industrial, commercial, and residential development would result in impacts related to population, employment, tax base/revenues, and general economic health. This level of development would also impact existing infrastructure carrying capacity and the ability for local private and governmental businesses and agencies to provide for the growing population effectively and expediently. Although oil and gas wells would add to the area's economic benefits, population growth associated with oil and gas jobs would contribute to the demand for housing and other public facilities and services. In addition, the demand for higher-paying oil and gas jobs would lead to a limited workforce for secondary service jobs.

Local communities would experience economic impacts from an increase in consumption of local goods and services and increased sales tax revenues, but they would also be stretched to budgetary limits by new demands for governmental services. Actual impacts would depend on the rate of development and the number of wells authorized. Because Rock Springs is the regional trade area and largest urban center within the study area, current growth levels would continue to impact the city's incorporated and unincorporated areas. Sweetwater County would also continue to be affected by the high level of development occurring throughout the region.

Increases in regional development over a short period can cause notable changes in employment and income. These variables can also cause changes in population trends, which could have impacts on community services, social structures, and lifestyles. Under all alternatives, increased oil and gas development and other activity is expected to cause an increase in taxes and revenues to all governments in the study area. Increases in ad valorem taxes would be expected to occur in all four counties, but particularly in Sweetwater County. Additional revenues would accrue to the United States in the form of personal and corporate income taxes. Sweetwater, Lincoln, Uinta, and Sublette Counties, as well as the State of Wyoming in general, are highly dependent on mineral revenues, and the funds anticipated from the proposed projects would add to those revenues.

A portion of the resident population places great value on preserving the natural character of the area and is not in favor of the high level of oil and gas development proposed in the MAA. These individuals may be affected on an aesthetic and moral level by one, several, or all projects proposed within the CIAA.

5.3.12. Land Use

Potential cumulative impacts to land uses, including grazing, recreation, and transportation, are described in the following sections.

5.3.12.1. Grazing

The CIAA for grazing is the combined area of all grazing allotments that intersect with or are contained within the MAA (Map 3-13). Based on the current grazing allotment arrangement, the CIAA extends approximately 30 miles east of the MAA and 20 west of the MAA. As a result, the CIAA encompasses a portion of five large development projects whose impacts must be considered when analyzing the cumulative effect on regional rangeland resources from development of the MAA. These five projects include Horse Trap, Hickey-Table Mountain, MMTA, Fontenelle, and Texaco-Washington Energy, most of which are oil and gas well developments. The exception is MMTA, a proposed trona mining area that would result in additional surface disturbance and loss of rangeland resources.

Impacts from these and other RFFAs would be similar to the impacts from the MAA and include vegetation and soil disturbance associated with construction activities, reclamation, weed control, road construction and use (i.e., dust and animal collisions), and rangeland functionality. Long-term, cumulative impacts would likely include a small net loss in total annual forage production from road construction and other permanently maintained areas. Assuming that successful revegetation occurs, this decrease in quantity would be partially offset by a temporary increase in quality, provided by younger, more nutritious herbaceous vegetation. Lower vegetation palatability from dust cover and the threat of health issues such as dust pneumonia could potentially create more significant impacts on grazing livestock than the effects associated with direct loss of vegetation.

Disruptions to livestock management, damage to facilities, and direct mortality of animals due to collisions and ingestion of non-native poisonous plants are impacts that are of more serious concern for the livestock ranches throughout the region. With each new development in the region, these impacts would be compounded by density of development and could potentially affect the viability of the industry in the region.

With proper consultation and stipulations set forth by the responsible agencies, effects of these issues can be minimized in the MAA and throughout the region. In particular, animal death loss can be minimized through adherence to standard traffic stipulations and an adequate weed reduction and management program. Because the weed halogeton (*Halogeton glomeratus*) is especially toxic to sheep, impacts related to poisonous plants are of greatest concern to sheep producers. This invasive species has not been adequately controlled and is expanding as new disturbances occur, increasing sheep death loss and reducing the amount of grazing land that is free of halogeton. It is not likely that this issue alone could affect the viability of sheep operations in the region, but when combined with loss of adequate grazing land from future development and increased available land for the spread of halogeton, these cumulative impacts could potentially create significant impacts to the economics of sheep ranching.

In addition to the factors mentioned above, the level of impact on livestock would depend on the rate and extent of development in the region and in the MAA. Each ranch would be affected differently. The larger ranches would be able to move livestock to minimize disturbance and the smaller ranches may be forced to suspend grazing during the development phase. Development at a slower pace allows operators to deal with problems as they arise and minimize disruptions. At times, often because of market and production requirements, oil and gas development occurs at a rapid pace and some impacts to grazing animals would be unavoidable during this phase. However, once development is completed, long-term cumulative impacts would be reduced to effects from increased

traffic and small-scale activities associated with maintenance of existing facilities. During the production phase, livestock grazing would likely return to previous levels of use.

5.3.12.2. Recreation

The CIAA for recreation is the combination of CIAAs for big game species and sage grouse. Existing activities in this area include historical and ongoing oil and gas development and proposed or reasonably foreseeable future oil, natural gas, and mining development.

Cumulative impacts to hunting, the main recreational activity in the CIAA, would occur because of the extensive impacts of natural gas development on wildlife. The increased road density, traffic, noise, and dust of development displace big game species and lead to declines in hunting success. Wildlife and hunters have already been displaced by existing development in portions of the CIAA. Development from ongoing activities and RFFAs in the CIAA would tend to concentrate game and hunters in undeveloped adjacent areas, which would impact the quality and quantity of forage, and therefore the health of the animals. There would also be an increase in the probability of hunting accidents due to increased hunter density in these adjacent undeveloped areas.

Relatively undisturbed scenery is an integral part of the recreation experience for many recreators. The visual impacts of development would make the area increasingly undesirable for many hunters as development progresses. Activities such as wildlife viewing and mountain biking also tend to be scenery-dependent. Thus incremental increases in development have corresponding decreases in the desirability of the recreational setting. Long-term cumulative impacts in the CIAA would be significant because they are likely to make the area less desirable for hunters, wildlife viewers, and other recreators.

5.3.12.3. Transportation

The CIAA for transportation includes the MAA and the county roads and state and federal highways in the four-county area that provide access to the site. Historic and existing traffic within the MAA has been associated with grazing uses, recreation, and oil and gas exploration and development. This traffic is minimal and seasonal in nature and is not anticipated to increase substantially. Cumulative transportation impacts within the Project Area are anticipated to be similar to those of the Proposed Action and alternatives. Table 5-2 displays WYDOT AADT projections for 2015 on Wyoming highways. AADT for individual highways was derived by using the percentage of total AADT for each highway from the BLM approved Expanded Moxa Arch Area Draft EIS, April 1995, and extrapolating the data to the same highways using current estimated AADT data. According to WYDOT, traffic on all highways is anticipated to increase by 2015.

Table 5-2. Proposed Action Peak Drilling Year (Year 10) AADT Compared with 2005 AADT and 2012 AADT on Affected Highways.

Highway Segment	2005 AADT	Projected 2015 AADT	% Projected 2015 AADT
I-80 (MP 6.26-107.09)	13,146 (5,877 Trucks)	15,652 (6,696 Trucks)	1.4
U.S. 30 (MP 55.13-100.03)	1,983 (928 Trucks)	2,554 (1,684 Trucks)	7.2
U.S. 189 (MP 0.0-66.86)	1,232 (162 Trucks)	1,443 (189 Trucks)	2
WY 372 (MP 0.114- 48.59)	1,207 (321 Trucks)	1,344 (358 Trucks)	1.5
WY 240 (MP 0.0-12.29)	399 (120 Trucks)	484 (121 Trucks)	1.7

Natural gas development-related traffic increases on highways providing access to the MAA are likely to peak over the next 10 years. Cumulative natural gas-related traffic increases would be evident on all roads in the MAA. Although the cumulative gas field traffic would accelerate maintenance requirements on the highways and increase the probability of accidents, the State of Wyoming would receive substantial revenues from severance taxes and federal mineral royalties, which could offset maintenance costs.

5.3.13. Visual Resources

The CIAA for visual resources is the MAA and a surrounding 1-mile radius. A majority of this area is classified as VRM Class IV; however, Class II and III areas are found along major roads and waterbodies.

The Proposed Action, along with other existing development and RFFAs in the CIAA, could lead to oil and gas facilities becoming the predominant visual feature in the landscape of southwest Wyoming. As development in the area increases, visual quality decreases incrementally. Additional wells and associated surface disturbance in the visual CIAA would become noticeable to recreators or those traveling through the CIAA. Portions of the existing and proposed disturbance from wells, roads, and pipelines are visible from VRM Class II and Class III areas. Cumulative impacts would be significant during construction and production because these features attract attention and dominate the view of the casual observer. During interim reclamation, these features become less noticeable and visual impacts decrease.

In some parts of the CIAA, establishing mature vegetation after final reclamation would take 30 years; therefore, the CIAA is not likely to return to its predisturbance character for up to 100 years (cumulative LOP plus 30 years). Because of the checkerboard land ownership, mineral development would likely continue on private and state land without regard to visual impacts. Therefore, significant cumulative impacts to regional visual resources would occur within the CIAA.

CHAPTER 6 CONSULTATION AND COORDINATION

An EIS must be prepared when a federal government agency considers approving an action within its jurisdiction that may impact the human environment. An EIS aids federal officials in making decisions by presenting information on the physical, biological, and social environment of a proposed project and its alternatives. The first step in preparing an EIS is to determine the scope of the project, the range of action alternatives, and the impacts to be included in the document.

The CEQ regulations (40 CFR Parts 1500–1508) require an early scoping process to determine the issues related to the Proposed Action and alternatives that the EIS should address. The purpose of the scoping process is to identify important issues, concerns, and potential impacts that require analysis in the EIS and to eliminate insignificant issues and alternatives from detailed analysis.

This EIS was prepared by the BLM KFO in Kemmerer, Wyoming. A third-party contractor was used by the BLM to conduct studies, gather data, and prepare documents. Cooperating agencies for the Moxa Arch Area Infill Gas Development Project include:

BLM KFO – lead agency
Bureau of Reclamation (Reclamation)
U.S. Fish and Wildlife Service (USFWS)
U.S. Environmental Protection Agency (EPA)
Office of State Lands and Investments
Wyoming Department of Environmental Quality (WDEQ)
Wyoming Governor's Planning Office
Wyoming State Historic Preservation Office (SHPO)
Wyoming Game and Fish Department (WGFD)
Wyoming Department of Transportation (WYDOT)
Wyoming Department of Agriculture (WDA)
Lincoln County and Lincoln County Conservation District
Sweetwater County and Sweetwater County Conservation District
Uinta County and Uinta County Conservation District

These agencies were actively involved in preparing, reviewing, and creating the draft EIS, as well as in developing mitigations and BMPs to reduce impacts from the proposed project.

6.1.1. Public Participation

The formal public scoping process began with the publication of the NOI in the Federal Register on October 7, 2005. The NOI announced the BLM's intent to prepare an EIS for the Operators' proposed Project and invited the public to comment and/or provide resource information. Four evening public meetings were held over a one-week period in mid-November 2005. The meetings were held in Evanston, Wyoming, on November 14, 2005; Rock Springs, Wyoming, on November 15, 2005; Lyman, Wyoming, on November 16, 2005; and Kemmerer, Wyoming, on November 17, 2005.

Numerous issues and concerns were identified and comments were submitted (post-marked) to the BLM from October 7, 2005 to December 2, 2005. While no written comments were received from the public during the scoping meetings, informal comments were shared with BLM staff and were noted. All comments received during the scoping process were reviewed and analyzed. The BLM identified 15 key issues, based primarily on the assumed quantity, intensity, or duration of a potential impact; and/or the volume of agency or public interest in the issue. These issues are summarized in Section 1.6.2.

During preparation of the EIS, the BLM and the consultant IDT have communicated with, and received or solicited input from, cooperating agencies; other federal, state, county, and local agencies; elected representatives; environmental and citizens groups; industries; and individuals potentially concerned with issues regarding the proposed drilling action. The contacts made are summarized in the following sections. The following organizations/individuals either provided comment or were provided the opportunity to comment during the scoping period.

Federal Offices

Federal Energy Regulatory Commission
Federal Highway Administration – Wyoming
National Park Service – Long-Distance Trails Office
Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Department of Energy
U.S. Environmental Protection Agency Region 8
U.S. Fish and Wildlife Service
U.S. Natural Resources Conservation
U.S. Representative Barbara Cubin
U.S. Senator Craig Thomas
U.S. Senator Michael B. Enzi
U.S.D.I. Bureau of Land Management, Wyoming State Office
U.S.D.I. Bureau of Reclamation
U.S.D.I. Office of Environmental Policy and Compliance

State Agencies

State Senators
State Representatives
Department of Revenue
Governor State of Wyoming
Public Lands Commissioner
State Engineer's Office
State Geologic Survey
Wyoming Association of Municipalities
Wyoming Department of Agriculture
Wyoming Department of Transportation
Wyoming Department of State Parks and Cultural Resources
Wyoming Department of Environmental Quality
Wyoming Farm Bureau Federation
Wyoming Game and Fish Department
Wyoming Livestock Board
Wyoming Mining Association
Wyoming Office of Federal Land Policy
Wyoming Oil and Gas Conservation Commission
Wyoming State Clearinghouse
Wyoming Planning Coordinator's Office
Wyoming State Historic Preservation Office
Wyoming State Parks
Wyoming State Lands and Investments
Wyoming State Trials
Wyoming State Grazing Board
Wyoming Water Development Commission

County Government
Lincoln County Conservation District
Lincoln County Commissioners
Lincoln County Historical Society
Lincoln County Library
Lincoln County Planning Commission
Lincoln Soil Conservation District
Lincoln-Uinta Association of Governments
Sweetwater County Commissioners
Sweetwater County Conservation District
Sweetwater County Historical Society
Sweetwater County Library
Sweetwater County Planning Office
Sweetwater Economic Development Association
Uinta County Planning Office
Uinta County Citizens Coalition
Uinta County Commissioners
Uinta County Conservation District
Uinta County Library System
Uinta County Weed and Pest

Municipalities
City of Kemmerer
Lyman Planning Office
Mayor of Diamondville
Mayor of Evanston
Mayor of Granger
Mayor of Green River
Mayor of LaBarge
Mayor of Lyman
Mayor of Mountain View
Mayor of Rock Springs
Rock Springs Library
Town of Opal

Native American Tribes
Eastern Shoshone Cultural Office
Eastern Shoshone Tribal Council
Eastern Shoshone Tribe
Northern Arapaho Business Council
Northern Arapaho Tribe
Northern Ute Business Committee
Northern Ute Tribe Cultural Resources
Shoshone Cultural Office
Shoshone Tribal Council
Shoshone-Bannock Tribal Council
Shoshone-Bannock Tribe

Grazing Permittees/ Lease and ROW Holders
DJR L&L LTD
Green River LST Co.
Green River Star
Horseshoe Spear Cattle Company

Joyce Kay Jacobs Trust
JR Broadbent Company
Julian Land and Livestock
Larson Livestock, Inc.
Rodwell Ranch, LLC
W&M Thoman Ranches, LLC
Charlotte Carlisle Living Trust
R. Gunter Family Partnership
St. Jeor Ranch, Inc.
Sims Livestock

Landowners
Jerry Aimone
Jay Anderson
Marijane S. Ashby
Ray Broadbent
Beverly Calhoun
Jon and Vicki Childs
Ron and Cathy Davison
Bob Eyre
George R. and Darlene Eyre and Sons
John L. and Cheryl Eyre
Kirk Eyre
Spencer Eyre
Gino and/or Glenna Foianini
Ernest Giorgis
Shawn Harris
Dennis Hunzeker
Arnold Larson
Tom Lozier
Frank Mau
John and Kathleen Rosas
Bill Sears
Blaine Thoman
Dora Trapp
William Tripp
Lee Van Gieson
George Zebre

Local Media
Associated Press
Casper Star-Tribune
Cowboy News Network
Daily Rocket Miner
KGNW-TV Kemmerer, WY
KJWY-TV Cheyenne, WY
KJWY-TV 2 Jackson, WY
KKTY Radio Jackson, WY
KMER/KAOX/KDWY Kemmerer, WY
KMTN/KJAX/KSGT/KZJH Radio Jackson Hole, WY
KOTB/KEVA Radio Evanston, WY
KOVE/KDLY Lander, WY
KRKK/KQSW/KSIT Rock Springs, WY

KTRZ Radio Riverton, WY
KTWO-TV Casper, WY
KUGR Radio Green River, WY
KUTV-2 Salt Lake City, UT
KVOW/KTAK Riverton, WY
KYOD 100 – FM Radio Douglas, WY
The Radio Network Green River, WY
Unita County Herald
University of Wyoming Public Radio
Wyoming Public Radio

Other Agencies, Industry Representatives, Individuals and Organizations

Alliance for the Wild Rockies Eco Defense
American Lands Alliance
Anadarko Petroleum Corporation
Anadarko E&P Company LP
API Cheyenne
Biodiversity Conservation Alliance
BP America Production Company
Cabot Oil and Gas Corporation
Chevron Texaco
Defenders of Wildlife
Ducks Unlimited
Earthjustice
Ecology and Environment, Inc.
Environmental Defense
EOG Resources, Inc.
FMC Corporation
FMC Wyoming Corporation
Frontiers of Freedom – People for the USA
General Chemical Co.
Greater Yellowstone Coalition
Independent Petroleum Association of Mountain States
Inside Energy
Klabzuba Oil and Gas
Medicine Butte Wildlife Association
Medicine Wheel Alliance
Medicine Wheel Coalition for Sacred Sites
Merrion Oil and Gas Corporation
Mormon Trails Association
Mule Deer Foundation
National Pony Express Association
National Trust for Historic Preservation
National Wildlife Federation
National Resources Defense Council
Painter & Company
People for the USA
People for Wyoming
Petroleum Association of Wyoming
Petroleum Information Corporation
Public Lands Advocacy
Questar Corporation
Rock Springs Grazing Association

Rocky Mountain Elk Foundation
Rocky Mountain Exploration
Sierra Club
Sinapu
Solvay Minerals
South Uinta Cattle Association
Southern Wyoming Dirt Riders
Southwest Wyoming Industrial Association
Southwest Wyoming Mineral Association
Sweetwater Wildlife Association
The Land and Water Fund of the Rockies
The Nature Conservancy
The Wilderness Society
Trout Unlimited
Union Pacific Resources Co.
University of Wyoming Libraries
University of Wyoming Cooperative Extension Service
Upper Green River Valley Coalition
U.S. Energy Corporation
Western Gas Resources
Western Watersheds Project
Western Wyoming Community College Library
Westport Oil and Gas Co. LP
Wexpro
Williams Energy
Wold Trona Company
Wyoming Association of Professional Archaeologists
Wyoming Association of Professional Historians
Wyoming Business Alliance
Wyoming Natural Diversity Database
Wyoming Outdoor Council
Wyoming Public Lands Council
Wyoming Sportsman's Association
Wyoming Wilderness Association
Wyoming Wildlife Federation
Wyoming Wool Growers Association
Zinke and Trumbo, Inc.

6.1.2. List of Preparers

The following tables identify the BLM IDT (Table 6-1) and the consultant IDT (Table 6-2) that were principally involved in preparing this EIS.

Table 6-1. List of BLM Interdisciplinary Team EIS Preparers.

Name	Responsibility
Kemmerer Field Office	
Mary Jo Rugwell	Field Manager
Lance Porter	Assistant Field Manager/Renewable Resources
Mark Meyer	Assistant Field Manager/Minerals & Land
Carl Bezanson	Range Management
Chris Crews	Wildlife
Michele Easley	Project Manager/Planning and Environmental Coordinator
Ed Feeley	Range Management
Ed Jess	Archeology
Kelly Lamborn	Realty
Wally Mierzejewski	Recreation
Dan Oles	G.I.S.
James Roberts	Fluid Minerals Surface/HazMat
Matt Warren	Fluid Minerals/PE
Wyoming State Office	
Susan Caplan	Air Quality
Roy Allen	Socioeconomics

Table 6-2. List of Consultant Interdisciplinary Team EIS Preparers.

Name	Primary Role
SWCA Environmental Consultants	
Jon Kehmeier	Project Manager
Kevin Thompson	Principal-in-Charge
Heather Neail Smith	Asst. Project Manager
Scott Phillips	Archaeology
Larry Semo	Biology Lead
Patricia Billig	Air Quality
Steve Kandell	Facilitation
Adrian Hogel	Resource Specialist
Kara Altvater	Resource Specialist
Krista Northcott	GIS Specialist
Keri Burns	Technical Editor
Cynthia Manseau	Technical Editor
Sarah Springer	Administrative Record
Petros Environmental	
Richard Bell	Project Coordinator
Joe Fetzer	Quality Assurance/Geology Lead
Mathis and Associates	
Nick Mathis	Transportation Lead
Kathol and Company (Socioeconomics)	
Jennifer Kathol	Socioeconomics Lead
Natural Resource Group (Air Group)	
Cheryl Pagard	Air Quality
William VonSee	Air Quality
Dr. Warner Reeser	Air Quality
University of Wyoming	
Tex Taylor	Socioeconomics
ENVIRON	
Sue Kemball-Cook	Air Quality
Yiqin Jia	Air Quality
Ed Tai	Air Quality
Ralph Morris	Air Quality

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CHAPTER 8 GLOSSARY

abandon: To cease producing oil or gas from a well when it becomes unprofitable. Usually, some of the casing is removed and salvaged, and one or more cement plugs are placed in the borehole to prevent migration of fluids between formations.

acre-foot or acre-feet (acre-ft): The volume of water that covers a one-acre area at a depth of one foot (43,560 cubic feet or 325,851 gallons).

ad valorem: Taxes levied according to assessed value.

aeolian: Refers to landforms shaped by wind or sediments transported and deposited by wind.

affected environment: The resource values potentially affected by the Proposed Action and alternatives analyzed in a NEPA document.

algal: Of, pertaining to, or composed of algae.

alkaline: Having the quality of a base (pH of 7.0 or greater).

allotment: An area of land where one or more permittees graze their livestock. Generally consists of public land but may include parcels of private or state lands. The number of livestock and season of use are stipulated for each allotment. An allotment may consist of one or several pastures.

alluvium: Clay, silt, sand, and gravel or other rock material transported by flowing water and deposited as sorted or semi-sorted sediments.

ambient air: The portion of the atmosphere, external to buildings, to which the public has general access (40 CFR 50).

ambient concentration: The mass of a pollutant in a given volume of air, typically measured as micrograms of pollutant per cubic meter of air.

ambient standards: The absolute maximum level of a pollutant allowed to protect either public health (primary) or welfare (secondary).

ambient: The environment as it exists at the point of measurement and against which changes or impacts are measured.

ancillary facilities: Facilities often required in an oil and gas field other than the wells and pipelines (e.g., compressor stations).

animal unit month (AUM): The amount of forage necessary to sustain one cow/calf pair for 1 month.

anticline: An area of rock deformation characterized by a downward slope to either side. In an exposed anticline, the oldest rock layers are in the center and the rocks on either side dip or slope away from the center of the structure. If covered by an impermeable layer of rock, an anticline is a potential oil or gas reservoir.

Application for Permit to Drill (APD): The Department of Interior application permit form to authorize oil and gas drilling activities on federal land or mineral estate.

aquifer: A water-bearing bed or layer of permeable rock, sand, or gravel capable of yielding water.

archaeological: The scientific studies of ancient peoples and cultures by analysis of physical remains (artifacts).

arcuate: Curved like a bow.

Area of Critical Environmental Concern (ACEC): An area on public lands designated for special management to protect important historic, cultural, or scenic values; fish and wildlife resources; other natural systems or processes; or human life and safety.

atmospheric deposition: A process by which air pollutants fall out of the atmosphere and are deposited on terrestrial and aquatic ecosystems. These pollutants are deposited via wet deposition (precipitation) and dry deposition (gravitational settling of particles and gaseous pollutants that adhere to soil, water, and vegetation).

background concentration: The existing levels of air pollutant concentration in a given region. In general, it includes natural and existing emission sources but not future emission sources.

badlands: Steep or very steep, commonly non-stony barren lands dissected by many intermittent drainage channels. Badlands are most common in semi-arid and arid regions where streams are entrenched in soft geologic material. Runoff potential is very high, and geologic erosion is active in such areas.

berm: A raised area with vertical or sloping sides.

Best Management Practices (BMPs): Structural, nonstructural, and managerial techniques that are recognized to be the most effective and practical means to prevent or minimize environmental impacts, yet are still compatible with the productive use of the resource to which they are applied.

calcareous: Containing calcium carbonate.

casing: Steel pipe placed in an oil or gas well to prevent the hole from collapsing.

cementing: The process by which cement is used to "set" casing in the well bore and to seal off unproductive formations and apertures.

colluvium: A general term applied to loose and incoherent deposits, usually located at the foot of a slope or cliff and typically brought there by forces of gravity.

commercial well: A well capable of producing profitably.

completion: The activities and methods to prepare a well for production. Includes installation of equipment for production from an oil or gas well.

condensate (gas condensate): Hydrocarbons (oil) contained in the natural gas stream, often removed by condensation.

conditions of approval (COAs): A set of restrictions, or conditions, included in the approval of a federal permit, including NEPA documents.

conglomerate: Rounded water-worn fragments of rock or pebbles cemented together by another mineral substance.

Council on Environmental Quality (CEQ): An advisory council to the President established by the National Environmental Policy Act of 1969. It reviews federal programs for their effect on the environment, conducts environmental studies, and advises the President on environmental matters.

Cretaceous Period: The most recent period of the Mesozoic Era, between 136 and 65 million years ago.

criteria pollutants: Air pollutants for which the EPA has established state and national ambient air quality standards. These include particulate matter (PM), nitrogen oxides (NO_X), sulfur dioxide (SO_2), carbon monoxide (CO), and volatile organic compounds (VOCs).

critical elements of the human environment: A list of resource concerns that must be addressed in every NEPA document.

crucial range: Any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain itself at a certain level over the long-term.

cryptobiotic soils: A biological soil crust composed of living cyanobacteria, green algae, brown algae, fungi, lichens, and/or mosses. Commonly found in arid regions around the world, cryptobiotic soils are important members of desert ecosystems and contribute to the well being of other plants by stabilizing sand and dirt, promoting moisture retention, and fixing atmospheric nitrogen.

cubic feet per second (cfs): The rate of discharge representing a volume of 1 cubic foot of water passing a given point during 1 second.

cultural resources: The physical remains of human activity (artifacts, ruins, burial mounds, petroglyphs, etc.) and the conceptual content or context (as a setting for legendary, historic, or prehistoric events, such as a sacred area of native peoples, etc.) of an area of prehistoric or historic occupation.

cumulative impact: The impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taken place over a period of time (40 CFR 1508.7).

decibel: A unit of measurement of noise intensity based on the energy of the sound waves. Changes of 5 decibels or more are normally discernible to the human ear.

deciview: The unit of measurement of haze developed to uniformly describe levels of monitored and modeled visibility impairment.

directional drilling: The intentional deviation of a wellbore from vertical to reach subsurface areas off to one side from the surface drilling site.

discharge: The volume of water flowing past a point per unit time, commonly expressed as cubic feet per second (cfs), gallons per minute (gpm), or million gallons per day (mgd).

dispersion: The spreading out of pollutants. Generally used to show the extent to which an air pollutant will spread from a particular point.

displacement: As applied to wildlife, forced shifts in the patterns of wildlife use, either in location or timing of use.

disposal well: A well into which produced water from other wells is injected into an underground formation for disposal.

disruptive activities: Those authorized Public Land resource uses/activities that are likely to alter the behavior, displace, or cause excessive stress to existing animal or human populations occurring at a specific location and/or time. This term does not apply to the physical disturbance o the land surface, vegetation, or features.

dissolved solids: The total amount of dissolved material, organic and inorganic, contained in water or wastes.

diversity: The distribution and abundance of different plant and animal communities and species.

drainage: Natural channel through which water flows at least part of the year.

drill rig: The mast, draw works, and attendant surface equipment of a drilling unit.

drilling fluid: Fluid used to lubricate and cool the drill bit, to assist in lifting cuttings from the borehole, and to control pressures in the borehole.

drought: Prolonged dry weather (precipitation less than 75% of average annual amount).

ecosystem: An interacting system of organisms considered together with their environment (e.g., forest, marsh, and stream ecosystems).

emergent vegetation: Erect, rooted, herbaceous plants that project out of or emerge from the water.

emission: Air pollution discharged into the atmosphere, usually specified by mass per unit time.

endangered species: A species that is in danger of extinction and whose survival is unlikely if the causal factors continue. Section 3 of the Endangered Species Act of 1973 defines "endangered species" as any species that is in danger of extinction throughout all or a significant portion of its range.

environment: The aggregate of physical, biological, economic, and social factors affecting organisms in an area.

Environmental Impact Statement (EIS): An analysis of alternative actions and their predictable environmental impacts, including physical, biological, economic, and social consequences and their interactions; short- and long-term impacts; and direct, indirect, and cumulative impacts.

Eocene: The second epoch of the Cenozoic Era; the start of the Eocene is marked by the emergence of the first modern mammals.

ephemeral drainage: A drainage area or a stream that has no base flow. Water flows for a short time each year but only in direct response to rainfall or snowmelt events.

epicenter: The portion of the earth's surface directly above the focus of an earthquake.

erosion: The removal, detachment, and entrainment of earth materials by weathering, dissolution, abrasion, and corrosion, later to be transported by moving water, wind, gravity, or glaciers.

evaporitic: Sediments that are deposited from aqueous solution as a result of extensive or total evaporation of the solvent.

exploratory well: A well that is drilled to evaluate the gas or oil resources that may be present.

fault: A fracture in bedrock along which there has been vertical and/or horizontal movement caused by differential forces in the earth's crust.

federal lands: All lands and interests in lands owned by the U.S. that are subject to the mineral leasing laws, including mineral resources or mineral estates reserved to the U.S. in the conveyance of a surface or non-mineral estate.

floodplain: The portion of a river valley, adjacent to the channel, that is built of recently deposited sediments and is covered with water when the river overflows its banks at flood stages.

fluvial: Of or pertaining to rivers.

forage: Vegetation of all forms available for animal consumption.

forb: A broad-leafed flowering herb other than grass.

formation: A body of earth material with distinctive and characteristic physical properties. A formation may be a made of rock or of unconsolidated material such as sand, gravel and clay and can be mapped on the earth's surface or traced in the subsurface.

fugitive dust: Airborne particles emitted from any source other than a controllable stack or vent.

gas reservoir: The "pool" of oil or gas that is being tapped.

gathering pipelines: Pipelines within a field that transport gas or oil from the well to a central production facility or to the point of sale.

Global Positioning System (GPS): Computer software that records and stores coordinates for positions on earth via satellite.

groundwater: Water contained in the pore spaces of consolidated and unconsolidated material.

habitat: A specific set of physical conditions that surround a single species, a group of species, or a large community. In wildlife management, the major components of habitat are considered to be food, water, cover, and living space.

habitat function: The arrangement of habitat features and capability of those features to sustain species, population, and diversity of wildlife over time.

halogeton: A coarse annual herb introduced into North America from Siberia; dangerous to sheep and cattle on western rangelands because of its high oxalate content.

human environment: The factors that include, but are not limited to, biological, physical, social, economic, cultural, and aesthetic factors that interrelate to form the environment.

hydrocarbon: A compound formed from carbon and hydrogen (e.g., oil and gas).

hydrology: A science that deals with the properties, distribution, and circulation of surface and subsurface water.

hydrostatic testing: Testing of the integrity of a newly placed but uncovered pipeline for leaks. The pipeline is filled with water and pressurized to operating pressures, and the pipeline is visually inspected.

impacts: Impacts include ecological (such as the effects on natural resources and on the components, structures, and functioning of affected ecosystems), aesthetic, historic, cultural, economic, social, or health, whether direct, indirect, or cumulative. Direct impacts are caused by the action and occur at the same time and place; indirect impacts are caused by the action but occur later in time or are farther removed in distance.

impoundment: The accumulation of any form of water in a reservoir or other storage area.

infiltration: The movement of water or some other liquid into the soil or rock through pores or other openings.

infrastructure: The basic framework or underlying foundation of a community, including road networks, electric and gas distribution, water and sanitation services, and facilities.

injection well: A well that is used to inject produced water from drilling operations in order to maintain pressure or to bring a field back under pressure.

interdisciplinary team (IDT): A group of federal and cooperating agencies selected to work within the NEPA process in scoping, analysis, and document preparation. The purpose of the team is to integrate its collective knowledge of the physical, biological, economic, and social sciences and the environmental design arts into the environmental analysis process. Interaction among team members often provides insight that otherwise would not be apparent.

interim reclamation: Reclamation initiated on well pads, roads, and pipelines after drilling activity is completed and wells are in production. Interim reclamation is considered successful when reclamation performance objectives are met.

intermittent stream: A stream or reach of a stream that is below the local water table for at least some part of the year and obtains its flow from both surface runoff and groundwater discharge.

invasive species: A plant or animal species that has moved into an area and reproduced so aggressively that it has replaced some of the original (native) species.

landslide: A perceptible downhill sliding or falling of a mass of soil and rock lubricated by moisture or snow.

lek: A traditional courtship display area attended by male greater sage-grouse in or adjacent to sagebrush-dominated habitat. Leks are categorized as:

Active - Any lek that has been attended by male greater sage-grouse during the strutting season.

Inactive - Leks where it is known that there was no strutting activity through the course of a strutting season.

Unknown - Leks that have not been documented either active or inactive during the course of a strutting season.

Occupied - A lek that has been active during at least one strutting season within the last 10 years.

Unoccupied (formerly termed "historical lek") - There are two types of unoccupied leks: (1) Destroyed - a formerly active lek site and surrounding sagebrush habitat that has been destroyed and is no longer capable of supporting greater sage-grouse breeding activity. (2) Abandoned - a lek in otherwise suitable habitat that has not been active during a consecutive 10-year period.

Undetermined - Any lek that has not been documented as being active in the last 10 years but that does not have sufficient documentation to be designated unoccupied.

life-of-project (LOP): Begins with the first disturbance authorized under the ROD for a project and ends when all wells are plugged and abandoned and all surface disturbance (each disturbed site) meets the reclamation performance objectives.

lithic scatter: A surface scatter of cultural artifacts and debris that consists entirely of lithic (i.e., stone) tools and chipped stone debris. This common prehistoric site type contrasts with a cultural material scatter (which contains other or additional artifact types such as pottery or bone artifacts), with a camp (which contains habitation features, such as hearths, storage features, or occupation features), or with other site types that contain different artifacts or features.

loam: A mixture of sand, silt, and clay containing between 7% and 27% clay, 28% to 50% silt, and less than 50% sand.

local roads: BLM roads that provide primary access to large blocks of land and connect with or are extensions of a public road system.

long-term impacts: For the purpose of this NEPA analysis, long-term impacts last for the life of the project or beyond.

migration corridor: A tract of land that forms a passageway and facilitates the seasonal migration of animals.

mitigation measures: Actions taken to reduce or minimize potential impacts to the environment.

mitigation: Avoiding the impact altogether by not taking a certain action or parts of an action; minimizing impacts by limiting the degree of magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and/or compensating for the impact by replacing or providing substitute resources or environments.

modeling: A mathematical or physical representation of an observable situation. In air pollution control, models afford the ability to predict pollutant distribution or dispersion from identified sources for specified weather conditions.

Modified Mercalli (MM) Scale of Intensity: A scale designed to describe the effects of an earthquake, at a given place, on natural features, on industrial installations, and on human beings. (See also Richter scale)

monitor: To systematically and repeatedly watch, observe, or measure environmental conditions in order to track changes.

National Ambient Air Quality Standards (NAAQS): The allowable concentrations of air pollutants specified by the federal government. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

National Environmental Policy Act of 1969 (NEPA): The federal law established in 1969, which went into effect on January 1, 1970, that 1) established a national policy for the environment, 2) requires federal agencies to become aware of the environmental ramifications of their proposed actions, 3) requires full disclosure to the public of proposed federal actions and a mechanism for pubic input into the federal decision-making process, and 4) requires federal agencies to prepare an environmental impact statement for every major action that would significantly affect the quality of the human environment.

National Register of Historic Places (NRHP): The official list, established by the Historic Preservation Act of 1966, of the nation's cultural resources worthy of preservation. The National Register lists archaeological, historic, and architectural properties nominated for their local, state, or national significance by state and federal agencies and approved by the National Register Staff.

native species: Plants or animals that originated in the area in which they are found (i.e., they naturally occur in that area); with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

natural gas: Those hydrocarbons, other than oil and other than natural gas liquids separated from natural gas, that occur naturally in the gaseous phase in the reservoir and are produced and recovered at the wellhead in gaseous form.

No Action Alternative: The management direction, activities, outputs, and effects that are likely to exist in the future if the current plan were to continue unchanged.

No Surface Occupancy (NSO): A stipulation in a lease that disallows any surface disturbance in the lease area at any time. Natural gas or oil from an NSO area, for instance, would have to be recovered by directional drilling.

Notice of Intent (NOI): A notice published in the *Federal Register* to announce the intent to prepare an EIS.

noxious weeds: Officially designated (State of Wyoming-designated, Sublette County-declared) undesirable or invading weedy species generally introduced into an area by humans.

oil and gas field: A natural accumulation of oil and gas in the subsurface. Oil and gas may be present in two or more reservoirs at different depths.

oil and gas lease: A federal legal document that gives the lease holder the right to explore for and develop any oil and gas that may be present under the area designated in the lease while complying with any surface use conditions that may have been stipulated when the lease was issued.

ozone (O_3): A molecule containing three oxygen atoms produced by passage of an electrical spark through air or oxygen (O_2).

paleontology: The science that deals with the history and evolution of life on earth.

particulate matter: A particle of soil or liquid matter (e.g., soot, dust, aerosols, fumes, and mist).

passerine: Of or relating to birds of the order Passeriformes, which includes perching birds and songbirds such as the jays, blackbirds, finches, warblers, and sparrows.

perennial stream: A stream or reach of a stream that flows throughout the year.

permeability: The extent that a porous rock, sediment, or soil is able to transmit a liquid.

permittee (grazing): An individual who has livestock grazing privileges on an allotment or allotments within the resource area.

physiographic province: A region having a pattern of relief features or landforms that differs significantly from adjacent regions.

playa: The shallow central basin of a desert plain in which water gathers and is evaporated.

$PM_{2.5}$: Airborne suspended particles with an aerodynamic diameter of 2.5 microns or less.

PM_{10}: Airborne suspended particles with an aerodynamic diameter of 10 microns or less.

Preferred Alternative: The alternative identified in the EIS as the action favored by the lead agency.

prevention of significant deterioration (PSD): A classification system established to preserve, protect, and enhance the air quality in National Wilderness Preservation System areas in existence prior to August 1977 and other areas of national significance, while ensuring that economic growth can occur in a manner consistent with the preservation of existing clean air resources.

produced water: Water brought to the surface through the borehole.

production casing: Steel pipe installed in the borehole to isolate formations and to eliminate communication among hydrocarbon-bearing zones and/or water aquifers and other mineral resources.

production: Phase of commercial operation of an oil field.

Proposed Action: The alternative identified in the EIS as the action favored by the project proponent.

public lands: Lands or interests in lands owned by the United States and in this case administered by the Secretary of Interior through the Bureau of Land Management, without regard to how the United States acquired ownership.

Quaternary: The geologic period beginning two to three million years ago and extending to the present; represented by local accumulations of glacial and post-glacial deposits.

rangeland: Land on which the natural vegetation is made up primarily of native grasses, forbs, or shrubs valuable for forage and suitable for grazing livestock.

raptor: A group of carnivorous birds consisting of hawks, eagles, falcons, kites, vultures, and owls.

reclamation: Rehabilitation of a disturbed area to make it acceptable for designated uses. This normally involves regrading, replacement of topsoil, revegetation, and other work necessary to restore it for use.

Record of Decision (ROD): A decision document for an EIS or Supplemental EIS that publicly and officially discloses the responsible official's decision regarding the actions proposed in the EIS and their implementation.

reserve pit: An excavated pit that may be lined with plastic that holds drill cuttings and waste mud.

reserves/recoverable reserves: Areas of mineral-bearing rock from which the mineral can be extracted profitably using existing technology and under present economic conditions.

residuum: Materials resulting from the disintegration, decomposition, or weathering of bedrock.

Resource Management Plan (RMP): A BLM planning document, prepared in accordance with Section 202 of the Federal Land Policy and Management Act, that presents systematic guidelines for making resource management decisions for a resource area. RMPs are issues-oriented and developed by an interdisciplinary team with public participation.

resource roads: Spur roads that provide point access, as to a well site, and connect to local or collector roads.

revegetation: The reestablishment and development of self-sustaining plant cover. On disturbed sites, human assistance will speed natural processes by seedbed preparation, reseeding, and mulching.

Richter scale: A logarithmic scale used to measure earthquake magnitude (intensity). Each unit increase in the Richter scale represents a 10-fold increase in the amplitude recorded on the seismogram and a 30-fold increase in energy released by the earthquake. (See also Modified Mercalli Scale of Intensity)

rig: A collective term to describe the equipment needed when drilling a well.

right-of-way (ROW): The legal right for use, occupancy, or access across land or water areas for a specified purpose or purposes.

riparian: Land areas directly influenced by water that usually have visible vegetative or physical characteristics showing this water influence. Streamsides and lake borders are typical riparian areas.

roosting: Refers to avian slumber; a bird will typically use the same roost for an extended period of time.

runoff: That part of precipitation that appears in surface streams. Precipitation that is not retained on the site where it falls and is not absorbed by the soil.

sagebrush obligates: Species that depend on sagebrush to survive (e.g., pygmy rabbit, sage sparrow, sage-grouse).

salinity: A measure of the concentration of dissolved salts in a given amount of water or body of water.

scatter (archeological): Archaeological evidence of prior disturbance that is distributed about an area rather than concentrated in a single location.

scoping: An early and open process for determining the scope of issues to be addressed in an EIS and for identifying the significant issues related to a proposed action. Scoping may involve public meetings, field interviews with representatives of agencies and interest groups, discussions with resource specialists and managers, and written comments in response to news releases, direct mailings, and articles about the proposed action and scoping meetings.

sediment: Soil or mineral transported by moving water, wind, gravity, or glaciers, and deposited in streams or other bodies of water or on land.

seismic: Pertaining to an earthquake or earth vibration, including those that are artificially induced.

sensitive soils: Soils having physical and/or chemical characteristics that could inhibit or limit successful stabilization and revegetation in the reclamation of sites disturbed by construction and the operation of oil and gas facilities.

shale: A laminated sediment in which the constituent particles are predominantly of the clay grade.

short-term impacts: For the purpose of this analysis, short-term impacts are generally defined as those that would last for five years or less.

significant impact: A meaningful standard to which an action may impact the environment. The impact may be beneficial, adverse, direct, indirect, or cumulative and may be short-term or long-term.

silt: Any earthy material composed of fine particles, smaller than sand but larger than clay, suspended in or deposited by water.

siltstone: A sedimentary rock whose grain size is intermediate in size, falling between the coarser sandstone and finer mudstone.

site-specific analysis: Environmental assessments designed to address issues related to small projects, such as individual wells, generally under the guidance of a more comprehensive NEPA document.

socioeconomics: The study of impacts on a region's current and projected population and relative demographic characteristics (housing, economy, government, etc.).

soil productivity: The capacity of a soil to produce a specific crop, such as fiber and forage, under defined levels of management. It is generally dependent on available soil moisture, nutrients, and length of growing season.

species of concern: Species of concern include federally listed threatened or endangered species, species proposed for listing, BLM sensitive species, WGFD priority species, and species considered rare or important by the Wyoming Natural Diversity Database.

stipulation: A legal requirement that is part of the terms of a mineral lease. Some stipulations are standard on all federal leases. Other stipulations may be applied to the lease at the discretion of the surface management agency to protect valuable surface resources. Stipulations are supported by the NEPA process; without NEPA support, a stipulation cannot be added to the lease.

structural basin: A large depression of structural origin.

substrate: Material consisting of silts, sands, gravels, boulders, and/or woody debris found on the bottom of a stream channel.

surface disturbing activities: An authorized action that disturbs vegetation, surface/near surface soil resources, and/or surface geologic features, beyond natural site conditions and on a scale that affects other Public Land values.

surface water: Water that sits or flows on the surface of the earth, including oceans, rivers, streams, lakes, wetlands, and reservoirs constructed by humans.

Tertiary: The older of the two geologic periods comprising the Cenozoic Era; the system of strata deposited during that period.

threatened species: Any species (plant or animal) that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Threatened species are identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act.

topographic basin: A large depression of erosional origin.

topography: The features of the earth, including relief, vegetation, and waters.

topsoil: The uppermost layers of naturally occurring soils suitable for use as a plant growth medium.

total dissolved solids (TDS): Total amount of dissolved material, organic or inorganic, contained in a sample of water.

trona: An evaporite mineral that is used as a source of sodium carbonate.

tuff(aceous): A rock formed by compacted volcanic fragments, generally smaller than 4 mm in diameter.

turbidity: A measurement of the total suspended solids in water.

two-track: A road that has not been constructed or maintained but that has been created by repeated use.

understory: A layer of vegetation underlying a layer of taller vegetation, such as brush and grass under trees.

viewshed: The areas seen from any given point.

visibility: The visual quality of the view or scene in daylight, with respect to color, rendition, and contrast definition.

visual resource: The composite of basic terrain, geologic features, water features, vegetation patterns, and land use effects that typify a land unit and influence the visual appeal the unit may have for viewers.

Visual Resource Management (VRM): A system of visual management used by the BLM. The program has a dual purpose: (1) to manage the quality of the visual environment, and (2) to reduce the visual impact of development activities while maintaining effectiveness in all BLM resource programs. The system uses four classes for categorizing visual resources.

> **Class I -** Natural ecological changes and limited management activity are allowed. Any contrasts created within the characteristic landscape must not attract attention. This classification is applied to wilderness areas, wild and scenic rivers, and other similar situations.
>
> **Class II -** Changes in any of the basic elements (form, line, color, texture) caused by a management activity should not be evident in the characteristic landscape. Contrasts are seen but must not attract attention.
>
> **Class III -** Contrasts to the basic elements caused by a management activity are evident but should remain subordinate to the existing landscape.
>
> **Class IV -** Any contrast may attract attention and be a dominant feature of the landscape in terms of scale, but it should repeat the form, line, color, and texture of the characteristic landscape.

water quality: Refers to a set of chemical, physical, or biological characteristics that describe the condition of a river, stream, or lake. The quality of water determines what beneficial uses it can support.

watershed: The total land area that drains to a given watercourse or body of water.

Waters of the U.S.: A jurisdictional term from Section 404 of the Clean Water Act referring to water bodies such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds with defined bed and bank.

well or wellbore: The hole drilled from the surface to the gas-bearing formation, several of which may be developed from a single well pad.

well pad: Relatively flat work area (surface location) that is used for drilling a well or wells and for producing from the well once it is completed.

wetlands: Areas that are inundated by surface water or groundwater with a frequency sufficient to support—and under normal circumstances do or would support—a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction.

wind rose: Any one of a class of diagrams designed to illustrate the distribution of wind direction experienced at a given location over a given period of time. Wind roses may also give information concerning distribution of wind speed, stability, or other meteorological parameters.

winter range: An area where migratory (and sometimes non-migratory) animals congregate during the winter season.

workover: Well maintenance activities that require onsite mobilization of a drill rig to repair the well bore equipment (casing, tubing, rods, or pumps) or the wellhead. In some cases, a workover may involve development activities to improve production from the target formation.

Wyoming Ambient Air Quality Standards (WAAQS): The allowable concentrations of air pollutants in the air specified by the State of Wyoming. The air quality standards are divided into primary standards (based on the air quality criteria and allowing an adequate margin of safety and

requisite to protect the public health) and secondary standards (based on the air quality criteria and allowing an adequate margin of safety and requisite to protect the public welfare from any unknown or expected adverse effects of air pollutants).

yearlong range: Locations where specific species are able to reside in the same area throughout the year.