Improving Access to Onshore Oil & Gas Resources on Federal Lands

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Project Researchers & Cooperating Agencies

IMPROVING ACCESS TO ONSHORE OIL & GAS RESOURCES ON FEDERAL LANDS

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I. PURPOSE AND OVERVIEW

A. INTRODUCTION

The United States relies on oil and natural gas to supply a significant portion of the nation's energy. These fuels currently supply greater than 60 percent of the nation's energy and are the prime transportation fuels supplying nearly 100 percent of the nation's needs (NEPDG, 2001). The energy needs of the United States are greater than domestic sources are currently supplying, a situation which is expected to continue at an ever increasing rate as the energy needs of the United States rise in the future. The Bush Administration's Energy Policy highlighted the means to meet the nation's future energy needs through conservation, increasing domestic supplies, strengthening the energy infrastructure and increasing alternative and renewable fuels (NEPDG, 2001), while sustaining environmental responsibilities and strengthening foreign alliances. The National Energy Policy Development Group which provided the basis for the Bush Administration's Energy Policy suggested that one way to increase domestic on-shore production is to increase access to federal lands thus producing more of our own oil and natural gas resources. The federal government owns approximately 30 percent of the land in the United States, with much of the nation's public lands estimated to have substantial undiscovered energy resources (NEPDG, 2001) representing a favorable source for increased domestic production. Therefore, access to federal lands for the leasing and development of oil and natural gas resources is critical to meeting the nation's current and future energy demands.

Considering the national importance access to federal lands has for energy development and supply, it is also critical to understand and address associated environmental and social concerns related to activities involving development on federal lands. This document is intended to serve as a reference and source of information for operators, land managers, and other stakeholders to more efficiently access the onshore oil and natural gas resources that are present under federally owned lands within the United States. Further, this document incorporates detailed information and guidance specific to requirements of the National Environmental Policy Act (NEPA) as it pertains to oil and natural gas leasing and development. This combination of information serves as a basis that can be leveraged to improve access to federal lands in an environmentally and technically sound manner.

The need to improve access to federally administered minerals is perhaps best demonstrated through historic and current statistics of oil and gas development. Statistics from the Energy Information Administration (EIA), the agency which tracks energy related data, demonstrates how the consumption of energy from oil and natural gas resources in the United States is outpacing domestic production (Figure 1). Figure 1 shows that current domestic supply of crude oil is approximately 5.5 million barrels per day, while consumption of crude oil is in excess of 20 million barrels per day; a domestic production shortfall of 14.5 million barrels per day (EIA, 2005). Projections for domestic production of crude oil show production fluctuating at approximately 5.5 million barrels per day through 2015, after which production is predicted to slowly decline (Figure 1). Consumption of crude oil is expected to steadily increase to over 27.5 million barrels per day by 2030, which would result in a domestic production shortfall of more than 20 million barrels per day (Figure 1).

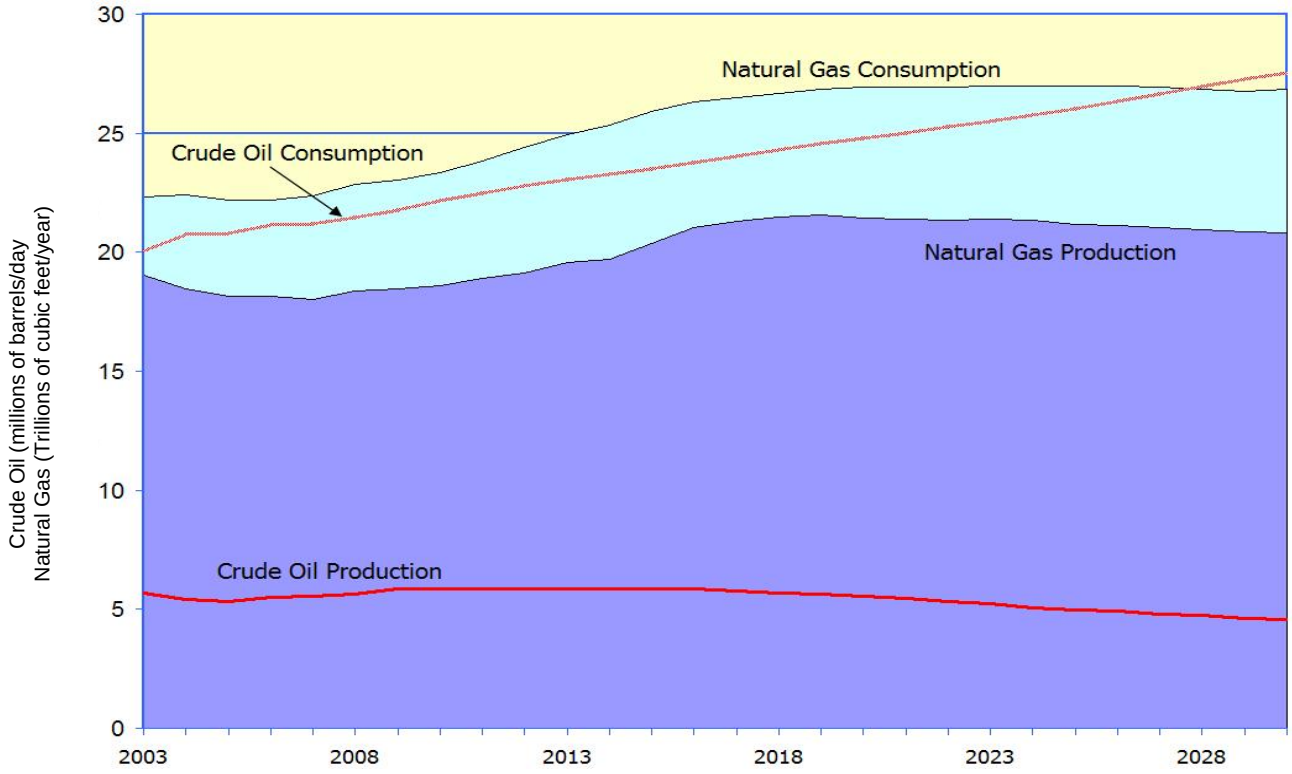
The Energy Information Administration projections for natural gas through 2030 are also shown in Figure 1. Current natural gas consumption is greater than domestic natural gas production, yet the natural gas domestic production shortfall is not as large as the shortfall seen for crude oil. The difference between domestic production of natural gas and consumption was approximately 4 trillion cubic feet (TCF) per day in 2003. While production of natural gas is expected to grow over the next 15 years, consumption is expected to grow at a faster rate which is predicted to result in a domestic production shortfall of approximately 7 TCF/day by 2030 (Figure 1). These projections illustrate the need the National Energy Policy Development Group identified for increasing domestic production of oil and natural gas resources from domestic reserves in order to help offset the need to import increasingly larger amounts of oil and gas resources from other producing countries.

The United States Geological Survey's (USGS's) national assessment of oil and gas resources estimates the current mean oil and gas resources of the United States to be 47.3 billion barrels of oil, 622 TCF of total natural gas, and 11.4 billion barrels of natural gas liquids (USGS, 2005). Analysis of oil and gas fields with the highest known reserves, as shown in Figure 2, indicate that these oil and gas fields are located predominantly in five regions: California, the Rocky Mountain States, the south-central United States, Alaska, and the Gulf of Mexico. The map of the United States in Figure 3 shows the federal surface distinguished by the various federal agencies which manage federally administered surface. Federal lands comprise approximately 30 percent of the United

States with the majority of the surface being located in the western half of the United States, including Alaska (Figure 3). A comparison of the maps in Figure 2 and Figure 3 identifies two regions that have large proven oil and gas reserves corresponding with large areas of federal administered surface: Alaska and the Rocky Mountain States.

Figure 1 United States Domestic Oil and Natural Gas Production and Consumption

Graph depicts estimated domestic oil and natural gas production and consumption through 2030 (EIA, 2005)



The Rocky Mountain Front contains considerable oil and natural gas reserves (Figure 2) and is a region with vast areas of Forest Service; Bureau of Land Management (BLM); Fish and Wildlife; and National Park Service administered lands. While Alaska's North Slope contains reserves that are estimated to contain the greatest untapped oil and natural gas reserves in the United States most of which are administered by the Fish and Wildlife Service (USGS, 2005).

There are numerous federal agencies which administer federal surface estates as Figure 3 shows, and each of the agencies has its own administrative land uses for the areas they manage. Only one federal agency, the BLM, is responsible for managing the 700

million acres of subsurface mineral estates and is solely responsible for the leasing of fluid minerals on all Federal Lands (BLM, 2005a). While the BLM is solely responsible for managing oil and gas leasing of federal mineral estates, the issuance of oil and gas leases and permits is not the BLM's sole responsibility. Efforts to increase oil and gas production from domestic federally managed reserves would, therefore, require the BLM to have the highest level of involvement. However, the involvement of multiple land management agencies complicates the federal decision-making process for developers.

There are a variety of reasons why oil and gas resources located on federal lands have not been previously developed to their full potential. To date, development has been limited by lease restrictions and stipulations which impede leasing on some of the federal lands, delays in obtaining federal permits, conflicts with the existing land uses, and in recent years increasing litigation which has delayed permitted actions. The issue of future oil and gas development on federal lands is further complicated by the current state of permitting and the assessment of potential impacts to the environment in NEPA documents which have become increasingly more complicated. In an attempt to be thorough and avoid litigation, today's NEPA documents are often unnecessarily long and cumbersome. Tom Richmond, Administrator of the Montana Board of Oil & Gas Conservation, addressed this concern when he stated:

> "Improved access to oil & gas resources on federal lands requires increasing the understanding of what the actual impacts caused by oil & gas development are, which are often much less than what is predicted through the current NEPA process. Further, because of document complexities, it is impossible to predict which issue(s) will drive analysis, which promotes a tendency to make documents even more complex. The increasing complexity of these documents is a growing impediment to leasing and development."

In recent years, the number of oil and gas development projects on federal lands has increased as technological advances and current economics have increased production from older fields, increased activities on continuous plays and on conventional oil and gas plays that were once considered economically marginal. As such, the rate of federal oil and gas production has seen a recent boom with the number of drilling permits issued by the BLM increasing between 1999 and 2004 from 1,803 to 6,399, respectively; an increase of more than 350 percent (GAO, 2005).

Figure 2 Map of Top 100 Oil and Gas Fields in the United States

Map shows the relative location of the reserves in the United States

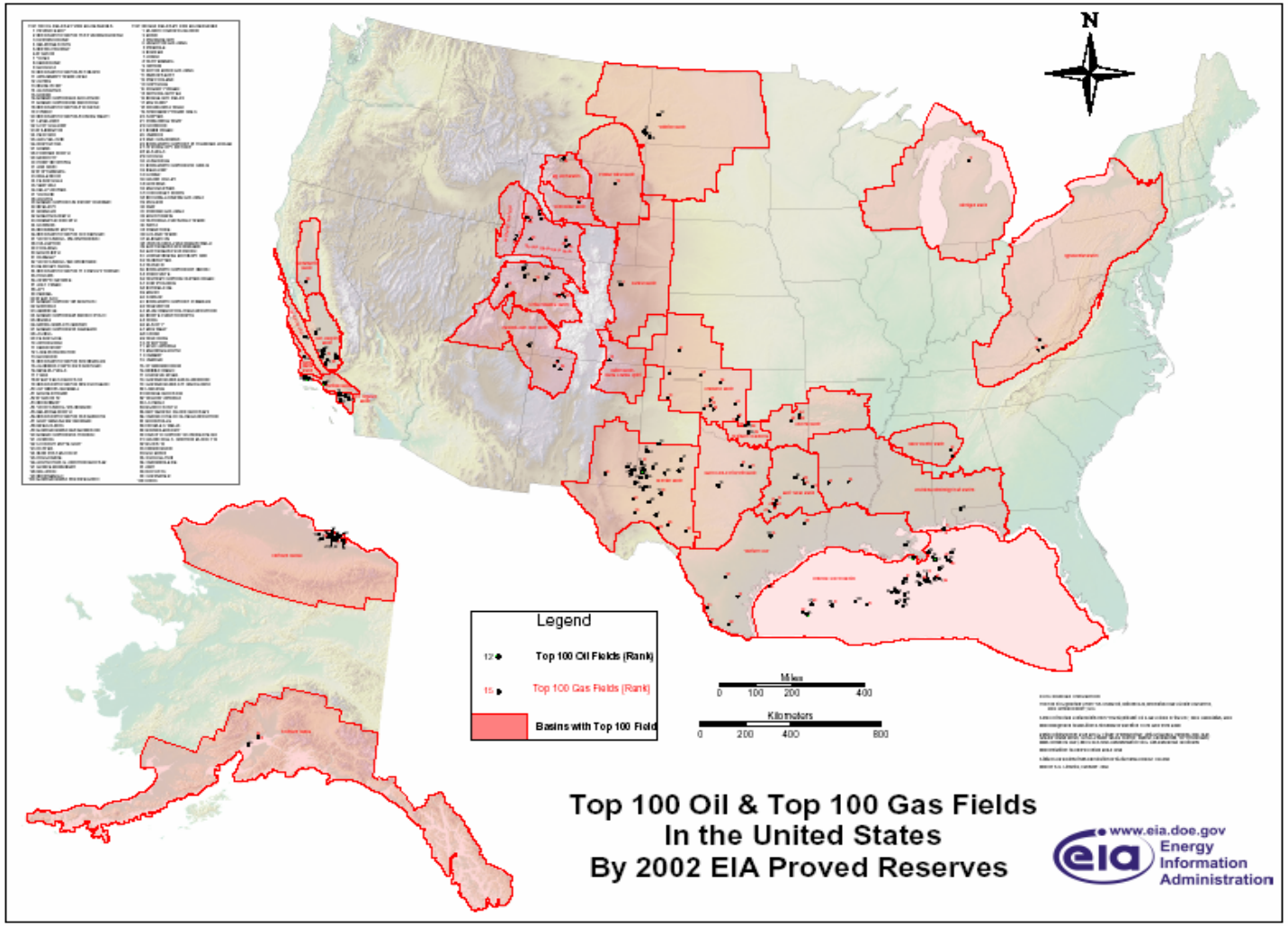
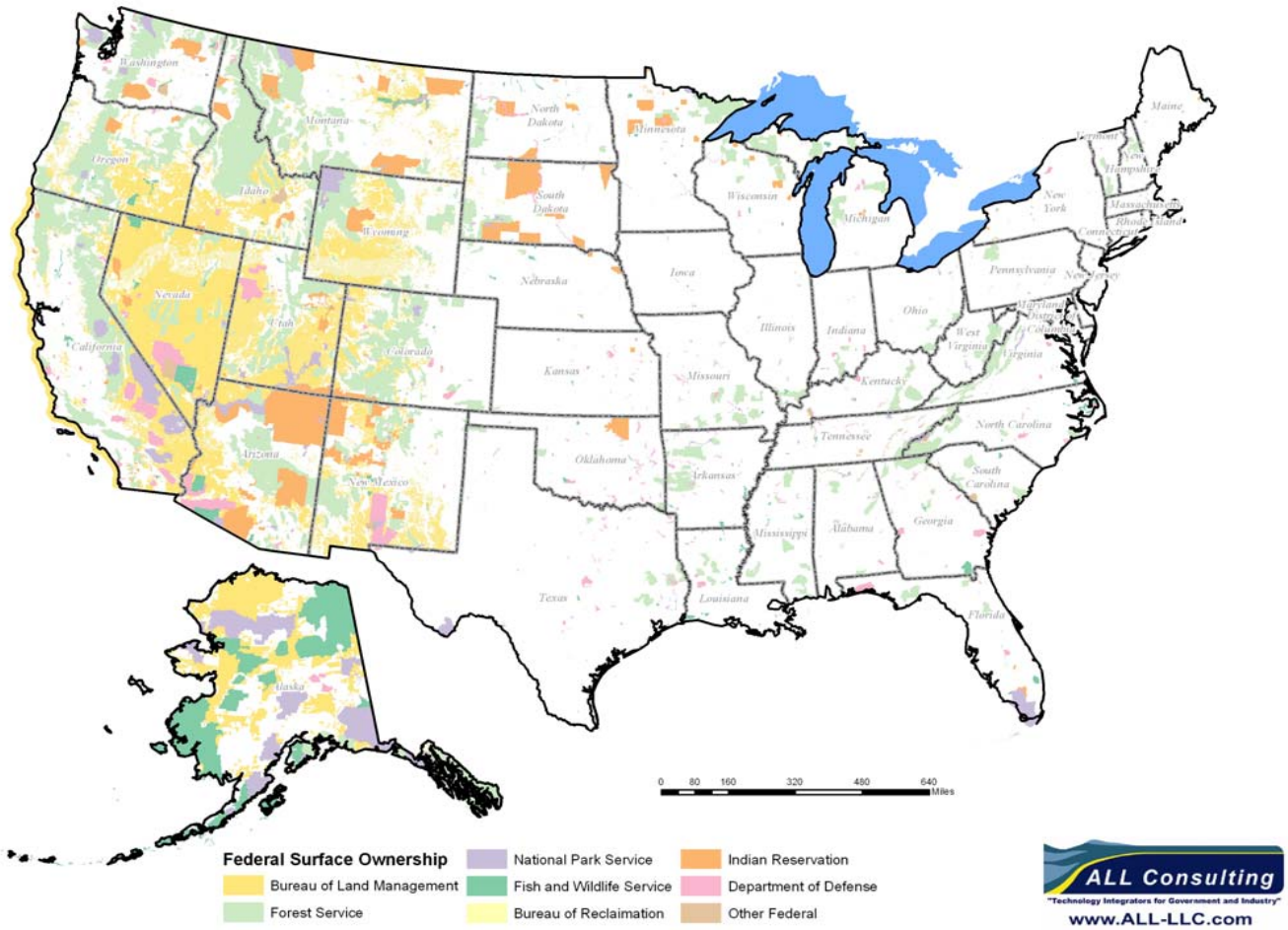


Figure 3 Federal Surface and Surface Managing Agencies



Further increases in the development of federal minerals would result in additional increases in the number of permits. The recent increase in the number of oil and gas permits has affected the efficiency of the BLM as current permits are taking longer to get approved than was normal previously. Although increasing the number of permits issued and reducing the time it takes to get a permit issued would aid in improving federal oil and gas development, permits are not the only limiting factor.

One of other issues identified in accessing oil and natural gas resources on federal lands is the environmental analysis federal development projects must undergo before the federal land management agency can approve one of these projects. As a process, NEPA establishes only the necessity of assessment; NEPA does not provide a list of standards by which regulators are to analyze impacts. Issues such as the natural environmental variations between physical geographical regions, variations in the agendas of managing federal agencies, as well as variations in the analytical methods employed during environmental assessment have created an atmosphere of obscurity in these assessments. The methods used in environmental analysis tend to be overly conservative, presenting findings on a worst-case scenario basis, which subsequently hampers oil and gas developers' access to federal land.

As noted by the House of Representative's NEPA Task Force, political pressure and litigation from Non-Governmental Organizations (NGOs) has resulted in increasing numbers of delays for oil and gas leasing and development. According to the Council of Environmental Quality, over 565 lawsuits regarding NEPA were filed between 2001 and 2004 (CEQ, 2005). Each of these lawsuits can postpone a development project for long periods of time. Development is sometime further delayed if additional analysis or supplements to NEPA analysis documents are ordered to be written by the court. A contemporary example of political pressure impeding oil and gas development are the attempts by the United States Senate to pass a bill to access the Arctic National Wildlife Refuge (ANWR). In 1980, the Alaska National Interest Lands Conservation Act provided Congress the authority to pass legislation that would allow oil & gas exploration and production in ANWR (DOE, 2004). Although there have been repeated attempts to propose bills for drilling at ANWR from Senate subcommittee's, none have been successfully passed to provide the opportunity to open ANWR for producing oil & gas to date (DOE, 2004).

The need for additional domestic production of oil and gas resources was identified in the Bush Administration's National Energy Policy. Some of the largest potential reserves of oil and natural gas in the United States are present on the lands owned by the federal government. In order for the resources present on federally managed lands to be developed, oil and gas operators would need to be able to access these lands. In part, making federal lands that were previously unavailable for oil and gas development would aid in increasing domestic production, but additional actions would be required to improve the permitting and environmental analysis performed to allow these projects to occur in a timely and environmentally responsible manner.

B. Purpose and Need

In many situations, NEPA related documents arising from oil and gas development can be characterized by their lack of oil and gas references, conflicting model parameter assumptions, and inconsistent impact analyses (Argonne National Laboratory, 2004). Although the BLM does have some guidance documents on oil and gas development (the Gold Book, etc.), there are no guidance documents that relate how NEPA documents for oil and gas development should be prepared. As a result, these NEPA documents are often delayed at the state or federal level while additional research efforts are employed to account for the lack of sufficient data related to oil and gas development and potential impacts. In addition, the basic information necessary to enable federal and state regulators and other pertinent parties to evaluate and make decisions in an efficient, but responsible manner, is often not readily available.

Subsequently, resources are not consistently analyzed and environmental consequences may be overestimated, which can result in a reduction of the amount of available lands for development. Regional offices of federal agencies (such as the USGS, NPS, USFS, BLM) can further complicate the process of assessing the effects from an oil and gas development project due to the use of varying assumptions regarding oil and natural gas development activities and different analysis methods for the same resources. In researching this issue, more than thirty NEPA documents were reviewed to compare assumptions and analyses from Resource Management Plans, Environmental Impact Statements, and Environmental Assessments. Research results found that not only did variations exist between federal agencies but also among field offices within the same agency. The need exists to simplify the process by providing federal agencies with common assumptions related to the development methods of oil and natural gas

resources which aid in the development of environmental analysis and speed the permitting process to increase domestic production of oil and natural gas.

This document is aimed at providing information which can be utilized nationally to increase access to federal lands through the development of consistent environmental analysis methods and supporting research and data needs specific to onshore oil and gas development. The goal is to accomplish this by fostering sound and standardized environmental analysis methodologies. The approach utilized to reach such objectives, in general, begins by identifying technologically based tools and methods that can be implemented in a practical and feasible manner to streamline the NEPA process for oil and gas development; while at the same time maintaining a legitimate balance with environmental protection and resource development which is consistent across different state and federal agency jurisdictions. This guide is intended to enable land management agencies and operators to make decisions that support access to federal resources while achieving a balance between environmental protection and fluid mineral development.

C. Overview of Research

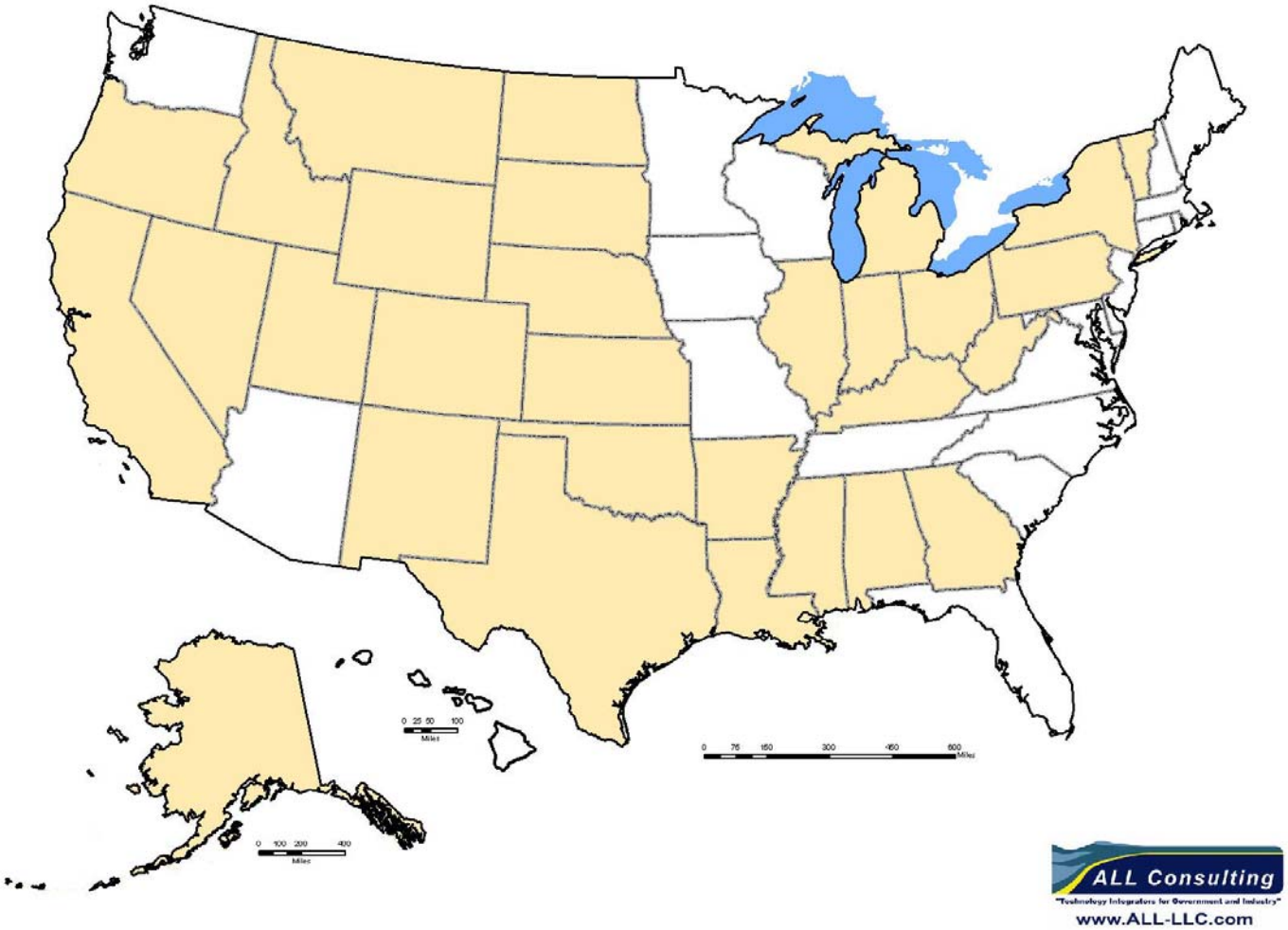
This document contains the results of research conducted to provide an overview of onshore oil and gas development on federal lands, an evaluation of the NEPA process and the evolution of NEPA documents. The research was conducted on a nationwide basin with federal and state agencies as well as interviews with industry personnel and citizens action groups from many states. The map in Figure 4 highlights the states in which research has been conducted for this project. The following are a list of some of the topics researched and presented in this document:

- *Onshore Oil and Gas Overview*: The researchers examined non-regulatory and regulatory guidance documents as well as industry personnel to identify characteristics of standard onshore oil and gas development. This section is intended to provide readers a familiarity with the phases and practices within the various types of oil and gas development in the United States. Researchers examined several existing documents pertaining to onshore oil and gas production processes include leasing, environmental consequences from the phases of exploration, construction, production, abandonment, and reclamation. Documents pertaining to specific resource elements were studied to determine

techniques that are used for predicting environmental consequences from activities relating to oil and gas development.

- *Existing Regulations*: Researchers examined the applicable and relevant regulatory literature as it applies to onshore oil and gas exploration and production sites for environmental assessment of oil and gas projects. The main focus of the regulatory research was NEPA which necessitates the environmental impact assessment process. In addition, land management regulations were studied from several government agencies including the BLM, the USDA Forest Service, and the US Fish and Wildlife Service.
- *Management Practices*: Researchers examined Management Practice (MP) documents from several existing federal agencies. These included Resource Management Plans (RMPs) and land use management plans; both programmatic and project specific. Such guides provide information on regional specific resources that affect oil and gas development and what practices are used to monitor and mitigate the environmental consequences of a project. The documents also provided information regarding the changes that have occurred to the level of detail included in the management practices identified in these documents.
- *Review of Environmental Impact Assessment Documents*: Numerous Environmental Impact Statements and Environmental Assessments were reviewed by researchers. In reviewing these documents the level of detail within each analysis as well as the myriad of different methods applicable to oil and gas development impacts were assessed. Documents from around the United States were reviewed to highlight regional variations in the assessment process, the most appropriate of which were included in this document for the purpose of creating a set of universally applicable methods for assessment.
- *Case Studies*: Two case studies were conducted. The Swanson River Oil & Gas Field case study took place in Kenai Peninsula Borough, Soldotna, Alaska. The Swanson River case study provides a historical perspective of federal land management approaches, which are implemented by varying regulatory agencies, to demonstrate conflicting agency objectives, as well as the complexities that are often involved in managing oil and gas lands. The objective of the Badger Hills Exploration and Production Area case study was to

Figure 4 Distribution of Participating States in this Study.



evaluate resource assessments and impact analysis by comparing the 2004 Badger Hills Environmental Assessment document to the analysis performed for the Montana Statewide EIS. The evaluation assessed the difference in the assessment methods of the EIS for comparison of statewide programmatic analysis and the site specific analysis of an EA. The Swanson River case study is presented in this document as Appendix A, while the Badger Hills case study is presented as Appendix B.

D. Project Advisory Council

The research herein was conducted under the direction of the Interstate Oil and Gas Conservation Commission (IOGCC), with oversight and direction from a Project Advisory Council (PAC). The PAC is comprised of a diverse group with interests related to federal land management and oil and gas develop that includes: oil and gas agency directors, state and federal agency representatives, industry representatives and other stakeholders. Because the PAC includes such a diverse group, input was actively sought during various stages of the research to provide direction for the research, and help in identifying issues that are relevant to the success of the research. The diversity of the PAC has resulted in the research obtaining unique perspectives into the issues of oil and gas development and access of federal lands.

E. Summary of Future research and Objectives (Phase II)

Upon completion of the Phase I portion of this Project, as summarized in subsection C, a system of SMART tools based on spatial data analysis will be developed to facilitate a uniform approach for assessment of NEPA related resource impacts, as well as generate predicted resource impact data that more accurately reflects observed actual impacts. The development of these SMART tools will be based on data collected and analyzed during the Phase I portion of this Project. The SMART tools will be further defined and validated by assessing and comparing predicted and actual resource impact data gathered for the Badger Hills case study. It is hoped this calibration technique will sharpen the analysis to better forecast actual resource impacts and provide field tested feedback to the research team to allow for identification of additional research needs

II. INTRODUCTION TO ONSHORE OIL & NATURAL GAS DEVELOPMENT

This section is intended to present concepts related to typical onshore oil and gas development procedures relevant to federal land use planning and provide the user with a basic knowledge of key concepts of oil and gas development and land use planning.

Fluid minerals are defined by the BLM as oil, natural gas and geothermal resources (BLM, 2005b). The discussion included here focuses on oil and natural gas and excludes reference to, or discussion of geothermal resources. Oil and natural gas are the primary hydrocarbons used for energy and transportation needs within the United States. Hydrocarbons are formed from organic matter altered deep within the earth's crust under slowly increased temperature, pressure and bacterial action. Over time the organic matter is heated to the point where the organic matter is altered resulting in the formation of oil and natural gas.

Within the United States there are 31 states with oil and natural gas production, with the majority of production coming from Texas and Louisiana (including offshore production). Figure 5 provides a comparison of relative energy production (measured in Btu's) from oil and gas by state for the year 2000. The data included in Figure 5 includes off-shore production from the Gulf of Mexico. The majority of oil and gas production within the United States occurs in only a handful of states, with most states having only minor production (Figure 5).

Figure 5 is a snap-shot of oil and gas production in the year 2000; of course production is in a state of constant change with new wells being drilled, new fields being found, and old fields depleting. Oil and gas production from the United States are both in a condition of decline from historical highs. This decline is largely due to the depletion of old, very large fields discovered years ago. Figure 6 illustrates the historical trend of annual oil production and Figure 7 illustrates the historical trend of natural gas from the nation's gas producing wells.

Figure 5 Oil and Gas Energy Production for the United States from the Year 2000.

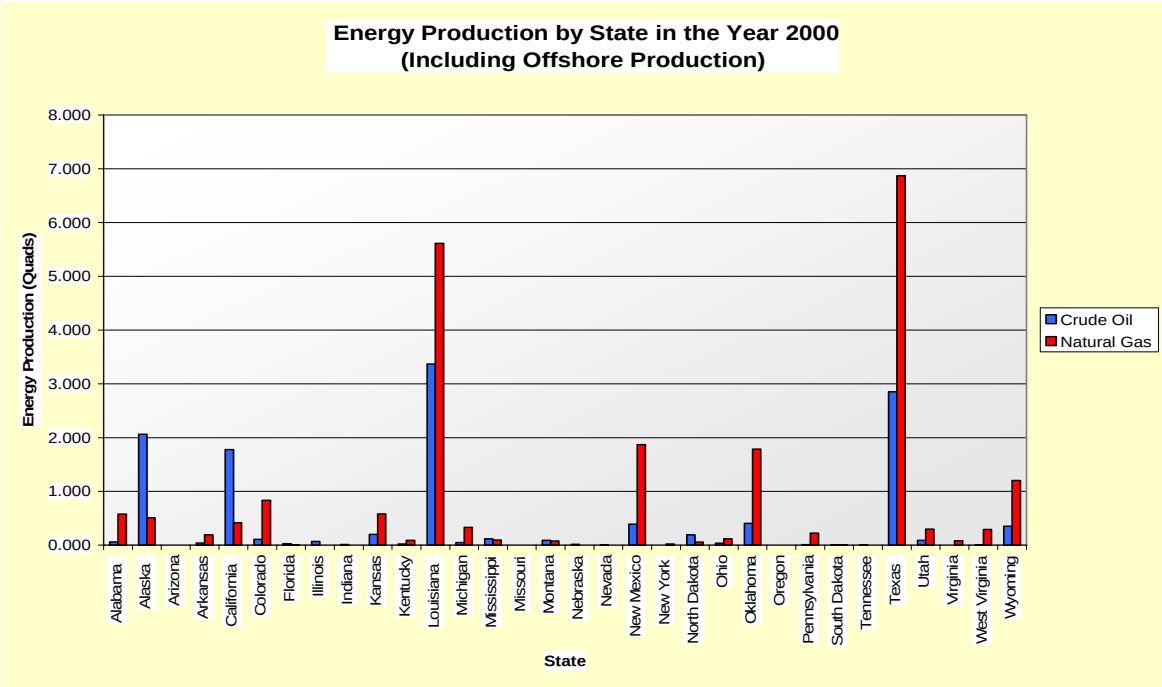


Figure 6 Annual Oil and NGL Production Rates – 1935 to 2010; peak is reached in early 1970's.

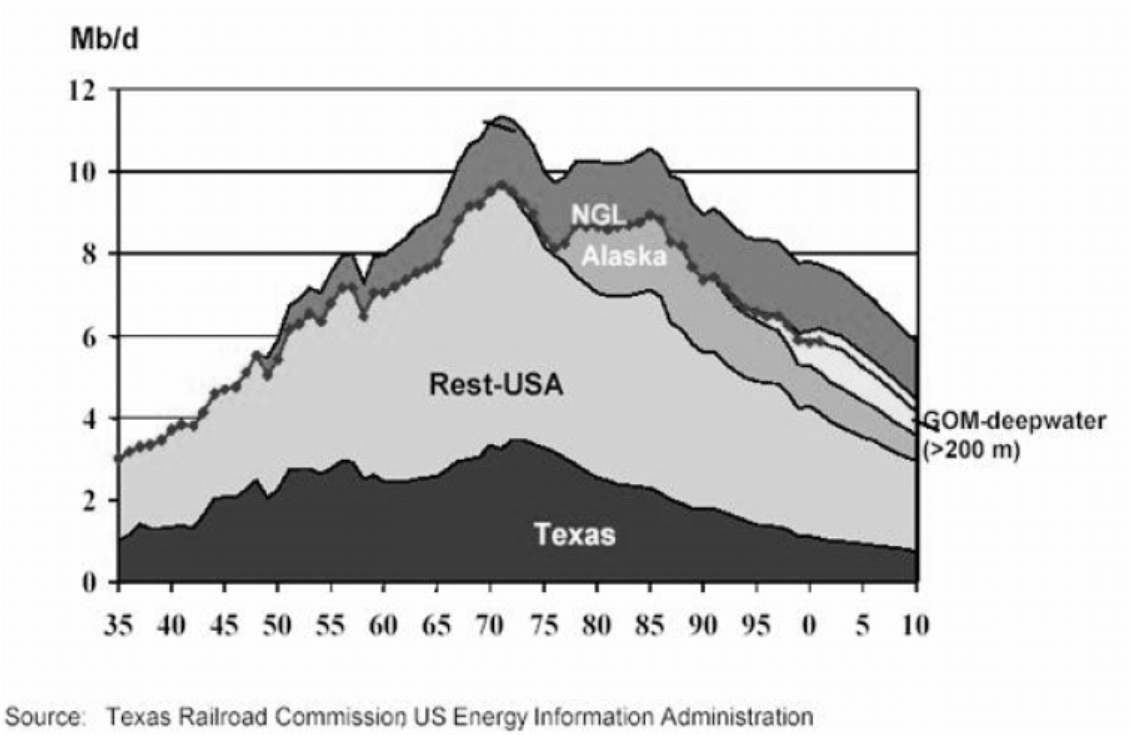


Figure 7 Annual Natural Gas Production Rates – 1930 through 2006 :peak is indicated at 1973.

U.S. Dry Natural Gas Production (MMcf)										
Decade	Year-0	Year-1	Year-2	Year-3	Year-4	Year-5	Year-6	Year-7	Year-8	Year-9
1930's	1,903,771	1,659,614	1,541,982	1,548,393	1,763,606	1,913,475	2,164,413	2,403,273	2,284,863	2,464,637
1940's	2,654,293	2,778,061	3,026,694	3,393,743	3,672,156	3,882,065	3,987,488	4,393,439	4,938,512	5,195,404
1950's	6,022,198	7,164,959	7,694,299	8,056,848	8,388,198	9,028,665	9,663,910	10,246,622	10,572,208	11,547,658
1960's	12,228,148	12,661,579	13,253,006	14,076,412	14,824,027	15,286,280	16,467,320	17,386,791	18,494,523	19,831,680
1970's	21,014,229	21,609,885	21,623,705	21,730,998	20,713,032	19,236,379	19,098,352	19,162,900	19,121,903	19,663,415
1980's	19,403,119	19,181,261	17,820,063	16,094,461	17,466,472	16,453,857	16,059,030	16,620,581	17,102,621	17,310,645
1990's	17,809,674	17,697,802	17,839,903	18,095,460	18,821,025	18,598,679	18,854,063	18,902,389	19,023,564	18,832,232
2000's	19,181,980	19,616,311	18,927,788	19,098,544	18,590,891	18,074,237	18,491,057			

Source: U.S. Energy Information Administration

The implications of these two hydrocarbon production trends suggest that the oil and gas industry will be forced to make up the increasing shortfall between growing demand and shrinking domestic supply. The shortfall predicted by these trends is even worse than that predicted by the USGS and shown in Figure 1. The shortfall can only be narrowed with increased production or costly imports. Operators will be exposed to tremendous political and economic pressures to accelerate exploration and development. Political pressure may be sufficient to truncate or modify the NEPA process. Operators and federal land managers can abate those pressures by utilizing some of the techniques outlined in this report.

Shortfall of natural gas may best be ameliorated by increasing development of tight gas, coal bed natural gas, and other unconventional resources. The EIA forecasts unconventional gas to grow in percentage of total gas production from 28 percent in 2003 to 36 percent in 2025 (EIA, 2003) ("EIA's natural Gas Outlook Through 2025", Aug 7, 2003). Unconventional gas resources frequently demand large numbers of wells and more intense infra-structure that can constrain access to certain federally controlled land areas. Actions that could help overcome these

constraints include in-depth environmental assessments that focus on the most significant constraints; the development of environmentally enhanced exploration and production technologies, such as low emission motors; the creative use of more environmentally sensitive water treatment and disposal methods; and minimization of the drilling footprint through use of single drilling pads with multiple, directional wells (EIA, 2002)(" Impact of Unconventional Gas Technology in the Annual Energy Outlook 2000", July 30, 2002).

The oil and gas producing regions within the United States are shown Figure 8. This figure illustrates that oil and natural production occurring within the United States occurs in relatively discrete regions. From Figure 8 the major production areas for oil and gas of the United States can be identified; these areas include the Gulf Coast, upper Appalachian Mountains, Mid-Continent, and the Rocky Mountain areas. Across these regions are inherent similarities in the way in which oil and natural gas are developed. The following discussion presents a discussion of the oil and gas development process, with a focus on development activities on federal lands.

A. History and Evolution of the Onshore Oil and Gas Industry

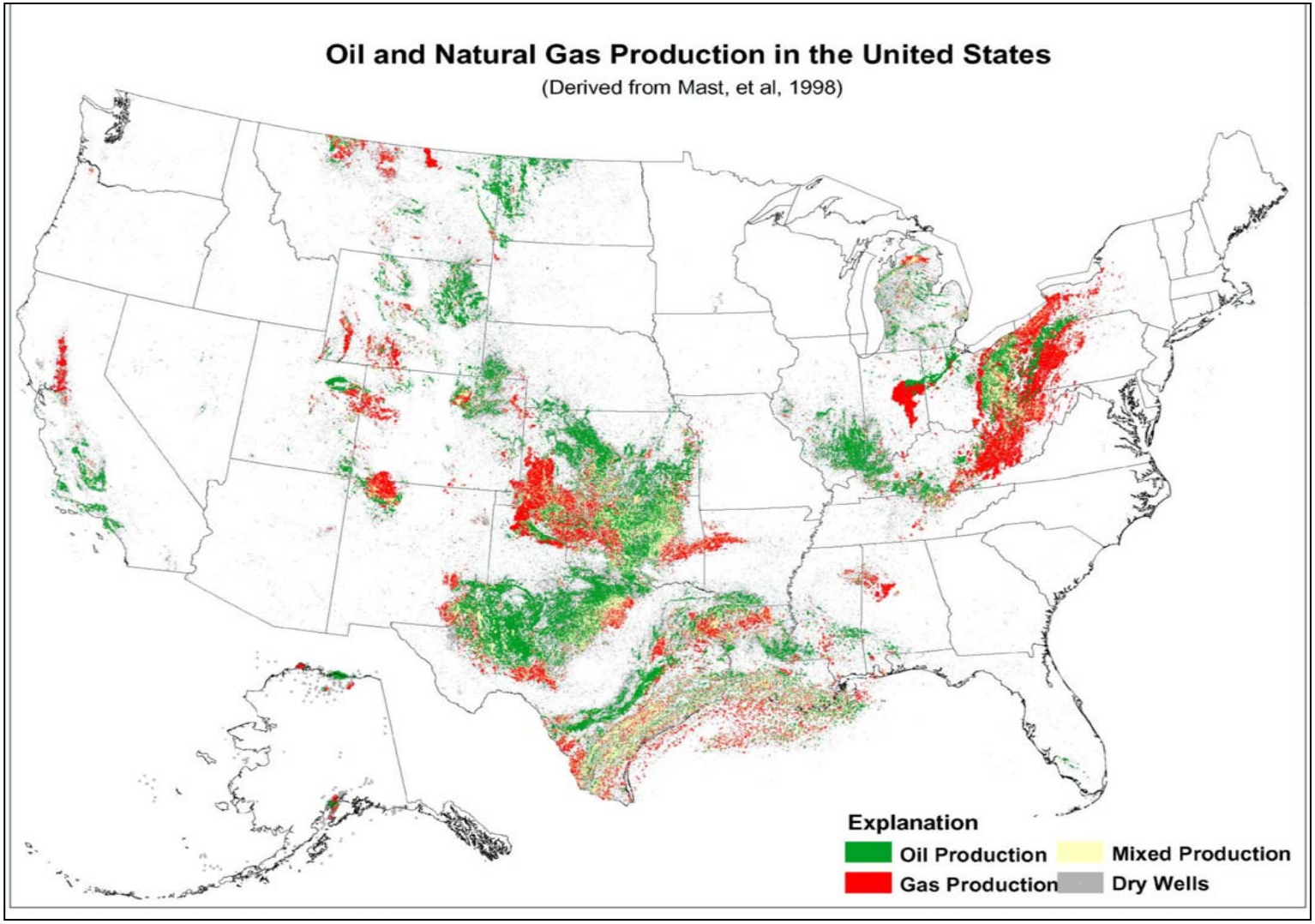
The oil and gas industry in the United States started with the earliest explorers who discovered petroleum deposits of various types near the surface as early as the 16th century (Wall, 2005). Oil and natural gas drilling and production have progressed since the latter half of the 19th Century. Technology has progressed by steps from shallow impact drilling to carefully control rotary drilling at precise angles and steering to tiny geographic targets. Drilling controls have allowed operators to protect every aspect of the environment while producing as much of the hydrocarbon resource as possible.

History

Early discoveries of oil resulted in settlers adapting oil to uses including medicine, grease for tools, and kerosene derived from distilled rock oil. By the late 19th century, the rock oil industry of the United States was overtaking the whale oil market; the oil production and refining market was growing at such a rate that the price of oil dropped considerably. The first oil company was formed in Pennsylvania in the 1850's which resulted in the first known oil production from a drilled well to the source (Wall, 2005). The initial oil boom in Pennsylvania resulted in Rockefeller interests in oil refining and led to the formation of the Standard Oil Company. Standard Oil Company led the industry with the formation of some of the earliest research and development programs which improved the quality of the kerosene making it more reliable, efficient and economic than most other fuels.

Figure 8 Oil and Natural Gas Producing Regions in the United States.

Map showing production regions by resource within the United States and the Gulf of Mexico



As additional discoveries of oil occurred in the west (California), in Texas, and parts of the Midwest around the start of the 20th century, the competition for Standard Oil Company grew and oil production from the United States was equal to that of the rest of the world (Wall, 2005). The growth of Standard Oil Company had also resulted in other changes to the economy and business regulations of the United States including the regulation of railroads and antitrust regulations. In 1911 the United States Supreme Court declared Standard Trust a monopoly and forced the trust to dissolve, resulting in the formation of smaller companies that handled the production and refining of oil under separate companies (Wall, 2005).

The invention of the internal combustion engine, the automobile, and airplanes all came as greater discoveries of oil were occurring across the United States (Wall, 2005). With World War I and World War II came the need for the United States to supply oil for the war effort forcing oil companies to work together. In turn, after WWI the American Petroleum Institute was formed. Since World War II, oil has become one of the primary issues in conflicts in the rest of the world, and increasingly America's reliance on oil has affected the nation's foreign policy.

Evolution of Oil and Gas Drilling and Production Activities

The oil and gas industry has evolved considerably since the first oil production from a well in Pennsylvania in the 1850's. Exploration and development equipment has changed as new technology has been developed to allow for deeper exploration, faster and more precise drilling, and the ability to directional drill. Production activities have changed with advances in oil water separation (down-hole oil water separators), pipeline materials, and surface pumps.

The earliest oil and gas exploration activities in the United States were chance encounters with oil or gas seeps at the ground surface by America's earliest explorers. Over time, exploration activities became more and more focused on looking for surface characteristics that were believed to be reflective of subsurface conditions, geologists discovered that anticlinal structures had a greater chance of containing hydrocarbons (NaturalGas.org, 2005). Almost 70 years after the invention of the seismograph for the detection of earthquakes, the technology was applied to oil and gas exploration to aid in the location of potential oil containing formations in the subsurface. Seismic exploration has evolved from using explosives to generate the seismic waves to the use of heavy commercial seismic vibrator trucks. The data compilation for seismic activities has

become increasing more complex with the advent of more technologically advanced geophones, recording trucks, and three-dimensional computer modeling. The information acquired prior to drilling the first "wildcat" well in a new area far surpasses the information from 15 years ago.

Drilling of onshore oil and gas wells has also evolved considerably in recent history. In the early 20th century, oil and gas drilling was performed using a cable-tool drilling rig in which the vertical movement of a "chisel-like" drilling bit was suspended from a cable that was raised and lowered to chip away at the rock (EPA, 1987). The advent and advancement of rotary drilling technology in the 1910's resulted in the eventual replaced cable-tool drilling techniques in the United States. Rotary drilling techniques allowed for deeper drilling, greater control of high pressure downhole conditions, and the removal of drill cuttings during drilling. Additional advances in drill bit technology, drilling fluids, drill pipe, and electronics have resulted in more precise and faster drilling, eventually leading to the development of horizontal or directional drilling which is becoming increasing more common in today's development of oil and gas resources. Horizontal drilling has allowed for increased recovery of oil and gas resources from older fields, development of previously identified marginal oil and gas plays, and reduced surface disturbances since spacing can be greater than traditional boreholes and multiple boreholes are possible from one pad site. Drilling technology is still evolving with multilateral drilling becoming more common, and slimhole drilling making recent advances in reducing the volume of cuttings produced from drilling (API, 2006).

Difficulties Encountered in Leasing Impaired Lands without Historical Oil and Gas Development

In general, the regional development of oil and gas on public lands can be summarized under three distinctive scenarios, each having the potential to affect the overall NEPA process in varying manners, e.g., impact analysis, public involvement or level of concern, process duration, etc. These scenarios include:

- An area with existing oil or gas production at, or within, a reasonable proximity of the lease.

- An area where oil or gas production may not have a history in the region, but which has had a history of previous uses such as ranching, logging, recreational use, etc. (Under this scenario and for the purpose of this study, such land uses are considered to have created an existing degree of environmental impairment such as road construction, habitat fragmentation, degradation of water quality, etc., from sources other than previous oil and gas development.)
- An area which is essentially pristine with no previous oil or gas history and no history of prior activities that would have in any way adversely affected the land.

Intuitively it would be expected that authorization for oil and gas development on lands defined as pristine, or those lands containing no previous oil and gas development, would be much more complex and thus, more time consuming throughout the NEPA evaluation, leasing, and APD process than would be the situation under the first scenario; more difficult not only from a public opposition standpoint, but also more difficult from a regulatory perspective because of the greater likelihood of threatened and endangered species, presence of sensitive habitats, traditional cultural properties, potential to introduce noxious weeds or other invasive plant species, visual resource classification, roadless designation, etc. which would complicate the NEPA process. Interviews with BLM personnel indicate (L. Ricci personal communication, 2006) there is no fundamental difference in the difficulty since the governing regulations are one-in-the-same for each scenario, assuming these lands are not managed for conservation or protection (e.g., wilderness areas, wildlife refuges, etc.). Other BLM personnel (L. Harrison and D. Judice, personal communication) and State Oil and Gas Agency personnel (D. Likwartz, personal communication) indicated that areas where oil and gas development has no prior history may be more difficult to permit.

The question then revolves around the second scenario: is it more difficult to permit areas with no previous oil or gas history (than it is to permit an area where oil or gas production has a history or is established within the region), even if that land has suffered previous impairment from historical activities such as ranching, agriculture, logging, etc.? It appears that this may in fact be the case since current lands proposed for oil and gas drilling under this scenario are becoming exceedingly more difficult to develop because of increasing opposition by the public and/or environmental special interest groups.

An example of this is provided by Blackleaf Canyon, which is located on the Rocky Mountain Front near Choteau, Montana. Blackleaf Canyon and the Rocky Mountain Front in general, are areas with high species diversity and ecological uniqueness that provides habitat for certain threatened and endangered species such as grizzly bears. For this reason, public concern and opposition to oil and gas development in the area has steadily increased.

Oil and gas development within Blackleaf Canyon has essentially been prevented as a result of public opposition. For instance, access across private surface ownership to nearby federal leases has been denied to a point that necessary re-route distances to access the federal leases would have become impractical for operators. Construction of access roads to circumvent privately held lands would require longer road corridors, thus causing additional surface disturbance, as well as greater impacts to other NEPA evaluated environmental resources. The overall public opposition to drilling at Blackleaf Canyon is well organized at both the local individual and regional/national environmental special interest group levels which are vehemently opposed to oil and gas development. Because of this, future oil and gas exploration opportunity in the Blackleaf Canyon area has presently been precluded from further oil and gas development consideration despite a long history of oil and gas activity within the area.

Interestingly, the BLM has chosen to reallocate its Blackleaf resources to the West HiLine area where historic oil and gas production is more established. The West HiLine area includes existing oil and gas development within and proximal to the Upper Missouri River Breaks National Monument (there are producing wells on the Monument that pre-date proclamation of the Monument). West HiLine involves a greater number of leases to let and a larger pool of potentially interested operators than did Blackleaf Canyon, as well as existing production in the area. As a result, West HiLine appears to represent an area where leasing and production may be more easily permitable, despite proximity to the National Monument.

According to BLM personnel interviewed (C. Trent and D. Judice, personal communication 2006); the West HiLine area has had previous impairment in the form of a long history of ranching and agricultural use as well as some limited areas of logging. There is also existing oil and gas production in the area, but a newly updated RMP for the area has not yet been through the scoping stage so unknown challenges may confront future development. According to the MBOGC, private mineral estate acreage

in this area is currently being developed, but the lack of a completed RMP is postponing development of federal mineral estate tracts. MBOGC also pointed out that despite the presence of proven reserves, new leasing within the Monument is precluded because of its designation. Two separate BLM studies: the Upper Missouri River Breaks National Monument RMP and the Oil and Gas Issues In and Adjacent to the Upper Missouri River Breaks National Monument are currently in progress to evaluate the Monument area.

The three land/mineral estate scenarios outlined above primarily address the mineral estate side of the equation. In fact, in the NEPA process one could also distill the associated issues into three categories or "levels of concern" (J. Majerus, personal communication 2006):

1 – Properties with minimal resource and social issues.

2 – Properties with moderate resource and social issues.

3 – Properties with highly complex and/or controversial resource and social issues.

Blackleaf Canyon falls within category 3 of this spectrum. At Blackleaf Canyon there were significant resource issues (threatened and endangered species and winter habitat in particular), significant cultural issues (Native American Traditional Cultural Sites), significant visual resource issues (the intrinsic beauty of the area), and significant social issues (a high level of public resistance to oil and gas development).

In practice, the three land scenarios and the three issue categories interweave into a complex multi-dimensional matrix. Any given property then falls somewhere within that matrix and one can realistically conclude that the more complex the issues, the more time consuming and challenging the NEPA and APD process will be whether it be driven by regulatory, environmental, or public concerns.

In summary, while the Blackleaf Canyon example involved complex, multidimensional issues, it does appear that the full cycle process of NEPA review, leasing, exploration, and development can indeed be more difficult and/or time consuming in areas where oil and gas are not already established facets of the economic landscape despite these same lands having suffered previous environmental impairment.

Increase in Environmental Awareness

As oil and gas development and drilling progressed, states with oil and gas production have developed regulations relevant to the oil and gas industry. Early oil and gas regulations focused on proration of oil production, an effort intended to avoid the waste

of oil resources because production was outpacing transportation capabilities (OCC 2006). The focus of regulations has evolved now to address more emphasis on public safety and protection of the environment; air, water, and soil. Regulations in states such as Ohio, Texas, and Oklahoma helped in forming the federal regulations written by the US EPA in the 1970's. Federal regulations contributed to the industry lobbing for making regulations equitable from state to state, so that oil and gas operators could do business around the country and know that regulations are commensurate and correlative.

Awareness in global climatic change or "global warming" continues to be a highly prolific subject, which is causing considerable controversy among politicians, oil and gas stakeholders and public citizen groups. Support of the global warming theory appears to be growing as new scientific research and data gathering efforts indicate warming trends in the earth's atmosphere are likely being enhanced due to anthropogenic causes. Energy-related carbon dioxide emissions, resulting from petroleum and natural gas, represent 82 percent of total U.S. human-made greenhouse gas emissions (National Energy Information Center, 2007). In addition, the U.S. produces about 25 percent of global carbon dioxide emissions from burning fossil fuels; primarily because the U.S. economy is the largest in the world and 85 percent of the Country's energy needs come from the burning of fossil fuels (National Energy Information Center, 2007). As such, public demands for the lowering of greenhouse emmisons are at the forefront within many political arenas. Consequently, it can be expected that potential legislation in the near future aimed at curtailing fossil fuel emissions will likely present the oil & gas industry with a quandary of regulatory and legal hurdles that may further hinder future exploration and development projects.

Many chemical constituents that occupy the Earth's atmosphere act as "greenhouse gases." Some of them occur in nature (water vapor, carbon dioxide, methane, and nitrous oxide), while others are exclusively human-made (like gases used for aerosols). When sunlight strikes the Earth's surface, some of it is reflected back towards space as infrared radiation (heat). Greenhouse gases absorb this infrared radiation and trap the heat in the atmosphere. The greenhouse theory revolves around the premise that disproportional concentrations of energy are not being radiated back into space, which is thus leading to an increase to the earth's surface temperature. However, given the natural variability of the Earth's climate, it is difficult to determine the extent of change that humans may have caused (National Energy Information Center, 2007).

Industrial nations rely on the use of fossil fuels to warm and cool homes and businesses, as well as provide ingredients for medicines, fertilizers, fabrics, plastics and other products. Because of this reliance, the use of fossil fuels is likely to continue for many years. The question then arises: how to effectively balance the United State's and other industrial nation's energy needs with the conservation and protection of critical resources needed to sustain natural conditions.

To begin with, current trends in the oil & gas industry involve close management of their own energy use. For example, one conservation strategy uses heat and power technology that is able to convert waste heat into energy, reducing energy consumption and emissions (API, 2007). The aim of this technology is to reduce emissions by 10 percent between 2002 and 2012. In addition, geological carbon sequestration to enhance oil recovery as well as remove carbon dioxide from the atmosphere has received considerable attention. The ideal carbon sequestration "project" would include a carbon dioxide source (i.e. coal fired gas plant) in close proximity to a carbon sink (i.e. aging oil and/or gas field). The United States Department of Energy estimates that 89 billion barrels could be added through CO_2 enhanced recovery, over four times the current proven reserves (DOE, 2006b). The dual benefit of enhancing oil and gas recovery and managing greenhouse gas emissions will likely continue to push the use carbon sequestration, both on private and public leases. The most recent data from the U.S. Energy Information Administration show that CO2 greenhouse emissions from U.S. industry, including oil and natural gas companies, have declined and were actually below 1990 levels (2007).

The oil & gas industry is also lowering greenhouse emissions by leading research efforts on alternative energy use, including solar power, biofuels, geothermal energy, and wind power. Furthermore, industry leaders are working with the automakers and government agencies on new fuel/vehicle technology such as fuel cells and hydrogen power; reducing natural gas flaring to cut emissions; storing CO2 underground, where it can be safely held for thousands of years; and implementing new emissions estimation and tracking tools to enable it to assess how well it is meeting the goals it has set for itself and report progress to the public (API, 2007). Because of these efforts the U.S. is projected to lower its carbon intensity by 25 percent from 2001 to 2025, and remain below the world average (API, 2007).

B. THE PROCESS OF ONSHORE OIL AND GAS DEVELOPMENT

Federal on-shore oil and gas regulations occur in three stages: planning, leasing, and development (NPS, 2003). The planning stage includes the development of Resource Management Plans, which are the guidance documents the BLM prepares to govern the development of oil and gas resources as well as other resources within designated planning areas. RMPs outline the uses and methods of development for federal minerals and surface estate and are required by the Federal Land Policy and Management Act. RMPs also identified lease stipulations and variances and explain how and when these should be applied. Generally, it is during the planning stage that the BLM and surface management agency's determine which public lands should be made available for oil and gas leasing. The leasing stage is when BLM offers the public lands identified during the planning stage to the public for lease. The development stage is when BLM monitors the oil and gas development actions to ensure that lease stipulations are being met. The activities associated with the operations of onshore oil and gas development can be divided into a sequence of events that occur in phases as a project progresses from exploration to development. These can include the following five phases: leasing, exploration, development/construction, production, and final reclamation. Figure 9 presents a sequential breakdown of activities that occur in the development of oil and gas fields providing information on each of the phases of oil and gas development as well as the preliminary investigations.

Leasing

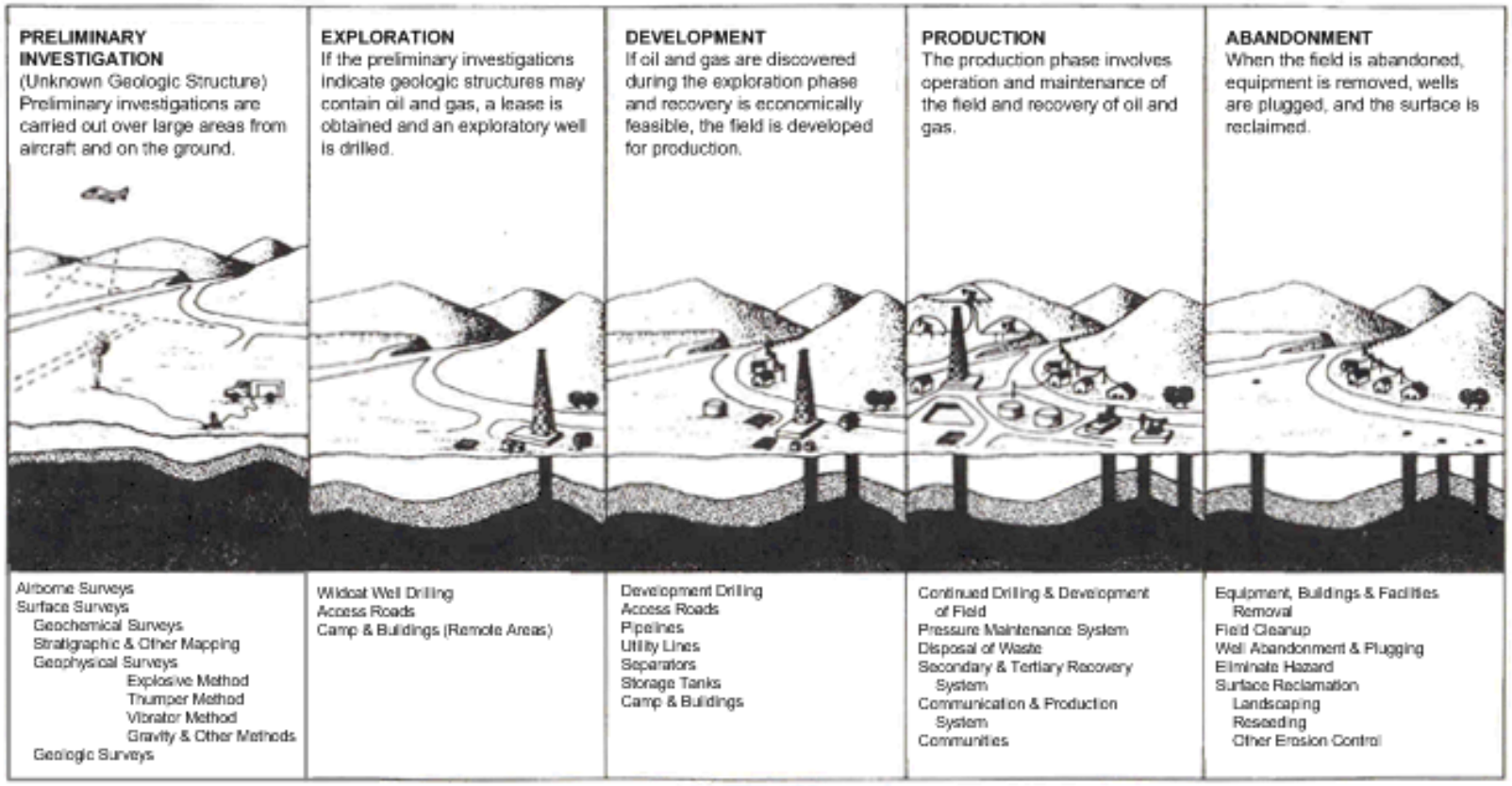
An oil and gas lease is a legal right granted to an operator (the lessee) to access leased lands for the purpose of exploring, drilling, extracting, removing, and disposing of oil and gas deposits (except helium) found in leased lands (BLM, 2004a). The BLM was assigned the responsibility for oil and gas leasing of minerals owned by the Federal Government in the Mineral Leasing Act of 1920, the Mineral Leasing Act for Acquired Lands of 1947, the Federal Oil and Gas Royalty Management Act of 1982, and the subsequent amendments to these Acts (BLM, 2004a). Public lands are only made available for oil and gas leasing after the BLM has assessed the lands using their multiple-use planning process (BLM, 2004a). The leasing decisions made by BLM have become increasingly challenged as issues regarding the required level of analysis under NEPA have been raised in federal courts. The issues raised involve whether an Environmental Assessment is sufficient at the time of leasing or if an Environmental

Impact Statement is necessary before public lands can be offered at oil and gas lease sales (NPS, 2003).

The EIS process requires the lead agency to identify a reasonably foreseeable development scenario that describes the predicted level of development that is expected to occur on the identified public lands. In some instances, when making public lands available for oil and gas leasing it is not always possible to predict accurately the level of development that would be expected to occur in the future; thus, development of an EIS would be difficult in the early stages. However, the issuance of an oil and gas lease results in the BLM being compensable for the property right interest of that lease should the BLM decide not to allow development of that lease when an Application for Permit to Drill (APD) has been submitted (NPS, 2003). Leases issued on federal lands contain a lease notice which identifies the terms of the lease; these terms set conditions to which the operator must uphold to remain in good standing. A lease notice provides the lessee with information on the limitations that have been placed on a leased property based on law, lease terms, regulations, or operational orders (BLM, 2003b). Oil and gas leases on federal minerals incorporate federal environmental regulations into the standard terms, but federal leases can also include additional terms that require additional mitigation measures to minimize environmental impacts.

The BLM offers two types of oil and gas leases for public lands: competitive and non-competitive (BLM, 2004a). Oil and gas leases must first be offered at a competitive lease auction. If the leases do not received a bid then the leases are made available as noncompetitive leases starting the first business day after the competitive bid auction. The size of a lease is established by the BLM prior to offering the lease for auction. Competitive leases are limited to 2,560 acres in the lower 48 states and to 5,760 acres in Alaska; noncompetitive leases are limited to 10,240 acres in all states. Leases are issued for a 10-year period and automatically continue as long as oil or gas is being produced in paying quantities and the terms of the lease are being met.

Figure 9 Summary of the Phases of Oil and Gas Development



Source: BLM 1986, Pinedale RMP

Exploration Phase

After a lease has been obtained and before an operator can begin drilling or other surface disturbing activities for an exploratory or wildcat well, the operator must post the lease bond and file an APD or Notice of Staking. The BLM must then perform the necessary assessment of potential impacts by completing either an Environmental Assessment or an Environmental Impact Statement prior to approval of the APD. The operator must specify in the APD information relative to the type of oil and gas well and depth of the targeted exploration zone. This information is used by the operator to determine the equipment and access needed to drill the exploratory well, and is used by the BLM to fulfill the necessary environmental evaluation obligations (NPS, 2003). The construction activities for an exploration well typically include a roadway and drill pad. These areas must be staked or flagged prior to the BLM field inspection, which is part of the APD approval process.

The size of access roads and drill pads for exploratory wells vary based on the depth of the target exploration zone. Shallow exploratory wells (500 to 2,000 feet) may require a simple bladed road to clear brush and allow access for a short time period (typically a few days); deep exploratory wells (5,000+ feet) may require the construction of a higher standard crown and ditched gravel roads as drilling may take a month to drill and require considerable heavy truck traffic (MBOGC, 1989). The size and type of drill rig necessary to drill a well is determined by the depth of target zone. Shallow CBNG wells in the Powder River Basin of Wyoming and Montana can be drilled with water well rigs, while deep oil and gas wells in most of the producing areas are drilled with double or triple derrick rigs. The drill rig selected is then used to determine the properties of the access road and size of the drill pad; water well rigs can use drill pads as small as ½ acre or less, while double or triple derrick rigs may require 3 acre or larger drill pads (MBOGC, 1989). The deeper wells and larger drill rigs require more materials including mud tanks, reserve pits, produced water storage, oil and gas storage tanks, pipe racks, and crew parking for the drill pad contributing to the need for a larger staging area. The construction of access roads is also based on the drill rig. Some of the smaller rigs can use bladed roads with a typical width of about 10 feet while larger rigs can require 24 feet wide graveled, crowned and ditched road.

After the drilling site has been inspected by the BLM and the APD approved and access roads and the drill pad constructed, exploratory drilling activities can be initiated by the

operator or the operator's contracted driller. An oil and gas well is typically drilled in three phases; the pilot hole is spudded using a large diameter auger bit, the drill rig then drills the surface hole in which a surface casing is set, and then the production hole is drilled. After the pilot hole is drilled large diameter casing (a 24 inch to 36 inch conductor pipe) is set and cemented, then the surface hole is drilled and a second casing is cemented in place to isolate the rest of the drilling operations from fresh water aquifers and supply sufficient pressure protection for the production drilling.

While drilling the well, testing may be conducted when potentially production zones are encountered. Typical oil and gas well testing is conducted through the drill stem when a productive interval is believed to be encountered. Tests are typically performed by a contractor hired by the operator with an operator's representative present to supervise (MBOGC, 1989). In addition to production testing through the drill tubing, once the well is drilled to depth, a series of well log tests are typically performed by a well logging contractor. After the tests, the operator makes the decision to either complete the well or plug the borehole.

If testing indicates the well might produce commercial quantities of oil or gas, the well is completed by running production casing into the borehole. The type of completion performed on a well will vary depending on type, depth, operator, and the characteristics of the producing formation. In some instances, casing is run to the depth of the production zone then casing is set and cemented from the bottom to a point above the production or pay zone (MBOGC, 1989). Once the casing is set and the cement has been given the appropriate time to cure, the casing is perforated based on the information collected from the tests, in particular, the data from the well logs. In other instance, a well may be completed as an open hole, in which case, drilling stops at the top of the producing formation, casing is set and cemented, and then the producing zone is drilled. An open hole completion allows a greater area to be exposed for potential production, but at the same time reduces the operators ability to control the amount of water produced (MBOGC, 1989). Once the production casing is set, tubing and a pump (as needed) are placed in the well and the wellhead is installed at the surface. The well is then tested for a period of time before permanent production equipment is brought onto the site; the period will vary based on the operator and the well characteristics.

Development/Construction Phase

Once the exploration phase has been completed and a producing zone has been identified, the operator begins to plan for the development phase of a project. The development phase of the project involves the operator increasing from a single well to multiple wells and associated access roads and production equipment. Production well spacing would need to be established by the state oil and gas agency and the BLM, as it is sometimes necessary to increase well spacing from the exploration requirements for optimal production of the oil and gas resource from the reservoir. The operator completes and submits APDs for each of the proposed production wells, identifies their location and access routes, as well as identify the locations of production facilities such as tank batteries, produced water management facilities, and pipelines and utility routes. In comparison, a field that produces primarily oil would require more production equipment than a field that primarily produces gas (MBOGC, 1989).

Once the operator has approval of the locations and drilling permits from the BLM, the operator will begin construction operations. Construction activities begin much like exploration activities with the construction of access roadways and well pads. However, during these construction activities, additional infrastructure may also be included such as installing power lines, pipelines, and production facilities; therefore, the quality of roads constructed may be higher than during the exploration phase commensurate with the increased level of traffic the roadways are expected to be able to handle for production. Some roadways may remain as simple two track trails to the well locations, while graveled, crowned and ditched roads may be constructed for the main road through the field (MBOGC, 1989). Depending on the lease stipulations the operator may be limited to certain types of production equipment such as buried utility lines instead of overhead power lines, or cavitation pumps as opposed to pumpjacks. There may be additional limitations set which only allow the operator to perform construction activities during certain times of the year. Lease stipulations can result in less disturbed surface acres from construction activities, but at the same time may limit an operator's choices of equipment or delay a project if the timing of APD submittals/approvals conflict with timing of lease stipulations set for wildlife breeding seasons or rearing activities. Other construction related limitations may be imposed depending on the surface management agency or private landowner requirements for a construction project.

Some federal mineral estates can be located under surface estates administered or managed by federal agencies other than the BLM, in these cases the operator may be subject to varying mitigation measures. BLM and US Forest Service managed lands will have strict requirements for the controlling of noxious weeds. As a remedy to control the spread of noxious weeds, the BLM and US Forest Service have special seed mixtures to help reestablish local plants; operators are required to use these mixes during reclamation activities. For most surface disturbing activities associated with the construction phase, project operators are utilizing active remediation practices to keep impacts to a minimum. Examples of active remediation include the stockpiling of soils and infilling of utility trenches as soon as the lines are placed in the trench, and the reseeding of portions of the well pad once drilling is completed.

Production Phase

The production phase starts when the operator receives approval from the BLM or state oil and gas agency to start production. Early in the production phase, onsite activities are usually limited to monitoring of equipment and production, maintenance of equipment, and disposal of production wastes. There is generally a field hand that is scheduled to perform routine monitoring and maintenance activities; this may be conducted as frequently as daily or weekly depending on the size of the field. The BLM estimates that an additional annual production job (pumpers, workover crew, water haulers, rig repair, etc) is created for approximately every 18 wells in production for any given year (BLM, 2006b). Put simply, for a field with 1,800 producing wells, approximately 100 qualified workers would be needed to properly run and maintain the field. The population pressure caused by this demand for qualified workers in the oil and gas industry can last for several years during production, and this may be overwhelming to the existing local community as demands for schools, infrastructure, and housing can quickly outpace the growth of the community. These socioeconomic impacts to a community are discussed in more detail in Section VI.D.

While population growth is to be expected due to the need for man-power to run the field during production, technological advances are being made to make fields more efficient through remote monitoring equipment. The location and type of equipment used to monitor production activities varies depending on the type of the well, location of the nearest sales point or main gas line, and can be influenced by mineral ownership. Production from oil and gas wells is monitored from individual leases if production is

gathered into a central processing facility and the field has not been unitized, i.e., production is not shared by all lease owners (MBOGC, 1989).

Produced water management is necessary for most oil wells and some gas wells, as wells will typically produced some water along with the oil and gas. Produced water varies in quality and quantity - the two principal factors which govern how the water is managed. Variations in produced water can range from fresh water near, or at, drinking water quality, to saline brines with total dissolved solids at concentrations 10 times greater than seawater. Management of produced water can be handled in a variety of means and there are numerous reports which discuss produced water management for the oil and gas industry (Argonne National Laboratory, 2004; ALL Consulting, 2003a, ALL Consulting, 2005). A few examples of how water is managed include:

- High quality water can be managed through discharge where it can be permitted;
- Low quantities of water can be managed in impoundments through evaporation; and
- Injection is a common means of disposal for large quantities and/or poor quality water. The water is typically injected into non-productive disposal zones (Class II Disposal) or productive zones as part of an enhanced recovery operation (Class II Recovery).

Enhanced recovery of oil generally occurs when the production rates of oil from a reservoir start to decrease as a result of declining reservoir pressure. Initial production activities which use gas or water pressure from the reservoir for production usually only produce 20 to 25 percent of the oil in place (MBOGC, 1989). An enhanced recovery phase is utilized to try and produce an additional 10 to 20 percent of the in-place oil. A secondary or tertiary recovery effort is employed if it is economically feasible. Secondary and tertiary recovery projects involve waterfloods, carbon dioxide (CO_2) or other chemical injections into the reservoirs in order to maintain or enhance reservoir pressures so that additional oil can be produced. Enhanced recovery projects are also influenced by the characteristics of the reservoir as some strata are less conducive to the successful injection of fluids to promote the recovery of oil.

The injection of CO_2, also known as geological carbon sequestration, has received a considerable amount of attention in recent years due to the ability of carbon

sequestration to enhance oil recovery as well as remove carbon dioxide from the atmosphere, which has been linked to global climate changes as a greenhouse gas. The ideal carbon sequestration "project" would include a carbon dioxide source (i.e. coal fired gas plant) in close proximity to a carbon sink (i.e. aging oil and/or gas field). The United States Department of Energy estimates that 89 billion barrels could be added through CO_2 enhanced recovery, over four times the current proven reserves (DOE, 2006b). The dual benefit of enhancing oil and gas recovery and managing greenhouse gas emissions will likely continue to push the use carbon sequestration, both on private and public leases.

Maintenance activities can range from fixing surface equipment leaks or mechanical failures to well workovers and well stimulations. Simple repairs are usually handled by field hands who either work for the operator or are contractors to the operator that handle the small day to day maintenance activities. Well workovers or well stimulation work is generally handled by contracted agents of the operator who specialize in that specific activity.

Reclamation Phase

Reclamation activities occur continually throughout the phases of an oil and gas development project, with operators actively reclaiming temporary surface disturbances during the construction phase and performing final reclamation after production has ceased. Well plugging is one of the ongoing reclamation activities that can occur throughout a project from the exploration phase through the end of production. Wells are plugged in a variety of ways depending on the status of the well at the time of plugging, i.e. production wells are plugged differently than dry exploration wells. Generally, the plugging activities are intended to isolate potentially productive zones from brine-filled zones and to isolate and protect underground sources of drinking water (USDW). Therefore, cement and mechanical plugs are typically set at various intervals defined by the depth of the well, material type, and managing agency regulations. Generally, the plugs are set in a well at top and bottom of the surface casing, the surface plug is set between the surface casing and the production casing, and bridge plug is set at the base of the surface casing.

Surface reclamation of the wellsite and other facilities generally involves the removal of production equipment, backfilling of pits, reseeding of denuded areas, flowlines may be removed or abandoned in place, and the land surface restored to pre-development

conditions. Unless the surface management agency or private surface owner specify otherwise, all oil and gas related materials are removed from the site and the land surface is restored according to the stipulation attached to the lease including reseeding the land for re-vegetation. After the reclamation has been initiated, managing agencies will perform site inspections to document the changes made and identify any conditions which need to be modified. Only after the site has been cleared by the managing agency and the site deemed reclaimed by the agency are the sites removed from their lease bonds.

III. REGIONAL ENVIRONMENTAL VARIATIONS

The United States contains more than 3,000,000 square miles of land surface, of which approximately 30 percent is owned by the Federal Government (NEPDG, 2001). Included is the expansive northern boreal forests in New England and Alaska; the dank swampy wetlands of the southeastern states; the temperate rainforests of the northwestern states; the arid deserts of the southwestern states; the grassland prairies spanning the central plains; and prominent mountain ranges in the east and west. As with state or privately owned lands, federally owned surfaces require varying management strategies by responsible agency's to provide reasonable protection of the environment, while at the same time maintaining a regulatory process to assure public or national needs are satisfied.

Federal managers must bear in mind their charge to establish multiple use strategies for federal land and the most appropriate uses for that land. Land use will vary from tract to tract based upon the past usage as well as the environmental resources of the tracts. This section will deal with some of those resources and their variability that will affect land management.

From an environmental assessment perspective, land management for oil and gas development is further complicated by the complex and diverse array of regional or local physical characteristics that can include habitat or community types, terrain, water quality, wildlife, etc., which define any given land. Additionally, the importance of protecting or conserving these characteristics differ from one region to the next, which results in regional prioritization disparities in land management decisions. Thus, methodology to assess oil and gas related environmental impacts on federally owned lands must account for the heterogeneous and evolving environments of the United States. These methodologies must also consider environmental resources which are important to the local regulatory and public communities since the importance placed on environmental resources often necessitates region specific approaches to land management strategies.

It is apparent that regional or local settings pose unique challenges which make it difficult for regulators and operators alike to uniformly assess environmental oil and gas related impacts across the United States. Therefore, land management decisions and the assessment of impacts from oil and gas development activities on federal lands that are taken into account when making these decisions require the consideration of

characteristics specific to the local environment. These characteristics can include regional variations in geology, climate, hydrology, biological features and surrounding activities. The aim of this section is to discuss some of the environmental characteristics which are pertinent to all phases of oil and gas operations and provide examples of how these resources vary on a regional basis. By discussing the extent of regional environmental variation in the United States, it is hoped that the need for regional land management decisions is adequately illustrated so that future decision processes which affect impact analysis on federal lands consists of more consistent and relevant methodologies through each region. Although this discussion is not considered all encompassing, it is intended to present information in a manner to allow for more prudent decision making and to clarify why impact assessment methodologies should be adapted to local conditions.

A. GEOLOGY

Recognizing and understanding the geologic variations which exist across the United States on federal lands is fundamentally important during the planning and assessment phases for oil and gas development projects. The physical and chemical characteristics of the geology in a region dictate overall oil and gas production design and are important elements in federal land management plans. A region's geology can be described by topography and soil type which determine potential erosion rates and stormwater runoff velocities, and by stratigraphy and structure which are important physical parameters in identifying the type of oil and gas reservoirs present and the quality of oil and natural gas produced water.

Topography and soil types vary across the United States from mountains, plains, deserts, plateaus and coastal lands. Topography and soil type figure in land management analyses with the relative slope of an area used to estimate the potential for surface impacts such as soil erosion or to identify areas that have the potential to be impacted by stormwater runoff. The Independent Petroleum Association of America (IPAA), in developing their guidance for Reasonable and Prudent Practices for Stabilization (RAPPS) at oil and natural gas exploration and production sites, identified separate regions of the country with similar characteristics based on slope, rainfall, soil erodibility, as well as distance to surface water bodies and vegetative cover (Horizon Environmental Services, Inc., 2004). Although the amount of precipitation that any given region receives directly relates to the magnitude of potential erosion events and

runoff, typically areas characterized by steep slopes experience accelerated runoff velocities, thereby having the potential to exacerbate erosion, especially when vegetative cover is reduced during construction activities. Conversely, under the right conditions topography can be utilized to reduce surface related impacts from runoff such as well pads and produced water management structures (e.g., minimize the risk of uncontrolled oil or brine spills and collect stormwater runoff) by using natural topographic barriers to contain facilities and prevent erosion by controlling surface water velocity.

Erosion rates from cropland in the United States for the year 1997, as published by the United States Department of Agriculture, National Resource Conservation Service (NRCS), averaged approximately 2.5 tons/acre/year. Technical resource figures presented by the NRCS indicate erosion rates, to a certain extent, are highest along major watersheds present in Midwest and Eastern states; whereas low erosion rates are more common in Rocky Mountain and Pacific Coast states.

E&P Construction Operations in Richland County, Montana
(Photo by ALL Consulting)

The affect erosion will have on a particular watershed or smaller water body will depend on several factors that relate to the water system's susceptibility to sedimentation and include vegetative cover, runoff, volume, existing surface water quality and regional soil types.

For example, in the context of erosion impact, soils are characterized by their erodibility, which refers to the amount of energy needed to detach soil particles and facilitate erosion. Soil texture affects the soils erodibility; soil particles that are large in size and coarse in texture, such as sandy soils, generally tend to have the greatest erosion potential; whereas, finer particles, such as silts and clays, tend to develop the attractive force of cohesion as the surfaces of the aggregates rub together. Outcrop geology has

a major effect on soil type since bedrock is often the raw material for the development of local soil types. This factor, as well as the aforementioned parameters, will require integration into the assessment process to develop protective land management strategies that make sense to land managers, the general public and regulatory agencies.

It must be noted that the data used to extrapolate this information was not collected on federal lands; data for the Rocky Mountain and Pacific Coast states is limited. Additionally, this erosion data may leave a misleading impression as to the significance of higher erosion rates in some areas where there is little cropland. However, for the purpose of this document, the data does reflect moderate regional erosion variation, which further illustrates the importance of assessing potential erosion impacts based on regional or local physical parameters.

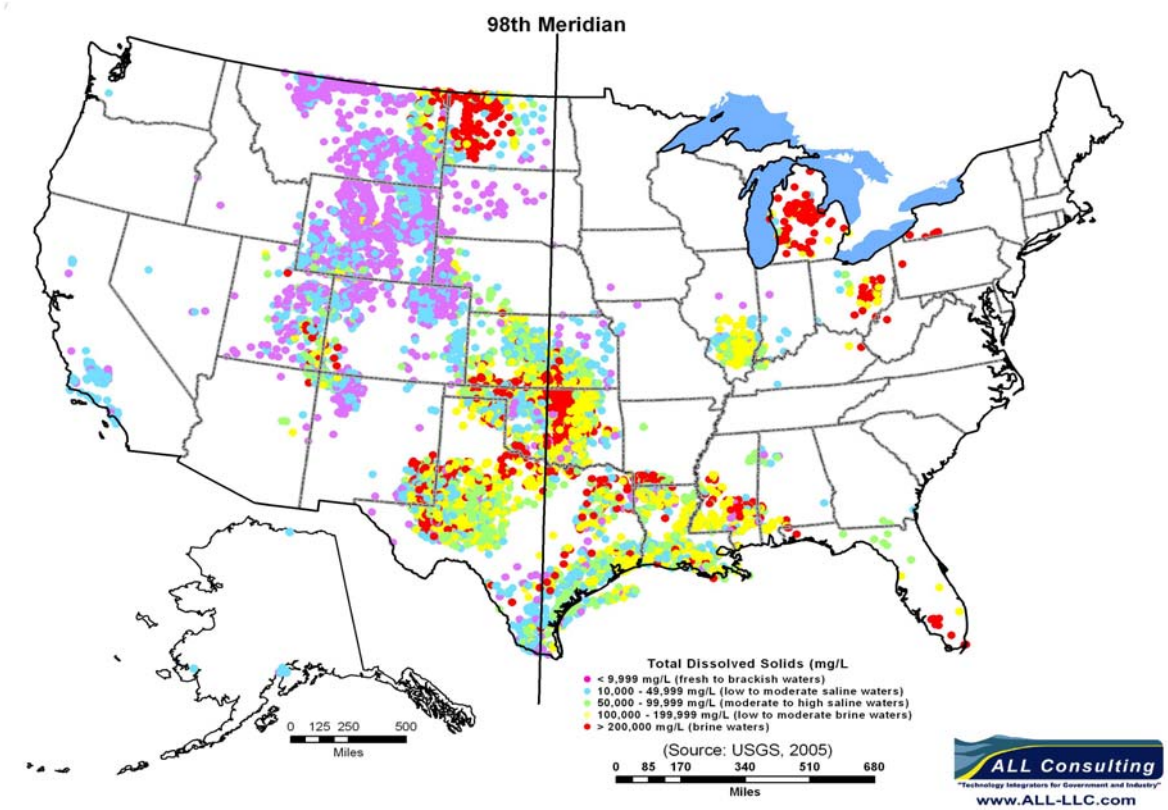
In many cases topography can also dictate hydrologic components of land management and development (e.g., impoundments, water treatment facilities, and storm water runoff) that, unless assessed correctly, may lead to additional soil erosion or sedimentation problems. Steep slopes, deep, narrow valleys, and dissected uplands can leave little room for flat wellsites or storage ponds. These elements of steep topography are themselves direct evidence of the erodibility of the soil and bedrock. State engineering offices or related agencies often provide specific construction guidelines for storage impoundments, while in some states oil and gas agencies oversee small pits related to oil and gas development. State guidelines dictate preventative elements in the design that may include topographic restrictions (slope), water right permitting requirements, flood spillway design and specific beneficial use limitations. In any case, during the impact assessment phase for oil and gas related projects on federal lands, the evaluation of regional or site specific topographic characteristics warrants certain land management considerations regarding remediation so as to reduce unnecessary resource impacts that may effectively delay or halt oil and gas operations.

The quality of produced water with oil and gas is a result of the interactions between the rocks and water that occur in the subsurface over geological time. As such, water quality can vary on a local scale as well as a regional scale. In the subsurface, water is part of a dynamic rock-fluid system that contains hydrocarbons and water. After sediments are laid down, subsequent movement of water and other fluids is largely lateral, driven by hydraulic pressure differences. However, the net movement of water

is consistently towards the surface, driven by induration, compaction, and maturation of the existing rock framework. As vertical movement continues, chemically active clay minerals can impede the passage of dissolved constituents, thereby increasing the salinity of the reservoir water. If upward migrating water has reduced salinity, the water left behind will have higher salinity. This, in general, is what is observed in many sedimentary basins, including the Anadarko Basin, where the oldest sedimentary rocks often have water that is very nearly saturated and younger and shallow strata that contains water of much less salinity.

The production of oil and natural gas is usually accompanied by the production of water that is present in the reservoir. Produced water quality varies from formation to formation and across a basin within a formation, but is typically inversely proportional to depth with deeper reservoirs having higher salinity waters than shallow reservoirs. While highly saline waters lack a beneficial use, shallow, high quality water can have beneficial uses and can in fact represent a valuable resource for local ranchers and farmers. These factors alone represent hurdles for the federal land manager – highly saline waters must be kept out of the surface environment or they will degrade soil and water while at the same time, high quality produced water should not be wasted. Figure 10 presents' water quality trend data for oil and gas produced water from the basins of the contiguous United States. The map shows the range of produced water quality and shows the Rocky Mountain states have a large percentage of fresh water (TDS <10,000 mg/l), while the Mid-Continent and eastern United States have largely poor quality water (TDS of 100,000 mg/l to 460,000 mg/l). Those parts of the western United States that are particularly arid would see great local interest in high quality produced water and these areas may receive extra attention from federal land managers so that the valuable resource is not lost.

Figure 10 Total Dissolved Solids from the Produced Waters Database in the United States



(Source: USGS, 2005)

Daily produced water volumes from oil and natural gas operations were estimated to be approximately 59 million barrels in 2004 or nearly 22 billion bbls for the entire year. Of that total, approximately 8.2 million barrels per day (~14%) is expected to be produced on Federal Lands and the majority of that will be sourced West of the 98th Meridian (Figure 10). The 98th meridian extends from near the eastern edge of the Dakotas through central Nebraska, Kansas, Oklahoma, and Texas. The EPA's 40 CFR 435, the Oil and Gas Extraction Point Source Category, Subpart C Onshore Subcategory, establishes there shall be no effluent discharge of produced waters. However, Subpart E-Agricultural and Wildlife Water Use, allows the discharge of produced water for agricultural or wildlife watering use if the facility is located west of 98' meridian. Under this subpart, the water must be of good enough quality to be used for wildlife, livestock, or agricultural use and that the water put to such use during periods of discharge.

In the case of CBNG, 40 CFR 435 is only applicable when state authorities deem the produced water as an oil and gas produced water. The State of Alabama, for example, does not consider CBNG produced water as an oil and gas extracted water and thus, this water is not regulated by above referenced standard. Currently the EPA does not have CBNG specific produced water effluent limitations since 40 CFR 435 was promulgated prior to initiation of current CBNG operations.

Table 1 presents produced water quality statistics for some of the oil and gas basins in the United States for the DOE-USGS Produced Water Database (USGS, 2005). The regional variability in water quality can be seen from the median water quality data which ranges from under 5,000 mg/l in the Big Horn Basin of Wyoming and Montana to the 200,000 mg/l of the Anadarko Basin of Oklahoma, Kansas, Colorado, and Texas. Table 1 also presents data on the percentage of produced water within the identified basins to have potential beneficial use quality, approximately 10,000 mg/l or less. The basin data clearly shows that much a higher percentage (60 percent +) of beneficial use quality water is produced in three of the Rocky Mountain basins compared to the water quality from the two Mid-Continent Basins (3.90 percent and 6.00 percent). Subsurface geology not only controls oil and gas accumulations but also produced water quality, as such the variability of this factor is of prime importance to federal land managers.

Table 1 Produced Water Quality for Oil and Gas Basins in the United States

Water Quality Statistics – Total Dissolved Solids					
Basin	**States**	**Number of Samples**	**Median Value (mg/L)**	**Percent below 10,000 mg/L**	**Max Value (mg/L)**
Anadarko	KS, OK, CO, TX	2,312	200,000	3.90%	365,960
Permian	NM and TX	10,172	92,649	6.00%	397,572
Williston	MT and ND	3,902	149,662	10.10%	399,943
Powder River	WY and MT	3,012	7,368	60.10%	307,713
Wind River	WY	2,490	6,468	74.70%	220,219
Big Horn	MT and WY	2,282	4,886	78.60%	220,200

B. CLIMATE

Climatic factors pertaining to oil and gas activities consist of differences in precipitation rates, surface temperatures, and certain atmospheric conditions. Average annual precipitation rates are significant in describing a region's climate relevant to any development activity in that precipitation rates are directly correlated with soil erosion capabilities. Figure 11 illustrates regional variation in the United State's average annual precipitation from 1961 through 1990. As the map depicts, precipitation rates vary widely throughout the country with averages ranging from 0.1 inches to 200 inches. The precipitation averages for the western states are characteristically more arid, depicting a region rarely receiving more than 20 inches annually, with a few exceptions such as the Pacific Northwest, which demonstrates climatic variability within a small region. Conversely, the precipitation averages for the eastern states are noticeably higher, ranging from 25 to 60 inches annually. Additionally, a transitional zone extending from northern Minnesota to the Gulf Coast of Texas and Louisiana can be observed on the map. Through this zone, precipitation rates decline rapidly from east to west. This trend of declination can be extreme even within states. For example, in northwestern Oklahoma the average annual precipitation is approximately 15 inches, however, in the southeastern part of the state, average precipitation data suggests that the area receives roughly 60 inches annually.

The frequency and intensity of precipitation that a region receives tends to vary temporally and are influential parameters that affect a soil's erodibility. In most cases, significant soil erosion events are driven by isolated storm events, which have the potential to cause water quality (sedimentation) or surface impacts unless, for example, roadways, impoundments or storage pits are designed to appropriately withstand the rigor of local conditions (Horizon Environmental Services, Inc., 2004). Design considerations for impoundments for example, should account for the system's ability to maintain stored water during normal and extreme climatic conditions. As such, regions with the potential to receive excessive heavy rainfall/snowmelt would require additional engineering controls (ALL Consulting, 2003a). Figure 12 is a map of oil and natural gas production in the United States. As the map indicates, as of 1998 a substantial proportion of oil and gas production occurred in areas that are subject to high annual precipitation rates. In all cases, local precipitation rates in conjunction with local conditions (e.g., topography or watershed vicinity) will dictate which erosion analysis

methods are best suited to accurately reflect potential erosion impacts (Horizon Environmental Services, Inc., 2004).

When surface development includes construction of oil and gas facilities consisting of certain hydrologic components such as impoundments or water storage reservoirs, surface temperatures can potentially result in varying surface or subsurface impacts. High surface temperatures are associated with greater rates of evaporation and in impoundments, for example, can result in an observed salinity increase within the impounded fluids. From this, questions arise. How will the increased salinity levels affect the surface soils? Will the reclamation process be prolonged or successful? Will the fluid migrate or leach to groundwater and if so, what impacts to the subsurface will result? Obviously, northern states such as Alaska or Pennsylvania will not experience the same temperature levels that are observed during the summer months in New Mexico or Alabama. In this situation, reduced evaporation rates in colder environments can often limit the size of impoundments, assuming evaporation is critical to the overall function of the facility (ALL Consulting, 2003a). Therefore, as stated earlier, local site conditions will need to be accounted for during the impact assessment.

Another important regional climatic consideration is the relationship between air quality and atmospheric or physical conditions. The air quality of any region is controlled primarily by the magnitude and distribution of pollutant emissions and the regional climate. The transport of pollutants from specific source areas is often times augmented by local topography and meteorology. For example, the relatively level topography in many Midwest states allows for uninhibited circulation of air pollutants. In general terms, regions that receive increased wind speeds can potentially experience higher air pollutant dispersal rates; whereas in areas of lesser wind speeds, pollutant dispersal is likely to be less.

Figure 11 Average Annual Precipitation Across the United States

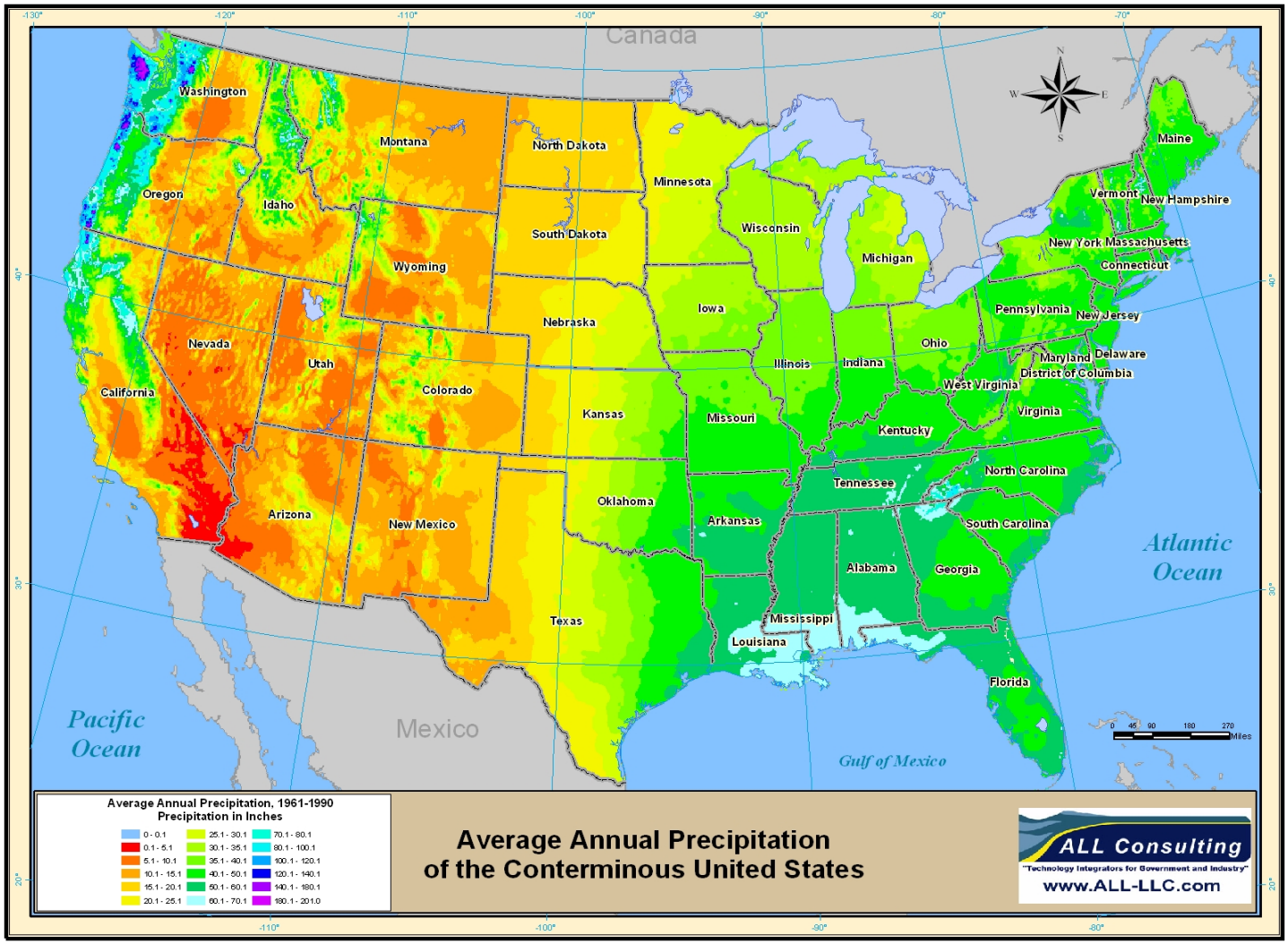
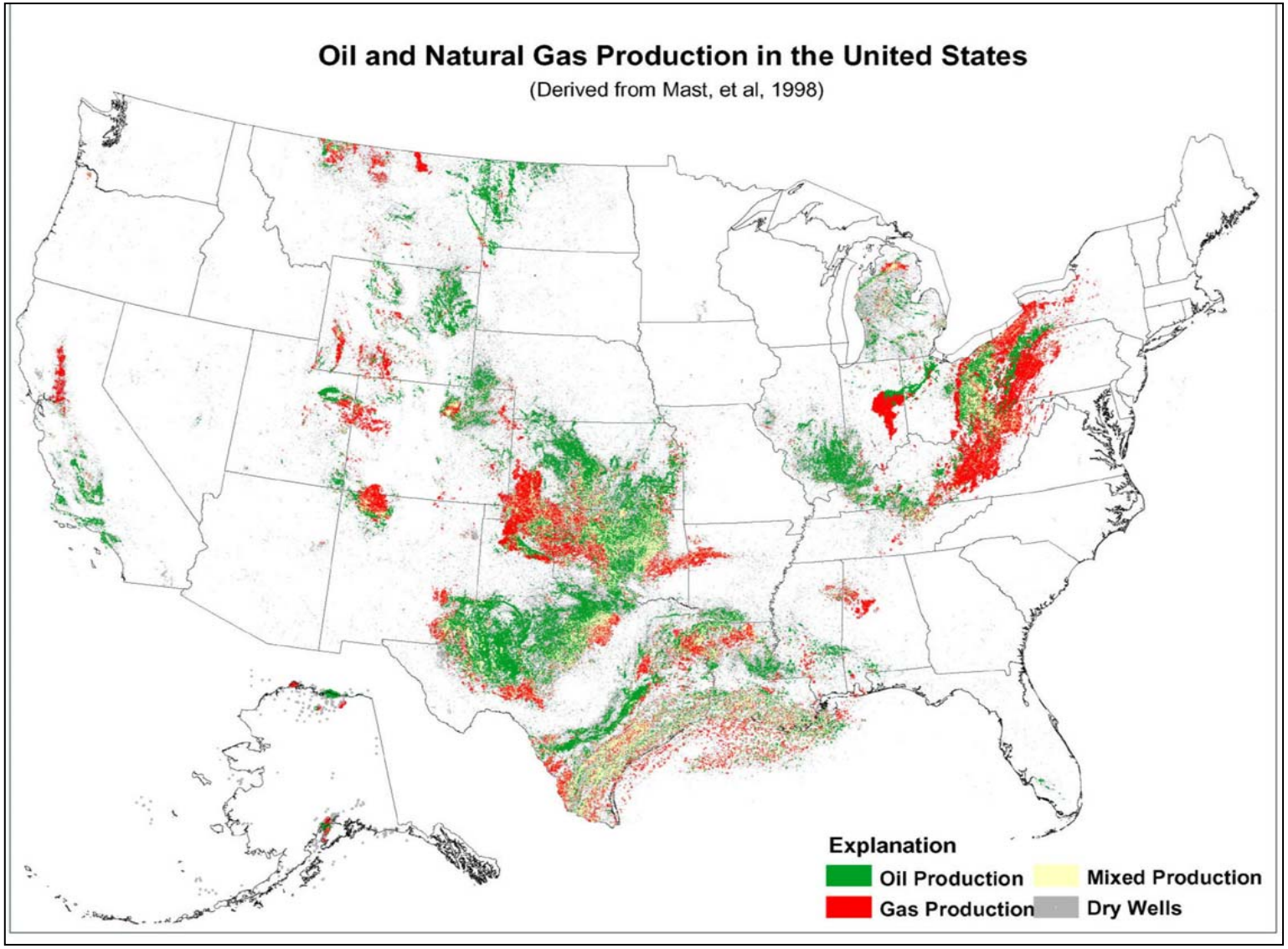


Figure 12 Hydrocarbon Production by Region and Resource in the United States.



Other, less technical air quality factors that may allow for delay in the NEPA or development process relate to the populous of the local environment (and the perceived perspective of air quality issues for that area) and the regional density of oil and gas development already present. Populations located in rural areas are accustomed to only minor air quality impacts that are typically associated with surrounding industrial facilities, while populations in more urban settings have reached a certain level of acclimation for higher air pollutant discharges. As such, observed air quality impacts, however minor they may be, are perceived differently by local populations, which in turn dictate or alter how fugitive air quality emissions are analyzed.

As oil and gas development or other industrial facilities increase within a region, state allowable margins for air pollutant attainment levels will continue to decrease. In Montana, the coal mining industry has observed a recent increase in development and with this, an air pollutant discharge proportional in magnitude. As such, air quality margins for the State are decreasing, or in other words, certain fugitive pollutants continue to edge closer to State permissible maximum levels. Therefore, the overall effects of increased development and associated pollutant discharges within the State of Montana may limit subsequent oil and gas development or other types of development activities in the future, unless reasonable, and possibly oil and gas specific legislation is promulgated.

Seasonal Variability

An integral component of climatic variation that exists within many regions of the United States is the observed seasonal differences in precipitation. For example, an important characteristic of surface water systems in many basins is the water quality and quantity variation shown by a single system over the seasons of the average year. In western States for instance, such water systems will typically be supplied by ground water as well as abundant runoff from precipitation during part of the year but, be limited to only ground water flow during the rest of the year (ALL Consulting, 2003a). More specifically, some seasonal rivers are fed by heavy fall monsoon rains while other streams are fed by snow-melt in the spring; in either case, seasonal streams will show wide variation in flow rate that is approximately repeated each year. Seasonal streams also commonly carry water that varies seasonally – when the river is full of meteoric water the quality is often high but when the river is being fed by ground water the quality may be demonstrably lower. Seasonal variation can be documented by frequent

flow rate and water quality measurements, often combined into monthly averages over several years to level out statistical variations. Historical monthly averages for flow rate and water quality parameters (important cations, total dissolved solids, sodium adsorption ratio, etc) will demonstrate seasonality for particular streams (ALL Consulting, 2003a). When characterizing such seasonal streams, federal land managers will describe water-quality parameters in terms of seasonal flow not as an annual average number.

Global Climate Change

An increasingly important aspect of the environment is the climate changes that accompany increases in the average CO_2 content of the Earth's atmosphere. This global process can be expressed locally by a variety of means, from general temperature shift to changes in the amount and timing of precipitation. These local changes can be profoundly important to residents and to local biota. Federal land managers will be driven to include this variability when characterizing the environmental resources. Local climate aspects would be more accurately described in terms of contemporary trends in addition to historical averages. The average of the past ten years records may be more indicative than the average of the past 120 years. In addition, plant and animal populations may no longer be in equilibrium with the local climate and because of this, the biota may be particularly vulnerable to land development issues.

Perhaps one of the most fitting illustrations of current challenges associated with managing resources in a time of such climatic variability, is that of the Colorado River Basin's continual and increasing threat of drought. The National Research Council (NRC) has issued a report entitled *Colorado River Basin Water Management: Evaluating and Adjusting to Hydroclimatic Variabilty* in which NRC explores future challenges of managing water resources in the basin.

Temperature records for the past century and climatic modeling projections in this region of the United States indicate a warming trend. Higher temperatures can have a profound affect on the hydrological landscape in this region due to decreased quantities of precipitation being stored as snow, spring snow melt peaking early, and increased losses of water via evapo-transpiration. According to NRC, based on analysis of many climate model simulations, increased annual temperatures will reduce future precipitation and stream flows in the Colorado River Basin.

In addition to significant climate warming patterns in the western region of the U.S., NRC has identified a rapid increase in urban populations in this region as a second culpable trend that will further stress future availability of water. From 1999-2000 Arizona's statewide population is estimated to have increased by approximately 40% (NRC, 2007). During this time period, Colorado's statewide population also saw a significant increase of approximately 30% (NRC, 2007). Projections suggest that this trend will continue. Despite currently implemented water conservation programs, it is believed that population growth will continue to drive increases in water demand (NRC, 2007). In order to meet future costly and un-avoidable shortages, tradeoff mechanisms will likely be necessary. For example, at the present time agricultural uses account for roughly 80% of western water supplies. A greater percentage of this supply may need to be reallocated to the municipal sector in the future. Such a transfer could result in possible third party effects such as adjustments in costs for rural communities and varying stresses to ecosystems.

Additionally, new data has surfaced concerning stream flows being lower than what has been recorded at any time in the past 100 years. For many years, scientific understanding of the Colorado River's flow regime has been primarily based on data obtained from gauging stations along the river, some of which were first installed in the late 1800's. However, as knowledge about the hydrology of the Colorado River system has matured, data from gauging stations is increasingly augmented with information collected in studies that focused on indirect evidence of historic climates. One such study focused on reading tree-ring data in order to learn more about the historic hydrology of the basin. Broad tree-rings are indicative of periods of high precipitation and flow rates while narrower tree-rings indicate dry periods that were stressful to the tree. Hydrological reconstructions based on tree-ring readings suggest that Colorado River flows have historically shifted into approximately ten-year periods in which average flows were significantly lower or higher than the moving-average annual rates. This finding supports the supposition that perhaps the future hydrology of the Colorado River basin may not be appropriately characterized by historical gauged records alone.

Successfully meeting the likely water demands with the likely reductions in available water supplies will entail strong and prolonged cooperation among the many involved parties. All seven of the states in which the basin is located have entered are collaborating on draft a set of guidelines on the subject of drought preparedness. The gap between water supply and demand may need to be addressed by alternative

supplies such as produced water from oil and gas fields. These water supplies may be appropriate for some agricultural uses while other water supplies may be economically treated to use requirements. This document may play a role in educating petroleum producers and community water planners about the availability and quality of produced water.

C. BIOLOGICAL FEATURES

The ecology of the United States is composed of multifaceted community biota and habitat structure that is capable of supporting complex vegetative composition and wildlife diversification. Variation of this assessment component is not only observed from region to region, but within regions themselves and even within small, local ecosystems composed of varying degrees of vegetative and wildlife trophic levels. In general, effective assessment of oil and gas related impacts to biological features will typically depend on the specific types of biological features present in the area, as well the perceived importance of these features from a public or regulatory perspective. For example the wood frog in Alaska is considered a rare species that is afforded significant protection from oil and gas related activities and subsequently, has the potential to limit certain aspects of development. Conversely, this frog has a broad distribution in the continental United States, which allows for reasonable amounts of oil and gas related impacts without further consideration of impacts.

To further illustrate this point, sage-grouse in Montana or Wyoming have the potential to delay oil and gas development without proper planning because of the public's high degree of interest in protecting them, despite the fact that both states allow hunting sage grouse. The intense public interest drives regulatory scrutiny as well as protection by federal land managers. To satisfy regulatory mandates, sage-grouse must be inventoried within the development area on three separate occasions during the bird's known breeding season. Although this requirement does not necessarily translate into delays in development, it does demonstrate the importance of certain factors that may only pertain to certain regions or localities that, without proper planning, potentially slow or limit access to federal lands.

Although cumulative impacts to biological populations or their habitats are often difficult to consistently quantify or accurately reflect due to the complex dynamics which define regional environments. An essential, yet variable component that often requires integration into the methods analysis approach for biological features is surface

reclamation. The successful reclamation of any given habitat can be viewed as a management tool which can potentially reduce future impacts to biological resources. From this it can be inferred that restoring habitat features to pre-existing conditions would result in little to no future impacts. However, certain biological features are more difficult to restore than others and biologic species often respond to surface disturbance in different ways. For instance, less vegetative structure in arid environments like those observed in the oil and gas fields of New Mexico are, from a functional perspective, often easier to reclaim than wetland habitats found on oil and gas lands in Louisiana. Additionally, the bald eagle, for example, is an isolated species that is sensitive to surrounding disturbance activities. Residential eagles that migrate to adjacent lands during oil and gas development for a prolonged period may not return to the area even after the lands have been reclaimed to original conditions. This is why many BLM field offices, for instance, will not approve oil and gas related surface disturbances that are within one mile of eagle nest or roost site locations.

Lastly, from a surface impact perspective, vegetative cover is commonly used to estimate impacts that will arise from oil and gas related activities because it is a physical representation of the ecosystem that is quantifiable. Typically, species composition and percent cover are two parameters that are used when describing a region's vegetative structure and are usually limited to defining ground cover and herbaceous vegetation since the degree of soil erosion is more dependent on their presence or absence. For instance, herbaceous/grassy communities are generally more capable of decreasing erosion because they contain more dense rooting systems; whereas upland woody species are generally more proficient at nutrient uptake. Thus, it is reasonable to assume oil and gas related surface impacts would be more pronounced in forest habitats versus prairie grass habitats and that differing approaches would be required to accurately reflect surface impacts.

D. HYDROLOGY

Regional variations in groundwater and surface water quality and aquatic-ecosystem health are controlled by a combination of factors including chemical use, land use, land-management practices, and natural features including geology, hydrology, soils, and climate (USGS, 2004). In multiple water quality assessments performed by the USGS (2004), data indicates water quality conditions are similar over large regions that have similar natural features and land management practices. For example, throughout much

of the Upper Midwest, groundwater underlying intensive agriculture lands, in general, have lower than expected concentrations of agricultural chemicals because the water is protected by low-permeability soils and glacial till. Surface water quality is more susceptible to agriculture or urban sources of non-point source pollution because protective barriers or natural filters seldom exist. In other regions where soils are highly permeable, underlain by sand and gravel or karst, groundwater is more susceptible to contamination from surface use of chemicals and land management activities (USGS, 2004).

Climatic variations also play an important role in hydrologic resources. Figure 11 shows the variation in precipitation across the United States, which can be used as an inverse correlation to the perceived value of hydrologic resources. In areas where precipitation is low (< 30 in/yr), groundwater and surface water resources are scarcer and water quality and quantity receive more attention from the public and regulators. As a result activities which influence the quality or quantity of these resources are more closely monitored as anthropogenic influences can have more direct affects resulting in changes to these resources. Climate change needs to be considered in those areas with little surface water and where precipitation is meager; rainfall average over the past 100 years may be adequate but if the conditions of the past ten years were to become the norm, how would this affect local surface water resources?

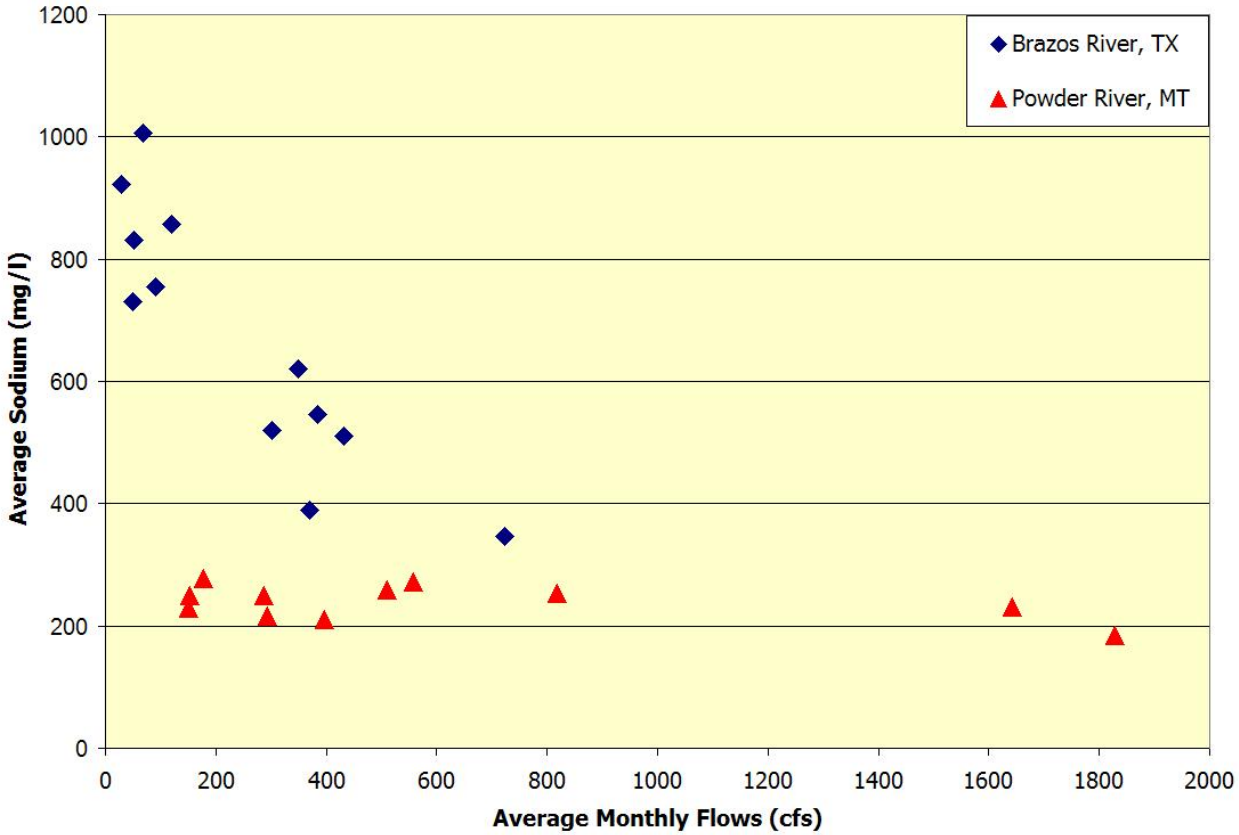
To accurately reflect impacts to surface or groundwater, it is important to not only consider potential chemical or sedimentation discharges (e.g., SAR, TPH, Barium, TDS), but to also consider the relationship between public water needs or perceptions, pre-existing water quality conditions, and the volume of available water. The Powder River Basin for example, contains water systems such as the Tongue, Little Powder and Powder Rivers that are composed of relatively high to low quality waters. The quantity of water that flows through these systems is low in comparison to surface water bodies with similar sized watersheds in the Midwest and Eastern United States. This results in magnified impacts when lower quality waters such as oil and gas produced water is discharged to rivers. Mississippi Basin watersheds, as well as east coast watersheds, on the other hand are typically characterized by large water sources with low quality water, which allows for greater discharge because the quality of the water is less likely to be impacted.

As previously noted, chemical use, land use, land-management practices, and natural features including geology, hydrology, soils, and climate, control the variability in surface water quality that is present across the United States (USGS, 2004). An example of the influence of all these factors can be seen by comparing two watersheds of approximately similar size. The Powder River near Moorhead, Montana, and the Brazos River near Aspermont, Texas, have similar size drainage areas of approximately 8,800 square miles. Figure 13 plots a comparison of the average water quality as represented by salinity concentrations versus the average monthly discharge rates for the two rivers. The plots show the relative difference in water quality that can occur in two river systems of the same size from the various influences on surface water quality. The Powder River in Montana has relatively low average sodium concentrations (<250 mg/l) that do not vary considerably when flow in the river increases or decreases (Figure 13). In contrast, the Brazos River quality appears to have a correlation between the relatively salinity and rate of discharge with lower discharges having higher salinity concentrations.

E. Surrounding Human Activities

When considering regional or local site conditions that might be impacted by increased access to federal lands, it is important to consider the surrounding human activities and land use in the area. For instance, in 2005 the U.S. Department of Agriculture (USDA) estimated the average farm size in the United States to be approximated 443 acres (NASS, 2005). Likely impacts from a small operational site, when compared to a typical farm, is not likely to cause a measurable increase in erosion and/or sedimentation relative to the existing rates resulting from routine agricultural activities. Additionally, considering that oil and gas development consists of more stringent water runoff regulations, small oil and gas sites are typically required to design and monitor surface runoff, thereby further reducing potential erosion issues. Further, when oil and gas sites are located in an agricultural area, operators are generally sensitive to the surrounding land use and attempt to limit stormwater runoff from construction sites to avoid negatively impacting the agricultural activities.

Figure 13 Salinity Comparison for Two Watersheds Montana vs. Texas.



Another surrounding land use consideration relates to the expansion of exploratory operations in atypical or non-traditional environments, such as urban or residential settings. Modern technologies are facilitating this trend as they allow for safe and efficient production, as well as minimization of obtrusive affects to natural landscape characteristics. As can be expected though, higher density residential development can lead to certain conflicts that may not be experienced in more rural environments. For instance, federal and state regulations which govern oil & gas operations can limit or hinder oil & gas development under certain conditions to assure important resources (e.g., water, visual, wildlife, etc.) are afforded certain protection. In an urban setting, local municipalities may hinder the development process further by promulgating more stringent regulations specific to their situation.

For example, upland hardwood forest is a common forest habitat type found throughout much of the United States that in most cases is not considered a sensitive habitat and thus, not afforded special protection. However, in urban areas that have experienced moderate levels of land clearing activities to accommodate population demands and

subsequent residential needs, the upland hardwood forest may be considered a sensitive habitat, both from a functional and visual perspective. In such cases, development of the area may become overtly complex in order to satisfy local ordinances and expensive, typically in the form of mitigation fees. Other prominent issues in urban settings may include; safety, due to increased human presence and activity; limitations and/or options for produced water management; land availability; and public acceptance or "not in my backyard" mentality.

Increasingly, rural populations are changing and the changes are resulting in a different public perspective of development. Oil and gas wells in the western United States are often located in rural areas near farms or ranchland; however, it is becoming increasingly more common for areas that were once rural to develop into small communities as the population of the United States moves out of the cities. This trend of moving away from metropolitan areas can be seen in data from the Economic Research Service and United States Department of Agricultural for the 1990's which shows some non-metropolitan areas of the Rocky Mountain states to have increases in population of over 25 percent while rural areas in the Midwest have seen populations decrease (ERS/USDA, 2004).

In any case, rural settings can also present the oil & gas industry with unique challenges, but typically will differ from those encountered in a more urban environment. As with the above example urban setting, the use of heavy equipment for road construction or well drilling constitutes a potential risk by changing the natural landscape. In this situation however, construction may affect recreational uses such as hiking, fishing, hunting, etc., as well as infringe on the solitude and rural characteristics of the area. In addition, other activities such as increased travel and vandalism resulting from access improvements, wildlife displacement and increased noise in the area may affect the area.

Environmental justice may also require consideration in certain situations, especially in more rural settings. Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority and Low-Income Populations" (1994) requires the non-discriminatory treatment of minority populations and low-income populations for projects that occur on federal lands, require federal permits, use federal funds, or are otherwise under the jurisdiction of a federal agency. Typically, in the NEPA process disproportionately high or adverse health or environmental effects on such populations must be identified and addressed as appropriate.

In general, additional employment opportunities generated by the oil & gas industry within areas prominently characterized by minority and/or low-income populations can provide some financial stability for many families, as long as employment is conducted in an appropriate manner. However, one facet of this law that can be commonly overlooked, especially in arid regions, is water drawdown. In Montana's Powder River Basin for example, CBNG development has the potential to result in the depletion of an estimated 21 percent of the groundwater resources. Furthermore, the drawdown also has the potential to reduce surface water flows in some drainages depending on specific site conditions. Obviously, the availability of water is important, as many rural families depend on the supply of groundwater for their household and ranch/agricultural (irrigation) applications. Subsequently, from a regional perspective water availability is an important environmental variation to identify and assess during the NEPA process.

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IV. MANAGEMENT CONSIDERATIONS BY AGENCY

Development of oil and gas reserves on federal lands within the United States takes place in a variety of regulatory settings and land use environments that often require authorizing agencies to prioritize potential resource impacts differently. Additionally, federal agencies, in general, are legally mandated to develop multiuse land management plans to satisfy the regulatory requirements per the land's use, as well as assure compliance with internal directives that often define an agency's "purpose". As discussed in Chapter 3 of this document, regional environmental variation on federal lands can result in the formulation of inconsistent analysis methods that are used to define local resource impacts. Oil and gas development on federal lands is further complicated because of the broad and diverse range of land uses that are management by various federal agencies. These uses can include, but are not limited to, recreation, academic study, livestock grazing, agriculture, plant harvesting, commercial timber cutting, protected wildlife refuges, hunting and outfitting, traditional cultural properties, saleable and leasable mineral development, and aesthetic appreciation. To further illustrate these issues, the Swanson River case study (Appendix A) provides a practical discussion to demonstrate oil and gas specific land management variation that can exist between federal agencies. The case study also helps to illustrate the regulatory relationships that exist between federal and state programs with discussion relative to the associated conflicts or access delays that may arise.

A frequent grieve in NEPA proceedings involves agency "segmentation". For instance, when considering the Endangered Species Act, agencies often must decide on a preferred alternative before receiving a biological opinion from the U.S. Fish and Wildlife Service. Additionally, because federal agencies involved in oil and gas development will differ in their missions, jurisdictions, and their management approach, significant disparities can occur when one agency or a component of an agency focuses on taking a specific action that is at odds with those starting to prepare a NEPA analysis. To illustrate this point, jurisdictional conflict occurred in South Shale Ridge near Grand Junction, Colorado when the BLM's Grand Junction Field Office disregarded comments submitted by the U.S. Fish and Wildlife Service (USFWS) in moving to lease the South Shale Ridge area for oil and gas drilling. In formal correspondence by the USFWS, the Service questioned BLM's decision to open proposed wilderness lands in the development area due to the project's likelihood to impact sensitive species known to inhabit the area (Lindauer, 2005). Although in this situation the USFWS could not

legally force BLM to move the project location, the conflicting management objectives between the two agencies resulted in the involvement of public interest groups and subsequently delayed the project.

To reduce inter-agency conflicts, the National Environmental Policy Act specifically directs federal, state, and local governments to cooperate and integrate regulatory objectives and missions with the goal of achieving productive initiatives to satisfy public and national needs. As an example, the EPA, Region 8 finalized a supplement to NEPA in 1998, through a Federal Leadership Forum, to provide cooperating agency guidelines for oil and gas development on public lands. More specifically, these guidelines established the role and responsibilities of the BLM, National Park Service, USFWS, Forest Service, and the EPA, "to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, when preparing environmental documents associated with oil and gas activities within the states of Utah, Colorado, Montana, Wyoming, and North and South Dakota" (Federal Leadership Forum, undated). In addition, in recent years this premise has been further supported by President Bush's Executive Order on Facilitation of Cooperative Conservation.

A present day example of cooperative interaction between two authorities took place on the Jonah Infill Drilling Project EIS in 2005. In this example, the Governor of Wyoming, Mr. David Freudenthal, worked directly with BLM's Pinedale Field Office to thwart potential litigation and project delays by commenting and suggesting appropriate actions for resource impact analysis. In this case, the people of Wyoming were represented via communication to BLM through the Governor's office which helped BLM streamline their decision process. Additionally, this exchange of information between these two public entities helped reduce public controversy and agency entanglements, as well as facilitated the formulation of an adaptive management approach to accurately and appropriately assess resource impacts important to the local communities.

According to data obtained form the Council on Environmental Quality NEPAnet (2005), from March 1, 2002 to February 28, 2004, 31,792 Environmental Assessments (EA) and 669 Environmental Impact Statements (EIS) were performed by Federal Departments or Agencies in the United States. Of these, 2,438 EA's or approximately 8 percent were executed with cooperating agencies while, 284 or approximately 43 percent of the EIS's were performed with cooperating agencies. The importance of interagency cooperation or the concept of an interdisciplinary approach to expedite oil and gas development on

federal lands cannot be overemphasized because of the predicted energy shortcoming that will most certainly arise without the development of additional national mineral reserves. Additionally, intra-agency collaboration to streamline access to public lands requires additional attention because of the significant role the oil and gas industry has on the overall economy of the United States. To financially illustrate the importance of this idea, energy resources on public lands within the United States generated $1.2 billion in revenue (BLM, 2006a). Of this, energy, mineral royalties, and other related factors accounted for $1.1 billion of the total (BLM, 2006a). Furthermore, the direct and indirect economic impact of energy and mineral production on the public lands amounted to an estimated $24.7 billion (BLM, 2006a).

The intent of this section is to provide a general overview of the key federal agencies involved in the oil and gas industry and their regulator relationship with one another, as well as discuss their primary regulatory roles that may affect federal land access during the development process.

A. Distribution of Federal Land Management

The federal government owns mineral resources contained within approximately 700 million acres of subsurface land (GAO, 2004) of which, approximately 570 million acres are open for oil and gas leasing (Environmental Working Group, 2006). Since 1982, the federal government has leased or offered for oil and gas drilling 229 million acres of public and private land through the sale of leases which typically last for 10 years or more.

The BLM is responsible for the subsurface management of all these lands; whereas they only have administrative rights for 37 percent of the corresponding surface area (approximately 261 million acres) (GAO, 2004). The United States Forest Service (USFS) manages 27 percent of the surface area, or approximately 192 million acres, while the National Park Service, USFWS, the Bureau of Reclamation and the US Army Corps of Engineers collectively manage 27 percent of surface area, or 190 million acres (GAO, 2004). Table 2 summarizes, in millions of acres, the quantity of the lands managed per responsible federal agency in the United States. It is important to note that four million acres of the subsurface located under federally owned surface lands is privately held and that some acquired forest lands have retained their mineral rights.

Table 2 Acres of Land Managed by Federal Agencies

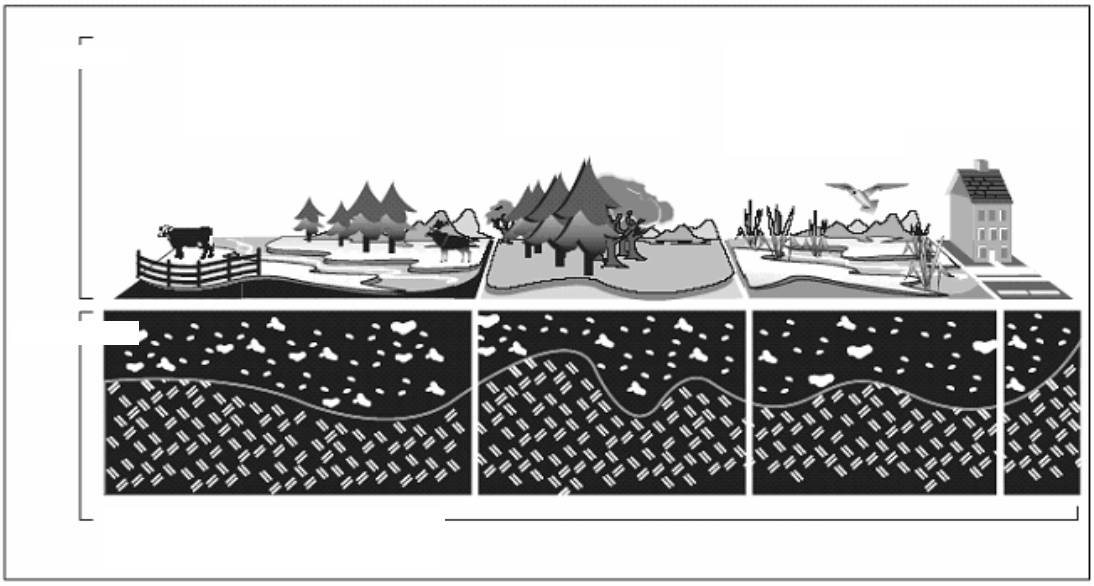
Federal Agency		Millions of Acres
Department of Interior		
	BLM	261.9
	NPS	84.4
	BIA	55.7
	USFWS	96
	BOR	8.7
USDA		
	USFS	192
Department of Defense		
	USACE	25

Certain rules have helped clear the way for oil and gas development and include specific provisions that allow drilling on land when the surface is owned by a private party but the oil and gas rights are owned by the federal government. Western states for example, as a result of the Homestead and Coal Land Acts, recognize separate ownership of surface and subsurface (or mineral) estates and have unique private property rights connected with each. Often, different parties own the surface and the subsurface. This is commonly referred to as “split estate” or "severed minerals". The ownership differences are commonly the result of the United States government reserving minerals when the lands were originally patented, or may be the outcome of a decision by a previous landowner to separately sell or lease the subsurface mineral interest. According to the GAO, there are 57 million acres of split estates in the United States where the federal government owns the mineral rights while another party owns the surface (2004). Figure 14 illustrates the discrepancy of subsurface lands managed per federal agency that contain mineral resources to the amount of surface land managed relative to the same agency.

B. OIL & GAS MANAGEMENT ON FEDERAL LANDS

Although there are many federal agencies that are associated with the development of oil and gas, BLM is the principle agency responsible for the management of subsurface mineral extraction in the United States. However, in many situations surface management over BLM administered minerals is overseen by other federal agencies. In any case, the lead federal agency responsible for managing the surface, whether it is the BLM or another agency, is known as the Surface Managing Agency (SMA). In general, the SMA is under legal mandate to provide varying, but reasonable land use specific protection of surface resources that in some circumstances conflict with oil and gas development. Under these circumstances, successful oil and gas development on federal lands necessitates collaborative decision making between BLM and the SMA to effectively balance SMA management directives with fluid mineral development. Although in theory this can be an effective approach or resolution, because of varying agency missions, jurisdictions, and concerns, development of federal lands can often be delayed or impeded. Further discussion of this issue is detailed in the following subsections.

Figure 14 Management Distribution of Subsurface and Surface Mineral Resources



(Source: GAO, 2004)

C. Federal Agencies Involved in Oil & Gas Development

The following agency discussion is aimed at describing the principle regulatory directives of the BLM, the USFWS and the USFS since their policies and responsibilities, in various capacities, can affect fluid mineral development. This section will also provide a general overview of other federal agencies that are often involved in the oil and gas development process.

Bureau of Land Management

The Secretary of the Interior, through the BLM, issues oil and gas leases on federal lands under various authorities. In addition to leasing federally owned oil and gas minerals, BLM is also responsible for supervising the exploration, development, and production operations of these resources on both Federal and Indian lands. BLM administers public lands within a framework of numerous laws, the most comprehensive being the Federal Land Policy and Management Act of 1976 (FLPMA). All Bureau policies, procedures, and management actions must be consistent with FLPMA and the other laws that govern public land use. BLM responsibilities are generally the same on split-estate (private surface, federal mineral) since, under these conditions the impacts that occur on private surfaces are caused as a direct consequence of BLM approved federal lease activities. A majority of the lands managed by BLM are located in the western United States, including Alaska, and contain a wide variety of resources and uses such as energy and minerals; timber; fish and wildlife habitat; and wilderness areas. Figure 15 shows the distribution of BLM field offices and the respective boundaries for the field offices. This map reflects the disproportional density of BLM administered public lands within the western United States. (Note: the figure does not delineate the additional 300 million acres of BLM subsurface mineral estates that are located throughout the United States.)

An important aspect of BLM land management is the directive, as mandated by the FLPMA, to develop Resource Management Plans (RMP). An RMP is best described as a land use plan that defines broad, multiple-use guidance for managing public lands and typically includes a mineral resource component, which provides land use policy and an estimate of reasonable foreseeable oil and gas development. The future development is usually estimated as a number of new oil, gas and possibly coal bed natural gas (CBNG) wells anticipated over the next 10 or 20 years. Currently, more than 140 RMPs are providing direction and authorization for land uses on public lands (BLM, 2006a). RMPs

are a key consideration during the planning process for development of BLM administered oil and gas since mineral extraction is often contingent upon RMP approval and implementation. In Alaska, for example, BLM is currently not administering new oil and gas leases in the Swanson River Field or surrounding areas and are not expected to do so until a revised RMP of the area is completed.

The defined role and expectations that BLM has for oil and gas development on federal lands is largely dependent on the development of regional or local RMPs and associated NEPA documents. RMPs provide BLM with an administrative tool to afford protection for certain resources or land uses and include: Wilderness Study Area (WSA), Areas of Critical Environmental Concern (ACEC), Outstanding Natural Areas (ONA), Research Natural Area (RNA), Special Recreation Management Areas (SRMA), and Extensive Recreation Management Areas (ERMA). Although BLM policies typically provide a consistent approach to oil and gas development per RMPs in the United States, regional variation in cooperating SMA responsibilities, state mandated directives, or oil and gas policy disparities can affect BLM's role or complicate development. Several examples to demonstrate these points are discussed below.

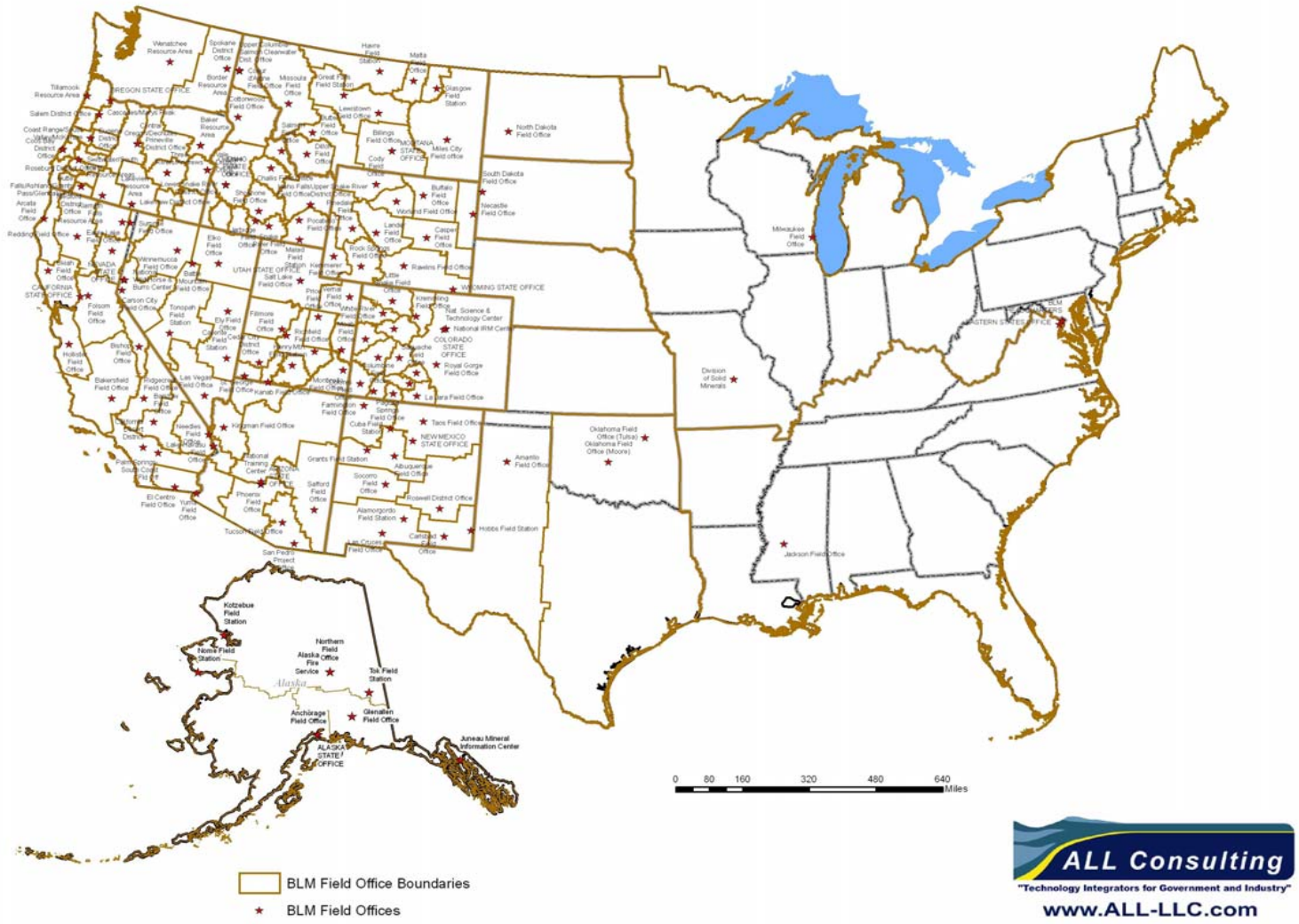
In general, interaction between cooperating federal agencies can be viewed in a positive manner. For instance, development of a comprehensive resource handbook entitled *Surface Operating Standards for Oil and Gas Exploration and Development,* or "Gold Book", was prepared by BLM and the USFS. This guide represents a good example of interagency cooperation that provides standards for oil and gas geophysical operations, construction, operation, production, reclamation, and abandonment, as well as procedural guidelines for development of federal fluid minerals. However, in Alaska for example, policy missions between BLM and the USFWS often conflict, which can result in the delay of existing and future development.

The relationship that exist between Alaskan BLM and USFWS offices differs, to a certain extent, from that which is experienced in the continental United States, e.g., Montana, Wyoming, New Mexico, etc. More specifically, because of state specific legislation [Alaska National Interest Lands Conservation Act (ANILCA)], the USFWS in Alaska has been granted, from a comparative perspective, additional authorization over oil and gas related activities on public lands. For instance, in the Swanson River oil and gas field, which is located within the Kenai Wildlife Refuge, the USFWS regulates surface uses to such an extent that BLM supported oil and gas development is contingent upon approval

from the USFWS based on priorities and "compatibility determinations". These compatibility determinations essentially authorize the USFWS to manage and restrict land uses within the Refuge. As an outcome of these determinations, oil and gas development, with the exception of pre-existing leases, has been deemed incompatible with the purpose of the Refuge and is therefore not permitted. A more detailed discussion of this subject matter is presented in the Swanson River case study (Appendix A) and a discussion of the USFWS role in the continental United States is discussed in a following Section.

Lastly, as an outcome of the recent Montana and Wyoming Coal Bed Methane (CBM) EISs and the subsequent Records of Decision, the Montana and Wyoming State BLM offices require operators to submit a Plan of Development (POD) prior to initiation of CBM (now referred to as Coal Bed Natural Gas (CBNG)) development on federal lands. For any given area or number of wells, PODs must define certain management parameters to assure CBNG development occurs in an environmentally sound manner and can include, for instance, water management, surface use, surface reclamation, and wildlife monitoring plans. The point of regional interest here is two-fold: (1), development of BLM PODs is only required in Montana and Wyoming; and (2) traditional oil and gas development on federal lands are not subject to this requirement. Although the latter may change pending new BLM directives, this situation illustrates policy differences that can exist within an agency which can affect oil and gas development on a regional basis.

Figure 15 Bureau of Land Management Field Offices and Office Boundaries



Fish & Wildlife Service

The USFWS is responsible for protecting and conserving migratory birds, endangered species, certain marine mammals, inland sport fisheries, and specific fishery and wildlife research functions. Currently, the agency manages approximately 96 million acres and consists of all lands contained within the National Wildlife Refuges System (NWRS). In 1920, the Mineral Leasing Act authorized the Secretary of the Interior to issue leases for oil and gas development on public domain lands including lands reserved for wildlife refuges. However, in 1966, as well as regulations pursuant to the National Wildlife Refuge System Improvement Act of 1997, the National Wildlife Refuges System Act emplaced "compatibility" standards for employment by the USFWS to ascertain the legitimacy of proposed land uses and subsequent authorization to limit or restrict uses deemed contrary with the purposes for which individual refuges (units) were established (USFWS, 2005a).

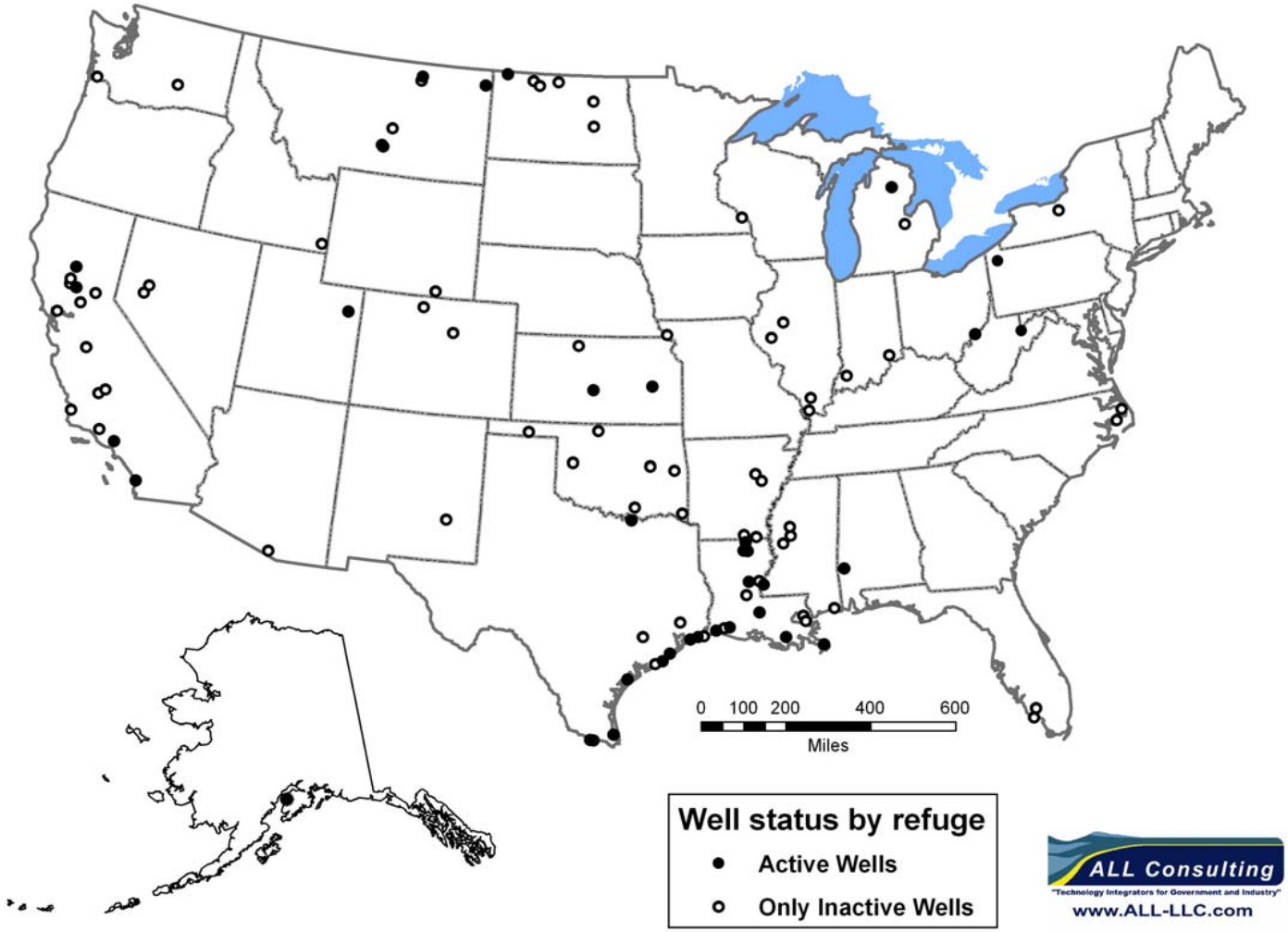
In principle, these "compatibility" standards (or compatibility determinations) enacted by the National Wildlife Refuges System Act are the fundamental USFWS regulatory process for any National Wildlife Refuge (NWR) in the United States. The determination of compatibility is fulfilled through the development of refuge specific Comprehensive Conservation Plans (CCP), which are congressionally mandated plans for providing broad policy guidance and establishment of long-term goals and management objectives on refuges (Frates, 1999). Currently, federally-owned oil and gas rights on NWR lands, including the Arctic National Wildlife Range, are not available for leasing as oil and gas activities are deemed incompatible with the purpose of NWRs. However, in a decision by the Interior Board of Land Appeals in 1981, it was determined that the prohibition against oil and gas leasing on "refuge lands" did not include lands acquired from other sources. In this situation, the persons holding those privileges have the full right to develop their minerals as long as reasonable regard for the surface estate, as required by state law, is met. Because of this decision, the USFWS does not have authority over non-federally owned minerals located on NWR lands in the continental United States, with several exceptions, nor do they have the authority to conduct oil and gas related compatibility determinations over non-federally owned minerals, again with several exceptions including Alaska (Frates, 1999). A more detailed discussion of this topic can be found in the Swanson River case study which is presented as Appendix A.

Of the 567 units present in the NWRS, 77 (or 14 percent) had oil or gas activities on their land in the year 2000 (GAO, 2001). Figure 16 depicts NWRs that accommodate oil and gas related activities. These units are located in 22 states and distributed through all seven regions of the USFWS: Louisiana, with 19 units, and Texas, with 11 units, had the most units with oil or gas activity. The majority of these units (41) which permit oil and gas development occur in situations where private entities, states, or native corporations, rather than the federal government, own the mineral rights. In 27 units, a pipeline constitutes the only oil or gas activity within a refuge, and these pipelines either were present before the USFWS acquired the land or were constructed under a right-of-way permit issued by the Agency after the land was acquired (GAO, 2001). In only eight circumstances does the federal government own the mineral rights and lease the refuge for oil and gas development. These include:

- Bitter Lake National Wildlife Refuge, New Mexico
- Bowdoin Wetland Management District, Montana
- Delta National Wildlife Refuge, Louisiana
- Hewitt Lake National Wildlife Refuge, Montana
- J. Clark Salyer National Wildlife Refuge, North Dakota
- Medicine Lake National Wildlife Refuge, Montana
- Salt Plains National Wildlife Refuge, Oklahoma
- Upper Souris National Wildlife Refuge, North Dakota

Although oil and gas related activities have been deemed incompatible with the purpose of NWRs, there are some varying exceptions that allow for oil and gas development to take place on refuges in which the federal government owns the oil and gas mineral rights. For instance, in two of the eight above listed units, oil or gas was already being produced on the land when the USFWS acquired it for inclusion in the NWRs. In four units, the federal government leased the refuge land for oil and gas development via a "drainage lease" to protect its interest in oil or gas resources that were being "drained" from refuge land by wells of another owner operating on adjacent land (GAO, 2001).

Figure 16 National Wildlife Refuges with Oil and Gas Wells



In this particular situation, once BLM determines that drainage is occurring on refuge land, it requests the USFWS's consent to lease the land to allow the federal government to collect a compensatory royalty for the oil and gas loss from drainage (USFWS, 2005). Before agreeing to lease the land, the USFWS must determine that the proposed activity is compatible with the purpose for which the refuge was established and provide BLM with recommendations for lease stipulations. When a drainage lease is issued, it generally contains a "no surface occupancy" stipulation that prohibits the occupancy and use of refuge land for the extraction of resources. As a result, operators who obtain such a lease must extract the oil and gas from land located outside the boundaries of the refuge via directional drilling.

In one of the two remaining eight units that allow oil and gas development, the executive order establishing the refuge in 1938 opened its land to oil and gas leasing because it was located on a known producing gas field and, at the time, oil and gas development on refuge land was not prohibited by Interior's regulations (GAO, 2001). In the other refuge, leasing was allowed under an exception to Interior's 1947 regulations that prohibited oil and gas leasing on refuge land. This exception, which no longer exists, allowed leasing if the lessees had an approved unit agreement plan that stipulated how the oil and gas field would be developed and operated (GAO, 2001).

Although the USFWS is not the principle agency responsible for oil and gas development on federal lands, as demonstrated they do supervise some surface lands where mineral leasing occurs. Of interest to this is currently the USFWS does not have a line item in its budget to fund the management of oil and gas activities that occur in the NWRS (GAO, 2001). As a result, units that have individuals assigned to the management of oil and gas activities usually use funds from their unit budget or find alternative sources of funding for this function. According to the USFWS only one refuge in the United States, the Sabine National Wildlife Refuge in Louisiana, has a full-time person assigned to oil and gas activities (GAO, 2001). The position is funded from a damage fund account which contains money collected from oil and gas operators for site-specific damage to refuge land.

The United States Forest Service

The USFS is responsible for managing 192 million acres, including 155 national forests and 20 grasslands. Currently, in the United States there are 26 USFS districts (e.g., National Forests and National Grasslands) that have oil and gas production wells located within their boundaries (USFS, 2005a). As with all federal lands, oil and gas minerals located under USFS land are managed by the BLM; however, it is the responsibility of USFS for determining which lands may

be leased, as well as establishment of surface stipulation requirements as authorized by the USDA Forest Service Oil and Gas Resources Regulation (36 CFR, Subpart 228, Section E) and the federal Onshore Oil and Gas Leasing Reform Act of 1987. Under this authority, permits to drill on USFS management lands are not granted without the analysis and approval by the USFS of a surface use plan, which covers proposed surface disturbing activities within the lease area (USFS, 2005b).

Although the official position of the USFS is to encourage mineral development on lands they manage, typically oil and gas related activities on these lands are limited because of restrictive land use stipulations that exist for a variety of ecological, cultural, and socioeconomic reasons. Under certain conditions, oil and gas development can occur on lands with restrictive lease stipulations, but typically will require performance of either an Environmental Assessment (EA) or EIS (USFS, 2005a). Conversely, on USFS lands that do not contain such stipulations, mineral related permits may qualify for a Categorical Exclusion (CE) if the proposed activity is within a specified threshold of environmental impact (USFS, 2005a).

Under the Energy Policy Conservation Act (EPCA), Congress directed the Department of the Interior to complete a summary of BLM and USFS land management plan decisions for oil and gas leasing for the most potentially important mineral areas with large amounts of public lands (USFS, 2005a). Phase I of this study focused on leasing decisions for federal managed lands for the Montana Thrust Belt, Powder River Basin, Greater Green River Basin, Uinta/Piceance Basin, and Paradox/San Juan Basin. Leasing decisions were divided into four categories of stipulations that are employed by both the BLM and USFS and include: standard lease terms, controlled surface use, no surface occupancy, and no lease. (Note: The "no lease" leasing decision represents lands where exploration and development are not allowed. This category includes any lands covered by a no surface occupancy lease, lands for which USFS has not made a leasing decision, and lands withdrawn from leasing by law.) The study indicated that 47 percent of USFS lands are unavailable for any surface exploration or development, 19 percent are available to exploration and development under standard lease terms and restrictions, and 34 percent are subject to additional restrictions beyond the standard lease terms and restrictions for additional protection of other forest or grassland resources or uses (USFS, 2005a). Figure 17 graphically illustrates the leasing management decision distribution for the study areas.

In 2001 President Bush issued an executive order to expedite the increased supply and availability of energy to the United States and called for responsible federal agencies to review oil and gas permits in an efficient manner and to take necessary internal actions to accelerate the completion of such projects. Additionally, in August 2005, President Bush signed the Energy, Policy Act of 2005 into law. In response to this order, and as part of the USFS Energy Implementation Plan process, the internal USFS oil and gas planning and environmental review process was evaluated by appropriate personnel. Results of this evaluation indicated the review process for oil and gas exploration and development frequently caused agency personnel to extend timelines and expend undue energy and funding in order to complete the planning and environmental documentation for minor exploration and/or development projects (USFS 2005b). Because of the findings of this evaluation, as well an important component of the Energy Policy Act, in December 2005 the USFS proposed certain amendments to their oil and gas regulations.

The Energy Policy Act establishes categorical exclusions which apply to five categories of oil and gas exploration and development activities on federal lands. Categorical exclusions define land surface actions that will not result in significant impacts to the environment and therefore, do not require an accompanying EA or EIS (USFS, 2005a). To take advantage of these new categorical exclusions, the USFS is currently proposing to include an oil and gas categorical exclusion for integration into the Forest Service Manual in an effort to facilitate the implementation of limited oil and gas projects on National Forest System land leases (USFS, 2005b). The proposed exclusion would allow for oil and natural gas exploration and development activities to take place on USFS managed lands within new oil or gas fields under certain limiting conditions.

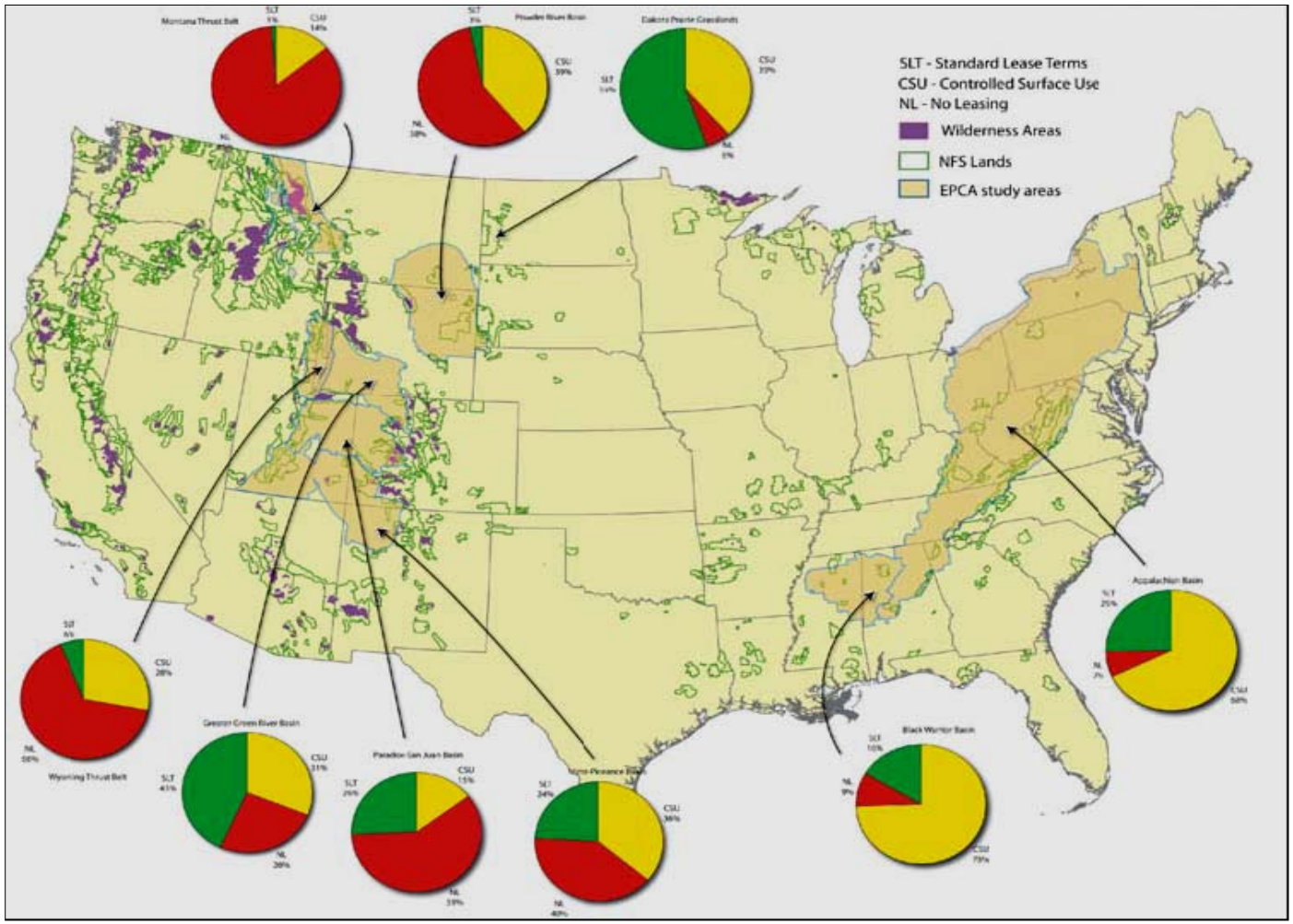
Conditions under this amendment for example, would limit new road construction to one mile, permit only three miles of pipeline installation and restrict drill sites to four locations. Additionally, these criteria would only apply when there are no extraordinary circumstances (e.g., critical habitat, wilderness areas, wetlands, archeological sites, etc.) present on the land. Lastly, to fulfill the amendment requirements, the exploration and development of oil and gas must be consistent with the land management plan direction such as, forest or grassland land management plans, including any current and applicable standards and guidelines (USFS, 2005b). Currently, approval of this amendment is contingent upon legislation.

The National Park Service

The National Park Service (NPS) currently manages approximately 84 million acres, 4.3 million of which are privately owned (NPS, 2006a). Oil and gas development on NPS lands is contingent upon compliance with applicable regulations and NPS policies which include the: Mining in the Parks Act, the Mineral Leasing Act, the Acquired Lands Mineral Leasing Act, the Surface Mining Control and Reclamation Act of 1977, the National Park System General Authorities Act, the Alaska National Interest Lands Conservation Act, and enabling statutes for individual parks. Additionally, the National Park Service Organic Act, as well as the acts responsible for establishing individual units, authorized the Secretary of the Interior to develop regulations for managing and protecting units. Based on these authorities, the NPS promulgated regulations 36 CFR Part 9, Subpart B, which govern the exercise of nonfederal oil and gas rights in park units.

Currently, NPS regulations governing oil and gas development prohibit *new* federal mineral leasing with the exception of three national recreation areas (Lake Mead, Whiskeytown, and Glen Canyon) in which Congress has explicitly authorized federal mineral leasing by enabling legislation for each of these area's (NPS, 2006b). Mineral exploration or development may be allowed in National Parks when prospective operators can legally demonstrate that they hold rights to valid mining claims, federal mineral leases, or non-federally owned minerals. (Many of the national parks and monuments in the United States were established with ongoing mining operations or other valid existing rights.) Although, the NPS cannot deny access to lease claims by those having valid existing rights, they have authority to regulate development to control and mitigate significant adverse effects on park, recreational, or wilderness values. As of 2006, data indicates that because of regulatory exemptions, about 50 percent of the 711 non-federal oil and gas operations in 13 units are outside the scope of the 36 CFR 9B regulations. That is, operators do not have to obtain approval from the National Park Service to operate.

Figure 17 Distribution of USFS Lands According to Lease Terms or Stipulation Categories



(Source: USFS, 2005) Green = Standard Lease Terms, Red = No Lease, Yellow = Controlled Surface Use

Designated Wilderness Areas

The development of oil and gas projects within federally designated wilderness areas provides a unique challenge for regulators and operators alike because of the inherent differences in management approaches that are administered for individual areas. Wilderness areas are not management by a single federal agency, but by four agencies having their own management mission, these include the BLM, USFWS, USFS, and the NPS. The Wilderness Act of 1964 created the current National Wilderness Preservation System that originally established a general management direction for each wilderness-managing agency and provided Congress with the necessary regulatory tools to designate certain areas as "Wilderness Areas" (Thompson, 1996).

Following the enactment of the Wilderness Act in 1964, Congress permitted mineral-related activities in designated wilderness areas for 20 years. During that period, new mineral rights could be established. However, following December 31, 1983, new mineral rights, under the terms of the Wilderness Act, were no longer permitted, with the exception of those entities holding valid existing mineral rights, because oil and gas development was not considered compatible with the preservation of the wilderness environment (Thompson, 1996). Additionally, the Act prohibits structures or mechanized equipment in designated wilderness areas, again pursuant to "valid existing rights". In this case, such rights may be created by oil and gas leases in effect when a particular area is designated as wilderness. With this exception, wilderness designation generally withdraws the land from oil and gas activity (Committee on Onshore Oil and Gas Leasing, 1989).

As a response to the Act, Congress historically has pursued a general situational approach and has adopted several approaches for mineral development in Wilderness Areas. Congress has sought either to accommodate mineral development by drawing the boundaries of the wilderness to exclude highly-mineralized, potentially-developable areas or to avoid development by acquiring mining rights through purchase or exchange (Thompson, 1996). In general, the BLM, USFWS, USFS and the NPS cannot deny access to privately held mineral estates, but can regulate mineral activities to varying degrees based on the local situation, as well as their own overall management mission. In some cases, certain mineral rights established during the Wilderness Act 20-year grace period are currently being exercised and developed in designated areas (Klabunde, 1995), such as the Salt Creek Wilderness in Bitter Lake NWR and the Bisti/De-Na-Zin Wilderness area.

Currently, there are 680 designated wilderness areas in the United States that encompass 106,620,784 acres or 4.71 percent of the entire United States. However, 54 percent of designated wilderness areas are found in Alaska, which equates to approximately 2.58 percent of the continental United States as designated wilderness. The smallest wilderness area is Pelican Island in Florida (six acres) whereas the largest wilderness area is Wrangell-Saint Elias in Alaska (9,078,675 acres). Currently, the USFS manages the most wilderness areas while the NPS manages the most wilderness acres. To date, no new mineral leasing projects are ongoing within the wilderness area system.

D. Other Federal Agencies Involved in the Oil and Gas Industry

The Environmental Protection Agency

The EPA's involvement in oil and gas development curtails from their responsibility to ensure environmental and human health protection from mineral resources extraction. Oil and gas development can potentially affect natural resources, such as water or air quality, or wildlife habitat, therefore mineral related activities fall within the EPA's jurisdiction. Besides the EPA's requirement to comment on all EISs, the agency administers several regulatory programs that affect the oil and gas industry. Two of the more important set of regulations include the Spill Prevention, Control, and Countermeasure (SPCC) and Phase II storm water rules.

SPCC Plans ensure that facilities put in place containment and other countermeasures that prevent oil spills that could reach navigable waters. Under EPA's Oil Pollution Prevention regulation, facilities must detail and implement spill prevention and control measures in their SPCC Plans. A spill contingency plan is required as part of the SPCC Plan if a facility is unable to provide secondary containment (e.g., berms surrounding the oil storage tank).

As a result of the 1987 amendments to the Clean Water Act, the EPA was required to address storm water runoff in two phases. Phase I of the National Pollutant Discharge Elimination System (NPDES) Storm Water Program began in 1990 and applied to large and medium municipal separate storm sewer systems and included construction sites disturbing five acres of land or more. The Phase II program uses NPDES permits to expand the Phase I program by requiring operators of small construction sites to implement programs and practices to control polluted storm water runoff. Phase II of the NPDES Storm Water Program applies to construction sites disturbing equal to or greater than one but less than five acres of land. Many oil and gas fields or well locations are now subject to this relatively new rule.

Bureau of Indian Affairs

The Bureau of Indian Affairs (BIA) is responsible for the administration and management of 55.7 million acres of land held in trust by the United States for American Indians, Indian tribes, and Alaska Natives (BIA, 2006). In terms of oil and gas, the BIA is responsible for the approval of any lease, agreement, permit or document that could encumber lands and minerals owned by either tribes or allottees. Title to these resources is held by the U.S. Government in trust. As such, agreements or arrangements, involving the trust assets that tribes or allottees make are not binding until they have been approved by the trustee (Bureau of Land Management, 2003b). The agency that has been authorized to act as the trustee to keep the resources from being harmed or alienated is the BIA (Bureau of Land Management, 2003b). The BIA is assisted by the BLM in developing oil and gas on BIA managed land.

Bureau of Reclamation

The Bureau of Reclamation (BOR) is responsible for water management in the western United States, including dams, reservoirs, power plants, and canals and is the largest wholesaler of water in the United States (BOR, 2006). Currently, the agency manages 8.7 million acres of lands associated with reclamation projects. Most BOR land is closed to new mineral claims however, it is possible for oil and gas companies to develop BOR land with the consent of BOR officials and safeguards to "insure the adequate utilization" of the land for reclamation purposes (BOR, 1999). Additionally, the BOR does have interest in produced water from oil and gas activities. In November, 2005 the BOR awarded $1.7 million for desalination research, including funding to Western Environmental Management, who is working on technology to recover produced water.

Department of Defense

The Department of Defense (DOD), established in 1949, is the agency which houses the United States' military branches. The DOD manages 25 million acres of land for military installations, munitions testing, deployment of weapon systems, and combat training exercises. Oil and gas development on DOD land is often managed by the Army Corps of Engineers and can be leased by the BLM under terms set forth by the DOD when commercial development adjacent to DOD land threatens to drain federal mineral resources (DOD, 1987).

Department of Energy

The Department of Energy (DOE) is the single largest Federal government supporter of basic research in the physical sciences in the United States, providing more than 40 percent of total Federal funding for various energy related research programs (DOE, 2006a). The Department's Office of Fossil Energy is responsible for funding research that relates to increasing energy supplies, modernizing energy infrastructure and ensuring energy resources are being optimally utilized, while maintaining protection of the environmental. In general, the DOE is focused more on existing resources and how to use them strategically and efficiently, rather than the exploration and development aspect of the industry. Currently the Fossil Energy Program, through the National Energy Technology Laboratory, is developing a full array of new technologies that can expedite the location and production of oil and gas (DOE, 2006a).

United States Geologic Survey

The United States Geologic Survey (USGS) does not manage or administer oil and gas leases but instead, is directly involved with the collection, monitoring and analysis of natural resource conditions, issues, and problems. As part of their Mineral Resources Program, the USGS conducts research and provides information on the quantity, quality, occurrence, and availability of mineral resources in the United States (USGS, 2006a). Additionally, the USGS, as part of the Energy Policy and Conservation Act (EPCA), performs national oil and gas assessments to evaluate and forecast the natural gas and oil endowment of the United States, as well as assess the potential for reserve growth in the United States (USGS, 2006b).

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V. REGULATORY FRAMEWORK AND THE NEPA PROCESS

Environmental analysis is required from a federal agency when proposed actions on federal land has the potential to impact man's environment, a requirement established under the National Environmental Policy Act (NEPA) of 1969. While NEPA applies specifically to federally owned and managed lands, there are states which have adopted NEPA-like state environmental policy acts. Figure 18 shows the distribution of states with state specific environmental policy acts, as well as states which have environmental review procedures for specific actions within their state. The map illustrates the 15 states (red) that currently have state environmental policy acts, and the nine states (blue) that require environmental review procedures for specific activities (Figure 18). One state, New Jersey (yellow), has implemented NEPA-like environmental reviews in the past by executive order. There are a variety of regulations and guidelines at both the state and federal levels of government that affect the environmental analysis approach that must be performed to assess the development of oil and gas resources. The purpose of this section is to provide a basic reference guide of regulations that must be considered prior to the development of energy resources. This section presents the evolution of the NEPA process as it relates to onshore oil and gas development, a discussion of how the NEPA process is being influenced by Non-Governmental Organizations (NGOs), and how NEPA documents are being affected by these influences.

THE NATIONAL ENVIRONMENTAL POLICY ACT

Signed on January 1, 1970, the National Environmental Policy Act (NEPA) was enacted to ensure federal agencies consider associated costs and benefits to the environment that could result from a proposed action during the decision making process. The NEPA process applies to major federal actions that are conducted, financed, regulated or approved by federal agencies; a major federal action has been defined by federal court to be any action with "significant environmental impact" (Montana ECQ, 2000). Environmental analysis under NEPA is performed at three levels: Categorical Exclusions, Environmental Assessment (EAs), and Environmental Impact Statement (EIS).

Categorical Exclusions: Certain actions qualify as categorical exclusions (CE) such that the action does not individually or cumulatively have significant impacts on the environment and no EA or EIS is required. An example of a categorical exclusion could be a small extension to a producing oil field or another routine action with known impacts that have been documented in previous planning documents. That is, the action is relatively small in size, is similar to existing

developments in the area, and the Documentation of a CE for a proposed action is intended to be much less thorough than an Environmental Assessment or Environmental Impact Statement.

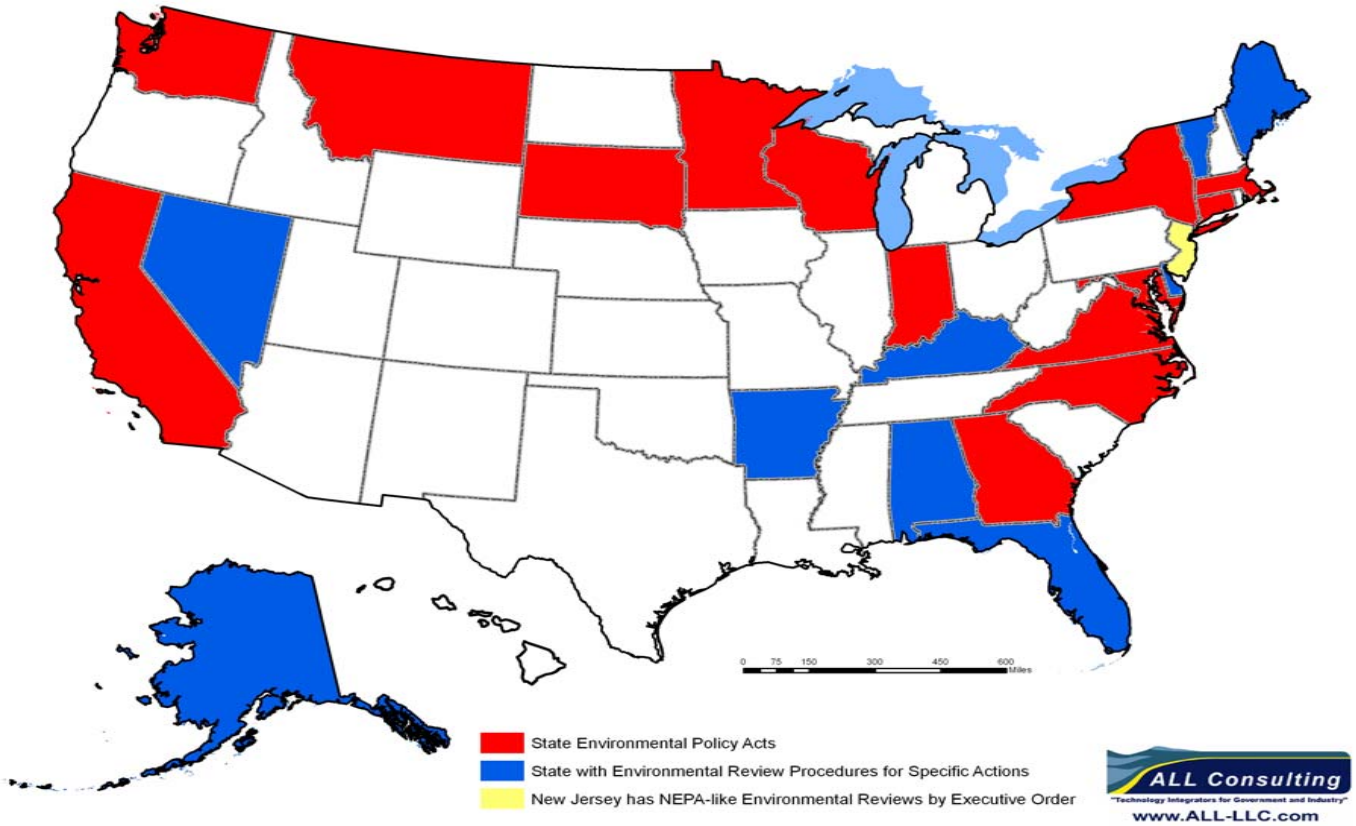
While the CE must be adequate to describe impacts, it is not meant to be an exhaustive documentation of quantitative detail. The CE will utilize existing, more thorough planning documents in the area to demonstrate similarity and lack of significant impact from those developments.

The United States Forest Service (USFS) has taken the lead in the use of CEs with oil and gas developments. The USFS plans to use the CE as a way of drastically cutting application evaluation and approval time from its current six-month period. The USFS will enable an operator to use the CE for "development activities associated with or adjacent to a new oil and/or gas field or area so long as the approval will not authorize activities in excess of any of the following: (a) One mile of new road construction; (b) one mile of road reconstruction; (c) three miles of individual or co-located pipelines and/or utilities disturbance; (d) four drill sites" (USFS, 2007). More extensive development actions may require the use of more detailed NEPA documentation.

Environmental Assessment: The EA is meant to document the environmental impacts expected from a proposed action. For example, an operator may need an EA if a proposed field extension takes oil and gas development from rolling pasture-land and crosses a major wetland or river system. The EA will determine expected impacts to wildlife, surface water and other environmental resources of the area. If the EA determines there may be a significant impact, then an EIS will be required to evaluate a series of alternatives that can accomplish the proposed action in various ways that are protective of the environmental resources. The EA is a planning document significantly shorter and less thorough than the Environmental Impact Statement.

Environmental Impact Statement: The EIS is a planning vehicle meant to thoroughly evaluate impacts to all aspects of the environment expected to occur with the proposed action. New oil and gas development projects or a proposal to open an area of federal land to oil and gas leasing are examples of action which typically trigger an EIS. A typical EIS addresses the potential for impacts to occur to a full variety of resources - physical and biological resources to human health and management resources.

Figure 18 Map of States with State Environmental Policy Acts and Environmental Review Processes.



(Source: Montana State Environmental Quality Council, 2000)

The NEPA process and development of an EIS is not designed to eliminate all the potential impacts that may result from a proposed action, instead the intent is to quantify and qualify the residual impacts so an educated decision can be made based on the proposed action's impact analysis of development alternatives. Public involvement is sought throughout the EIS process from public scoping meetings at the beginning of the process to formal public comment periods between the draft and final version (ALL Consulting, 2003b).

In synopsis, if the impacts of a proposed action are not known, or if an action is not expected to result in significant impacts, an EA is prepared. If during the analysis process for the EA, the action is found to not have significant impact, a Finding of No Significant Impact (FONSI) is issued and the action may proceed. If it is determined during the EA analysis that the action will result in significant impacts, an EIS is prepared to document the level of impacts that are expected to occur. In some cases, development of an EIS can be performed by tiering assessment information (see below).

Tiering: Tiering of environmental impact statements refers to the process of addressing a broad, general program, policy or proposal in an EIS, and analyzing a narrower site-specific proposal, related to the initial program, plan or policy in a subsequent EIS. The concept of tiering was promulgated in 1978 by the Council on Environmental Quality (CEQ) and is contained within the 40 CFR NEPA Implementing Regulations, Section 1508.28. The regulations do not require tiering; rather, they authorize its use when an agency determines it is appropriate. It is an option for an agency to use when the nature of the proposal lends itself to tiered EIS(s). From this regulation, tiering is appropriate when the sequence of statements or analyses is:

- From a program, plan, or policy environmental impact statement to a program, plan, or policy statement or analysis of lesser scope or to a site- specific statement or analysis.
- From an environmental impact statement on a specific action at an early stage (such as need and site selection) to a supplement (which is preferred) or a subsequent statement or analysis at a later stage (such as environmental mitigation). Tiering in such cases is appropriate when it helps the lead agency to focus on the issues which are ripe for decision and exclude from consideration issues already decided or not yet ripe.

The original intent of the tieirng concept was to encourage agencies to eliminate repetitive discussions within the NEPA analysis and to allow for a more focused assessment of actual impacts at each level of environmental review. However, the concept of tiering has resulted in mixed feelings for those involved in the NEPA process. From one perspective, tiering assessment issues has caused a certain amount of confusion and uncertainty, although not universal, and is belived by some to have caused an additional layer of paperwork to the process, as well as added an extra legal requirement to NEPA.

According to the CEQ the tiering concept does not add an additional legal requirement to the NEPA process. From their perspective, an environmental impact statement is required for proposals for legislation and other major Federal actions that may adversely affect the quality of the human environment. In the context of NEPA, "major Federal actions" include adoption of official policy, formal plans, and programs as well as approval of specific projects, such as construction activities in a particular location or approval of permits to an outside applicant. Thus, where a Federal agency adopts a formal plan which will be executed throughout a particular region, and later proposes a specific activity to implement that plan in the same region, both actions need to be analyzed under NEPA to determine whether they are major actions which will significantly affect the environment.

In this example, assessment of the issues can be performed in two ways: Either preparation of two environmental impact statements, with the second repeating much of the analysis and information found in the first environmental impact statement, or tiering the two documents. If tiering is utilized, the site-specific tiered EIS would contain a summary of the issues discussed in the original EIS, typically in the form of reference discussions, but would not duplicate those broader issues assessed in the first EIS.

OVERVIEW OF STATE ENVIRONMENTAL POLICY ACTS

There are 15 states and two jurisdictional entities of the United States (District of Columbia and Puerto Rico) that have State Environmental Policy Acts (SEPAs) that are similar to NEPA (Table 3). In some cases, similar requirements under NEPA and SEPAs can result in redundant analysis. In fact, the United States House of Representatives Committee on Resources' Task Force on Improving the National Environmental Policy Act and Task Force on Updating the National Environmental Policy Act Initial Findings and Recommendations addressed this by recommending that the CEQ complete a study regarding NEPA and SEPA interaction and any overlap in their assessments (US House of Representatives, 2005). (Note: This report has not yet been officially adopted by the Committee on Resources).

The 15 states that have legislation similar to NEPA include six of the 33 states that have oil and gas development and the Nevada/California Tahoe area. Although the specifics of SEPA programs vary from state to state, the purpose of these programs is the same: to require agencies to review proposed actions to determine if the action would result in significant impacts to the environment. There are three process steps common to most of the SEPA programs, first is determining if a project or action triggers the act and, therefore, requires an environmental review (Montana ECQ, 2000). The second step is to determine whether the action exceeds a level of impact that could be defined as significant, or if the project would result in a finding of no significant impact (this step is similar to the performance of an EA in the NEPA process). The final step would take place if there is a finding of, or the potential for significant impacts, which would require the completion of an environmental review with multiple alternatives and an impact discussion (an EIS in the NEPA process). Table 3 presents a matrix for determining the triggers under which the various SEPAs require a need for environmental review. There are ten states which require environmental reviews when the project is undertaken or funded by State actions only, while six of the states, the District of Columbia, and Puerto Rico require environmental reviews if the project is funded or undertaken by state and local agencies. Four of these ten states also require environmental reviews of state issued permits, while all six of the states and the two jurisdictions that require environmental reviews of state and local actions require reviews of permitted actions. There are six states with SEPA programs that exclude state and local permitted actions from environmental review (Table 3).

Table 3 State Environmental Policy Acts and the Need for EISs.

State	Law Since	SEPA Applies to Projects Undertaken/ Funded by:		SEPA Applies to Projects Permitted by:		EIS is Required for Actions that:		
		State Only	State and Local Agencies	State Only	State and Local Agencies	May Significantly Affect Environment	Significantly Affect Environment	And are Major
NEPA	1970	federal		federal			X	X
California	1970		X		X	X		
Connecticut	1971	X				X		X
District of Columbia	1989		ordinance		X			
Georgia	1991	X				X		
Hawaii	1974		X		X	X		
Indiana	1972	X					X	X
Maryland	1973	X					X	
Massachusetts	1972	X		X			X	
Minnesota	1973		X		X	X		X
Montana	1971	X		X			X	X
New York	1976		X		X	X		
N. Carolina	1971	X					X	
Puerto Rico	1970		X		X		X	
S. Dakota	1974	X		X				
Virginia	1973	X					X	
Washington	1971		X		X	X		X
Wisconsin	1971	X		X			X	X

Individual state SEPAs define the trigger for an EIS differently, seven of the states require an action to be defined as a major action to trigger the need for an EIS, there is some variation on whether the proposed action is triggered when the action "may" or "will" cause significant impacts as shown in Table 3 (Montana ECQ, 2000). SEPA programs may also identify actions which qualify for exemptions to the analysis or that are categorically excluded from the review process, or have specific statutory exemptions from environmental review. Most states which have categorical exclusions also define exceptions to these exclusions which require analysis to be conducted if the action occurs in a certain location or at a certain time frame (Montana ECQ, 2000).

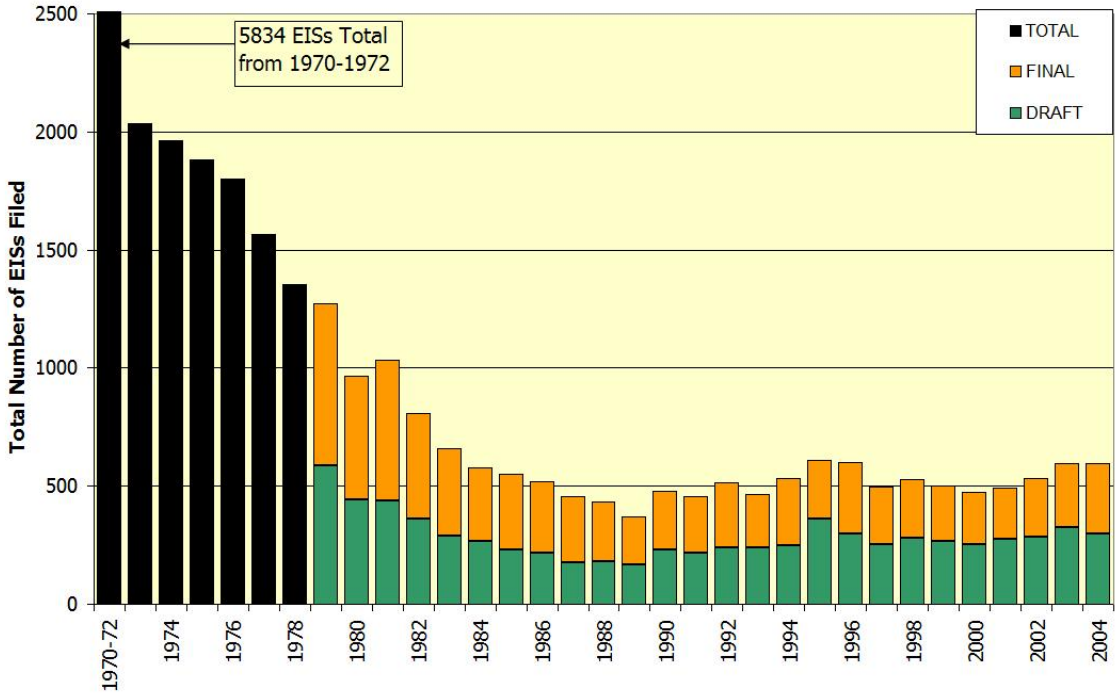
The identification of actions which require SEPA analysis can further vary from state to state by the manner in which thresholds are defined and the determination of significance of impacts. Some states define standardized thresholds (New York and North Carolina for instance) in the environmental review process which define the level of analysis that must be performed for an action of a particular size. Other states list actions by the level of review requirements, states like Montana require a third party review, and still other states list actions after public review and comments have been gathered. The need to determine significance of the potential impacts from an action is common to all SEPA programs. Most of the SEPA programs leave the determination of significance to the agency in charge through the review process with input from outside sources, with no states having a defined measurable significance criterion (Montana ECQ, 2000).

EVOLUTION OF NEPA RELATIVE TO THE OIL AND GAS INDUSTRY

Since 1970 when the National Environmental Policy Act was signed, the assessment of environmental impacts from onshore oil and gas activity has evolved. In applying NEPA to federal land management decisions, environmental studies are completed on two levels; the first is the programmatic level which includes revisions or amendments to resource management plans (RMPs), considerations of the effects of activities across a resource area and leasing parcels of land for a specific use (IPAMS, 2003). The second level at which environmental studies are completed is the project-level which includes considerations of new development projects, the issuance of rights-of-ways, and the permitting of every well drilled on federal lands (IPAMS, 2003). During the first two years after the passing of NEPA, federal agencies filed more than 5,800 EISs; an average 1,700 EISs were filed per year during the 1970's (Figure 19). The number of draft and final EISs filed during the 1980's and 1990's dropped to 588 and 518 per year, respectively or approximately 33 percent of those filed in the

1970's. While the numbers could be interpreted as the NEPA process is being streamlined and fewer EISs are required, actual reviews by federal agencies indicate the environment review process is being drawn-out (NEPA Task Force, 2003).

Figure 19 Federal Environmental Impact Statements Filed Since the Passing of NEPA in 1970



The evolution of EISs and EAs has resulted in these documents increasing in size and complexity with greater number of appendices and more technical information included in each successive document, while at the same time the reading level used in the documents has become less technical. NEPA documents as defined by 40 C.F.R. § 1502.7 were originally intended for EISs to be less than 150 pages unless the scope was unusual or complex, in which case the documents should be less than 300 pages (IPAMS, 2003). A review conducted as part of this study looked at 21 EISs relative to onshore oil and gas development activities on federal lands published between 1997 and 2004 and found the average page count to be more than 750 pages. Other research on length of NEPA documents found similar results, according to the Cambridge Scientific Abstracts in the year 2000 a Final EIS had an average length of 742 pages (US House of Representatives, 2005).

The environmental documents are taking up to several years to write, and development can then be tied up for years due to litigation once the documents are finalized. The increased timeframe for completing documents was a primary concern noted in the report by the United States House of Representatives Task Force to improve and update NEPA. The Task Force's initial recommendations included a move to "Amend NEPA to add mandatory timelines for the completion of NEPA documents. A provision would be added to NEPA that would limit the time for completing an EIS to 18 months. The time to complete an EA will be capped at 9 months. There will obviously be situations where the timeframes cannot be met, but those should be the exception and not the rule." (US House of Representatives, 2005). Increased timelines and page lengths often result from efforts to provide complete analysis to avoid litigation. From 2001 to 2004, between 130 and 150 NEPA litigation cases were filed each year (Table 4). Litigation is seen by some as an important means of enforcing NEPA, while others view many of the

Table 4 Litigation Summary for NEPA Documents from 2001-2004

Year	NEPA Cases Filed	Injunctions	Percent Success
2001	137	6	4.4 %
2002	150	27	18 %
2003	130	6	4.6 %
2004	150	11	7.3 %

Source: Council on Environmental Quality's NEPAnet. (CEQ, 2006).

lawsuits filed as efforts to delay or prevent actions on federal lands. In fact, the United States House of Representatives NEPA Task Force report noted that "Litigation was seen by many as the single biggest challenge with the NEPA process," and further made the additional recommendation that NEPA should be amended to "create a citizen suit provision. In order to address the multitude of issues associated NEPA litigation in an orderly manner the statute would be amended to create a citizen suit provision. This provision would clarify the standards and procedures for judicial review of NEPA actions." (US House of Representatives, 2005). NEPA analysis, when accompanied with litigation, can be a lengthy and costly process such that projects on federal lands are avoided by smaller companies as these processes become barriers to economic viability of the project (IPAMS, 2003).

Litigation has lead to increased influence by non-government organizations (NGOs) in the environmental analysis and the land management decision process of federal agencies. Table 4 presents an annual summary of the litigation associated with NEPA analysis from 2001 to 2004 as well as a breakdown on the number of injunctions that resulted from the cases filed. Table 5 presents a breakdown of the plaintiffs for the cases filed from the same time frame. The breakdowns shown in Table 4 and 5 indicate the largest number of plaintiffs trying to stop actions on federal lands are not property owners or local government, but are public interest groups (Table 5). Analysis by the NEPA Task Force has identified NGOs as one of the primary reasons the NEPA documents are becoming increasingly more complex, taking longer to finish, and often end up in litigation (NEPA Task Force, 2003). In order to counteract the efforts of NGO's to delay actions on federal lands through lawsuits, federal agencies are increasing including more analysis and data in NEPA documents.

Table 5 Plaintiffs in NEPA Lawsuits by Group and Year

Plaintiffs	2001	2002	2003	2004
Public Interest Groups	175	229	191	232
Individual/Citizen Association	95	142	82	83
State Government	11	16	8	11
Local Government	37	50	16	21
Business Groups	52	64	28	27
Property Owners/ Residents	15	19	5	11
Indian Tribes	11	18	9	13
Combination Plaintiffs[1]	63	84	42	9

[1] Combination Plaintiffs include local governments and individuals; in these cases the plaintiffs are counted in their individual category as well as the combination category.

The result of this litigation is that draft and final environmental impact statements and environmental assessments are growing substantially in size. As part of this research a review of 21 EISs that were generated between 1997 and 2004 relative to oil and gas actions on federal lands showed the average length of these documents to be approximately 750 pages. The smallest EIS was over 200 pages, the largest was nearly 1,850 pages, and the standard deviation of the 21 EISs reviewed was nearly 425 pages. Five of the 21 EISs reviewed had

page counts that exceeded 1,000, two of which exceeded 1,500 and three had fewer than 500 pages, each of which were developed for a field specific oil and gas development. The increases in page counts were also seen in the 12 EAs and FONSIs reviewed which averaged approximately 135 pages. Six of the 12 documents reviewed were more than 150 pages, with the largest being approximately 345 pages and the smallest EA being 64 pages.

In part, the increasing page count results from the inclusion of background data analysis and additional language relative to the alternatives analyzed in these documents to counteract lawsuits and the use of non-technical language to accommodate the general public. While the purpose of NEPA is to ensure that federal agencies assess the environmental impacts of an action on federal lands to aid in the decision making process, encourage and facilitate public involvement, and use all practicable means to restore and enhance the quality of the human environment (40CFR 1500.2), the process of environmental analysis has become increasingly more complex. The Badger Hills case study found in Appendix B further illustrates the variation and complexities that are associated with NEPA related resource impact analysis.

Research performed by Argonne National Laboratory into the federal constraints of natural gas development identified delays and inefficient use of resources that result from NEPA-related lawsuits and the threat of lawsuits which cause agencies to prepare lengthy, time-consuming, and costly EISs and EAs that are beyond the basic requirements (Elcock, 2004). Additionally, in order to facilitate public involvement, the language of environmental documents has become less technical which lends to the increased page counts of NEPA documents. Other causes of increased page counts include the more conservative analysis of the impacts from proposed actions (worse-case analysis). Additionally, time and resources are sometimes spent analyzing alternatives that are extremely expensive or not technically practicable. The United States House of Representatives NEPA Task Force report made an initial recommendation to "Amend NEPA to require that 'reasonable alternatives' analyzed in NEPA documents be limited to those which are economically and technically feasible." (US House of Representatives, 2005).

EPA Rating for NEPA

The development of environmental documents is further influenced by the EPA review process for draft EISs under the NEPA and Section 309 Clean Air Act reviews. In many cases, the EPA is not a cooperator in the development of an EIS and acts only as a reviewer of the analysis that is performed as required under Section 309. This places the EPA in a position to review the document after it has been developed without having previously provided input on the direction of analysis in the document at any time prior to the issuance of a draft document. When

commenting on draft EIS's, EPA focuses its evaluation in two specific areas: the adequacy of the analysis and the potential impacts to the environment. In an effort to standardize this process and provide a basis upon which recommendations are made, EPA has developed a set of criteria for rating draft EISs specific to both the environmental impact of the action and the adequacy of the analysis presented in the draft EIS. EPA's review and comment process is performed dually for the purpose of improving the EIS and fully safeguarding the environment.

In evaluating the environmental impact of the proposed action, the following ratings may be awarded by the EPA:

Lack of Objections (LO). A rating of LO signifies that the EPA's review did not identify any potential environmental impacts that would result in a need to modify the preferred alternative. However, EPA may still make recommendations with regard to application measures that could be accomplished with little more than minor changes to the proposed action.

Environmental Concerns (EC). A rating of EC indicates that the EPA's review has determined that the preferred alternative would be likely to cause environmental impacts and these should be avoided. In this instance, EPA may require that changes be made to the preferred alternative or proposed mitigation measures in an effort to reduce the estimated environmental impact.

Environmental Objections (EO). A rating of EO is an indication that during its review, the EPA found evidence of significant environmental impacts that should be avoided in order to adequately protect the environment. In this case, EPA can require substantial modification to the preferred alternative, or perhaps even consideration of a completely different alternative. The basis for an EO rating can result from several issues:

- The planned action may be in direct violation of or inconsistent with regulatory standards and/or requirements.
- The planned action may have a strong potential for significant environmental degradation that could be avoided with substantial modification to the preferred alternative and/or mitigation measures. Or,
- The proposed action could set a precedent for future actions that could have significant, negative environmental impacts.

Environmentally Unsatisfactory (EU). A rating of EU is an indication that the EPA has identified adverse environmental impacts that are of sufficient magnitude such that it is the recommendation of the EPA that the proposed action must not proceed as proposed. A rating of EU can be assigned if at least one of the following conditions applies:

- An identified violation or inconsistency with national environmental standards exists or will occur on a long-term basis.
- There are no applicable national standards but the severity, duration, or geographical scope of the impacts associated with the proposed action warrant special attention.
- The potential environmental impacts resulting from the proposed action are of national importance because of the threat to national environmental resources or to national environmental policies.

In evaluating the adequacy of the draft environmental impact statement, the following ratings may be provided:

1 (Adequate). A rating of 1 suggests that the EPA found the draft EIS to sufficiently describe all of the environmental impact(s) of all of the alternatives reasonably available to the project or action. Draft EISs that are found to be adequate typically require no further analysis or data collection. However, the reviewing party may require clarification of language.

2 (Insufficient Information). A rating of 2 suggests that the draft EIS was found to insufficiently present information necessary to fully assess environmental impacts that should be avoided in order to completely protect the environment. A rating of 2 may also mean that the reviewer has identified new and reasonably available alternatives that have the potential to reduce the environmental impacts of the proposal and that are within the range of available alternatives analyzed in the draft EIS.

3 (Inadequate). If an EIS is assigned a rating of 3, this is an indication that the EPA did not believe that the document thoroughly or adequately analyzed the potentially significant environmental impacts of the proposal. A rating of 3 can also mean that the reviewer has been made aware of new and reasonably available alternatives which are outside of the spectrum of analyzed alternatives that should be assessed in order to reduce the potentially significant environmental impacts. In this case, the additional information, data, analyses, and discussion would likely warrant full public review at the draft stage. In most cases, such a document would require extensive revision and should be made available to the public for review following completion of revisions.

The EPA may address the forecasted impacts or adequacy of the NEPA documents that apply to oil and gas development projects. Operators and regulators need to be aware of the possibility of the EPA misinterpreting or mis-construing the actions, mitigating circumstances, or alternatives being considered in the planning document. The operator must be careful in describing the proposed actions within the planning document and must carefully review the EPA's rating results.

Analysis of the draft EIS reviews for oil and gas projects conducted by the EPA between 2004 and 2005 showed 20 documents were reviewed and rated by the EPA (EPA, 2006a). Table 6 presents the ranking results for these 20 draft EIS documents EPA reviewed. Table 6 shows that only one draft EIS received the EPA's highest rating, a lack of objections (LO) rating, in which both the proposed action and the draft EIS are deemed adequate. More than half of the draft EISs for oil and gas development reviewed were given an EC2 rating indicating the EPA has identified concerns with the environmental impacts that could result from the action and that the analysis in the draft EIS did not contain sufficient analysis to fully assess the impacts. Analysis of the ratings in Table 6 indicate that in the EPA's opinion 18 of the draft impact statements either provided insufficient information to fully assess the impacts of the proposed alternatives, or the action itself presented environmental concerns or significant impacts which the EPA feels should be avoided. For one of the draft EISs reviewed by the EPA no rating was issued as the EPA was awaiting additional analysis that was being performed.

Table 6 EPA Ratings of Draft Oil and Gas Project Environmental Impact Statements for 2004-2005.

EPA Ratings	Number of Draft EISs	Percent of Total
Lack of Objections	1	5%
Environmental Concerns – Adequate Ranking (EC1)	2	10%
Environmental Concerns – Insufficient Information (EC2)	13	65%
Environmental Objections – Adequate Ranking (EO1)	1	5%
Environmental Objections – Insufficient Information (EO2)	2	10%
Environmentally Unsatisfactory – Inadequate (EU or 3 rating)	0	0%
Unrated	1	5%

In order to provide a comparison between the ratings of oil and gas draft EISs to the EPA's analysis of other draft EISs, the ratings for 496 draft EISs reviewed by the EPA between 2004 and 2005 were also analyzed. Table 7 provides the ratings breakdown for the 496 draft EISs reviewed by the EPA. Table 7 shows that 160 of the 496 draft EISs reviewed received the highest rating, a lack of objections (LO) rating, in which both the proposed action and the draft EIS are deemed adequate. The most frequent rating for draft EISs issued by the EPA in 2004 and 2005 were EC2 ratings, representing 58 percent of the ratings given.

A comparison of Tables 6 and 7 shows that a higher percentage (7 percent more) of the oil and gas draft EISs were rated EC2 when compared to all draft EISs reviewed by the EPA, while a smaller percentage of draft EISs for oil and gas (27 percent) were given the EPA's highest rating of LO when compared to the ratings of all draft EISs reviewed by the EPA.

Table 7 EPA Ratings of All Draft Environmental Impact Statements Reviewed in 2004 -2005

EPA Ratings	Number of Draft EISs	Percent of Total
Lack of Objections	160	32%
Environmental Concerns – Adequate Rating (EC1)	25	5%
Environmental Concerns – Insufficient Information (EC2)	287	58%
Environmental Objections – Adequate Rating (EO1)	1	0.2%
Environmental Objections – Insufficient Information (EO2)	17	3.4%
Environmentally Unsatisfactory – Inadequate (EU or 3 rating)	5	1%
Unrated	1	0.2%

VI. IMPACT ANALYSIS METHODOLOGY

The development of assessment methodologies for environmental analysis on federal lands varies amongst the federal agencies, amongst the various regions of the United States, and amongst the field offices within an agency. The analysis that is performed relative to an environmental assessment of an action varies in a similar manner, as the agency's analysis and land management decisions are influenced by their land management objectives. For instance, the National Park Service is guided by the Council on Environmental Quality's (CEQ) guidance on the NEPA process and the "Forty Most Asked Questions Concerning CEQ's NEPA Regulations"; the NPS has also developed it's own NEPA guidance including the Director's Order #12 and Handbook 12 (NPS, 2001). The environmental analysis of each resource is further complicated by the action that is being analyzed; certain oil and gas developments are less likely to cause impacts to certain resources. As an example, deep oil and gas development may have little to no impact on groundwater resources. In comparison, the impacts to groundwater resources from a CBNG development projects in which coal bed aquifers are the primary groundwater aquifers in a region may be substantial. The Swanson River and Badger Hills case studies found in Appendices A and B, respectively, provide specific examples for varying agency assessment methodologies and land management objectives to further demonstrate these points.

Thus, when performing environmental analysis for oil and gas actions on federal lands it may not be appropriate for the environmental analysis of different actions to detail each resource to the same level. A fact that is intrinsic to the nature of NEPA as detailed in section 1500.1(b) of the act states that "NEPA documents must concentrate on issues that are truly significant to the action in question, rather than amassing needless detail." Under some actions, the potential for affects to certain resources may be greater than the potential for affects to the same resource under another action and thus may require additional analysis to be performed. In other circumstances, the action itself may pose no threat of impact to a resource and, therefore, minimal analysis need be presented. The NPS Director's Order #12 guidance specifically addresses this issue in Section 4.5 F, "(d)escribe only those resources that may experience or cause impact or be affected if the proposal or alternatives are implemented. If specific resources would not be affected (e.g., threatened and endangered species) or impacts would be negligible (impact is at a low level of detection), you should list them in the issues discussion as 'issues and impact topics considered but dismissed' (NPS, 2001)". This is different than when existing mitigation measures are in place under the agency's land management program

which reduces effects to certain resources and as mitigation changes the manner in which impacts are assessed for an action.

This section evaluates a set of methods that are utilized for impact assessment of various resources resulting from onshore oil and gas production activities. Although other methods exist, those presented in this text have been found to be functionally appropriate to provide sound scientific analysis for actions related to onshore oil and gas production activities. The organizational format used in this section is unique. First, a general framework for environmental impact analysis is introduced. This most often includes an examination of the direct/indirect impacts, consideration of cumulative impacts, and appropriate pollution prevention measures calculated to mitigate these impacts. Secondly, this framework is discussed as it applies to specific environmental resources. In order to best address the intricate network of inter- and intra-actions among various environmental resources within a project area, those presented below have been assigned to separate groups - physical/biological resources, and human environment and management resources. The physical and biological resource group consists of: soil, surface water, groundwater, wildlife, vegetation, visual, geology, noise, air quality and climate. The human environment and management resources group consists of: socio-economic, Native American concerns, and cultural resources. The discussion of land-use and surface disturbance and cultural and paleontological resources have been grouped together under two heading discussions as the analysis performed and the effects to these resources are similar.

A. General Framework for Assessment

Framework: Environmental assessment consists of measuring ambient baseline conditions, identifying the direct and indirect impacts/effects to those conditions that result from the identified action, cumulative impacts/effects from the identified action and other reasonable foreseeable actions which may impact the area being analyzed, and mitigation measures applied to the identified action.

Baseline Conditions: In order to determine the effects of an action and to assess the significance of these effects, baseline conditions must be established and documented for the affected environmental resources. In establishing the baseline conditions the resources, ecosystems, and human communities need to be characterized in terms of the affective response to changes and capacity to withstand stresses from the action being analyzed. Federal agencies need to consider system dynamics and the effective stresses need to be

characterized with relation to legal, regulatory, and management plan thresholds as the basis for assessing the action.

Significance:

Analysis of environmental impacts revolves around the concept of significance; important impacts should be thoroughly investigated and mitigated while trivial matters should be ignored. How does NEPA explain significance? The BLM NEPA Handbook (Handbook 1790-1, 1988) includes these basic instructions:

Direct, indirect, and cumulative impacts on the affected environment should be analyzed for the proposed action and each alternative, if any, to the extent necessary to determine if impacts are significant. The analysis of impacts should be based on the premise that all standard operating procedures and other standard Bureauwide requirements will be followed in implementing the proposed action or alternatives unless changes in such practices are specifically being addressed in the analysis. Design features or management practices which are intended to avoid or minimize environmental harm and which have been incorporated into the proposed action or alternatives must be treated as an inherent part of the action. The analysis should be based on the best available information and should be objective, i.e., should not reflect subjective value judgments and, if possible, should be quantified.

Significant impacts should be described in objective, quantitative terms but what then is the numerical, scientific definition of the term significant? It is defined in the Glossary of the Handbook as requiring considerations for both context and intensity:

a. Context. This means that the significance of an action must be analyzed in several contexts such as society as a whole (human, national), the affected region, the affected interests, and the locality. Significance varies with the setting of the proposed action. For instance, in the case of a site-specific action, significance would usually depend upon the effects of the locale rather in the world as a whole. Both short- and long-term effects are relevant.

b. Intensity. This refers to the severity of impact. Responsible officials must bear in mind that more than one agency may make decisions about partial aspects of a major action. The following should be considered in evaluating the intensity:

1. Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.
2. The degree to which the proposed action affects public health or safety.

3. Unique characteristics of the geographic area such as proximity to historic or cultural resources, public lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.
4. The degree to which the effects of the quality of human environment are likely to be highly controversial.
5. The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks.
6. The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.
7. Whether the action is related to other actions with individually insignificant but cumulative significant impacts. Significance exists if it is reasonable to anticipate a cumulatively significant impact on the environment. Significance cannot be avoided by terming an action temporary or by breaking it down into small component parts.
8. The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.
9. The degree to which the action may adversely affect or endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.
10. Whether the action threatens a violation of Federal, State, or local law or requirements imposed for protection of the environment.

As can be seen, significance is largely subjective; the question becomes, whose opinion determines significance? Will the BLM or other agency give more weight to the wildlife specialist or to public opinion? Because a precise definition is often impossible, federal agencies may conclude that any measurable impact is significant and that minority public opinion carries the same weight as preponderant scientific opinion. Agencies should be guided in their impact analyses by the scoping process, in which agencies identify those "significant" issues to be addressed in an environmental impact statement (40 CFR 1500. 1(b), 1500.4(g), 1501.7, and 1508.25)). In the context of scoping, agencies typically decide the extent to which "it is reasonable to anticipate a cumulatively significant impact on the environment" (40 CFR 1 508.27(b)(7)). Agencies should ensure that their NEPA compliance processes produce

environmental information that is useful to decision makers and the public by reducing the "accumulation of extraneous background data" and by "emphasizing] real environmental issues and alternatives" (40 CFR 1500.2(b)). Accordingly, the NEPA process requires agencies to identify "the significant environmental issues deserving study and deemphasizing insignificant issues, narrowing the scope of the environmental impact statement" at an early stage of agency planning (40 CFR 15001.1(d)).

Direct/Indirect Impacts: NEPA regulations and guidance documents identify seven types of impacts, these include: direct, indirect, cumulative, short term, long term, irretrievable, and irreversible. However, the argument has been made that only two types of impacts exist: direct and indirect, and the rest are simply derivatives of these two impacts (The Shipley Group, Inc., 2005). Direct impacts are those that occur within the same time and location of the activity while impacts that occur at a different time and location of the activity are referred to as indirect. Direct and indirect impacts for some resources can be determined for a particular resource using a discrete set of calculations. Other resources can only be qualitatively analyzed, thus determinations of affects to these resources from a particular action is typically qualitative as well. In all cases of impact analysis and for all alternatives, the intent of NEPA has not been to define the worst case scenario of an action but to concisely define the environmental effects of an action using scientific analysis (CEQ, 1981).

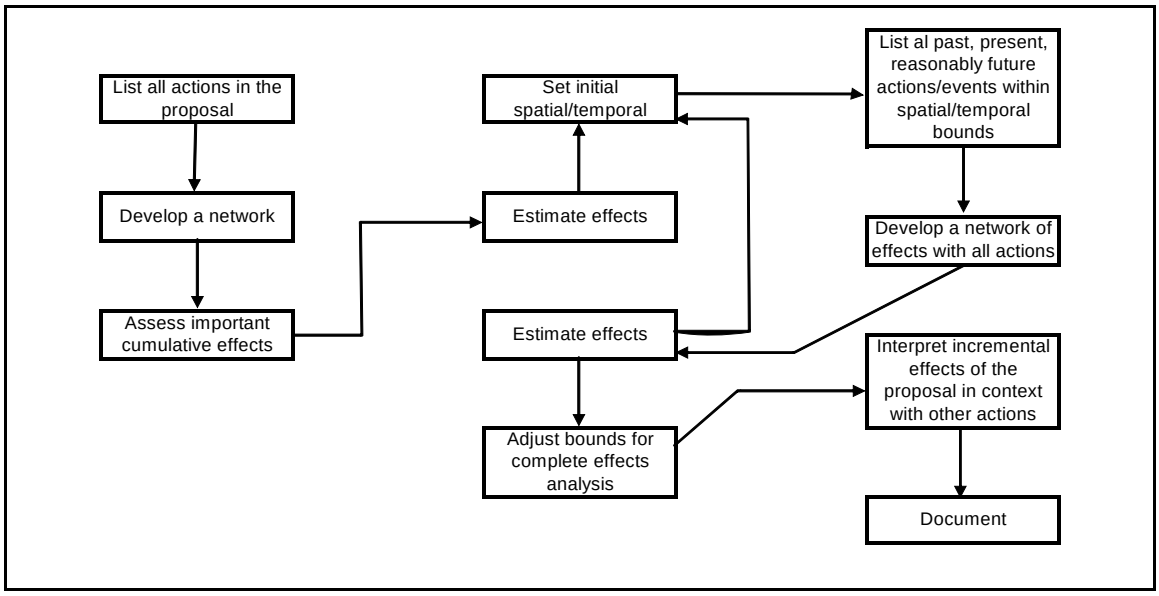
Cumulative Impacts: Although unequivocally important, these are generally less obvious than direct and indirect impacts and require deeper analysis for assessment. Cumulative effects analysis is a process with several non-concrete steps. The United States House of Representatives report on improving and updating NEPA offered this initial recommendation regarding cumulative effects analysis: "Amend NEPA to clarify how agencies would evaluate the effect of past actions for assessing cumulative impacts. A provision would be added to NEPA that would establish that an agency's assessment of existing environmental conditions will serve as the methodology to account for past actions." (US House of Representatives, 2005). The Shipley Group has outlined a set of methods with which to evaluate cumulative impacts. Figure 20 provides a visual diagram of the process.

- *STEP ONE:* Create a list of all actions associated with the proposal and alternatives.
- *STEP TWO:* Construct a "network" of direct and indirect effects that emanate from the proposal and alternatives.

- *STEP THREE:* Determine which direct and indirect effects warrant an in-depth assessment of cumulative effects (i.e., which effects could be significant and/or important to the decision).
- *STEP FOUR:* Make an initial estimate of those effects (quantitative and qualitative) from the proposal for different spatial and temporal bounds.
- *STEP FIVE:* Determine an initial extent for the spatial and temporal bounding for each environmental resource affected by the proposal.
- *STEP SIX:* Inventory past, present, and reasonably foreseeable actions/disturbances within the initial spatial and temporal bounds that overlap with the proposed action and/or alternatives.
- *STEP SEVEN:* Construct a network of effects for the proposal with past, present, and reasonably foreseeable actions within the initially established spatial and temporal bounds.
- *STEP EIGHT:* Estimate the effects (individually, collectively, synergistically) of the past, present, and reasonably foreseeable actions with the project's spatial and temporal bounds (may require reiterating steps 6 through 8).
- *STEP NINE:* Estimate the incremental effects of the proposal and alternatives for multiple spatial and temporal bounds and compare with the relative contributions from past, present, and reasonably foreseeable actions.
- *STEP TEN:* Clearly document rationale used in all of the above, as needed.

Mitigation: The final element of the assessment framework is determining appropriate measures for mitigation of impacts from the identified action to the resources analyzed. Federal guidance on mitigation measures notes that measures must be identified once a proposed action has been deemed to cause significant effects to the environment (CEQ, 1981). Mitigation can best be achieved by applying pollution prevention technologies to avoid impacts rather than to apply repairing efforts to mitigate impacts to the physical environment.

Figure 20 The Cumulative Effects Analysis Process



(Source: The Shipley Group Inc., 2005)

B. DATA SHORTFALLS

It is important to note that during the assessment of resource impacts, relevant and accurate data is often not available or incomplete. This situation does not allow for a sound scientific assessment or more commonly requires additional research or the formulation of broad impact assumptions and qualitative verses quantitative conclusions. For instance, the sage grouse in Montana and Wyoming is an important ecological species found within the region. Considerable controversy has evolved around the development of oil and gas in the region because of the unknown affects the industry may have on this bird. Additionally, current research projects focused on this issue have resulted in inconsistent findings that have further complicated the efforts to develop mitigation and conservation strategies to allow for safe development in areas that may be occupied by this species.

The lack of sufficient data to allow for the reasonable assessment of resource impacts can lead to analysis delays and in worst case scenarios, project litigation brought upon by public interest groups who have identified and exploited data shortfalls. Typically, data shortfalls can be resolved by planning and implementing research projects prior to environmental analysis. However, common to this resolution is a lack of financial funding within agency fiscal budgets to support such research prior to the initiation of the environmental analysis.

Furthermore, when pertinent data is available, it is in some cases difficult to obtain. Regulators often guard critical data in a programmatic effort to protect crucial resources. For example, the Forest Service protects the locations of sensitive floral species on their lands to prevent collection by the public; the BLM has a similar approach for protecting important archeological sites. In general, this data is stored in internal databases or can be scattered throughout various field offices. Although available, this type of data is often difficult to acquire since financial constraints often limit the amount of time that agencies can allocate to organize and fashion the data into a useable format. This in turn leads to delays and in some cases, results in unidentified data that may have allowed for a more comprehensive evaluation of certain resources impacts and thus, thwarting unnecessary litigation.

C. Physical and Biological Resources

Following is a discussion of the physical and biological resource groups which include soil, surface water, groundwater, wildlife, vegetation, visual, geology, noise, air quality and climate.

Soil

Oil and gas activities can impact the soil profile of a site in number of ways, primarily by causing erosion, compaction, and contamination. Site soils have the greatest likelihood of incurring impacts during the primary phases of development, more specifically during the exploratory and construction phases. The primary stages of construction require the removal of vegetation which leaves soil bare and more susceptible to erosion and sedimentation. During this time soil erosion can result from the construction of roads, well pads, storage facilities, and other oil and gas infrastructure. Erosion peaks in this phase and wanes during reclamation.

Direct/Indirect Impacts

Baseline Study

A solid baseline study of site soils should identify the vertical profile of the soils located within the vadose (unsaturated) zone as well as a clear identification of the soil type. Special attention should also be paid to the physical and chemical nature of the soil as well, such as the soil structure, moisture content, porosity, bulk density, and hydraulic conductivity. The vegetation at a project site should also be included in the baseline study as biota (including plant roots and related microbes) can dictate the chemical signature of a soil, ultimately affecting its regeneration (Hemond and Fechner-Levy, 2000).

Soil Erosion

To determine soil erosion, many local factors must be considered. Erosion may be calculated using the Revised Universal Soil Loss Equation (RUSLE):

$$\mathbf{A} = \mathbf{R} \times \mathbf{K} \times \mathbf{LS} \times \mathbf{C} \times \mathbf{P}$$

where:

A = predicted average soil loss in tons/acre/year

R = rainfall-runoff erosivity factor

K = soil erodibility factor

LS = slope factor

C = cover management factor

P = management or conservation practices factor

Source: (USFS, 2001)

The R-factor, or rainfall-runoff erosivity factor, is calculated for different geographic locations. It is the summation of the total storm kinetic energy multiplied by the maximum 30-minute storm depth for all storms in a year for a certain location.

The K-factor indicates how susceptible soil is to erosion and runoff. K values range from approximately 0.10 to 0.45. Soils that are easily detached or have high rates of runoff have higher K values. Generally, soils with high sand or clay contents have values on the lower end of the scale while soils with high silt content have higher values (USFS, 2001).

The LS, or soil erodibility factor, represents the effect that slope length and slope steepness have on soil erosion (NRCS, 2002). Table 8 is modified from the USDA Agricultural Handbook No. 703 (NRCS, 2002) and shows LS-factors for "freshly prepared constructed and other highly disturbed soil conditions with little or no cover (not applicable to thawing soil)" that would be applicable during the construction phase of an oil and gas development project.

Table 8 Soil Erodibility Factors (LS) for New Construction Sites with Little to No Cover

Slope (%)	Slope Length (ft.)																
	<3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06
0.5	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.08	0.09	0.09	0.10	0.10	0.10	0.11	0.12	0.12	0.13
1.0	0.09	0.09	0.09	0.09	0.09	0.10	0.13	0.14	0.15	0.17	0.18	0.19	0.20	0.22	0.24	0.26	0.27
2.0	0.13	0.13	0.13	0.13	0.13	0.16	0.21	0.25	0.28	0.33	0.37	0.40	0.43	0.48	0.56	0.63	0.69
3.0	0.17	0.17	0.17	0.17	0.17	0.21	0.30	0.36	0.41	0.50	0.57	0.64	0.69	0.80	0.96	1.10	1.23
4.0	0.20	0.20	0.20	0.20	0.20	0.26	0.38	0.47	0.55	0.68	0.79	0.89	0.98	1.14	1.42	1.65	1.86
5.0	0.23	0.23	0.23	0.23	0.23	0.31	0.46	0.58	0.68	0.86	1.02	1.16	1.28	1.51	1.91	2.25	2.55
6.0	0.26	0.26	0.26	0.26	0.26	0.36	0.54	0.69	0.82	1.05	1.25	1.43	1.60	1.90	2.43	2.89	3.30
8.0	0.32	0.32	0.32	0.32	0.32	0.45	0.70	0.91	1.10	1.43	1.72	1.99	2.24	2.70	3.52	4.24	4.91
10.0	0.35	0.37	0.38	0.39	0.40	0.57	0.91	1.20	1.46	1.92	2.34	2.72	3.09	3.75	4.95	6.03	7.02
12.0	0.36	0.41	0.45	0.47	0.49	0.71	1.15	1.54	1.88	2.51	3.07	3.60	4.09	5.01	6.67	8.17	9.57
14.0	0.38	0.45	0.51	0.55	0.58	0.85	1.40	1.87	2.31	3.09	3.81	4.48	5.11	6.30	8.45	10.40	12.23
16.0	0.39	0.49	0.56	0.62	0.67	0.98	1.64	2.21	2.73	3.68	4.56	5.37	6.15	7.60	10.26	12.69	14.96
20.0	0.41	0.56	0.67	0.76	0.84	1.24	2.10	2.86	3.57	4.85	6.04	7.16	8.23	10.24	13.94	17.35	20.57
25.0	0.45	0.64	0.80	0.93	1.04	1.56	2.67	3.67	4.59	6.30	7.88	9.38	10.81	13.53	18.57	23.24	27.66
30.0	0.48	0.72	0.91	1.08	1.24	1.86	3.22	4.44	5.58	7.70	9.67	11.55	13.35	16.77	23.14	29.07	34.71
40.0	0.53	0.85	1.13	1.37	1.59	2.41	4.24	5.89	7.44	10.35	13.07	15.67	18.17	22.95	31.89	40.29	48.29
50.0	0.58	0.97	1.31	1.62	1.91	2.91	5.16	7.20	9.13	12.75	16.16	19.42	22.57	28.60	39.95	50.63	60.84
60.0	0.63	1.07	1.47	1.84	2.19	3.36	5.97	8.37	10.63	14.89	18.92	22.78	26.51	33.67	47.18	59.93	72.15

The C-factor, or cover management factor, differs from previous components discussed because it changes based on the phase of development. The C-factor considers the effects of plants, soil cover, soil biomass, and soil disturbing activities on soil erosion (NRCS, 2002). It is calculated based on prior land use, crop canopy, surface or ground cover, and surface roughness (USFS, 2001). Lastly, the P-factor represents conservation practices that are used to prevent soil erosion.

Using RUSLE software, soil loss can be predicted for different slopes at a development site and for different seasons.

Soil Compaction

To assess the impacts from soil compaction and rutting, the following must be considered:

- **Soil type**. Soil compaction and rutting is affected by a soil's texture, moisture content, and organic matter (BLM, 2003b). Soils composed of sand, silt, and clay are more prone to compaction than soils that are more homogeneous, and coarser textured soils are more susceptible to compaction than finer textured soils (BLM, 2003b). In addition, soils with higher organic matter content compact less than those with less organic matter (BLM, 2003b).
- **Weather conditions**. Wet soil compacts more easily than dry soil; therefore, areas with higher precipitation levels may be more susceptible to soil compaction and rutting. As discussed earlier, oil and gas development usually does halt for inclement weather, such as heavy rain, so care should be taken to avoid impacts. If possible, the weight of equipment should be reduced and wider tires should be used on vehicles and equipment to prevent soil compaction and rutting.

Soil Contamination

Soil contamination resulting from vehicles and equipment used for oil and gas development can sterilize soils or damage soil productivity (USFS, 2001). Soils can become contaminated from oil spills or from fluids from equipment and vehicles, such as antifreeze and motor oil. To comparatively assess soil contamination, the number of wells between development scenarios can be compared, assuming that more wells would require more vehicles and equipment travel and thus an increase in contamination from spills and fluids. To avoid contamination, vehicles and equipment should have maintenance work performed regularly to correct leaks. Also, any hazardous substances should be disposed of properly.

Cumulative Impacts

Cumulative impacts to soils can be assessed by synergistically incorporating the impacts to soils from one project to that of other reasonably foreseeable actions and other projects occurring within the same geographical and temporal bounds.

Mitigation

Erosion Control Practices

There are numerous guidance documents on management controls and best management practices that can be implemented to minimize soil erosion (including RAPPs Guidebook, BLM Goldbook, and Pollution Prevention at Exploration and Production Sites in Oklahoma BMP Guidebook). The best approach to controlling erosion on development related roads and access ways is to adapt these resources to local conditions such that they provide good drainage of runoff water at non-erosive velocities (Horizon Environmental Services, 2004). Ensuring that runoff occurs at non-erosive velocities can be accomplished using several methods that vary based on regional conditions, but may include:

1. Design a roadway with an overall shape that allows water to be shed into stable ditches and culverts. Culverts (most often the cross-drain design) should be installed at recommended spacing with the appropriate pipe size (Table 9). The size of the culvert can be selected according to the area of the road and hillslope that drain into the ditch. In steeper sloped areas, cross-drain culverts should be spaced more closely together; doing so minimizes ditch erosion and helps to prevent overflow and washouts.

Table 9 BLM Recommended Maximum Spacing of Cross-Drain Culverts (feet)

Soil Type	Road Grade 2-4%	Road Grade 5-8%	Road Grade 9-12%
Highly erosive granitic or sandy	240	180	140
Intermediate erosive clay or load	310	260	200
Low erosive shale or gravel	400	325	250

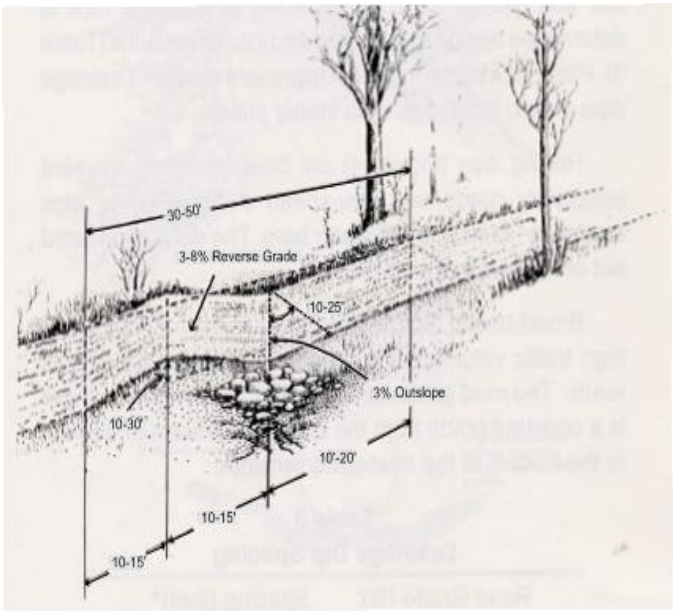
(Source: BLM Goldbook)

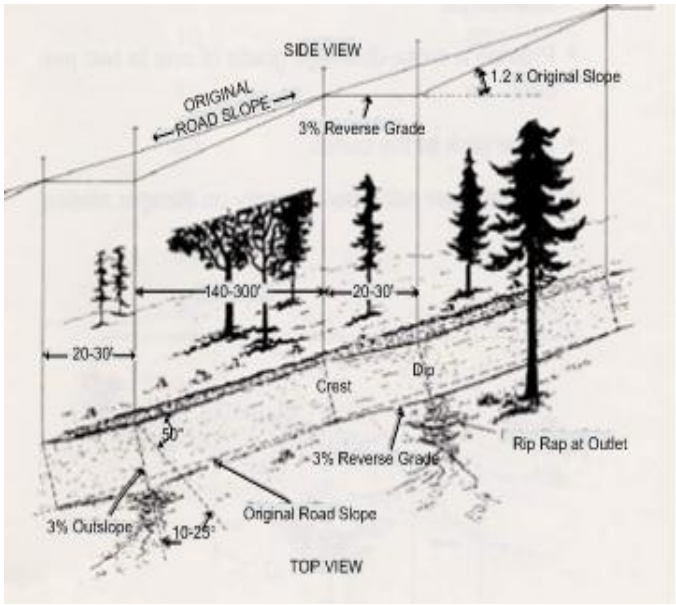
To properly install culverts, the adjoining ditch should first be plugged immediately downhill from the culvert inlet, thus directing all water into the culvert. Rip rap should also be installed to prevent erosion beyond the fill slope. Additionally, culvert gradients should be at least two percent greater than the ditch gradient. Culverts should be located in such a manner that they do not discharge directly into streams.

2. Drainage dips should be employed where ever useful/necessary. Drainage dips remove water from road surfaces without requiring a cross-drain culvert. This type of drainage system is commonly used on temporary roads. A key to the success of this type of drainage system is that the dips must be deep enough to carry the anticipated flow to the intended direction and wide enough to allow for intended equipment to travel on the road. The type of dip selected is dependant upon the expected use and type of the road. The spacing of drainage dips should be determined by the steepness of the slope as well as local conditions. Drainage dips should discharge onto stable outlets. Rocks should be placed below the outlet to prevent erosion.

There are two types of dips: Rolling and Broad-based. Rolling dips are best for roads with little or low-speed traffic, usually temporary roads. Such dips resemble "stretched out" water bars. The dip is excavated out of the existing road grade.

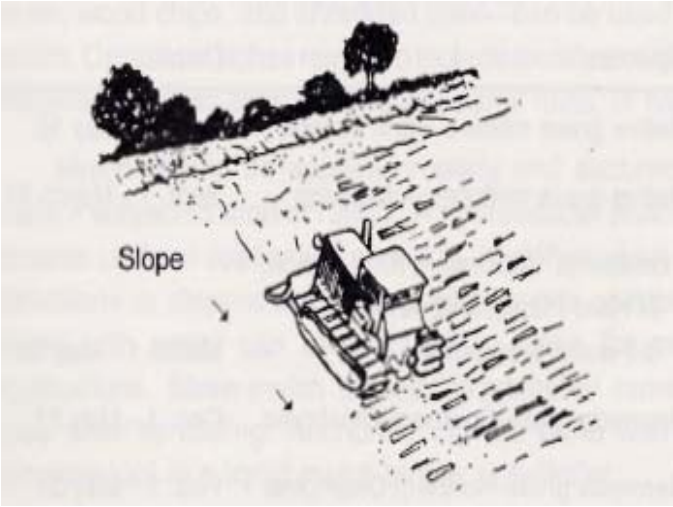
Broad-based dips are typically better suited for roads with high traffic volumes and speeds, such as main access roads. The road grade between dips is adjusted so there is a constant grade from the crest of the berm of one dip to the base of the next dip down-slope.





3. Water bars should be employed wherever useful/necessary. Water bars prevent erosion on seismic survey lines and other right-of-ways. Water bars should be installed at a 10 to 25 degree angle downslope. A cross-drainage grade of one to two percent should be provided. They should be spaced more closely in steeper areas and rock should be placed at the outlet to prevent erosion.

4. Turnouts and wing ditches should be employed wherever useful/necessary. Turnouts release water from road ditches near ridges, points of ridges, and gentle sideslopes. On flat roads, turnouts provide drainage and help the road to dry out. Turnouts are most effective if there is little slope. When installing turnouts on sloping roads the guidelines for cross-drain culverts should be used (Table 9). Slope turnouts should be one to three percent from the bottom of the road ditch and turns should be at a 30 to 40 degree downslope angle. Turnouts should discharge to stable outlets and not directly into any stream channels. As well, rocks should be placed in at the outlet to prevent erosion.



5. Vegetation, gravel, and mulch should be used to stabilize surfaces. The most effective and least intrusive way to prevent erosion and stabilize surfaces is with vegetative cover. Factors to consider in planning vegetative cover include:

- *Preparing the seedbed*: The soil on a disturbed area must be prepared before planting. The soil should be loose enough to allow water to infiltrate and penetrate roots. Soil pH must be in a tolerable range. Fertilizer can be added to ensure adequate nutrients for plants. In acidic soils, lime can be added to raise the pH. Liming can also make other nutrients more available to plants and prevent aluminum toxicity. A rough seedbed with clods and stones helps hold water, seed, and fertilizer. During final grading of fill slopes, the last 4 to 6 inches should be roughened. On steeper slopes, tracked machinery can be operated up and down the slope to leave horizontal depressions (Horizon Environmental Services, 2004).
- *Planting the vegetation:* Climate, soil, and topography of an area are the major factors to be considered when determining which plants to use. The desired appearance, level of maintenance, steepness, and mowing requirements will all also have an effect on the types of plants to be selected. Vegetation is planted by seeding, sprigging, or sodding. Plant species can be sensitive to temporal cycles, so it is often best to coordinate the selected plant species with the date of planting with respect to reproductive cycles.
- *Mulching*: Mulching can be applied to the soil surface to lessen the occurrence of erosion as well as encourage plant growth. Several materials can be used as mulches: straw, wood chips, and shredded bark. Organic mulches may also include materials such as animal waste, peanut shells, or hay. If the site to be mulched is subject to frequent strong winds or runoff, the mulch can be anchored down. This can be done with a crimping tool, a liquid mulch binder, or a tackifier (emulsions or dispersions of vinyl compounds or rubber mixed with water). Netting, fabrics, and mats can also be efficient in keeping mulches in their intended places. Mats are used to promote seedling growth and are useful in establishing grass in channels and waterways. Netting is most commonly used on waterways and slopes.
- *Inspecting and repairing:* Vegetation should be inspected periodically especially after rain events to check for erosion, dislocation, or failure. If erosion has occurred, the mulch will need to be repaired, reseeded, replanted, or additional mulch might need to be applied. Soil erosion may lessen during the production phase of development due to revegetation efforts.

- *Soil Compaction and Rutting:* Soils can be compacted by heavy equipment and vehicles used during oil and gas development and from traffic throughout the development area. Rutting from vehicle and equipment can also occur. Compacted soils have lowered rates of water infiltration, which leads to greater surface runoff. Vegetation can be both beneficially and negatively impacted by compaction depending on various factors (University of Minnesota, 2001).

Surface Water

Oil and gas development activities have the potential to affect surface water quality and quantity, and channel morphology. Surface water quantity can be affected by withdrawals for consumptive water uses associated with oil and gas activities such as make-up water for drilling muds and secondary recovery activities employing waterfloods. Surface water quantity increases occur from discharges associated with increased stormwater runoff, produced water discharges and storage pond seepage. Surface water quality can be affected by increased sedimentation, increased streambank erosion, and discharges or seepage of produced water. Channel morphology changes can be affected by increased sediment load from erosion associated with stormwater runoff or by increased flows from discharge activities. Surface water impacts can occur at all stages of oil and gas development activities with the greatest potential for impacts to occur during construction activities when vegetative cover is reduced and during production operations when produced water management practices may include discharge of produced water. The primary stages of construction require the removal of vegetation which leaves soil bare increasing erosion, stormwater runoff and sedimentation. During this time soil erosion and increased stormwater runoff can result from the construction of roads, well pads, storage facilities, utility routes, and other oil and gas infrastructure. Erosion and stormwater runoff peaks in this phase and wanes during reclamation. Other potential effects to surface water quality can result from accidental releases of contamination such as equipment fluids, lubricants, drilling fluids and produced water (BLM, 2003a).

Direct/Indirect Impacts

<u>Baseline Study</u>

Background studies for surface water resources should identify the existing surface water quality and quantity conditions on a scale relevant to that of the oil and gas activity being analyzed. Federal agencies under the direction of the EPA have been conducting analysis at a watershed scale (4th and 5th order) during recent environmental analyses. By analyzing

background conditions at a watershed scale, the holistic approach to water quality management for surface water that the EPA desires can be accommodated. Programmatic analysis by most Surface Management Agencies tends to be conducted as a holistic approach to a management region and; therefore, analysis of surface water at a watershed scale is encompassed in this approach. In environmental analysis documents, the affected environment discussion presents much of the background study data in the form of baseline analysis performed relative to surface water quality and quantity. In establishing the baseline conditions for surface water, analysis that considers the relationship between quantity and quality over a period of record relative to state and federal standards allows for a sound assessment of the potential impacts from an action. The evaluation over a period of record as opposed to current conditions incorporates natural variability that can exist in surface water conditions into the analysis of potential impacts.

Sedimentation

Direct impacts to surface water from conventional oil and gas development can result from surface disturbing activities. Sedimentation or sediment yield to surface water results from erosion of soil as a result of stormwater runoff, an impact that can be enhanced during construction activities. Sediment yield can be used as an indicator of the stability of a watershed and to quantify the effects surface disturbances may have on water quality (BLM, 2003a). Modeling, such as the Soil-Water Analysis Tool (SWAT) developed by the Natural Resources Conservation Service, can be utilized to evaluate the effects of changes to vegetation coverage from roadways, wellpads, and infrastructure to predict the potential increases in sediment yield that can result from oil and gas activities (BLM, 2003a).

Surface Water Quality and Quantity

Potential impacts to surface water quality and quantity for conventional oil and gas activity result from accidental contamination associated with spills of machinery fuels, lubricants, produced water, and drilling fluids (BLM, 2003a). These spills typically occur as a result of accidents and therefore the determination of quantitative impacts is generally not performed and impact discussions in NEPA environmental analysis documents usually address them qualitatively.

The evolution of oil and gas development into continuous reservoirs such as CBNG has resulted in the production of produced water that is frequently higher in quality than conventional oil and gas developments. The produced water from some CBNG development is of high enough quality that it can be managed in a larger variety of uses, some of which have the potential to

result in discharges to surface waters. The management of CBNG produced water can include the discharging of this water to surface water bodies (ALL Consulting, 2004). CBNG produced water discharges can result in changes to surface water quality and quantity; the assessment of these changes have been both qualitatively and quantitatively analyzed in NEPA environmental assessment documents. In most areas, state or federal oversight of the Clean Water Act regulations is through the issuance of NPDES permits which limit the effects of CBNG discharges to surface water quality and quantity. The method of quantitatively assessing the effects to surface water quality and quantity from CBNG discharges can include analyses which utilize surface water mixing models. The mixing models can vary from simple mixing models such as the models used in the assessment for CBNG discharges for the Powder River Basin development of Wyoming and Montana (Greystone Environmental Consultants and ALL Consulting, 2003) to equilibrium reaction models such as the PHREEQ model developed by the United States Geological Survey.

Cumulative Impacts

Water quality can vary within a watershed as a result of the influence of factors such as surficial geology, hydrogeology, infiltration-runoff relationships, seasonal variation, vegetation, land use, agricultural irrigation (non-point source contributions) and anthropogenic disturbance (EPA, 2003). Cumulative impact analysis can look at downstream water quality to assess impacts that results from the mix of the components contributed from each upstream tributary. A watershed-based approach to cumulative impact analysis identifies how the changes occurring in one or several upstream tributaries impact downstream water quality (EPA, 2003).

Mitigation

The mitigation of sedimentation impacts from construction activity erosion at oil and gas facilities is discussed in detail in the previous section on soils. These mitigation measures include BMPs identified in industry and federal agency guidance resources such as the CBM BMP Handbook (ALL Consulting and MBOGC, 2002), RAPPs Guidebook (Horizon Environmental Services, 2004), BLM Goldbook (BLM and USFS, 2005), and Pollution Prevention at Exploration and Production Sites in Oklahoma BMP Guidebook (OCC, 1993). Other federal agencies such as the NPS have guidelines and regulations that further mitigate potential impacts from sedimentation such as the NPS regulations under 36 CFR § 9.41(a) that require a setback of 500 feet from waterways for all oil and gas operations, unless specifically authorized in a plan of operations. Current legal and policy requirements of all federal agencies require oil and gas operators to obtain Clean Water Act Section 404 permits prior to undertaking any work in

waterways which helps to mitigate impacts at stream crossings (NPS, 2004). Stormwater discharge permits and NPDES permit requirements for the construction of any road or wellpad ensure that mitigation measures are implemented to reduce sediment loads in surface waters (NPS, 2004).

Methods to mitigate impacts from accidental spills from reserve pits, transportation lines, and other oil and gas drilling and production equipment are included in the BLM Goldbook and state agency regulations provide guidance on the necessary containment structures needed for mitigation as well as the reclamation practices required when accidental spills occur. The Goldbook provides detailed discussion of the construction practices to be utilized to mitigate potential spills from reserve pits constructed for drilling activities including the location of the pits, lining of the pits, and construction standards to mitigate contamination of groundwater and surface water (BLM and USFS, 2005). The Goldbook also provides information relative to maintaining adequate secondary containment structures (berms, fences or dikes) to prevent the discharge of accidental spills to waters of the United States.

Mitigation of impacts to surface water quality and quantity is achieved by the state or federal agency that issues NPDES permits to the oil and gas operator, and by the BLM through authorizations under Onshore Oil and Gas Order No. 7, Disposal of Produced Water. The NPDES permitting process was established under the Clean Water Act to control the discharge of pollutants to surface waters through point source and non-point source permits. These permits control the volume and quality of water that can be discharged which acts to mitigate the potential impacts to surface water that could occur if the volumes of produced water discharged to surface waters were uncontrolled.

Groundwater

The potential for impacts to groundwater resources from oil and gas development include the infiltration of contaminants from accidental spills, consumptive use of groundwater for make-up water for drilling muds and waterfloods, extraction of groundwater from unconventional oil and gas developments, and injection disposal of saline produced water. Most of these impacts have been minimized with the development of regulations that are intended to protect groundwater.

Direct/Indirect Impacts

<u>Baseline Study</u>

Prior to conducting assessment of impacts to groundwater, data should be collected relative to the specific groundwater quality and quantity of the resources present in the area of analysis.

The USGS, state water quality agencies, and regional water conversation districts often have collected groundwater resource data available that can be used as part of the baseline analysis. These sources can provide information on the occurrence of groundwater aquifers in a region, historical and present day groundwater quality, and the locations of existing groundwater wells. Baseline studies should identify regional groundwater patterns and include assessments of recharge zones for groundwater in the area, the aquifer yields, and interactions between groundwater and surface water. Baseline assessment of groundwater quality should evaluate quality relative to state and local regulatory standards for water uses.

Impacts to Groundwater from Oil and Gas Activities

The potential for impacts to groundwater quality from oil and gas development are limited to drilling, well development, well testing activities, infiltration from unlined pits, injection wells, and accidental discharges or spills (BLM, 2003a). Assessment of the impacts these activities will have on groundwater need to address the incremental decrease in water quality that would result from oil and gas activities. For conventional oil and gas development, existing regulations are in place for the drilling and completion of wells that are intended to reduce impacts to groundwater from drilling, well development and well testing activities. Therefore, the assessment of groundwater resources for conventional oil and gas development activities is usually qualitative as most impacts to groundwater occur as a result of infiltration from accidental releases at the surface and cannot be quantified during the analysis process.

For continuous resources such as CBNG development, the impacts to groundwater quantities can be more significant then conventional oil and gas as these activities can include development in water aquifers being used for various purposes. The assessment of impacts to groundwater from continuous resources needs to include the evaluation of these reservoirs relative to the use as a source of domestic, livestock, or agricultural supply. Impacts to groundwater can be assessed qualitatively or quantitatively. Consumptive uses of groundwater resources need to evaluate the volumes of which will be withdrawn and used for drilling muds and injection make-up water, and water right issues associated with these withdrawals.

Cumulative Impacts

Cumulative impacts to groundwater resources must consider other natural and anthropogenic demands on water resources.

Mitigation

Existing federal and state oil and gas regulations provide mitigation for the impacts to groundwater resources. BLM's Onshore Oil and Gas Order No. 2, Drilling Activities, requires that all useable aquifers be protected by casing or cementing. Most modern drilling systems use low circulation and low fluid loss materials in the drilling operation. Monitoring of make up water is used to verify that water is not entering or leaving the system (BLM, 2003a). Injection of produced water on federal lands is consistent with BLM policy and the EPA's Underground Injection Control permit program (40 CFR Part 144), which further mitigate the majority of potential impacts from these activities. When water is disposed of underground, it is always introduced into a formation containing water of equal or poorer quality or a formation that has been specifically exempted by a state or federal regulatory agency (BLM, 2003a).

Wildlife

Activities associated with oil and gas development can affect wildlife and their habitat during exploration, development, production, and abandonment operations (Bromley, 1985). Additionally, wildlife impact issues relating to the degree of human disturbance, conservation, management constraints, local communities' interests, and development are influenced by the resource's availability and abundance overtime. As such, assessing methods to minimize impacts to wildlife or their preferred habitats can be very challenging since the dynamics of any environment will vary from region to region and is often the case, will change over time (ALL Consulting, 2004). The application of legal and policy requirements, and project-specific operating stipulations, result in variations in how, where, and to what extent resource protection is applied. In any case, choosing appropriate mitigation measures or wildlife management options to reduce oil and gas related impacts will depend on the wildlife populations which inhabit the area.

Direct/Indirect Impacts

<u>Baseline Study</u>

A comprehensive inventory that evaluates the abundance and distributions of wildlife species is essential in addressing development impacts that pose threats to the effective and sustained management of wildlife species, including those that are federally or state protected. Typically, wildlife surveys or monitoring programs will facilitate the formulation of adaptive wildlife management plans that document mitigation objectives to reduce impacts. Thus, prior to the initiation of oil and gas development, operators should implement and design work plans based

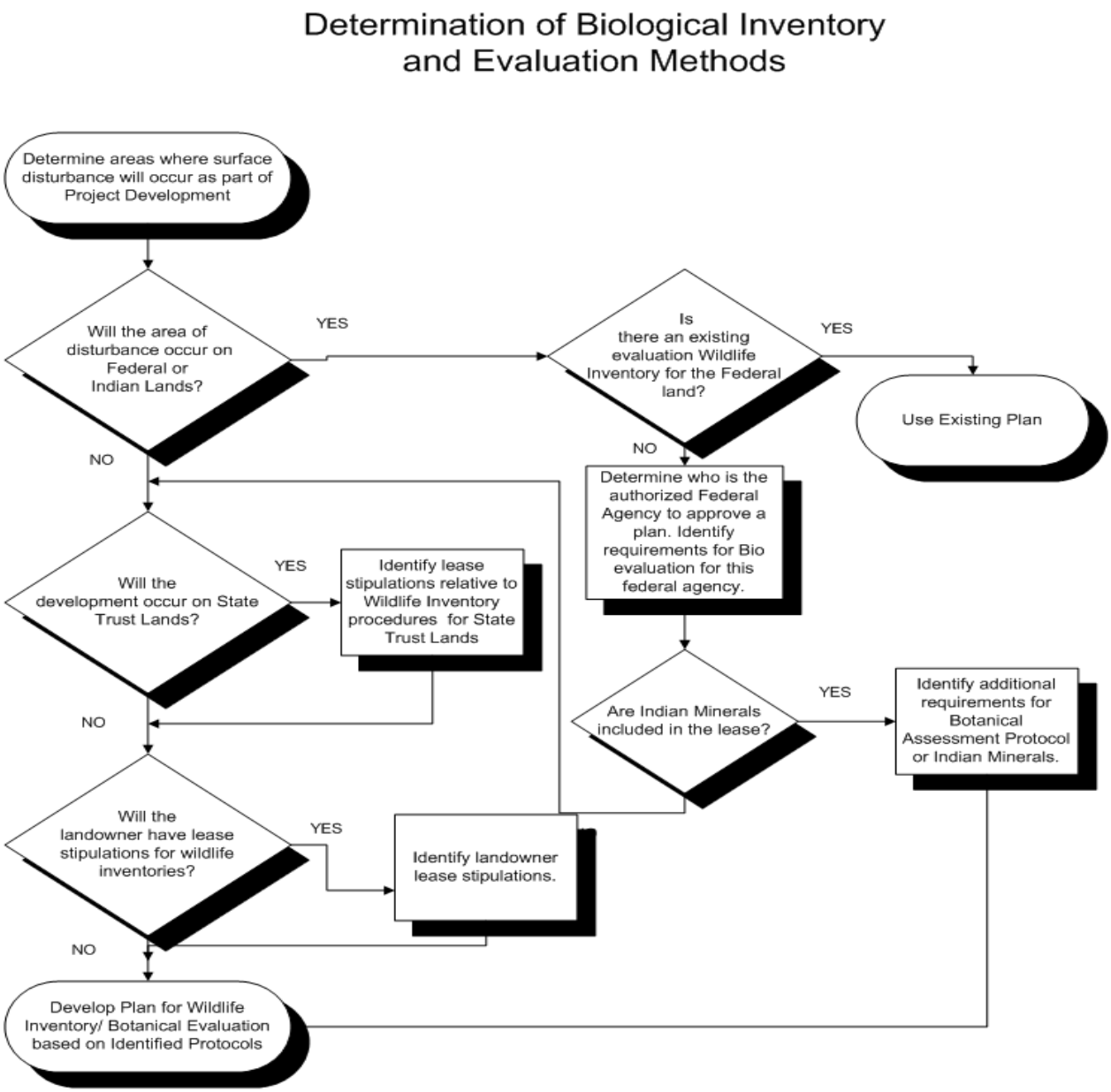
on inventory results to ensure planning elements consider the appropriate species and their subsequent protection. Figure 21 illustrates the planning process to determine what steps are necessary to develop appropriate wildlife inventory strategies (ALL Consulting, 2004).

Project features associated with oil and gas activities will affect wildlife in different manners and will largely depend on the adaptive nature of the species and the magnitude and type of impact. In most regards a scientifically sound and consistent approach for determining potential impacts to wildlife will include analysis of habitat loss and fragmentation, noise, human presence, and spill management mitigation.

Habitat Loss and Fragmentation

The effects of oil and gas related surface disturbances on wildlife are typically evaluated by assessing a project's potential to cause individual displacement or fragmentation due to habitat loss and project specific features that may elevate individual mortality rates. Such project features can include construction or reconstruction of access roads, clearing and leveling of drill pad sites and construction of pipelines, compressor stations and other associated infrastructure (USFS, 2004; BLM, 2003b). Method analysis to effectively address the magnitude is partially dependent on the species that populate the project area. For instance, sensitive species displaced from important habitat features effectively experience loss of habitat relative to more widely distributed species (BLM, 2003b). In general, sensitive species do not have the ability to migrate to adjacent lands in response to disturbance since critical habitat may not be present or may be already occupied by other individuals of the same or different species. Another example to illustrate this point involves the construction of roads, which can result in population fragmentation that can affect wildlife by encouraging species that use early successional and forest edge habitats such as the eastern towhee and wild turkey, and discourage animals that use interior forest habitats such as the ovenbird and hooded warbler (USFS, 2004).

Figure 21 Pre-Plan Development Biological Evaluation Flowchart



Prepared By ALL Consulting

It has been established that ecological effects of roads are generally negative and, therefore, require close scrutiny to reasonably assess potential impacts (Forman, 2000). Roads can prevent or hinder the movements of small species of wildlife such as amphibians, reptiles, and small mammals (Gibbs, 1998; Trombulak and Frissell, 2000). Similarly, the avoidance of roads by large species of mammals has been documented to result in the functional loss of habitat and reduced carrying capacity (Dyer et al., 2001; Rowland et al. 2000). Vehicular traffic can also result in direct impacts (mortality) and will depend on the frequency of vehicular use, density of constructed roads and the presence of susceptible species such as, small mammals, reptiles, and amphibians (USDI and USDA, 2001). In general, impacts due to collision mortality should be assessed at the overall population level. For instance, more significant impacts would occur to small and declining populations with limited distribution. In most cases the amount of surface disturbance that will potentially occur is quantifiable and can be estimated by simple calculation. For example, in the Final Statewide Oil and Gas Environmental Impact Statement and Proposed Amendment of the Powder River and Billings Resource Management Plans, BLM (2003) used the following calculations to predict surface impacts:

- Two-track = 0.30 acres based on 12-foot-wide roads by 0.21 miles/well
- Graveled Roads = 0.11 acres based on 12-foot-wide roads by 0.075 miles/well
- Bladed Roads = 0.075 acres based on 12-foot-wide roads by 0.05 miles/well
- Bladed Roads = 0.75 acres based on 12-foot-wide roads by 0.5 miles/well

However it should be noted that other EISs (BLM, USFS) dealing with oil and gas development in similar western regional settings such as Wyoming, Colorado and New Mexico used different amounts of disturbance for roads and well pads to calculate the potential impact. These difference starting quantities were based on type and depth of drilling, the resource being extracted (oil, gas, CBNG) and regional geography and regulations. This being said is understandable but not all EISs documented the quantities and basis for disturbance, leaving the reviewer with the argues task of back calculating the rational for total disturbance based on number of wells, total acres disturbed, length and type of roads, type of drilling etc. It is important to stress that this simple calculation needs to be well documented and supported with actual observed disturbance levels for the various types of activities (roads, well pads, power-lines, pipelines, compressor stations, etc) in that regional area so that overly conservative estimates are reduced and impacts quantified consistently.

Noise

Typically, noise levels during oil and gas activities are greatest during exploration and development, with lower noise levels during production operations (BLM, 2003b). The extent of noise impacts to wildlife will vary, but development in areas containing dense populations of song birds will likely observe greater impacts. For example, male neotropical migrant birds that breed in short grass prairie, sagebrush, and riparian communities use songs to establish and defend breeding territories and attract females. Noise interferes with this ability, and with the level of interference related to the volume and frequency of the noise (Luckenbach, 1975; Luckenbach, 1978; Memphis State University, 1971; Weinstein, 1978). Indirect impacts related to noise are usually limited to a localized area and are relatively short in duration, with wildlife avoiding or moving away from the source, but returning after the noise source has been reduced or eliminated (NPS, 2004).

Human Presence and Habitat Effectiveness

Wildlife impacts associated with an increase to human presence are inconsistently evaluated, if at all, since methodology to accurately reflect impacts is typically only available when specific research has been performed within the project area. However, wildlife can potentially be adversely impacted when access is increased or human access becomes easier, especially in areas that were previously inaccessible (NPS, 2004). The oil and gas development discussed in the Southern UTE EIS (USDI, 2000) suggested that human presence associated with exploration and development of oil and gas wells disturbed wildlife at distances up to ½ mile, and that operation and maintenance activities caused disturbance within ¼ mile of wells and roads. Wildlife species will typically avoid humans and facilities associated with oil and gas, although many exceptions to this exist. In any case, avoidance should be qualified in terms of the under-utilization of otherwise suitable habitats, or similarly, the displacement of wildlife from disturbed areas that may lead to the overuse of suitable habitats in undisturbed areas, increasing competition for limited resources (BLM and USFS, 2004).

Methods to analyze oil and gas related impacts should also assume the presence of humans in wildlife habitats will cause additional mortalities (e.g., hunting), stress, disruption of normal foraging and reproductive habits, abandonment of unique habitat features, and increased energy expenditure. These factors contribute to reduced over winter survival for individuals, poor condition entering the breeding season, reduced reproductive success and recruitment, and eventually population declines (BLM, 2003b). For instance, the golden eagle prefers to nest

away from human disturbances, including roads, and have reduced nesting success in nests located closer to roads than in nests farther from roads (Fernandez, 1993).

Spills and Soil Contamination

Methods to predict wildlife impacts resulting from spills and/or soil contamination are qualitative in nature and will need to vary depending on mineral operations (e.g., gas, oil, coal bed natural gas). For instance, the largest volume of waste generated from CBNG drilling activities is non-hazardous drilling mud and cuttings, which will have little affect on local wildlife individuals. Analysis of impacts none-the-less should be based on the potential release of drilling muds, hydrocarbons, produced waters, or treatment chemicals during drilling, production, or transport. The analysis should also consider impacts if releases are transported or migrate into waterways where fish and other species occupying the water may potentially be impacted. The severity of impacts will depend on the type and amount of pollutant released, physical and environmental factors of the site, the method and speed in which cleanup occurs, and the sensitivity of wildlife (or fish) to these impacts during different stages of their life cycle (NPS, 2004).

Cumulative Impacts

The collective effect of different impacts on wildlife that result from changes caused by past, present or foreseeable future actions will vary depending on any number or parameters. The frequency of individual wildlife impacts per species should be used to predict or quantify population trends. During CBNG development for example, isolated impacts to certain species may occur, but the overall cumulative impacts in respect to specie's population trend will likely be minor or negligible. In any case, the cumulative impact analysis should assess habitat loss or habitat effectiveness, the effects of habitat fragmentation, and individual mortality. Noise and human presence are also important considerations since these impacts can affect sensitive wildlife species over very large areas, causing local population declines for some species (BLM, 2003b). Lastly, a project's duration can be an important assessment parameter. Typically, oil and gas related impacts to wildlife are classified as moderate and long term, but not permanent. Upon operational completion and reclamation, wildlife species are expected to return to former use patterns (BLM and USFS, 2004)

Mitigation

As with impacts, implementing appropriate mitigation measures designed to conserve and protect wildlife will depend on project features, regional characteristics, and the potentially affected species. In most cases preventative mitigation on federal lands is developed by federal

state offices or their associated field office. Species specific surface use stipulations are often employed for wildlife species during critical time periods to protect nesting, migration, and breeding behaviors to ensure long term population viability. Provided below are common examples of species or habitat specific practices that are currently required or recommended in various state resource management plans to minimize oil and gas related impacts to wildlife and their habitats. This list is not considered all inclusive as wildlife mitigation measures are generally species specific and are continually being revised as more information is collected.

- Enhance existing big game winter range in suitable undisturbed portions to reduce effective loss of winter range.
- Perform inventory for snags and where possible to protect all nest cavity trees from loss to construction activities
- No surface occupancy or use within 0.5 miles of known nests or riparian nesting habitat to nesting bald eagles.
- Construction activities would be avoided during breeding periods to allow nesting mountain plovers to establish territories.
- Surface occupancy and use is prohibited within ¼ mile of wetlands used by nesting interior least tern during exploration.
- Construction of facilities or roadways that will impact migration routes of terrestrial wildlife species would be avoided, unless construction activities could be schedules in a manner to minimize disturbance.
- Overhead electric lines can threaten birds such as raptors or waterfowl and may impair visual resources. Buried electric lines can prevent such incident and be as cost effective as pole-mounted lines when utility corridors are utilized. In situations where pole-mounted lines are the only feasible or the best option, the use of raptor safe poles should be incorporated into the mitigation strategy.
- Minimize construction in riparian areas.
- Upon project completion, disturbed areas associated with access roads, pads, flow lines and pipelines will be reclaimed to further minimize impacts on fish and wildlife.
- Upon project completion, disturbed areas will be properly seeded with native species to expedite the return of habitat and reduce the potential for invasion of non-native species.

- Use of already-disturbed areas for siting new operations would minimize loss of fish and wildlife habitat.
- Use primary and secondary containment systems to reduce spill potentials.
- Open containers that collect stormwater will be netted or covered to prevent bird and other wildlife species from accessing stormwater that may have contacted and mixed with oil and gas.
- Use remote monitoring of field data to reduce traffic volume and any subsequent wildlife collisions.
- Use existing water structures including reservoirs, impoundments, or stock ponds to dispose of water to avoid unnecessary impacts to other areas, while possibly benefiting landowners or wildlife.
- Beneficial use of CBNG produced water.

Vegetation

Impacts to vegetation during oil and gas development generally result from the removal, disturbance, and contamination of vegetation; habitat alteration; and the introduction of noxious weeds. These disturbances are most likely to occur during the primary phases of development, such as the exploratory and construction phases.

Direct/Indirect Impacts

Baseline Study

Golder Associates (2004) identified four factors for the development of a baseline study for the assessment of impacts to vegetation:

- The distribution and quantity of vegetation present in area
- The distribution and quantity of endangered species or sensitive species
- The distribution and quantity of traditional use plants
- The distribution and quantity of noxious weeds

Vegetation Removal and Disturbance

During the survey and permitting phase of oil and gas development, vegetation is often removed along seismic lines to allow for vehicle use and equipment movement (USFS, 2001). The greatest impacts, however, occur during the construction phase. To build access roads and

well pads, vegetation must be removed while plant life adjacent to these construction areas may be disturbed (including trampling, breaking, etc.). During the production phase, impacts to vegetation from removal and disturbance are not as great as previous phases because the primary removal is complete and the process of reclamation begins. However, reclamation of roads may occur immediately after construction is complete when certain roads or portions of roads are no longer needed.

Acres of vegetation removed or disturbed is based on the size of the well pads and facilities, and the acres of roads. To determine the short term versus long term impacts to vegetation, an estimate of the acreage to be reclaimed should be subtracted from the initial total disturbance. The extent of these impacts would need to be assessed considering the species present and the environmental characteristics of the region. In a forest, for example, the effects of vegetation removal would differ from the effects in a grassland. Operators in forests would need to consider the impacts that vegetation removal would have on canopy cover as well as the age of the forest stand. Also, as when analyzing any impacts to vegetation, special consideration must be given to endangered, sensitive, and traditionally used species.

Contamination of Vegetation

Contamination of vegetation is of biggest concern during the actual drilling and well completion. During this phase there is the possibility of spills or releases or harmful substances, however the risk is still small (USFS, 2001). There is always the risk of contamination from vehicles and equipment throughout the entire project, but primarily during the construction phase.

Habitat Alteration

Alteration of habitat can hinder a species' survival at a development site. This could include filling in wetland or soil erosion. Depending on the species, such alterations to habitat can be deleterious to vegetation.

Noxious Weeds

Noxious weeds are non-native plants that out-compete local vegetation for necessary resources. After vegetation is removed, the barren area is particularly susceptible to noxious weeds establishing themselves at the soil disturbance. This means that oil and gas development sites are more susceptible to noxious weed invasion before the reclamation process begins. When analyzing the impacts on the presence of noxious weeds, specialists should consider the species of noxious weeds present in the area and the control measures present to prevent the introduction of noxious weeds.

Cumulative Impacts

In assessing cumulative impacts of site vegetation, the incremental effects of the proposed action should be incorporated into the bigger picture of development in the area such that the impacts to vegetation resources from one project are synergistically incorporated with that of other reasonably foreseeable actions and other projects occurring within the same geographical and temporal bounds.

Mitigation

To minimize negative impacts when removing vegetation, operators should time construction to avoid critical seasons or times of year that are crucial to vegetation survival. As well, to prevent the spread of noxious weeds to the development site, equipment should be washed if possible to remove any seeds that have attached to vehicles and/or equipment. Operators should also avoid driving through areas where noxious weeds are present to prevent the spread. In addition, if hay is used as mulch to cover the soil, care should be taken to ensure that it is weed-free.

Visual

Oil and gas activities may have negative impacts on visual resources that are valued by people who live in or use an area. Visual impacts from oil and gas development mainly result from the clearing of vegetation, the construction of oil and gas infrastructure, and the presence of equipment in an area. The assessment of visual impacts can be difficult because it is more subjective than that for other resources. Opinions differ on what is or is not visually pleasing and a consensus on visual definitions/criteria is often lacking. Communication regarding visual quality can become unclear due to lack of experience by professionals in assessing visual impacts and due to vague descriptions of assessment standards or definitions. In addition, there are not currently any federal laws pertaining to visual impacts (although there may be state or local ordinances, etc.). In spite of these difficulties, there are methods to standardize impact assessment and make it more objective.

Direct/Indirect Impacts

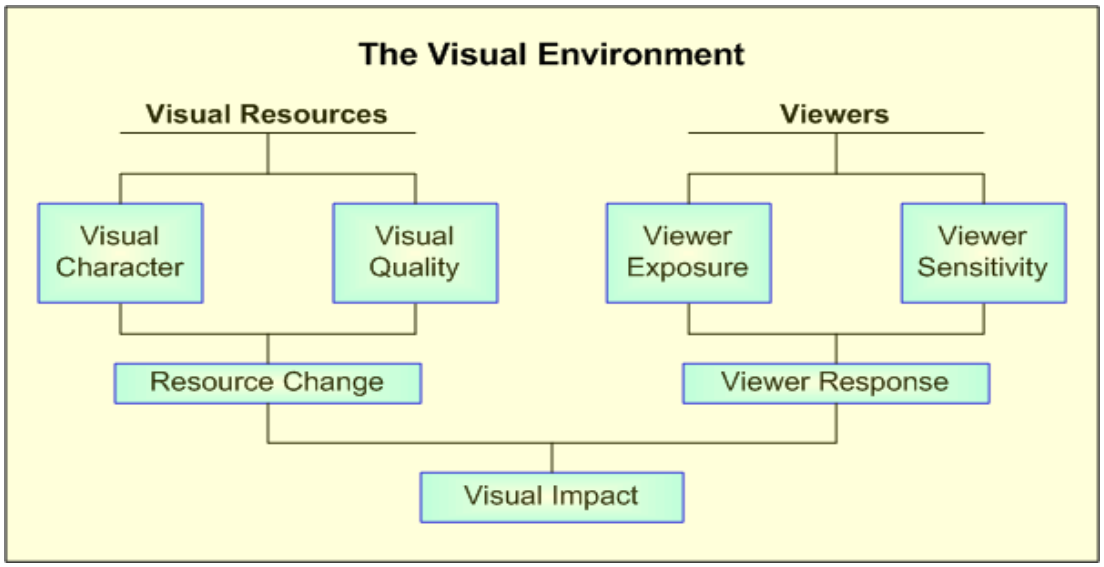
<u>Baseline Studies</u>

The first step in visual impact assessment is the preparation of a baseline study documenting current visual resources to use as a point of reference when predicting impacts from a proposed action. The baseline study should define the area that will be affected by visual impacts and

provide photographs and descriptions of various aspects of the area including geologic features, existing infrastructure, and other attributes that characterize the area. When applicable, the attitude toward the viewsheds of the community inhabiting or using the area should be included.

Visual impacts result from the combination of changes to the physical environment and people's responses to those changes, as illustrated in Figure 22, taken from the Department of Transportation's publication Visual Impact Assessment for Highway Projects. Impacts to visual resources result from changes in visual character and/or quality, while viewers' responses are comprised of how visible these changes are to the viewer (viewer exposure) and how sensitive the viewer is to these changes (USDOT, 1988). To assess viewer sensitivity, a resource specialist must have a complete understanding of the area's user groups and their attitudes toward their surroundings.

Figure 22 Defining the Visual Environment for NEPA Impact Assessment



(Source: USDOT, 1988)

Prior to assessing the significance of impacts to visual resources, the types of impacts from oil and gas development should be identified. Typical impacts are summarized below.

- Oil rigs, storage tanks, pipelines, and other facilities built in an area may alter or obstruct views.
- Oil and gas infrastructure can change the character of open spaces, or on the flipside, the clearing of vegetation or natural barriers can create a more open viewshed than previously existed.

- Access roads constructed to develop an oil and gas fields can cause a viewshed to be less aesthetically pleasing.
- Equipment traveling throughout the project area can alter the viewscape; however, the extent of this may vary over the total term of development.
- Development can change the character of an area that has historical or cultural significance.

Methods of Assessing Impacts to Visual Resources

One method of analyzing visual impacts is based on the principle of contrast. The BLM uses this methodology stating in the agency's Visual Resource Management Manual 8431 that "The degree to which a management activity affects the visual quality of a landscape depends on the visual contrast created between a project and the existing landscape. The contrast can be measured by comparing the project features with the major features in the existing landscape." (BLM, 1986). Using this method, the BLM's Visual Contrast Rating Worksheet (Form 8400-4) is completed during the assessment process. The steps outlined in the BLM manual for assessing visual impacts are:

1) Obtain a Project Description so an accurate assessment can be made.
2) Identify any visual resource management objectives.
3) Select Key Observation Points (KOPs) from where the contrast rating will be completed. The angle of observation, number of viewers, length of time the project is in view, relative project size, season of use, and light conditions should be considered when choosing KOPs.
4) Prepare Visual Simulations utilizing GIS and other software in order to compare development options and to facilitate the public discussion. More information about this step can be found in the BLM's *Visual Simulation Techniques* guide.
5) Complete the contrast rating considering form, line, color, and texture. The following list taken from the BLM's Visual Resource Management Manual 8431, provides definitions of these terms.

- **Form**: Contrast in form results from changes in the shape and mass of landforms or structures. The degree of change depends on how dissimilar the introduced forms are to those continuing to exist in the landscape.

- **Line**: Contrasts in line results from changes in edge types and interruption or introduction of edges, bands, and silhouette lines. New lines may differ in their sub-elements (boldness, complexity, and orientation) from exiting lines.
- **Color**: Changes in value and hue tend to create the greatest contrast (Figure 23). Other factors such as chroma, reflectivity, color temperature, also increase the contrast.
- **Texture**: Noticeable contrast in texture usually stems from differences in the grain, density, and internal contrast. Other factors such as irregularity and directional patterns of texture may affect the rating.

Figure 23 BLM Swatch of Standard Environmental Colors

6) The following Table 10, also taken from the BLM Visual Resource Management Manual, provides the criteria for the different contrast ratings (none, weak, moderate, and strong) (BLM, 1986).

Table 10 BLM Visual Resource Guidance on Contrast Ratings

Degree of Contrast	Criteria
None	The element contrast is not visible or perceived.
Weak	The element contrast can be seen but does not attract attention.
Moderate	The element contrast begins to attract attention and begins to dominate the characteristic landscape.
Strong	The element contrast demands attention, will not be overlooked, and is dominant in the landscape.

When completing the above impact assessment, many factors need to be considered in order to accurately predict visual impacts. These factors include distance, angle of observation, length of time the project is in view, relative size and scale, season of use, light condition, recovery time, spatial relationships, atmospheric conditions, and motion (BLM, 1986). BLM's Visual Resources Management Manual 8431 outlines this list of considerations and details for each factor when completing the impact assessment.

Cumulative Impacts

When addressing cumulative impacts, the Cumulative Effects Analysis Process outlined in the beginning of this process should be utilized. To properly assess cumulative impacts, other activities in the area that could impact visual resources need to be documented and analyzed. It should then be determined what direct and indirect visual effects necessitate detailed analysis of cumulative effects. The incremental effects of the proposed action should be incorporated into the bigger picture of development in the area.

Mitigation

Mitigation measures can be utilized to reduce negative visual impacts at oil and gas sites from roads and production facilities (pumping units, pipes, compressors, tanks, treaters, etc.). To reduce the visual impact of a road for example, an operator may build a road in a curved pattern rather than straight. This practice, especially in a wooded area, better hides the road from sight. To reduce visual impacts at an oil and gas site, existing roads should be utilized to the maximum extent possible.

The visual impact of production facilities can be mitigated by painting the structures in shades that minimize contrast with the surroundings. Semi-gloss paint should be chosen in a shade that is one to two shades darker than surroundings. In addition, all equipment used at the site should be painted the same color (BLM, 2004b). Figure 23 is a swatch of standard environmental colors that the BLM uses when considering paint colors for oil and gas structures, while Figure 24 an example of a structure that is painted to blend with its surroundings.

Serious visual impacts from oil and gas facilities may also be avoided by strategically locating them so they are more hidden from commonly traveled paths or from lookout points. An example would be placing a facility behind a hill so it can not be seen from a common observation point.

Lastly, as much vegetation should be retained at an oil and gas site as possible to lessen impacts to visual resources. Selective cutting should be adopted in place of clear cutting if it is feasible and revegetation with native plants should begin as quickly as possible.

Figure 24 Pumpjack Painted to Minimize Contrast with Surrounding Environment.

(Source: BLM, 2004b)

Paleontological

The paleontology of site consists of fossils and other records of past life. Compliance with Section 106 of the National Historic Preservation Act (NHPA) and relevant state preservation regulations is required prior to the initiation of any activities associated with oil and gas exploration. Paleontological sites are not always visible from the ground surface, therefore increasing the difficulty in location detection. Adverse impacts to such sites are often irreversible. Impacts to paleontological resources are usually evaluated in environmental assessment analysis on the number of sites per the land surface area of the project site in acres.

Direct/Indirect Impacts

Baseline Study

In conducting a baseline study of the paleontology of a site, a prehistoric survey of the location should be completed. To do so, specialists need to be familiar with local geological history. Consulting residents within proximal distance to the proposed site can be helpful in gaining perspective about a site's history.

Surface Disturbance

Impacts to paleontological resources are evaluated on the number of sites per the land surface area of the project site in acres. Impacts to paleontological resources have the greatest chance of occurrence during the primary phases of development such as site preparation and construction (USFS, 2001). Adverse effects to this resource can be caused by any variety of ground disturbance associated with the construction of roads and well pads. The removal of artifacts from their original location and disturbance of the site will destroy much of their value (USFS, 2001). The position of the artifacts relative to their surroundings should be studied to determine their age as well as the context in which they were originally used.

Erosion and Deposition

Increased erosional activity would remove artifacts from their surroundings and destroy much of their value (USFS, 2001). Soil erosion would also likely make artifacts visible and, therefore, making illegal artifact collection more likely. Increased soil deposition resulting from construction activities associated with oil and gas development may provide protection for paleontological resources, but would ultimately make them inaccessible and more difficult to relocate (USFS, 2001). If artifacts are unearthed during construction, all development related activities should cease (USFS, 2001).

Seismic Surveying

Ground disturbing geophysical surveys conducted off-road prior to oil and gas development can also impact paleontological resources. Detonation of explosive charges associated with seismic exploration may have an effect on the distribution and condition of artifacts in a surface artifact scatter or the condition of the surface features (USFS, 2001).

Cumulative Impacts

Adverse cumulative impacts to site paleontology can occur via the increase of roads and access ways from multiple development projects. Increased access can heighten vandalism, or perhaps illegal artifact collection.

Mitigation

Mitigation of adverse impacts to paleontological resources would be best met through locating those resources, achieved through comprehensive surveying, and then adjusting well pad and access road siting to avoid them. For sites that can not be avoided, adverse effects can be mitigated through data recovery, such as archeological excavation.

Geology

Geologic materials and geologic processes control or influence many aspects of the physical environment, such as slope aspect; slope steepness; the areal extent of landforms and associated vegetation; the distribution and composition of soil parent material; and the structure and composition of vegetation (USFS, 2004). In terms of oil and gas development, understanding the prominent geological features which define an area is important for designing exploratory and production procedures, as well as assessing any potential subsequent geology related impacts. Impacts to geological features during oil and gas development can result when geological characteristics of an area are altered in a manner that cause changes to local erosion conditions, transportation of sediment, landsliding properties (topography), changes in stream channels or direct surface disturbance and the irretrievable commitment of oil and gas resources (USFS, 2004). Soil type and its associated attributes for a specific area is an important geologic component that requires important consideration since the characteristics of soil are often directly related to the magnitude or types of observed impacts. As such, a comprehensive discussion specific to soils is necessary to adequately explain the impact analysis approach for soils and for this reason is detailed in an earlier subsection of this chapter.

Direct/Indirect Impacts

Baseline Study

Baseline information necessary for analysis of geologic impacts should include a descriptive assessment of surface and subsurface geological features. A proper assessment of these features will allow for more efficient use of the surface, extraction of minerals, and minimization of impacts to the surface and subsurface. Preferably this assessment will be performed by a geologist familiar with the area to allow for proper identification and analysis of appropriate features that include underlying formations, unconsolidated surficial deposits, sedimentary layers, subsurface salt movement, natural faulting or fracturing locations, and local topographic relief characteristics such as canyons, cliffs, elevated plains, low plateaus, mesas, buttes, arroyos, and valleys.

During this assessment phase certain questions should be asked. These can include, but are not limited to: Will the project affect local landforms and physical landscapes? Will oil and gas development affect other resource development such as the mining of coal or the development of other subsurface mineral resources in the area? Will surface disturbance associated with the construction of additional roads and well pads affect existing landslides and slope stability or increase the likelihood of new slope movements? Will roads be necessary in steep topography?

Will injection of produced water affect the geologic stability of the subsurface? Are underlying formations stable or do they contain natural fractures? Will extraction of water and oil or gas cause any degree of subsidence?

These are important questions to consider because they can often affect surface planning strategies and mineral extraction effectiveness. For example, sloping ground is typically leveled using cut-and-fill construction methods when roads, well pads, or other facilities are built. The amount of cut and fill material necessary to construct such surface facilities will proportionally increase with the frequency and magnitude of slope(s) in the area (BLM and USFS, 2004). In another example, localized structural deformation in some cases can cause fractures and, in CBNG development for instance, may enhance coal bed permeability and enhance the movement of water and gas through coal beds. Conversely, fractures may offset coal beds against rocks with lower permeability and impede the movement of gas or water and slow production (BLM and USFS, 2004). Natural subsurface fractures may enhance injection disposal options of some deep formations, while fault displacement may enhance the interconnectivity of subsurface zones enhancing migration pathways for across zones.

Surface Impacts

In general, surface or geologic impacts associated with facility development are considered unavoidable and associated adverse effects, if any, will persist during the life of the project or until reclamation of facilities. Management activities that involve earth-moving such as road construction or overland vehicles to transport equipment and personnel have the most potential to effect geologic resources. The potential effects vary depending upon the type, size, and sensitivity of the resource and the magnitude of the ground disturbance (USFS, 2004). When new wells are to be installed, the methods to analyze impacts should focus on the construction and maintenance of access roads, wellpads, flowlines, and pipelines and the potential for these types of facilities to erode, compact and rut soils, introduce nonnative construction materials, and reduce soil permeability that may result in localized impacts. Special attention should be paid to existing landforms since they may need to be altered or removed during energy resource development, and in some cases, may not be able to be completely restored during reclamation. In this situation the loss of these geologic features would be an irreversible and irretrievable commitment of the surface geologic environment (BLM, 2003a).

The following are examples of additional geological issues that should be assessed or studied to determine potential impacts to this resource.

- Construction of roads, well pads, and flowlines can result in disturbance to poorly-drained soils that support riparian or wetland vegetation, the loss of long-term productivity, and reduce potential for successful reclamation.
- Construction can disturb slopes, which would result in long-term erosion;
- Release of oil and gas or other contaminating and hazardous substances into the environment would impact soils.
- Increased erosion rates or reduction in soil productivity and stability could prevent successful reclamation with native species and composition.
- Material site development (gravel) can result in localized topographic changes to the extent gravel is extracted.
- Development can alter naturally occurring rock outcrops and deposits where surface exposures have been excavated to construct roads, drilling locations, or facilities.

Subsurface Impacts

In regards to mineral extraction, removed commodities or resources represent an irreversible and irretrievable commitment of these nonrenewable resources, that once developed, are consumed (BLM, 2003a). As such, subsurface geological resources are modified to the extent that mineral or gas reserves are produced. Therefore, the assessment of the impacts to geologic resources must consider the effect of committing these resources to development, the potential for delays in the development of other geologic resources in proximity to these resources, and the potential for mineral drainage issues of proximally located uncommitted resources. Reservoir analysis can be used to assess the potential for drainage to occur, and state and federal oil and gas regulations guide oil and gas development activities such that resources are conserved during development and not wasted (BLM, 2003b).

Cumulative Impacts

Abandoned, ongoing and proposed oil and gas operations can adversely affect geologic resources without proper planning. During the analysis phase, short-term impacts typically result from geophysical exploration and short and long-term impacts occur from the construction, maintenance and use of access roads, wellpads, flowlines or oil and gas pipelines (NPS, 2004). More specifically, construction activities can cause compaction and rutting, reduce permeability, and increase erosion and deposition of sediments that can alter the topography, increase turbidity in streams, modify surface water flows and indirectly adversely affect

vegetation, and fish and wildlife (NPS, 2004). However, the cumulative effects on the surface geologic environment can be minimized if proper techniques for well pad and facility siting, construction, and reclamation are used.

The pattern of naturally occurring landforms can be altered wherever excavation occurs. The topography and characteristic landforms of an area affected by construction can often be restored during reclamation; however, an important consideration during the cumulative impact analysis is that restoration typically can only approximate pre-existing conditions. For example, because of the limitations of replacing "unbroken or in-place material" with loose material that takes up more space, the same landscape form may not be obtained (NPS, 2004). Cumulative impacts to the environment may vary depending on the type of reclamation effort and the success of these efforts may not be known until several years after the restoration process.

Lastly, unplanned actions should be analyzed in the cumulative impacts assessment. These actions can include wildfires, prolonged wet periods, or large storms that can destroy vegetation or introduce excessive precipitation that can trigger slope movement (BLM and USFS, 2004). In the case of slope movement or slope failure, for example, predicting the probability of occurrence is difficult to do, as well as accurately reflect, because there occurrence are dependent on many factors and typically are not quantifiable. Although impacts can be minimized with properly implemented engineering and mitigation measures, potentially unstable slopes subjected to the removal of vegetation or facility construction of drill pads, roads, or other facilities can cause these controls to fail.

Mitigation

Mitigation measures to reduce impacts to geological resources are typically derived from planned reclamation procedures, surface related avoidance practices, and by implementation of sound engineering practices. The removal of fill materials and the re-contouring and re-vegetation of disturbed areas can reduce soil erosion and re-establish surface drainage flows. Surface stipulations established by the responsible federal agency or land owner can restrict areas permitted for vehicular travel or geophysical exploration and thereby eliminate many of the adverse impacts associated with their use. In geophysical exploration, for instance, hand-held augers can be utilized in areas where vehicle access is prohibited (e.g. perennial wet or saturated soils and unstable slopes) to reduce damage and unnecessary loss of vegetation (NPS, 2004). Other options include the use of 3-D seismic minihole techniques that involve drilling shallow shotholes in a cluster or tight linear pattern with a hand-held portable-drilling

tool. With this technique, equipment can be carried on foot or transported via helicopter and thereby reduce adverse impacts from overland vehicle use.

The most effective mitigation measure for construction on unstable slopes is avoidance (BLM and USFS, 2004). In situations where avoidance is not feasible, geotechnical engineers can design stabilization measures such as subsurface drainage, retaining walls, and soil reinforcement that can be incorporated in construction or reconstruction plans. Additionally, wells pads can be constructed in areas defined by low topographical relief to reduce the risk of landslides and erosion events. Lastly, appropriate and successful reclamation of existing access roads and wellpads, for instance, can reduce overall cumulative impacts to geologic resources and in many cases can beneficially impact soils.

Noise

Noise is generally defined as any unwanted sound. Noise at oil and gas sites results from trucks and other equipment, drilling operations, and facilities. Assessing impacts from noise is important as noise can be disruptive to humans and wildlife. With proper mitigation measures, many of the expected impacts from noise can often be avoided.

Direct/Indirect Impacts

Baseline Study

The first step in impact assessment of noise is the description of existing noise conditions in the project area to serve as a baseline study to which impacts can be prepared. This should include noise levels and patterns as well as the sources of noise in the area. The attitudes towards different noises of people who live in or use the area should be documented when applicable.

Identification and Assessment of Noise Impacts from Oil and Gas Development

Noise resulting from oil and gas operations can have a wide range of effects including:

- Noise can cause disturbance/annoyance of humans.
- Noise can cause disturbance/annoyance of wildlife.
- Hearing loss can result from long-term exposure to noise.
- Sleep loss can result from disturbing or annoying noises.
- Property can be devalued due to noise pollution.
- Noise can cause behavioral changes in wildlife.

Methods of Assessing Impacts from Noise

Assessing impacts from noise is important because noise can affect the health and well being of humans and wildlife. Definitions of the following terminology are necessary to begin noise impact assessment. The New York States Department of Environmental Conservation's document *Assessing and Mitigating Noise Impacts* identifies the five characteristics of environmental effects of sound and human perceptions of sound as:

1. **Sound Pressure Level**: is the perceived loudness as expressed in decibels (dB) or A-weighted decibel scale dB(A) which is weighted towards those portions of the frequency spectrum, between 20 and 20,000 Hertz, to which the human ear is most sensitive. Both measure sound pressure in the atmosphere.
2. **Frequency**: is the rate at which a sound source vibrates or makes air vibrate.
3. **Duration**: is the recurring fluctuation in sound pressure or tone at an interval; sharp or startling noise at recurring interval; the temporal nature (continuous vs. intermittent) of sound.
4. **Pure tone**: is composed of a single frequency. Pure tones are relatively rare in nature but, if they do occur, they can be extremely annoying.
5. **Equivalent Sound Level**: is related to the average of the sound energy over time. The L_{eq} integrates fluctuating sound levels over a period of time to express them as a steady state sound level. As an example, if two sounds are measured and one sound has twice the energy but lasts half as long, the two sounds would characterized as having the same equivalent sound level. Equivalent Sound Level is considered to be directly related to the effects of sound on people since it expresses the equivalent magnitude of the sound as a function of frequency of occurrence and time. By its derivation L_{eq} does not express the maximum nor minimum Sound Pressure Levels (SPL) that may occur in a given time period. These maximum and minimum SPLs should be given in the noise analysis. The time interval over which the L_{eq} is measured should always be given. It is generally shown in a parenthetic; $L_{eq}(8)$ would indicate that the sound had been measured for a period of eight hours (NYDEC, 2001).

Sound Pressure Level is calculated as:

$$SPL = 20\ [\log_{10} (P/P_0)]$$

where:

SPL = sound pressure level in decibels (dB)

P = actual sound pressure in microbars (10^{-6} atm)

P_0 = reference pressure (0.0002 microbars, which is the threshold of hearing)

Noise impact assessment generally compares the proposed noise with actual noise levels. Impacts will result from how the proposed noise differs from the character and/or SPL of the current ambient noise (NYDEC, 2001). According to *Assessing and Mitigating Noise Impacts*, the basis of impact assessment relies on the identification of noise receptor locations, a description/calculations of the ambient noise conditions at the receptor locations, and the increase in SPL or changes in character that create noise impacts (NYDEC, 2001).

When determining the effects from noise, various environmental factors must be taken into consideration. These factors can affect how noise travels, changing the significance of the impact:

- **Distance from Noise Source**: Noise is lessened as one travels away from a noise source. According to the Northern San Juan Basin Coalbed Methane project Draft EIS, "noise decreases by 6 dBA with every doubling of distance from a source" (BLM and USFS, 2004).
- **Vegetation Present in the Area**: Sound levels can be reduced up to 7 dB(A) when vegetation is at least 100 feet in depth (NYDEC, 2001).
- **Topographical Characteristics**: Topographical characteristics, such as a hill, can block noise travel between the source and receptors (NYDEC, 2001).
- **Time of Year**: Opportunity for impacts are greater during the summer when people spend more time outside their homes and often keep windows open (NYDEC, 2001).
- **Wind Direction and Speed**: Receptors located upwind of sound can reduce sound impacts, however, being located downhill will not increase the noise impact (NYDEC, 2001).
- **Background Noise Level**: A noise that is much louder or different than the background noise level may be perceived as a worse impact than if noise is similar to the background noise (NYDEC, 2001).

- **People's Attitude Towards the Source of Noise**: If people have a negative attitude towards oil and gas development they may perceive the noise as having more negative impacts than those who see oil and gas development as positive.

Table 11 below provides a guide to levels of noise from construction equipment used during oil and gas construction to aid in the noise impact assessment analysis.

Table 11 Noise Levels Generated by Various Types of Construction Equipment

Equipment Type	Noise Level (in dBA) at distance:				
	50 feet	500 feet	1,000 feet	1,500 feet	2,000 feet
Crane	88	68	62	58	56
Backhoe	85	65	59	55	53
Pan Loader	87	67	61	57	55
Bulldozer	89	69	63	59	57
Fuel Truck	88	68	62	58	56
Water Truck	88	68	62	58	56
Motor Grader	85	65	59	55	53
Vibrator/Roller	80	60	54	50	48
Mechanic Truck	88	68	62	58	56
Flat Bed Truck	88	68	62	58	56
Dump Truck	88	68	62	58	56
Flat Bed Trailer	88	68	62	58	56
Tractor	80	60	54	50	48
Concrete Truck	86	66	60	56	54
Concrete Pump	82	62	56	52	50
Front End Loader	83	63	57	53	51
Road Scraper	87	67	61	57	55
Air Compressor	82	62	56	52	50
Average Construction Site	85	65	59	55	53

Modified from: BLM, 2004 (Source: Crocker and Kessler, 1982)

Cumulative Impacts

Other development in the location of the proposed oil and gas development can cause significant cumulative impacts depending on the size and location of other development. Cumulative impacts resulting from more than one area of development in proximity to each other would be affected by the same factors as described above, including distance between the development, wind, topographical characteristics, all affecting the severity of the impact.

Mitigation

Possible mitigation measures to reduce impacts from noise include:

- Locate sources further from noise receptors (BLM and USFS, 2004)
- Build fences, berms, or other structures, and enclose compressor stations to lessen noise impacts on receptors (BLM and USFS, 2004)
- Use mufflers on machinery such as diesel engines (NYDEC, 2001)
- Limit hours that noisy operations may take place or plan for loud operations to occur during the day when people are not sleeping (NYDEC, 2001)
- Notify people that a loud operation will soon occur (NYDEC, 2001)

Air Quality

Air quality in a given location is controlled primarily by the magnitude and distribution of pollutant emissions and the regional climate (BLM and USFS, 2004) and is defined by pollutant concentrations in the atmosphere as compared to a national or state ambient air quality standard (BLM, 2003a). These standards represent the maximum allowable atmospheric concentrations that may occur and still protect public health and welfare and include a reasonable margin of safety to protect the more sensitive individuals in the population (BLM, 2003a). The federal Clean Air Act (CAA) of 1969 and its subsequent amendments establish air quality regulations, including the National Ambient Air Quality Standards (NAAQS), and delegates responsibility to states to enforcement these standards. The NAAQS represent maximum acceptable concentrations that generally may not be exceeded more than once per year, except the annual standards, which may never be exceeded. Currently, the EPA has designated all areas of the United States as having air quality better than (attainment) or worse than (nonattainment) the NAAQS (BLM, 2003a). A nonattainment designation generally means that a primary NAAQS has been exceeded more than once per year in a given area.

Areas known (or assumed) to be attaining NAAQS are allocated to one of three "classes". These classes identify the level of effort that must be expended to maintain good air quality where it already exists (USFS, 2004). Class I Areas (e.g., wilderness areas, national parks, self-classified Indian Reservations, other sensitive areas designated by Congress) can receive only small amounts of additional pollution. Class II areas can receive moderate increments of additional air pollution, as long as neither a NAAQS violation nor a significant deterioration of resources is anticipated. Class III areas can be designated to receive larger increments of additional pollution, enough to bring attainment areas all the way down to (but not below) NAAQS. Except for the 156 congressionally designated Class I Areas, all of the United States is designated as Class II (USFS, 2004).

Direct/Indirect Impacts

Baseline Study

An inventory of pre-existing emission sources in a specific area or region, referred to as air quality related values (AQRVs) (USFS, 2004), will facilitate a comparative analysis by the responsible regulatory agency or operator to ascertain additional emissions and resulting impacts, if any, that may be contributed from new oil and gas developments. For example, in the Big Thicket National Preserve EIS, the baseline study indicated the Preserve was located in two of the most polluted air sheds in the State of Texas and that the area already exceeded NAAQSs (NPS, 2004). Baseline data to assess pre-existing air quality conditions is normally available at appropriate state management programs. Typically, the pollutants of primary concern for air quality analysis include volatile organic compounds (VOC), nitrogen oxides (NO_X), carbon monoxide (CO), nitrogen dioxide (NO_2), Sulfur Dioxide (SO_2), ozone (O_3), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$).

Baseline analysis for local or regional air quality conditions should also include an evaluation of near and far field pollutant impacts specific from oil and gas production with the use of dispersion modeling to determine if proposed emissions contribute to a predicted exceedance of an ambient air quality standard (BLM, 2003a). Lastly, the analysis should incorporate the effects of local topography to the transport of pollutants from specific source areas. For example, in the mountainous western United States, topography is particularly important in channeling pollutants along valleys, creating upslope and downslope circulation that entrain airborne pollutants, and blocking the flow of pollutants toward certain areas (BLM and USFS, 2004).

Construction and Operational Practices

Air quality impacts resulting from oil and gas development, if present, are often the product of normal oil and gas construction and operational practices. Although many scientific methods are available to assess air quality impacts, more common approaches are dispersion models (e.g. EPA Screen3 and ISCST3) or by use of CALMET/CALPUFF methods. Typically, air quality impacts are classified as negligible and short-term for project elements associated with construction and well drilling and testing, and negligible and long-term for project elements associated with oil and gas production (USFWS, 2002). For instance, earth moving practices for road or well pad construction can cause excessive dust emissions for a local environment; however, upon completion of such construction activities, excessive dust production is considerably reduced. However, as stated earlier, the extent of air quality impacts will be dependent on regional climatic conditions (e.g., prevailing air flow) and existing air quality conditions, as well as the nature of the source. Provided below is a summary of oil and gas related practices or activities that should be evaluated during the air quality impact analysis.

- Combustive emissions due to the operations of mobile and stationary source equipment and fugitive dust emissions (PM_{10}) from earthmoving activities and the operation of vehicles on both unpaved and paved surfaces
- Gas well production and the operation of associated gas-fired sources such as wellhead compressors, water separator units, condensate tank heaters, dehydrators, and compressor stations
- Operation of mobile source equipment for overburden and coal handling and stationary coal handling equipment. Air quality impacts would occur from combustive and fugitive dust emissions.
- Land use policies that would affect the level of off-road mobile sources and ground-disturbing activities
- Accidental spills of volatile petroleum products resulting in emissions of hydrocarbons or volatile organic compounds, and other pollutants such as hydrogen sulfide (H_2S)
- Emissions from gas pipeline leaks
- Wind eroded dust
- Gas emissions and the effect on visibility levels

Project Duration

The amount of air pollution generated over the productive life of oil or gas wells depends on the characteristics of the product and the production practices used (NPS, 2004). Typically, when assessing air quality impacts, however, well development and associated production rates are assumed to be constant on an annual basis. Under this scenario peak annual production and emissions will occur at the end of the proposed projects duration (usually a 20-year period). The important consideration here is that maximum predicted operational air quality impacts are often based on maximum projected development. In many situations this method or analysis approach does not accurately reflect development or its associated air quality impacts. More commonly, actual development occurs in phases that results in lower air quality impacts at a projects start-up with proportional increases as development advances.

Cumulative Impacts

To a certain extent, the degree of cumulative impacts to air quality within a local or regional environment that will be contributed from oil and gas related projects are dependent on the duration and type of the oil or gas project, the overall size of the project, in-place mitigation, and pre-existing emission sources. Additionally, air quality impacts often change or are distributed differently overtime as new operations are developed or while older operations are plugged, abandoned, and reclaimed. Population levels over time can also change as well. Increases to population growth can increase adverse impacts at the regional level (NPS, 2004). In all cases, however, based on "reasonable, but conservative" assumptions, cumulative impacts are required to be within applicable air quality standards (BLM, 2003b).

Mitigation

Proper maintenance of gasoline and diesel-fueled engines and use of low sulfur fuels are important control measures that can be used to minimize exhaust emissions (NPS, 2004). Pollution control devices, such as catalytic converters, should be used on exhaust gas to reduce unnecessary emissions. Inspection and maintenance of production equipment such as flares and treater facilities is also necessary to ensure that deteriorated components and equipment are detected and replaced or repaired. In addition, using flareless flow-back units to capture otherwise released gas instead of flaring the gas would lower emissions (BLM and USFS, 2004).

In terms of roads and wells constructed on soils susceptible to wind erosion, appropriate surfaces should be utilized to reduce the amount of fugitive dust generated by traffic or other activities, and dust inhibitors (i.e., surfacing materials, non-saline dust suppressants, water,

etc.) should be used as necessary on unpaved collector, local, and resource roads (BLM, 2003b; BLM and USFS, 2004). Additional, operators could establish and enforce speed limits (15 to 30 mph) on all project-required roads in and adjacent to the project area (BLM, 2003b; BLM and USFS, 2004).

Surface Disturbance

The footprint of drilling and production operations for oil and gas projects is variable and is dependent upon the needs of the operator and the mutual objectives established by the operator and managing agency and land owner. Furthermore, the land uses within any producing area will also vary considerably and can include forest preserves, residential communities, rangeland, and national parks. In any case, oil and gas development within a given area must comply with the land use plans and policies adopted by federal, state, and county governments. In addition, different land uses will often require operators to vary their approach during the development process and in some instances, may require operators to vary production practices to avoid impacts to existing land uses (ALL Consulting, 2004). Under these varying circumstances the development of surface use plans will allow for more efficient use of the land while balancing protection of important local resources by minimizing surface impacts.

Surface use planning is an important aspect of surface disturbance or land use impacts because it can provide an opportunity for developers to work in cooperation with landowners to establish scientifically sound and economically profitable development while maintaining existing land uses or possibly facilitating future land use opportunities (ALL Consulting, 2004). For example, the location of ponds, roadways, and multi-well pads can allow for the continuation of current land uses while providing improvements to the landscape that would be beneficial to future uses. Additionally, surface use planning can alleviate concerns that development will impact cultural and wildlife resources, for example, through avoidance practices and noise reduction technology. In most cases a surface use plan will constitute an important component of the permit to drill application to specify measures that will minimize surface damage and degradation of visual resources, as well as define actions that will not be detrimental to other uses or properties.

Direct/Indirect Impacts

<u>Baseline Study</u>

Prior to assessing surface related impacts caused by oil and gas exploration or production procedures, it is necessary to determine if the proposed project will be consistent with the

adopted land use plans of the area, if any, and if the proposed actions will conform with associated policies of federal, state, and local agencies (BLM and USFS, 2004). Obviously then, the first step is to determine the land's current use conditions (e.g., agriculture, livestock, national forest) followed by a preliminary evaluation to determine or predict how development will affect this use (or resource). In all likelihood the easiest approach to assess potential land use or resource impacts will be to compare proposed actions to existing oil and gas projects similar in nature. Additionally, review of federal and state guidance documents and scientifically sponsored studies, as well as discussions with the managing agency, will allow for a more informed project design to facilitate the minimization of impacts.

Another important consideration during this preliminary process is surface ownership as land use impacts will vary depending on surface and mineral ownership at specific locations. For example, private landowners have full control over the location of oil and gas facilities for properties in which they hold surface and mineral rights. In such situations, the owner may have certain surface stipulations that will force certain concessions in facility location, access, or aesthetic requirements. Conversely, landowners that do not own the mineral rights cannot prevent mineral lessees from drilling a well on the property, but will typically be given opportunities to participate in developing surface use plans and defining needs or surface restrictions (BLM and USFS, 2004).

Lastly, in most cases when federal agencies are involved, inspection of the proposed surface disturbing locations are delineated prior to permit approval to identify sensitive areas and environmental consequences associated with the proposal at each specific location (BLM and USFS, 2004). Thus, operators should take an adaptive and flexible approach to account for changes in initial design plans that may be required by the authorizing agency. BLM's POD requirements for CBNG development in Montana or Wyoming is an example of this permit and inspection process.

Construction Related Impacts

A surface related impact has the potential to affect many resources in various manners and, therefore, requires specific discussion per resource. Although this type of discussion is considered beyond the scope of this particular section, analysis of impacts per resource pertinent to this subject is provided in the appropriate resource discussions in this chapter.

Surface disturbance analyses for a specific area should be supported by technical data and reasonable assumptions and should be described in terms of type, duration, severity, and aerial extent (BLM, 2006a). Direct surface related impacts are quantifiable and will result from

construction of well pads, access roads, pipelines, compressor stations, disposal wells, impoundments, and use of heavy equipment. Obviously, calculating and thus analyzing the extent of surface disturbance for any project area will be dependent on several factors that can include the density or length of proposed new roads, width and length of ROWs that may include pipelines, and the estimated size of well pads. Additionally, the duration of the project will affect surface disturbance calculations as well since, under most circumstances surfaces are reclaimed when certain facilities are no longer needed (BLM and USFS, 2004). The following formulas can be used to calculate surface disturbance as described by the BLM (2006).

Gross surface disturbance = current disturbance + future disturbance
Net surface disturbance = current disturbance + future disturbance – reclamation

In general, oil and gas development can potentially affect existing land uses in several ways. First, surface disturbances during both the construction and operational phases of development can cause displacement of some existing land uses and will typically occur for the life of the project. Secondly, land uses near oil and gas facilities can be affected by intrusive effects. For example, vehicles on existing roads will generate additional noise, dust, and traffic. These effects may conflict with nearby land uses, primarily residential properties (BLM and USFS, 2004). Lastly, oil and gas development may affect growth patterns, possibly resulting in conflicts with local goals for future land use. As stated earlier, to properly assess and qualify each particular land use disturbance will require an understanding of existing lands uses, local policies and perceptions, planned mitigation and an estimate of the surface impact.

Watersheds

A recent trend by federal agencies is to manage resource programs on a watershed basis. Analysis of information on surface disturbances by watershed is important as it can be used to predict short and long term impacts on soils, sediment yields, habitat fragmentation, cultural resources, and surface water quality (BLM, 2003a). In terms of sedimentation, surface disturbance, especially bare soil on unpaved roads, is a major contributor to changes in sediment yield in a watershed (BLM, 2003a). One limiting factor when analyzing the effects of sedimentation on watersheds is that known locations of new wells, roads, pipelines, compressors, etc. are needed for proper assessment of impacts. In many cases this type of information is either not available or as is more common, can frequently change to accommodate project needs, land uses, or regulatory requirements. In general, however, it can be concluded that areas with the highest density of development, the least ground cover, and the most erodible soils will generate the highest sediment yields. Therefore, the analysis should

focus on quantifying changes in surface disturbance, amount of vegetation disturbed, and road density, with the assumption that increased sediment yields will have proportional increases in watershed parameters (BLM, 2003a).

Cumulative Impacts

To adequately address cumulative impacts resulting from surface disturbances, a sum of the gross and net area of potential surface disturbed as a result of oil and gas activity by the number of years of expected operations should be calculated. This calculation should not only address anticipated future activity, but also existing activity and anticipated changes in existing activity. For example, existing activity such as plugging a well and subsequent reclamation of the well site will serve to reduce overall net surface effects of oil and gas activity (BLM, 2006a). The analysis of cumulative impacts should also address impacts to visual resources, noise, dust, recreation, transportation, and potential effects to residential property values, land use conflicts, land displacement and associated benefits that may be achieved from the implementation of BMPs.

Mitigation

It is likely that erosion and sedimentation will result from initial surface disturbance. However, realized impacts can be reduced once well pads, roads, and pipelines are stabilized by seeding and by proficient use of surface water controls and other BMPs (BLM, 2003a). For instance, in CBNG development not all subsurface completions require additional surface locations and, subsequently, additional land disturbing activities. Additionally, disposal and deep tests wells can be placed on pads that also accommodate producing wells. There are a wide variety of control measures that can be utilized on oil and gas projects to control impacts that may arise from surface disturbing practices. Although the successful and appropriate implementation of these control practices will vary per situation, in most cases these controls can be established and monitored with minimal project costs. Below is a list of some of the control measures that are currently be used in the oil and gas industry.

- Use of directional drilling to avoid or minimize land use conflicts and reduce surface impacts
- Fencing of allotments into pastures to control cattle distribution
- Developing stock ponds
- Construction of erosion control structures to protect watersheds

- Immediately reseed depleted or abounded areas
- Establishment of noise and visual ordinances
- Construct fences and cattle guards to reduce land displacement issues
- Immediately repair or replace any improvements damaged by project implementation
- Protect or avoid all permanent monitoring stations
- Minimize road construction to all extent possible by utilizing existing roads
- Avoid use of heavy equipment during periods of heavy rain
- Avoidance of construction activities is sensitive habitats (e.g., wetlands, riparian, critical habitat, etc.)

D. Human and Management Resources

Following is a discussion of the human environment and management resources group consisting of socioeconomic, Native American concerns, and cultural resources.

Socioeconomic

Socioeconomic impacts encompass social and economic effects in areas where oil and gas exploration and production is proposed. The "Gillette Syndrome" is a term that was coined in 1974 to describe the social and economic effects that can occur in a community due to rapid population growth (Kohrs, 1974). In addition to changes in population and population demographics, the Gillette Syndrome also refers to changes in tax revenue, crime rates, mental health, social and community bonds, cost of living, the need for government services, and more. In addition to researching data to predict future impacts, it is important that socioeconomic analysis also consider "softer" data such as the attitudes of residents in an area to changes in their region. Socioeconomic impacts can encompass many different topics; therefore, it is important to focus on the most significant potential impacts, even when these impacts are difficult to quantify (DOC, 1994).

Direct/Indirect Impacts

<u>Baseline Study</u>

The first step in socioeconomic impact assessment is the description of existing socioeconomic conditions in the project area to serve as a baseline study to which impacts can be compared. The following list from *A Guide to Social Impact Assessment in the Oil and Gas Industry*

published by the International Petroleum Industry Environmental Conservation Association (IPIECA) outlines data sources useful for completing a baseline study. Data includes census and other quantitative data, as well as qualitative interview techniques to determine how people feel about their community and the issues that arise from development proposals.

- **Secondary Data Sources**: includes official material such as maps, censuses, government records, research reports, social needs assessments, and historical texts. Such data may need to be updated or augmented by field survey data collected by the social impact assessment study team.
- **Qualitative Interview Techniques**: provides insight into how people perceive themselves and how their community organization and leadership work together. Interviews take into account preferences and expectation regarding overall project benefits, specific mitigation measures, compensation and community development needs. Qualitative techniques can also be used to fill gaps in baseline data surveys which might have missed or understated. They can also enhance and verify quantitative data.
- **Quantified Data**: is often collected on such parameters as household assets, income streams, expenditures, vulnerable individuals or groups, health, education, skills of the labor force, etc. Quantitative data allow for effective assessment of potential project impacts over times. Reliable quantitative data also provide a sound basis to challenge unfounded claims and future disputes concerning project impacts. However, quantified data collection should focus on what really counts rather than what is easy to count.
- **Participatory Rural Appraisal**: the participatory approaches suggested by the Work Bank can be used to share learning between local people and companies. Experience suggests that the quality of baseline data collection can be enhanced by the use of appropriate participatory approaches, particularly in Greenfield sites where the company has a limited understanding of the stakeholders.
- **Supply-chain Analysis**: is helpful at an early stage of a project. Assessing the inventory of goods and services that a project will requires for the development of opportunities for local people or local businesses (IPIECA, 2004).

Impacts to socioeconomics will typically vary during the construction phase and during operations for the life of the project. The following can be used to aid in the identification and assessment of population impacts from oil and gas development:

- Changes in population demographics, including an increase or decrease in population and a change in the make up of the population. When oil and gas development begins in an area, this can sometimes result in an influx of men who relocate to the area for work. Depending on the local population, the number of people brought into an area for oil and gas activities can be negligible, or a significant change.
- Change in need for government services resulting from a population change, such as increased need for schools, water, power, health care, and an increase in the use of roads (IPIECA, 2004)
- Economic impacts, including increased county revenue from oil and gas development, increased employment opportunities in both the oil and gas industry and other sectors, such as an increased need for teachers or nurses (IPIECA, 2004).
- Impacts to a community's way of life, including community attitudes and community values (IPIECA, 2004).
- Impacts to different population groups, including minorities, low-income populations, and the elderly.

Methods of Assessing Socioeconomic Impacts

Assessment of socioeconomic impacts relies upon a variety of different methods. Some aspects of socioeconomic impact assessment can be more difficult to quantify, however, it is important to focus on the most relevant and significant impacts rather than those that are easiest to assess (DOC, 1994).

A common way to assess socioeconomic impacts from oil and gas development is to compare the proposed development to similar development in another area. Similar scale development at a similar location provides insight into which impacts may occur from proposed actions. Other methods, as outlined in the document from the Interorganizational Committee on Guidelines and Principles for Social Impact Assessment entitled *Guidelines and Principles for Social Impact Assessment* are:

- **"Straight-line trend" projects:** taking an existing trend and simply projecting the same range of change into the future.
- **Population multiplier methods:** each specified increase in population implies designated multiples of some other variable, e.g. jobs and housing units.

- **Scenarios:** (1) logical - imaginations based on construction of hypothetical futures through a process of mentally modeling the assumptions about the variables in question; and (2) fitted empirical - similar past cases used to analyze the present case with experts adjusting the scenario by taking into account the unique characteristics of the present case.
- **Expert testimony:** experts can be asked to present scenarios and assess their implications.
- **Computer modeling:** involving the mathematical formulation of premises and a process of quantitative weighing of variables.
- **Calculation of "future foregone":** a number of methods have been formulated to determine what options would be given up irrevocably as a result of a plan or project, e.g., river recreation and agricultural land use after the building of a dam.

As discussed in the Baseline Study section, a wide variety of socioeconomic data is available, ranging from public scientific literature, to secondary sources such as the census, and lastly primary sources such as interviews with local residents who may have a unique insight into potential impacts from the proposed action (DOC, 1994). When there are data gaps, however, it is more important to identify significant impacts than to only include impacts in the analysis that can be well quantified. It is important that a trained social scientist address impacts that do not have much data to complete an analysis (DOC, 1994).

Land Use

Land use impacts result from changes in how land is managed due to oil and gas development. Changes in land uses can result in both positive and negative impacts to residential, agricultural, and industrial areas.

Direct/Indirect Impacts

Baseline Study

Prior to completing an impact analysis, a baseline study of land management to which impacts can be compared needs to be completed. This should include data regarding various land uses including agriculture, industry, residential, commercial, as well as any land use plans or other planning documents governing the locality.

Land use impacts result from changes to how land is managed due to oil and gas development. Impacts include:

- Loss of land used for agriculture or industry due to oil and gas development. However, some land owners may want oil and gas development in the event that oil and gas development would be more profitable than their current operations (BLM, 1997).
- Changes in land use due to impacts from the effects of oil and gas development such as the loss of recreational use due to increased noise or negative visual impacts or disruption of residential areas (BLM, 1997).
- Increase in traffic due to oil and gas construction and maintenance (BLM, 1997).
- Falling out of conformance with a land use plan that is implemented in a region due to oil and gas development.

Methods of Assessing Land Use Impacts

The primary method to assess impacts to land use is the determination of how much land will be managed for a different purpose due to proposed oil and gas development. This would include how many acres of agriculture, land used for industry, or residential areas are lost. Changes in land uses due to impacts from oil and gas development, such as loss of recreation or disruptions to residential areas, can be estimated after impact predictions about other resources are established, such as visual resources and impacts from noise. The number of homes impacted by oil and gas development should be estimated when applicable. Analysis will vary between proposed actions based on the current land uses in an area and population.

The amount of traffic due to oil and gas development should be calculated based on the number of wells. There will be more vehicle trips expected during the construction phase than for maintenance.

All land use plans and other planning documents that govern a region should be reviewed to ensure that any proposed development is in within their guidelines as should any special designation land classifications.

Cumulative Impacts

Cumulative impacts analysis should discuss all other development that will result it changes to land use, especially those affecting agriculture, recreation, and residential areas. The cumulative impacts of oil and gas development and other developments occurring in the area can together have significant impacts to the area, and therefore must be analyzed.

Mitigation

Mitigation measures to avoid or lessen impacts from land use changes include:

- Discussing oil and gas operations with land owners that will be affected by new development. This will give land owners an opportunity to understand the details of development as well as provide suggestions to avoid impacts.
- Minimize impacts from increased traffic by utilizing back roads for vehicles traveling to oil and gas sites and by crews carpooling (BLM, 1997).

Environmental Justice and Native American Concerns

According to the Environmental Protection Agency, "Environmental Justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." (EPA, 2006b). In the impact analysis project, environmental justice is analyzed to ensure that low-income and minority populations do not bear a disproportionate burden of impacts from oil and gas development and that these population groups have their needs adequately addressed. Due to the fact that analysis is similar for environmental justice and Native American concerns they are grouped together in this document, however, many EISs analyze these issues separately.

Direct/Indirect Impacts

Baseline Study

Prior to completing impact analysis of environmental justice and Native American concerns, a baseline study of low-income and minority groups, including Native Americans, needs to be completed. Information about population, income, economic status, where these groups live, etc. needs to be compiled so that changes due to oil and gas development can be analyzed.

Identification and Assessment of Environmental Justice Impacts and Impacts to Native Americans from Oil and Gas Development

Environmental justice impacts and impacts to Native Americans are similar to socioeconomic impacts (see socioeconomic section), however there are some additional considerations when analyzing impacts to low-income and minority populations:

- Disproportionate human health and/or environmental impacts to low-income or minority groups

- Low-income or minority populations may not be adequately represented in the scoping process, resulting in development that has adverse impacts on these population groups
- Increased population and traffic on Native American reservations (by Native Americans or other races)
- Change, often an increase, in revenue or economic gains for low-income or minority populations
- Impacts to traditional cultural properties or land used by Native Americans for religious or cultural purposes
- Impacts to wildlife that is traditionally hunted or vegetation that is traditionally collected by Native Americans

Methods of Assessing Environmental Justice Impacts and Impacts to Native Americans

Methods of assessing impacts regarding environmental justice and Native American concerns are similar to those from the socioeconomic section. Data regarding low-income and minority populations, including their population, income, where these groups live, etc., should be analyzed to determine if oil and gas development will affect these groups any differently than higher income and non-minority groups. The range of effects needing to be considered includes environmental, human health, and economic impacts. Interviews with low-income and minority persons are necessary because these groups may be underrepresented during the scoping process. When considering Native American concerns, these interviews can determine where areas of religious or cultural significance are so that impacts to these areas can be specifically analyzed. This is also true for wildlife and vegetation that are traditionally harvested by Native Americans.

Economic analysis, as conducted for socioeconomic impacts, should be considered to determine if low income or minority groups would suffer any disproportionate negative consequences when compared to other groups in the area.

Cumulative Impacts

Other development in the area should be analyzed to determine if their impacts, combined with the impacts from the proposed oil and gas development, will disproportionately affect low-income and minority communities.

Mitigation

In order to prevent or avoid disproportionate impacts to low-income and minority communities, discussions should begin with these affected groups. By facilitating dialogue, NEPA specialists will ensure that issues important to these groups are not overlooked even if these groups are not as active during the scoping process. Once the potential impacts are known, steps can be taken to alter or relocate certain aspects of development to avoid severe or disproportionate impacts.

Cultural Resources

Cultural resources are best described as material remains of, or the locations of past human activities, including sites of traditional cultural importance to both past and contemporary Native American communities (ALL Consulting, 2004); whereas, paleontological resources consists of fossils and other records of past life. Section 106 of the National Historic Preservation Act (NHPA) requires an inventory prior to the commencement of construction or other surface disturbing activities for both of these resources if federal involvement is present either in terms of surface or mineral estate, federal funds, federal grant, or federal license. In addition, consultation with the Advisory Council on Historic Preservation and state historic preservation officers (SHPOs) is required by law and regulation. In many cases, regulations and management policies also require consultation with Native Americans and other concerned ethnic groups, other federal agencies, state and local governments, and other interested parties.

Direct/Indirect Impacts

Baseline Study

Potential impacts to paleontological and cultural resources, either by removal or degradation in value, are often related to the location and degree of surface disturbance within any given project area. To adequately assess impacts to these resources requires the identification of potential sites within a specific location through examination of existing records, field surveys, interviews, subsurface excavations and inspection of ethnographic materials for areas that are proposed for disturbance on federal (or state) lands (BLM and USACE, 1999).

The baseline study for these resources should include delineation of planned surface disturbance activities (e.g., roads, impoundments, heavy equipment) that will provide resource specialists with the information necessary to develop appropriate inventory strategies and subsequent establishment of "protective" corridors. Additionally, baseline evaluations should

include investigation of soils and geomorphology, especially in areas where this information is limited, as the occurrence of unexpected discoveries is heightened under these conditions (BLM and USACE, 1999). Lastly, the assessment of impacts should not only include the inventory of physical artifacts, but should also include surveys of landscape's period(s) of historical significance and the features, patterns, and context contributing to its significance (NPS, 1998). For example, the physical setting of a site is a key component in its eligibility for the National Register of Historic Places (BLM and USFS, 2004).

Operators of recent oil and gas developments within the Powder River Basin have recognized that the use of block surveys verses site or route specific surveys have great benefits with their project schedules and local Tribes and special interest groups. The use of block surveys prevent the repetitive surveying of routes or pads sites when these are moved due to the discovery of cultural resources. Furthermore, consultation efforts with local tribes or special interests groups are enhanced by the area knowledge gained verses the discovery of a single site or handful of sites. Block surveys are recommended by the BLM Miles City Field Office for all CBNG proposed PODs.

Surface Disturbances

Direct impacts to paleontological and cultural resources are evaluated on the number of sites per the land surface area (ratio) which are contained within the boundaries of a project location. Impacts to these resources have the greatest chance of occurrence during the primary phases of development such as site preparation and construction (USFS, 2001; BLM, 2003b). Activities that involve the use of heavy equipment (road construction, well drilling, pad construction, pipeline and utility placement, etc.) that result in changes to the natural landscape cause the most disturbance and have the greatest effect on paleontological and cultural resources (BLM, 2003b). Additionally, detonation of explosive charges associated with seismic exploration may have an affect on the distribution and condition of artifacts in a surface artifact scatter or the condition of the surface features (USFS, 2001; NPS, 2004). The position of the artifacts relative to their surroundings should also be assessed for impacts to determine their age as well as the context in which they were originally used.

Erosion and Deposition

Increased erosion or changes to vegetation warrants impact assessment for these resources since erosion events can change the characteristics and integrity of a site, remove artifacts from their surroundings, and destroy much of their value (USFS, 2001; BLM and USFS, 2004). Soil erosion would also likely unearth some artifacts and; therefore, potentially make impacts from

illegal artifact collection more pronounced. Conversely, increased soil deposition resulting from construction activities associated with oil and gas development may provide protection for cultural or paleontological resources but would ultimately make them inaccessible and more difficult to relocate (USFS, 2001).

Other Indirect Impacts

Indirect effects to cultural or paleontological resource require close evaluation during the assessment phase because they are not always as obvious or immediate as direct effects and can include effects that occur off site from the areas of construction and operation (BLM and USFS, 2004). Indirect physical effects to resources can include deterioration of structures or rock art from vibration, dust, or exhaust produced by construction or operation (BLM and USFS, 2004; BLM, 2003b). If the setting and feeling of a site are essential elements of its importance, visual or auditory intrusions or deterioration of the local environment would also cause indirect effects to the aesthetic quality of the site. Some indirect effects such as visual and auditory intrusion or acceleration of deterioration caused by vibration may extend a half-mile or more from the source, but are still essentially local. Lastly, some emphasis should be placed on hydrocarbon spills since the ability to get good carbon dating from some cultural or paleontological resources can be affected (USFWS, 2002).

Cumulative Impacts

In many cases impacts to cultural or paleontological resources are irreversible and, thus, can result in adverse cumulative impacts. The Advisory Council on Historic Preservation regulations implementing Section 106 of the NHPA (36 CFR 800) include a definition of adverse effect with respect to cumulative effects on significant historic properties. In terms of NEPA, adverse effects include reasonably foreseeable effects caused by the preferred alternative that would occur later in time, that would be farther removed in distance, or that would be cumulative (36 CFR 800.5). A determination of no adverse effect means that there is an effect, but the effect would not diminish in any way the characteristics of the cultural resource that qualify it for the National Register (BLM, 2003b).

Mitigation

Specific plans to mitigate potential impacts to cultural and paleontological resources should be identified and completed prior to project implementation. These plans should be developed in consultation with the SHPO, affected Tribes, other consulting parties and, if applicable, the private surface owner (BLM, 2003b). Mitigation of adverse impacts to cultural and

paleontological resources is best achieved by locating resources through comprehensive surveying and then adjusting well pad and access road siting to avoid them, as directed by federal mandate (BLM and USFS, 2004). For sites that can not be avoided, adverse effects can be mitigated through data recovery, such as archeological excavation. In situations when exploratory or development procedures unearth previously undiscovered resources, enforceable mitigation would require that work be stopped in the area of discovery until consultation with the SHPO/tribal historic preservation officer and the Advisory Council on Historic Preservation can be performed (BLM, 2003b; USFS, 2001; NPS, 1998). Appropriate and responsible action would be determined by these agencies and coordinated with operators and/or landowners.

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APPENDIX A

SWANSON RIVER OIL & GAS FIELD CASE STUDY

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Swanson River Oil & Gas Field Case Study

Location: Kenai Peninsula Borough, Soldotna, Alaska

Watershed: Cook Inlet Basin

Operator: Union Oil Company of California

A. INTRODUCTION

Kenai National Wildlife Refuge

The Swanson River Oil and Gas Field is located in South Central Alaska near Soldotna (refer to Figure 25) and is operated by the Union Oil Company of California (Unocal). The Field is situated within the Kenai National Wildlife Refuge (KNWR), which is managed by the U.S. Department of the Interior, Fish and Wildlife Service (USFWS), and is currently the only refuge in Alaska where commercial oil and gas production is permitted. KNWR is one of over 400 refuges in the National Wildlife Refuge System, a nationwide system of lands and waters managed by the USFWS. KNWR was first established as the Kenai Moose Range in 1941 to protect and provide sanctuary for resident moose populations, but the name of the range, as well as the purpose of the land (i.e., to manage all wildlife species), was thereafter changed by the Alaska National Interest Lands Conservation Act in 1980 to the Refuge's present status.

Hidden Lake within the Kenai National Wildlife Refuge
Photograph courtesy of the U.S. Fish and Wildlife Service

The KNWR is composed of 1.92 million acres of boreal forest of which 1.35 million acres is set aside as federal wilderness. Oil and gas development in the KNWR encompasses approximately 7,880 acres and accounts for only a small portion of the refuge's use. From a functional perspective, much of the land on the KNWR is available to the public and is

Figure 25 Cook Inlet Oil & Gas Fields

Relative location of the Swanson River Oil & Gas Field in the Cook Inlet Basin

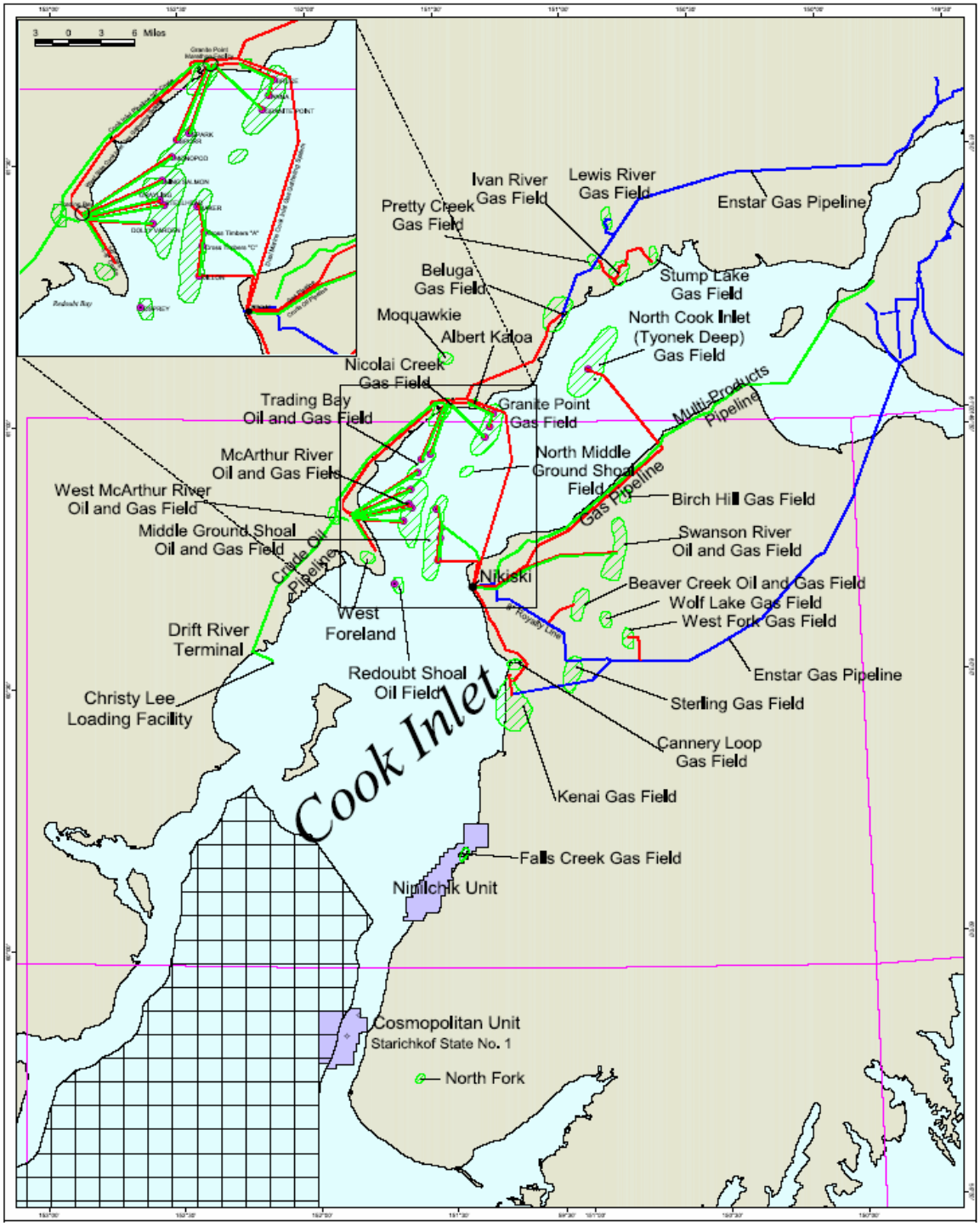


Figure courtesy of the Alaska Department of Natural Resources, Division of Oil & Gas.

predominately maintained by the USFWS for primitive recreational use. The refuge maintains 13 campgrounds and harbors many wildlife species that include brown and black bears, caribou, Dall sheep, mountain goats, wolves, lynx, moose, wolverines, eagles, and thousands of shorebirds and waterfowl.

Swanson River Oil & Gas Field

The Swanson River field is Alaska's first oil and gas field and in the minds of many, is the historical catalyst for Alaska becoming the 49th state (Kenai Peninsula Borough, 2004). Oil in the field was discovered by Richfield Oil Corporation in 1957 at a depth of 11,000 feet with a discovery well flow rate of approximately 900 barrels a day (Alaska Department of Natural Resources, 2004). The first major gas discovery occurred two years later by Unocal and the Ohio Oil Company as a by-product of the oil development (Alaska Department of Natural Resources, 2004). Swanson River has had three unit operators since 1957: Chevron USA (1957-1986); ARCO Alaska, Inc. (1986-1992); and Unocal Corp. (1992 to present).

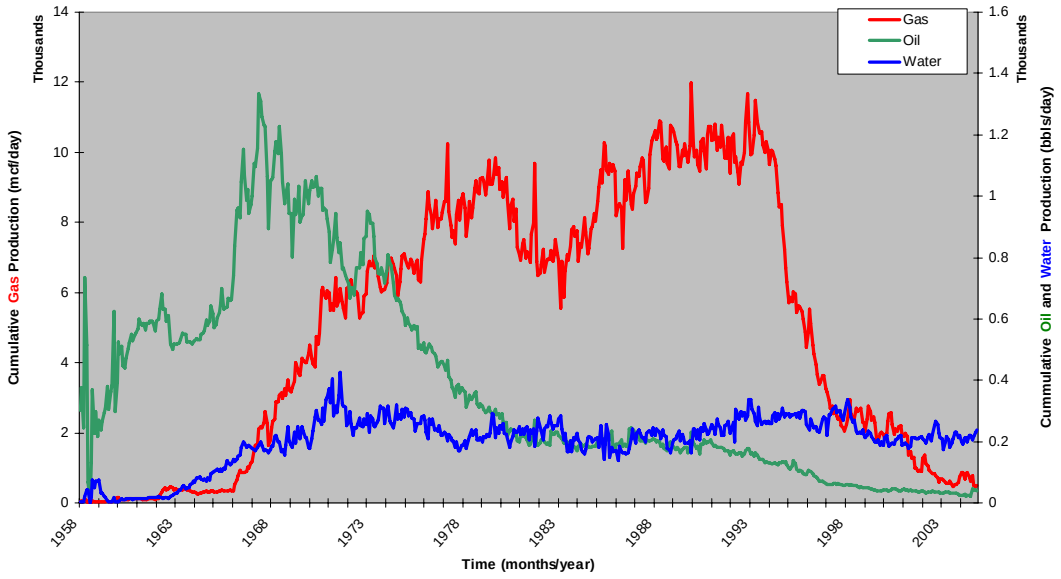
Well Site at Swanson River

After the Swanson River finding, additional wells were developed in Cook Inlet and more leases were approved throughout the basin. By 1959, 187,000 barrels of crude oil were produced annually in Cook Inlet (Alaska Department of Natural Resources, 2004). In 1969, the Swanson River field observed its highest oil production with 40,000 bbl/day. Early reservoir estimates conducted by the USGS projected a total of 437 million recoverable barrels of oil in the Swanson River field. In 1998, the field's cumulative production since discovery exceeded 225 million barrels, or in excess of over 50 percent of the original oil-in-place estimates (Frates, 1999).

As additional fields were discovered in the Kenai Peninsula area, surrounding markets for gas were developed to supply heat and generate electricity. By 1984, net annual natural gas production reached 217 billion cubic feet (bcf) per year, and peaked at 223 bcf in 1996 (Alaska Department of Natural Resources, 2004). As of 1999, approximately 80 million cubic feet of gas is transported daily to the Unocal Chemical Plant (Frates, 1999). All remaining gas is reinjected for formation pressure maintenance. Historically, the Swanson River field has been a major net gas producer in Cook Inlet, but more recently, as production rates have steadily declined, the Field is expected to primarily function as a gas storage facility (Alaska Department of Natural Resources, 2004).

As recently as 2003, the Swanson River oil and gas field was composed of 52 oil producing wells and nine gas producing wells, as well as one water and one gas injection well. As of May 2005, the field produced 13 thousand cubic feet per day (mcf/day) of natural gas (which is supplied to local utilities), 4500 gallons of propane, and 1,300 barrels per day (bbls/day) of oil and consists of 26 active wells, seven which are gas, and two class II UIC wells. Produced water production has slowly decreased from its high (14,000 bbls/day) to its current production of 6,000 bbls/day. From a cumulative perspective, 228,688,608 barrels of crude oil and 46,881,785 million cubic feet of natural gas have been produced from the field (as of January 2005). Figure 26 illustrates the historical cumulative production of the Swanson River Field.

Figure 26 Swanson River Oil and Gas Field Production



The "footprint" or surface use area of the Swanson River oil and gas field consists of approximately 43 miles of road, 60 well pads, 177 acres of building and storage areas, five residences, office and maintenance shop buildings, a compressor station for gas injection, an oil pumping station, and 35 acres of gravel and sand pits (Frates, 1999). The compressor station is the largest structure present on the field; whereas, field pads collectively account for the largest amount of surface occupancy. Additionally, a "market" pipeline runs across the refuge between the Swanson River Oil Field and the coastal town of Nikiski 20 miles to the west. The Field has the ability to store 80,000 gallons of propane via two 40,000 gallon above-ground storage tanks. Many of the roads within the KNWR were built by oil companies and are now used to reach campgrounds, hiking trails, a moose research center, and an outdoor educational center.

According to personnel located at the Swanson River facility, the oil and gas field observes approximately 20 to 25 spills a year, primarily as a result of pipeline leaks. Recently, the largest reported spill at the field occurred in 1997 and consisted of 1,300 barrels of oil and produced water. In 2005 (as of May), the field reported six spills to BLM and the USFWS. Of these six spills five were less than one gallon while the remaining spill consisted of approximately 600 gallons of produced water.

B. Objective and Purpose

The Swanson River case study provides a historical perspective of varying land management approaches by different regulatory agencies and demonstrates an example of conflicting objectives that can arise between management approaches. Additionally, this case study provides a reference for the complexities involved in managing oil & gas development on sensitive public lands. The use of the Swanson River oil and gas field for this case study was of particular interest, not only because of Alaska's considerable importance in the domestic production of oil in gas in the United States, but also because of the field's unique and complex operational and access challenges that must be overcome by both the operator and Alaskan regulators. Additionally, the KNWR is the only refuge in Alaska where commercial oil and gas production is permitted. Further justification can also be inferred for selection of this study area when one considers the importance of recently discovered oil and gas fields in other regions of Alaska when coupled with the ever increasing "resource impact" controversy which has arisen between environmentalist, operators, and regulators.

C. Regulatory and Historical Overview of the Kenai National Wildlife Refuge

To fully appreciate the array of regulatory challenges and complexities for oil and gas development in the KNWR, as well as to answer the "why" questions, it is important to consider certain historical milestones which, at a minimum, are partially responsible for the current regulatory climate observed at the refuge.

In 1920, the Mineral Leasing Act (41 Stat.43 7) was approved by legislature that provided language for the issuance of oil and gas leases on lands of the United States, including those lands reserved for wildlife refuges. Soon thereafter (1935), wildlife refuge specific legislature was approved that authorized the sale of oil and gas, and in 1947 the Secretary of the Interior was legally given the ability to issue leases for oil and gas on lands owned by the United States per the Mineral Leasing Act.

By the 1950's oil companies began extensive searches for oil throughout the Kenai Peninsula, including the refuge, as federal law had already released the area for exploration and development. The exploratory actions of oil companies in the refuge facilitated significant controversy in the area as concerns for leasing in Refuge lands were made. These concerns prompted the Secretary of the Interior to issue a directive to the BLM in 1953 (Frates, 1999). The directive suspended oil leasing in wildlife lands until a review of federal oil and gas practices could be conducted.

Anchorage Daily Times

RICHFIELD HITS OIL

PRODUCTION CHIEF FLIES HERE

Dulles Pleads For World Disarming

Alaska Talks, Thinks Oil As Predictions Spread

Swanson River Oil Discovery, 1957

Following some political bargaining, the first lease of 50,000 acres on the Refuge was submitted by the Atlantic Richfield Corp. of California (Richfield) on November 29, 1954, and was approved in 1956 even though from a bureaucratic perspective, the land was supposedly closed for development (Frates,

1999). The onset of political debate that followed gave way for the first documented guidance for the Refuge. Established in 1954 as an interim stipulations policy, the guidance document, as directed by the Bureau of Sport Fisheries and Wildlife (BSFW), prohibited the use of bulldozer operations or surface disturbances to roads, trails or other physical features.

In 1955 the USGS approved the Swanson River Unit Agreement which called for the formulation of a unit plan of development by the lessees for oil and gas fields located in a National Wildlife Refuge. The unit plan defined reservoir unit boundaries and spacing requirements for wells and required a single unit operator (Frates, 1999). Work began on the construction of what is now the Swanson River Road in the winter of 1956 and on July 19, 1957, the first oil discover was made by Richfield.

Later in 1957, Richfield teamed with Standard Oil of California (now Chevron USA), Union Oil Co. (now Unocal) and Ohio Oil (now Marathon) to strategically enhance the company's limited capital resources (Frates, 1999). The height of drilling activity occurred during the period from 1960 to 1962, during which time 51 oil development wells and eight gas wells were completed. In 1963, Chevron completed their Nikiski refinery and began processing Swanson crude, which was being produced at a rate of approximately 28,000 bbl/day (Frates, 1999). By the mid-1960's, oil production had climbed to over 33,000 bbl/day, and finally reached a peak in 1968 at 38,000 bbl/day from approximately 60 wells.

Cook Inlet Regional Corporation and the Alaska National Interest Lands Conservation Act

In 1972, the Cook Inlet Regional Corporation (CIRI) initiated a lawsuit against the Department of the Interior for improperly allocating entitlement lands in the Cook Inlet Region. The resulting settlement directed the United States to convey 16 sections of land (both surface and subsurface estate) in the Tustumena Lake area to CIRI and to remove these lands from the boundaries of the Refuge (Frates, 1999). Of these lands, CIRI was given entitlement to of all mineral subsurface estates for more than nine townships. Additionally, the new law further established guidance for resource exploration and development, specifically setting in motion procedural requirements for working within the KNWR (Frates, 1999). Ultimately, this lawsuit specifically provided for CIRI ownership of oil, gas, and coal within the KNWR.

One outcome of the newly established guidance was the promulgation of a Surface Use Plan which authorized CIRI and any contractor of its choosing to conduct operations on the refuge. The Surface Use Plan essentially called for review, comment and prior approval by the USFWS for an operating plan prior to any proposed work on entitlement lands. It also established the

need for stipulations and other appropriate rules and regulations in addition to holding CIRI and its cooperators responsible for any environmental damages.

The Alaska National Interest Lands Conservation Act (ANILCA) was passed in 1980 and is often called the most significant land conservation measure in the history of the United States. The promulgation of ANICLA, which protects over 100 million acres of federal lands in Alaska, effectively doubled the size of the United States national park and refuge system and tripled the amount of land designated as wilderness (Frates, 1999). As part of this act, refuge lands were classified to identify areas that would not be subject to oil and gas leasing. In affect, ANILCA expanded the national park system in Alaska by over 43 million acres, creating ten new national parks and increasing the acreage of three existing units. Prior to ANILCA, 771,000 acres, or 45 percent of the Kenai refuge, was opened to leasing. In 1980, the ANILCA wilderness designations reduced the area subject to future leasing to about 536,000 acres, as oil and gas leasing is prohibited in wilderness (Frates, 1999). To date there are now 18 national wildlife refuges in Alaska encompassing more than 78 million acres.

Prior to passage of ANILCA, decisions concerning oil and gas development were essentially handled at the Refuge level through a process of special use permits. However, following passage of the act, the scope of USFWS involvement expanded considerably. The most notable effect was in the extended time periods for project review and authorization. Most pertinent to the Kenai Refuge was Title 11 of the act which resulted in the codification of procedural requirements for rights-of-way application, environmental review and assessments (Frates, 1999). Additionally, ANILCA was the catalyst for promulgation of the Alaska Natives and the Land Claims Settlement Act (ANSCA) of 1971, which significantly increased private mineral inholdings within the KNWR.

ANILCA also defines refuge purposes, specifies planning and management requirements, and authorizes studies and programs related to wildlife and wildland resources, commodity resources, and recreational and economic uses (oil and gas exploration and development, subsistence opportunities, access, and transportation and utility systems). It gives specific guidelines for administration of refuges including directions that all uses must be compatible with the purposes of the refuge or they may not be permitted.

Current Regulatory Considerations for the KNWR

Currently, the KNWR is not open to leasing for oil and gas activities except for those which have been historically established (e.g., Swanson River) or have subsurface inholdings selected by CIRI. Inholding access is granted under the terms of ANSCA and whose right of access was affirmed by ANILCA.

Bureau of Land Management

The BLM is responsible for the leasing of federal oil and gas minerals. BLM is also responsible for supervising the exploration, development and production operations of these resources on both federal and Indian lands. BLM's operational authority is conducted pursuant to the regulations and the Surface Operating Standards for Oil and Gas Exploration and Development (3rd edition). A more detailed discussion of BLM regulations and policies is contained in Chapter 4 of this document.

In Alaska, the role BLM plays in the development of oil and gas differs, to a certain extent, from that which is experienced in the States of the Continental United States, e.g., Montana, Wyoming, New Mexico, etc. The primary reason for this is two-fold:

(1) Alaska is comprised of approximately 365 million acres of which 90 million acres (to date) are owned by the state. The federal government is the largest landowner in Alaska with 60 percent of the total area (222 million acres), but of this only 77.9 million acres is administered by the BLM. More importantly in situations where the USFWS manages the surface of these BLM lands, as is the case at the Swanson River field, oil and gas related development supported by BLM is contingent upon approval from the USFWS based on priorities and compatibility land uses, often which counter or severely restrict the BLM approval process.

(2) BLM is currently not administering oil and gas leases, and is not expected to do so until revised BLM specific guidance, e.g., Resource Management Plan (RMP) and/or Land Use Plan are completed. Thus, BLM decisions for NEPA related projects/issues are currently being managed under "representative" Environmental Assessments when resource impacts are deemed similar. (Note: Potential regulatory changes to the oil and gas process that may result from a revised RMP in Alaska were unknown during development of this document.)

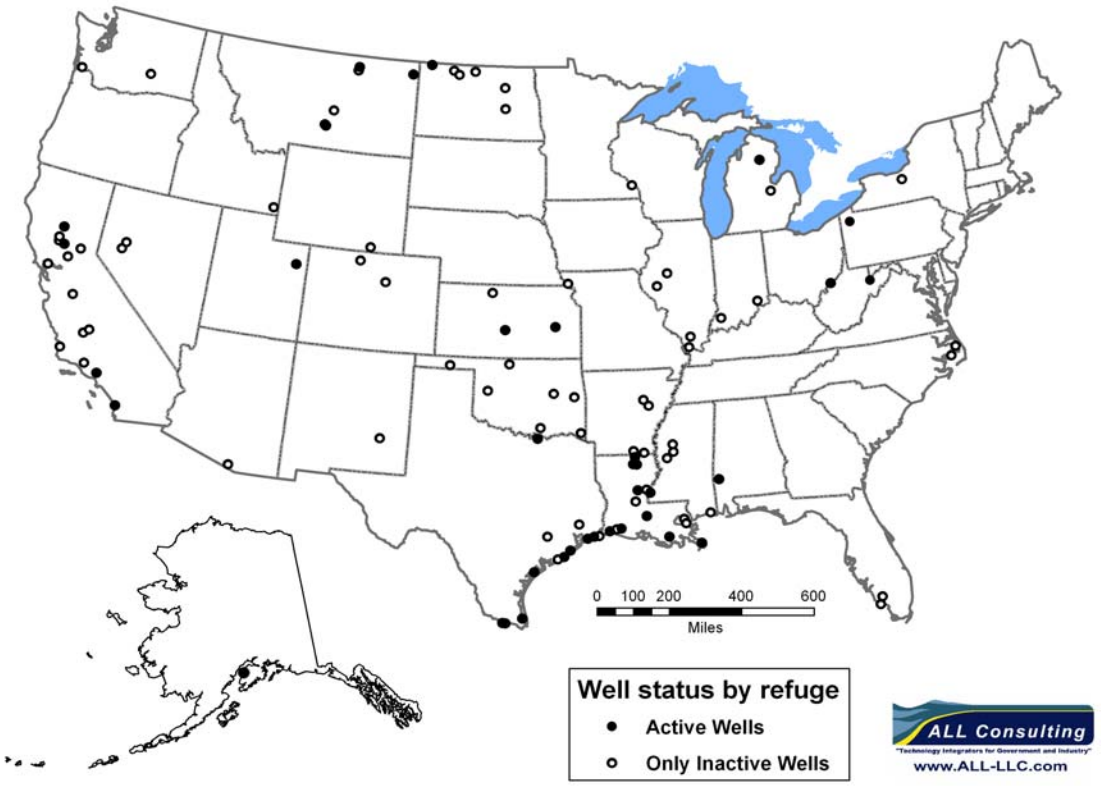
U.S. Fish and Wildlife Service

Pursuant to the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, administration of the national wildlife refuges is delegated to the USFWS. Regulations for the entire Wildlife Refuge System are contained in 50 CFR Part 25-36. Figure 27 delineates those NWR's withi oil and gas wells.

The USFWS manages approximately 71.0 million acres in Alaska to protect resources and conserve fish and wildlife.

The USFWS regulates surface uses of the refuge and have the authority to require rights-of-way for certain uses outside the scope of oil and gas production such as the transportation of oil, natural gas, synthetic liquid or gaseous fuels. However, the USFWS authority does not extend to uses associated with oil and gas production under valid leases on lands administered by the USFWS or include gathering lines and associated structures used solely in the production of oil and gas. A more detailed discussion of USFWS regulations and policies is contained in Chapter 4 of this document.

Figure 27 National Wildlife Refuges with Oil and Gas Wells



Evaluation of USFWS Policies and Regulations

The USFWS plays a vital role in how, where, and when oil and gas development can occur at the Swanson River field. Because of ANSCA as well as other federal requirements (NEPA), the KNWR is managed in a comprehensive manner to control resource impacts by following procedures and plans promulgated under a series of National Wildlife Refuge specific documents. These policies can and do directly affect access to federal lands for oil and gas development, and for this reason warrant further consideration. Additionally, in some cases, the execution or requirements contained within these documents differs in Alaska from those found in other regions, which further justifies discussion in this case study.

The remaining portion of this case study provides a discussion for those USFWS plans and policies that can affect the development of oil and gas on National Wildlife Refuges. Additional discussion in this Section provides a relative comparison of these policies to those policies of other federal management agencies including BLM oil and gas management approaches specific to BLM designated sensitive lands. It should be noted that the intention of this case study is not to criticize or judge the policies of federal land management agencies, as the protection and conservation of resources is of vital importance. It is hoped, however, that an evaluation of these policies will aid in the identification of a process or tool that can be utilized to expand or expedite the access process, while at the same time, legitimately protect sensitive resources.

The KNWR Purpose and USFWS Compatibility Determinations

The primary purpose of the KNWR is specific to protecting Alaskan wildlife such as moose, bear, mountain goats, Dall sheep, wolves, and salmonoids and their associated habitats. Approved permitted actions or land uses of the KNWR are limited to certain recreational uses and include sightseeing; nature observation and photography; interpretive centers and exhibits; hunting and fishing; bathing; boating; camping; ice skating; picnicking; swimming; and water skiing. The purposes of Kenai Refuge, as stated in ANILCA, are unique among the 16 refuges in Alaska in two aspects. First, Kenai is the only refuge for which opportunities for compatible fish and wildlife-oriented recreation is a major purpose. Second, Kenai is the only refuge for which provision of subsistence use opportunities is not a major purpose. Additionally, the purpose of this refuge, as specified by ANILCA, conforms to general objectives outlined under the National Wildlife Refuge System Improvement Act and includes:

- To fulfill the international treaty obligations of the United States with respect to fish and wildlife and their habitats;
- To ensure water quality and quantity;
- To provide opportunities for research, interpretations, environmental education, and land management training; and
- To provide in a manner compatible with these purposes, opportunities for fish and wildlife-oriented recreation.

Compatibility regulations pursuant to the National Wildlife Refuge System Improvement Act of 1997 were finalized in October 2000, and essentially allow the USFWS to manage and restrict land uses within all National Wildlife Refuges (NWR). In principle, a compatibility determination is the fundamental USFWS regulatory process for any NWR in the United States which provides refuge managers with the basic guidelines to establish the legitimacy of proposed actions, e.g. road construction, hunting, facility development, etc., relative to compatibility and the purpose for any given refuge. The determination of compatibility is fulfilled through the development of refuge specific Comprehensive Conservation Plans (CCP), which are congressionally mandated plans for providing broad policy guidance and establishment of long-term goals and management objectives on refuges (Frates, 1999).

Currently, federally owned oil and gas rights on NWR lands in the Continental U.S. are not available for leasing as oil and gas activities are deemed incompatible with the purpose of NWRs. However, in a decision by the Interior Board of Land Appeals in 1981, it was determined that the prohibition against oil and gas leasing on "refuge lands" did not include lands acquired from other sources. In this situation, the persons holding those privileges have the full right to develop their minerals as long as reasonable regard for the surface estate, as required by state law, is met. Because of this decision, the USFWS does not have authority over non-federally owned minerals located under NWR lands in the continental United States, with several exceptions, nor does the USFWS have the authority to conduct oil and gas related compatibility determinations over non-federally owned minerals, again with several exceptions, including Alaska (Frates, 1999). Table 12 depicts the current ownership status of the KNWR as presented in the Draft Swanson River Satellites Environmental Impact Statement.

Table 12 Land Status of the Kenai National Wildlife Refuge

Land	Ownership	Acres Patented or Interim Conveyed (IC)	Acres Selected Remaining	Entitlement in Kenai Refuge
Surface	Kenai Natives Association	16,767.55 (IC) 803	3,596.34	1,204.02
	Point Possession, Inc.	4,481.32	0	0
	Salamatof Native Assoc., Inc	15,815.98	44,123.56	
	Tyonek Native Corporation	31,620.15	0	0
	Native Corp Conflicting Selections	0	77,158.00	0
	CIRI Cemetery & Historic Sites	0	2,147	680
	CIRI Other	0	165	0
	Native Allotments	79.97	210	≤210
	Small Parcels	289.97	0	0
	State of Alaska	1,136.90	7,425	0
Subsurface	CIRI Coal, Oil, Gas Only	180,256.11 (IC) 5,883.85	49,456.60	≤36,537
	CIRI Entire Subsurface Estate	13,627.68 (IC) 526.76	0	0
	State of Alaska Entire Subsurface Estate	0	7,425	0
	State of Alaska Mineral Estate	0	97,561	0

In Alaska, the USFWS is authorized to perform compatibility determinations (on non-federally owned and federally owned lands) for oil and gas development because of provisions set forth under ANILCA. Although refuges in Alaska are open for oil and gas leasing (with the exception of the Arctic National Wildlife Refuge (ANWR)), in 1999 oil and gas development in the KNWR was deemed incompatible by the USFWS. Therefore, *new* oil and gas development or leasing on the refuge's lands is not permitted.

A compatible use is defined as "a proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purposes of the national wildlife refuge." Although guidelines for compatibility determinations do not specifically address oil and gas development, FWS regulations specific to NWR's do not allow compatibility provisions for the replacement of lost habitat values or other compensatory mitigation. Thus, this regulation affectively prohibits new surface disturbance actions that will impact habitats, an action which is often observed during the construction phase of development.

Oil and gas development on NWR's may also be delayed or prohibited thru the compatibility process because refuge managers typically do not have experience specific to oil and gas and may not understand the impacts associated with development or how mitigation or best management practices can be used to minimize impacts. In any case, compatibility determinations are often implemented when a refuge manager perceives that a proposed action may be contrary to the purpose of the refuge. A summary of the information that is used by the refuge manager to perform a compatibility determination is listed below:

- The proposed or existing use;
- The purpose of the refuge;
- The purpose of the NWR;
- Is the use a priority public use?
- Where would the use be conducted?
- Why is the use being proposed?
- The expected impacts of the use on the refuge's and National Wildlife Refuge purposes; and
- Whether the use is compatible or not compatible.

Unocal Gas Storage Compatibility Determination

The following example describes a recent compatibility determination that was performed as part of a request by Unocal to expand their storage facilities in the Swanson River field. Information collected for this description was gathered from publicly available documents.

Until recently, Unocal has been injecting gas into a depleted gas reservoir during the summer months (when there is an excess in supply) and producing that gas back during the winter months (when demand exceeds supply). All of the gas placed into storage had physically come from Sterling, Beluga, and Tyonek gas wells within the Swanson River Field. Gas was produced from the Swanson River field wells into existing gas gathering facilities, compressed with existing compressors, and, instead of being sold off-lease, was piped to the gas storage wells.

Unocal estimated that by 2005, additional storage capacity (additional wells/reservoirs) would be required to handle forecasted seasonal deliverability demand. In order to address this seasonal demand, Unocal submitted a request to BLM to create additional storage capacity. To facilitate seasonal deliverability under this new request, it would be necessary to supplement gas that is physically produced from Swanson River Field and injected into storage with gas that is physically produced outside of the Swanson River Field. Upon approval, this "outside gas" would be transported to the Swanson River Field via the existing gas pipeline, compressed with existing compressors, and piped to existing and newly designated storage wells.

As stated earlier, sub-surface or "down hole" operations within the field are administered by the BLM under the provisions of the Minerals Leasing Act, whereas, surface use and occupancy are coordinated with the refuge via the provisions of a lease agreement and through the review and approval of annual plans of development and operations. Activities within the lease area for exploration and development of oil and natural gas are legal entitlements held by Unocal and are not subject to a compatibility review. However, because the new storage capacity was not designed for production purposes, i.e. gas injection, the USFWS believed gas storage was not a legal entitlement of the operator within the field's lease. (It should be noted the Secretary of the Interior, via Minerals Leasing Act regulations, has the discretion to authorize gas storage, but is not required to do so.)

Upon a regulatory review by Unocal, it was argued that the USFWS did not have the authority to require rights-of-way for certain uses outside the scope of oil and gas production, e.g., transportation of oil, natural gas, synthetic liquid or gaseous fuels, with the exception, (as stated earlier), that the authority does not extend to uses associated with oil and gas production under valid leases such as gathering lines and associated structures used solely in the production of oil and gas (50 CFR 29.21-9 and 43 CFR 2881.3) (Unocal Memorandum, 2004). From this the question arose, is gas storage a normal or necessary element of oil and gas development? Although open for interpretation, it was argued that gas storage is a reasonably and ancillary component that is necessary for oil and gas production.

To further justify this interpretation, under 43 CFR 3101.1-2 the owner of a severed mineral estate has the right to use so much of the surface estate "as is reasonably necessary to enjoy the severed mineral estate" (Unocal Memorandum. 2004). That is, the lessee is granted the exclusive right and privilege to drill for, mine, extract, remove and dispose all the oil and gas deposits with the right to construct and maintain thereupon, all works, buildings, plants, waterways, roads, telegraph or telephone lines, pipelines, reservoirs, tanks, pumping stations, or other necessary structures (Unocal Memorandum, 2004).

After significant debate, in the end the USFWS approved Unocal's request for construction of additional storage facilities since their belief was that additional gas storage would not contribute additional impacts to the refuge over entitled production operations currently permitted within the area. Although the conclusion was that such normally permitted activities may have significant long-term impacts on fish and wildlife, their habitats, and the refuge's ability to manage for its mandated purposes, such operational actions were considered beyond the purview of a compatibility review.

The important consideration here was not the regulatory justification of Unocal's request, or even the USFWS defense for the need to perform a compatibility determination for such a request, but that compatibility determinations and the policies which dictate them allow for interpretation, or in this case, provide unclear guidelines for refuge managers to follow. The types of determinations that are performed at any given refuge are typically directly related to the purpose of the refuge. Although the purpose of each refuge, to a certain extent, is dependent on the critical resources that the refuge was designed to protect or conserve, the underlying policies which govern each NWR remains the same - that is, to develop a national program of wildlife and ecological conservation and rehabilitation.

From this it seems reasonable to infer that clarification is needed at the national level to aid in the identification of compatibility issues common to all NWR's, or those issues which are likely to occur, as well as appropriate procedures to mitigate unnecessary resource impacts for already approved actions. Further more, a better defined oil and gas national policy would provide refuge mangers with the ability to efficiently evaluate issues which affect them the most and subsequently, allow for a more informed, consistent decision.

KNWR Comprehensive Plan

Currently, the existing Comprehensive Conservation Plan (CCP) for the Kenai refuge which was approved in 1985 is being revised per ANILCA requirements and is scheduled for final approval

in 2006. Draft versions of the new CCP were not available during the time of this report, with the exception of the proposed alternatives and, therefore, subsequent discussion of the KNWR CCP in this section is based on the 1985 CCP.

A CCP is a congressionally mandated plan which serves as a "master" plan, providing broad policy guidance and establishment of long-term goals and management objectives for the USFWS on the refuge. Interestingly, the concept and requirements for a CCP originated in the KNWR as part of the requirements established under ANILCA. Later, in response to congressionally acted law, USFWS managed refuges in the continental United States were required to adopt similar CCP's for their own use.

In general, a CCP will contain a description of the existing environment on the refuge, a discussion of management alternatives and impacts, and an assessment of the long-term effects of implementing these alternatives on refuge resources. Section 304(g) of ANILCA contains the requirements for comprehensive conservation planning specific to Alaska. One such requirement dictates the specification of uses within the refuge that are considered compatible with the major purposes of the refuge. It also specifies that prior to developing a plan for any refuge, the Secretary of the Interior is required to identify and describe:

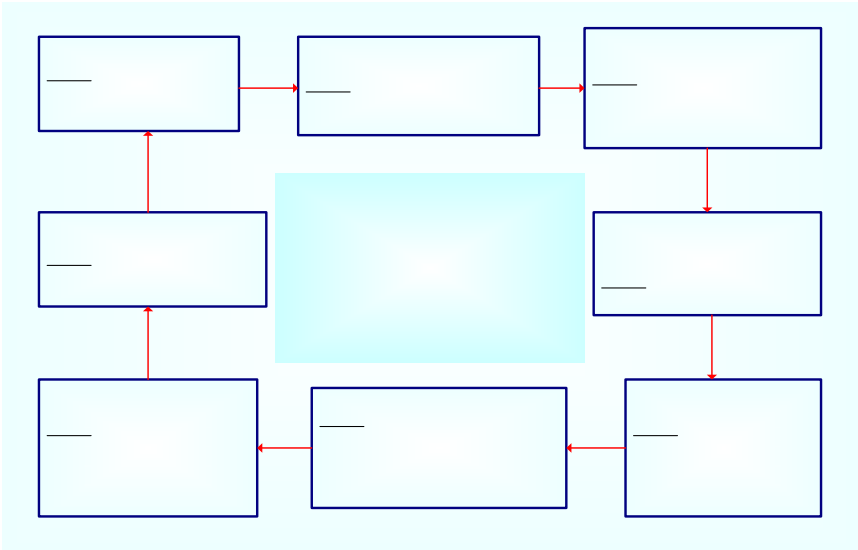
- Populations and habitats of fish and wildlife resources of the refuge;
- Define special values of the refuge, as well as any other archeological, cultural, ecological, geological, historical, paleontological, scenic, or wilderness values of the refuge;
- Identify areas within the refuge that are suitable for use as administrative sites or visitor facilities;
- Present potential requirements for access with respect to the refuge; and
- Identify significant problems which may adversely affect the populations and habitats of fish and wildlife.

Additionally, Section 304(g) of ANILCA gives specific directions to the USFWS to account for and protect "special values" present in Alaskan refuges, as well as archeological, cultural, ecological, geological, historical, paleontological, and scenic values. Oil and gas activities are prohibited in an area considered as a special value. However, none of these values are impacted by the Swanson River oil and gas activities. According to the existing KNWR CCP, six special values have been identified:

- Harding Ice Field;
- Tustumena-Skilak Benchlands;
- Kenai River and its Tributaries;
- Chickaloon Watershed and Estuary;
- Lowland Lake and Canoe System; and
- The Skilak Loop Area

The planning process (refer to Figure 28) used to develop the CCP for NWRs is designed to fulfill the legal mandates as well as the administrative requirements pertaining to all units of the NWR system. Each plan contains management alternatives which represent a long-range strategy and a broad framework for management and use of refuge resources. In the KNWR, each alternative is developed and evaluated via the NEPA process, i.e., Environmental Impact Statement, based on the purposes of the refuge as set forth in ANILCA.

Figure 28 The Comprehensive KNWR Planning Process



In Alaska, other than the Arctic National Wildlife Refuge, a refuge may be open to oil and gas leasing if such a use is found to be compatible with the purpose for which they were established. The determination of compatibility is fulfilled through the development of a refuge CCP. As stated earlier, in 1999 new oil and gas development was deemed as an incompatible use on the KNWR. However, inholders with valid surface or subsurface are afforded adequate and feasible access subject to reasonable regulations to protect the refuge's values in accordance with section 1110(b) of ANILCA.

In addition, to further support oil and gas development in the refuge, the State of Alaska specifically requested that development of the new CCP "…remain flexible regarding new oil and gas facilities or modification of existing facilities". In other words, the USFWS has the complicated responsibility of balancing the protection of critical resources specific to the KNWR while approving state supported oil and gas production that in some instances may counter the purpose of the refuge.

In the existing KNWR CCP, oil and gas development is described as a "significant problem". However, specific details to mitigate or manage the effects of oil and gas development are not provided. Instead, the CCP is limited to a general discussion in regards to the purpose of the refuge and broad issues which are being propagated by oil and gas related activities. Such discussion within the CCP is as follows: "Existing laws recognize the need for energy development as well as wildlife, wilderness, and recreation and resource protection. Refuge management will be challenged to meet the requirements of sometimes conflicting management goals. Innovative and costly management actions will be needed to avoid or minimize adverse impacts of these industrial developments."

Thus, it is apparent that specific management decisions or processes, as they pertain to oil and gas, are not contained within the overall "master" management objectives of the refuge, but rather are handled on a case by case scenario via the compatibility determination process when appropriate. Furthermore, content requirements contained within the CCP in Alaska are not driven by USFWS policy in general, but rather are encapsulated in stipulations specified under ANILCA. The promulgation of ANILCA and the subsequent effects the Act had on refuges in Alaska (or specifically the KNWR) can be looked upon as a necessity given Alaska's unique position in the oil and gas industry. However, one glaring consequence of the ACT again is the USFWS's inability to formulate consistent nationwide policy.

In the case of oil and gas development on Alaska refuges, the USFWS has the responsibility to satisfy ANILCA requirements, as well as there own, while at the same time appeasing state request to allow for flexible oil and gas management. As a result, this struggle can slow the oil and gas development process even for those operators who have been afforded certain mineral privileges under existing lease agreements.

Summary of Federal Agency Oil & Gas Surface Management Policies on Sensitive Lands

Although the BLM is responsible for leasing federally owned oil and gas minerals, as well as supervising the exploration, development, and production operations of these resources, they are also responsible for protecting and managing BLM specific sensitive lands, designated by BLM as Areas of Critical Environmental Concern (ACEC). ACEC's are locations where special management attention is required to protect and prevent irreparable damage to important historic, cultural, or scenic values; fish and wildlife resources; or other natural systems or processes or to protect life and safety from natural hazards. The ACEC program was conceived in the 1976 Federal Lands Policy and Management Act (FLPMA), which established the first conservation mandate for the BLM. The management of sensitive resources, which define an ACEC, is identified within the framework of a Land Use Plan or regional RMP and the impact analysis of these resources is evaluated per the NEPA process. Proposed surface disturbance activities within any given ACEC are only approved when the protection and conservation of "relevant and important values" can be assured.

BLM national policies and regulations do not prohibit oil and gas development on ACEC lands nor do they specifically address oil and gas development in ACEC's. Instead procedures to address and evaluate development within an ACEC are provided under the general framework of BLM policy, as well as BLM's statutory requirements to protect public lands. In any case, the management of resources within ACEC lands is accomplished through development of regional RMP's, which are generated and administered by BLM field offices. BLM field offices are also required to stringently evaluate potential impacts to ACEC resources through the NEPA process to assure resource management strategies (protection and conservation) identified in the RMP can be successfully implemented.

In most cases, approval for oil and gas development on ACEC lands is granted by the BLM, although difficult, when proposed protective stipulations and mitigation measures can be utilized to minimize or prevent resource impacts. In situations where impacts to ACEC defining resources cannot be effectively managed for protection, then development for that particular area is not permitted. Unlike the USFWS, as discussed above, BLM policies allow for a moderate level of flexibility that enables the development of oil and gas when the protection of sensitive federal lands or resources can be demonstrated.

When comparing the regulations of the BLM, the USFWS, the USFS and the NPS and the affects these regulations have on oil and gas development, it is clear that the USFWS and the NPS have the most stringent internal energy policies. As discussed in Section 4 of this document, current NPS policies, as with USFWS policies, prohibit new federal leasing. For these two agencies, leasing can only be approved when prospective operators can legally demonstrate that they hold rights to valid mining claims, federal mineral leases, or non-federally owned minerals. It is important to consider however, that even under these ownership scenarios, leasing of surface lands for exploration or development proposes is typically impeded or delayed because of surface use restrictions, stipulations or other relevant policies (refer to Section 4).

The USFS on the other hand is curtailing policy and taking advantage of certain categorical exclusions established by the Energy Policy Act to encourage development on surface lands they manage when certain protective conditions can be satisfied (refer to Section 4). Although the oil and gas policies of the USFS are still limiting, oil and gas development can occur on lands with restrictive stipulations, as specified under their land management plans, when impacts to protected resources can be properly evaluated through the NEPA process and effectively mitigated by use of common and successful industrial practices. This new proactive approach and realization for the potential of maintaining a legitimate balance with environmental protection and resource development, as well as establishing energy policy more consistent with that of BLM's, may provide a future policy template and catalyst for energy development on federal lands.

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APPENDIX B

BADGER HILLS COAL BED NATURAL GAS CASE STUDY

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Badger Hills Coal Bed Natural Gas Case Study

Location: Bighorn County, Montana

Watershed: Tongue River Watershed

Operator: Fidelity Exploration & Production Company

The Badger Hills case study presents a comparison of the impacts predicted in both the Programmatic Final Environmental Impact Statement (FEIS) for Coal bed Natural Gas (CBNG) development in Montana, and the BLM's EA for the Fidelity Tongue River-Badger Hills Plan of Development to actual impacts that have been monitored or observed to various resources. The impact analyses referenced in this case study were performed to meet National Environmental Policy Act (NEPA) and Montana Environmental Policy Act (MEPA) requirements for the regulatory agencies which oversee CBNG development in Montana. Fidelity's Badger Hills Project was an expansion of existing CBNG development in Montana (CX Field) which included 5,500 acres of mineral leases of which slightly less than 60 percent were on federally managed mineral estates. Assessment of the impacts predicted for the Badger Hills EA and MT FEIS include an evaluation of the assumptions used in each document which are the basis for development of the impact analysis contained within each document.

There are inherent differences in the assumptions for each document because the MT FEIS was a programmatic evaluation of CBNG development and the Badger Hills project is site-specific expansion of an existing CBNG field. These differences related to the data used to perform the impact analysis and include differences in the expected well life, density of CBNG wells, number of producing coal seams, rate of water production, and per well surface disturbance. An evaluation of the estimates of acres from surface disturbing activities which is used as the basis for the development of impact predictions for several resources including wildlife, soils, vegetation, and cultural resources, showed a considerable difference based on the assumptions utilized in each document.

For some of the resources impacts between the two assessments could not be directly compared without extrapolating the statewide programmatic assessment from the MT FEIS to the project level of the Badger Hills EA. These included lands and realty impacts, and social and economic impacts. Furthermore, predicted impacts for these resources could not be compared to actual or observed impacts because there have been no surveys conducted to identify what actual impacts may have occurred at this time. Some comparison was facilitated to illustrate differences in the modeling approaches and the results for the air quality impacts, while for the

social and economic impacts information was extrapolated from outside sources to indicate that impacts (both positive and negative) have not be realized in the local area.

For some resources monitoring data was available for comparison including limited air quality data, surface water flow and quality data, and groundwater levels. Surface water impacts predicted in the MT FEIS and Badger Hills EA to date have not been realized in terms of increased flow in the Tongue River and decreased water quality (increased EC and SAR). Surface water monitoring data comparisons from USGS gauging stations along the Tongue River indicate no observable changes as most data shows comparable flow and quality to predevelopment conditions. Analysis of predicted water production values from the MT FEIS and Badger Hills EA when compared to reported groundwater production data from the MBOGC indicate that the predicted volumes are nearly 7 times greater than the average reported production from the Badger Hills CBNG wells. Groundwater monitoring data collected by Fidelity indicates that the predicted radius of drawdown from the Badger Hills EA is not being realized, with drawdown from the Dietz coals in 2004 extending less than 0.8 miles from the producing field, approximately 40 percent of the distance predicted in the Badger Hills EA. Actual impacts to other resources have not been documented in follow-up monitoring reports, but generally, the smaller acreage of surface disturbance and lower produced water volumes have resulted in lesser impacts to most of the resources than the NEPA analysis had predicted.

A. Introduction

The development of impacts for the programmatic MT FEES and the project level Badger Hills EA are based in part on assumptions used to develop their respective analysis. For the MT FEIS the assumptions were generated based on the rational of developing a full-field statewide analysis for CBNG development, while the Badger Hills EA assumptions were based on information provide to the BLM by Fidelity as defined in the Badger Hills Plan of Development. In order to facilitate a relative comparison of the impacts predicted from each document some of the MT FEIS analysis had to be interpreted from the programmatic level in the MT FEIS to the project level of the Badger Hills EA. The interpretation included assessing per well impacts when available in the MT FEIS to the number of wells being developed in the Badger Hills POD, or by assessing the impacts for Big Horn County to the level of development predicted in the MT FEIS to have occurred by year two. Direct, indirect, and cumulative impacts from the Badger Hills EA as described for Alternative C are compared to the impacts predicted from the MT FEIS as described for Alternative E.

B. Objective and Purpose

Ultimately, the objective of this case study is to validate the impact calibration methods and results discovered during the project's phase I research efforts by applying data from a practical "real life" scenario to a series of comprehensive calibration and evaluation tools. It is hoped that the use of a real world check and balance study will sharpen the analysis to better forecast actual resource impacts and provide field tested feedback to the research team to allow for identification of additional research needs. By providing a consistent approach to conducting oil and gas impact analyses under NEPA requirements and by developing a series of "smart" scenario evaluation tools, agencies and preparers will have an improved understanding of predicted impacts vs. actual impacts allowing decision makers to have more confidence in their development choices. Ultimately, this will help expedite the NEPA process, as well as increase access to Federal lands for oil and gas development.

C. Assumptions Used in Developing the Comparisons of Impacts

Impact comparisons from the MT FEIS are evaluated for Big Horn County, Montana, and assume the timing of this project to equate to year two of the MT FEIS analysis timeline from the impact analysis in the MT FEIS. When available, predicted impacts are drawn directly from the MT FEIS for Big Horn County; however, these impacts are not always available so equivalent level of development assumptions have been made to assess comparison of impacts from the MT FEIS and the Badger Hills EA. The following discussion compares and identifies the assumptions used in the determination of impacts from the Badger Hills EA to the assumptions used in the development of impacts for the MT FEIS. Table 13 presents a series of assumptions that were utilized for the impact analysis for the preferred alternatives for the MT FEIS and the Badger Hills EA. These assumptions were the basis for the development of level of impact that could be expected to occur to various resources. Data presented in Table 13 for the Badger Hills EA assumptions account for a shorter duration than the MT FEIS, and reduced relative impacts from surface disturbance activities and hydrologic resources.

Table 13 Comparison of Assumptions from MT FEIS and Badger Hills EA

Assumptions presented for both the MT FEIS and Badger Hills EA represent assumptions that were common to all alternatives.

Assumption	MT FEIS	Badger Hills EA
Well Life	20 years	10-15 years
Well Spacing	1 well per seam/80 acres	1 well per seam/160 acres
No. of Productive Coal Seams	Up to 3 seams	Up to 5 seams
Surface Disturbance per Well[1]	3.25 (2.00)	1.68
Initial water production rate	14.661 gpm	14 gpm
Decline in water production	$Q = 14.661e^{-0.0242x}$	20% annual decline

1. Surface disturbance per well represents total construction acreage disturbed for the well and associated roads and facilities, for the MT FEIS construction and reclaimed operation values are presented.

D. Surface Disturbance Impacts

Surface disturbance impact comparisons are based on calculations from data from the FEIS, Badger Hills EA and actual values from the project. Table 14 presents a comparison of the impacts based on the number of CBNG wells present in the Badger Hills Plan of Development. The data in the Table provides a comparison of pre and post construction disturbance values for the wells based on ownership. Column 2 from Table 14 presents predicted impacts calculated to estimate the number of disturbed acres that were expected to result from the Badger Hills project if develop occurred as described for a typical CBNG project as detailed in the MT FEIS. Using data from the Badger Hills POD and EA, a total of 177 new CBNG wells would be drilled and put into production under this project with one previously drilled well being brought into production for a total of 178 producing CBNG wells (BLM, 2004c). The new CBNG wells for the project include 92 wells completed on MBOGC managed minerals and includes private (72 wells) and state (20 wells) minerals, and 85 wells completed on federal minerals. Column 3 presents the total disturbance area based on data that was provided by Fidelity during the development of the EA. The values in the Badger Hills Actual column are based on data provided by Fidelity for the construction disturbance that would result from their proposed developed (Table 14, column 4). The disturbance values are broken down by mineral ownership because the BLM can require mitigation measures on federally managed minerals that are not applicable to fee and state minerals; therefore, the disturbance from the Badger Hills POD federal wells is less than the fee and state wells. The actual disturbance values in Table 14 are much less than the

predicted level of surface disturbance from the Badger Hills project with actual disturbances at 35 percent of the construction and 17 percent of the production disturbance based on the MT FEIS calculations. While the Badger Hills EA closer to actual the disturbance predictions were nearly 2X greater than actual disturbances.

Table 14: Surface Disturbance Acreage for the Badger Hills Project.

The table provides calculated acres of surface disturbance using the MT FEIS assumptions and the number of wells from Badger Hills POD, Badger Hills EA values are from the Badger Hills POD.

Wells by Mineral Ownership	MT FEIS Construction / Production Disturbance (acres)	Badger Hills EA Construction / Production Disturbance (acres)	Badger Hills Actual Construction / Production Disturbance (acres)
72 Fee	175.5 / 144	199.5 / 121 1	62 / 24.6
20 State	48.7 / 40		17.2 / 6.8
85 Federal	207.2 / 170	98.5 / 17	73.2 / 29.1
Totals	**431.4 / 354**	**298 / 138**	**152.4 / 60.5**

1. The Badger Hills EA computed the Total Disturbance for the fee and state well sites together under Alternative A.

Table 15 provides a detailed breakdown of the disturbance analysis showing the individual components which were identified as necessary by Fidelity in the Badger Hills Project Plan of Development. Table 15 shows the relative disturbance broken down for short term and long term disturbances as well as providing a separate accounting for the disturbances associated with the federal wells. Table 15 shows that the level of access roadway surface disturbance impacts that were predicted using the MT FEIS assumptions (73.6 acres) is 160 percent greater than the level of disturbance from access roadways that Fidelity presented in the Badger Hills Plan of Development (45 acres). Fidelity was able to reduce long term impacts from roadways by obtaining the necessary access for the project by making use of existing roadways, which reduced the total road related surface disturbance impacts was reduced by 28.6 disturbed acres, which corresponds to a 23 percent decrease in the long term disturbance when compared to the MT FEIS road assumptions. Other differences in surface disturbance between the MT FEIS assumptions and the Badger Hills EA can be seen in the 80 percent greater surface disturbance from Water Management Structures proposed in the Badger Hills EA (81 acres) than the MT FEIS (44.25 acres). This larger water management structure surface disturbance results in a larger long term surface disturbance for the Badger Hills EA project than the MT

FEIS assumptions predicted. The need for the larger area for water management structures can be accounted for in a difference in water management practices described in the MT FEIS and Fidelity's proposed plan. The MT FEIS predicted the use of infiltration impoundments which allow for greater volumes of water to be managed with lesser surface disturbance than the Fidelity's planned containment ponds which do not allow infiltration of produced water. Table 15 shows that the short term surface disturbances from the Badger Hills EA range from 33 to 90 percent of the surface disturbance impacts predicted by the MT FEIS assumptions for a development the size of the Badger Hills Project. Fidelity was able to reduce the short term surface disturbances by combining water, gas and electric utilities within a common disturbance associated with existing and newly constructed roads, and by developing more than three coal seams from a combined well site.

Table 15: Level of Surface Disturbance Comparison

This table presents a breakdown of the components which make up the total surface disturbance values for a CBNG project and assumes the 178 well level of development for the Badger Hills Project.

CBNG Facility	MT FEIS Assumptions Common to All Alternatives (acres)	Badger Hills EA Fee and State Wells (acres)	Badger Hills EA Federal Wells (acres)
Long Term Disturbance			
Roads			
All Weather (graveled)	20.5	10	3
2-Track	53.1	20	12
1	*73.6*	*30*	*15*
Compressor Sites			
Field Compressors	3.6	6	2
Sales Compressor	0.89	4	0
2	*4.49*	*10*	*2*
Water Management			
Impoundments	44.5	80	---
Discharge Points	0.36	1	---
3	44.9	81	0
Total Long Term *(1+2+3)*	**123**	**121**	**17**
Short Term Disturbance			
Well Sites			
State Well Sites	5	4	
Private Well Sites	18	18	
Federal Well Sites	21.25	0	18
4	44.25	22	18
Flowlines			
Gas/Water Flowlines (from wells)	160.2	29.5	50.5
Produced Water Flowlines (to river)	6	6	
5	166.2	35.5	50.5
Powerlines			
Aerial	35.6	6.5	3
Buried	62.3	14.5	10
6	97.9	21	13
Total Short Term *(4+5+6)*	**308.4**	**79**	**61.5**
TOTAL *(1+2+3+4+5+6)*	**431.4**	**199.5**	**98.5**
		Total for the Badger Hills EA	**298**

E. AIR QUALITY

Air Quality Impact predictions for each document are based on modeling efforts which evaluated the direct and indirect impacts from CBNG development and cumulative impacts from activities across the eastern Montana.

DIRECT AND INDIRECT IMPACTS TO AIR QUALITY

The Badger Hills EA analyzed expected air impacts from the Project by drawing upon two separate dispersion modeling analyses and reports. The first was a project-specific analysis performed by the BLM using the Industrial Source Complex Short Term model which included one pollutant, NO2, and the development level described in Alternative B. A single instance of a monitored exceedance of the 24-hour particulate matter (PM10) National Ambient Air Quality Standard (NAAQS) from 2003 for pollutants expected to be emitted was reported as a result of the Project. The Badger Hills EA project specific modeling analysis for NO2 shows a localized 200 percent greater increase in annual NO2 compared to the modeling data from the MT FEIS. However, a comparison of the monitoring data found no significant ambient air impacts have been detected to date and the predicted site-specific levels would be below the state and federal ambient air quality standards. The MT FEIS air quality model predicted impacts that would result in exceedances on a regional scale. These impacts included: modeled exceedance of the 24-hour PM_{10} NAAQS, possible visibility degradation in certain Class I areas and one case of concern over acid deposition. In general, the modeled analyses presented for the MT FEIS and the Badger Hills EA represent the greatest expected air impacts for full field development of CBNG (MT FEIS) and the Badger Hills Project, respectively.

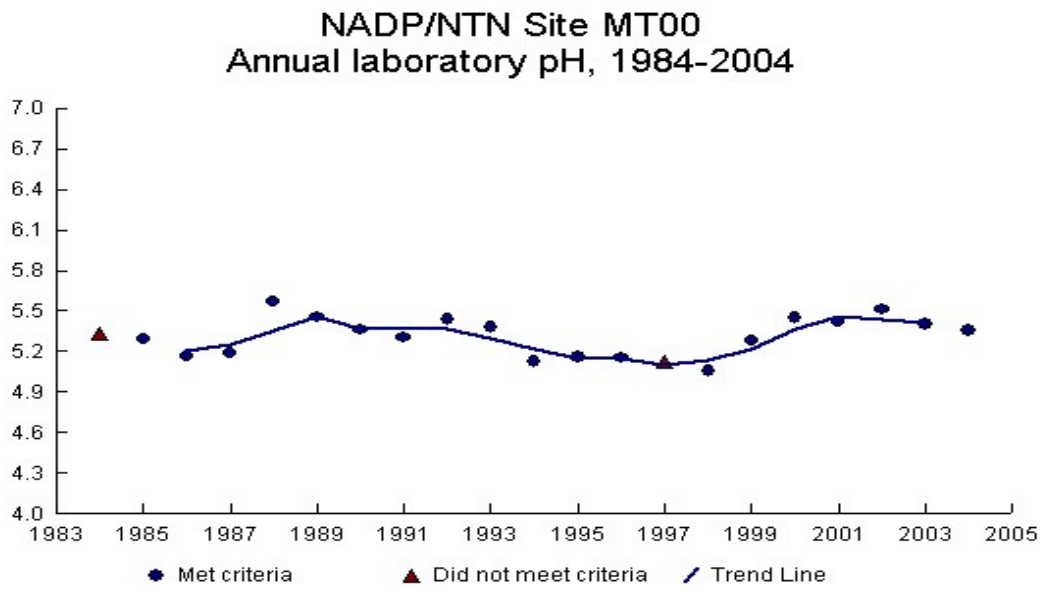
ACTUAL IMPACTS TO AIR QUALITY

Since CBNG activities from the CX field and Wyoming CBNG projects has been ongoing for several years, one effective means of understanding whether this activity is making an impact on the ambient air quality conditions in the Project area is to consider recent monitored data. Since the significant air impacts from the dispersion modeling results included short-term (24hr) PM10, visibility, and acid deposition impacts, these were assumed to be potential concerns and monitoring data was researched. From the EPA's National Atmospheric Deposition Program website, pH trend data (see Figure 29) from the monitor located at the Little Bighorn Battlefield National Monument (MT00) was charted. Figure 29 shows that pH levels of rainwater collected between 1985 and 2004, the pH has varied between 5 and 5.5 over the 20 year period of record. This monitored EPA data from near the Project area indicates that to date there does

not appear to be a change in the acidic deposition from CBNG Project emissions.

Figure 29: EPA Monitored Annual Laboratory Rainfall pH Data

Rainfall pH data from the EPA's monitoring station at the Little BigHorn Battlefield National Monument Station MT00 (1984-2004)



Finally, the EPA collects criteria pollutant data from across the nation and makes those data available on their Airdate web page by State and County. Table 16 summarizes a portion of those data for three counties in or near the Project area. Table 16 shows that for the Big Horn, Rosebud, and Yellowstone Counties of Montana all monitored PM_{10} concentrations are well below NAAQS and MAAQS levels (50 µg/m^3 for the annual and 150 µg/m^3 for the 24-hr standard). In fact, the monitored concentrations are generally half of the ambient standards. Rosebud County's data tends to run higher than the data recorded in the other two counties, but it remains well below standards. A review of Table 16 shows that the modeled cumulative 24-hr PM_{10} concentrations were 107 µg/m^3 and when a conservative background value of 105 µg/m^3 is added to that, the result is 212 µg/m^3. This predicted value is higher than any recorded concentration for any of the county monitoring sites.

Table 16: Summary and Comparison of Cumulative Air Quality Impacts

Table of cumulative air quality impact data from MT FEIS and Badger Hills EA compared to actual monitored air quality values and the state and federal ambient air quality standards.

Air Quality Pollutants and Averaging Periods	MT FEIS ($\mu g/m^3$)	Badger Hills EA ($\mu g/m^3$)	Actual/Monitored Impacts ($\mu g/m^3$)	NAAQS/ MAAQS ($\mu g/m^3$)
Annual NO_2	11 (22[12])	23.9 (29.9[11])	6[1]; 11[8]	94
(H2H) One hour NO_2	207 (324[12])	263.5 (338.5[11])	75[1]; 117[8]	564
(H2H) 8 hour CO	337 (6937[12])	Not modeled	6600[8]	10000
(H2H) 1 hour CO	548 (15548[12])	Not modeled	15000[8]	26450
Annual SO_2	1 (17[12])	Not modeled	0.5[2]; 16[8]	52
(H2H) 24 hour SO_2	11 (84[12])	Not modeled	8[2]; 73[8]	262
(H2H) 3 hour SO_2	24 (315[12])	Not modeled	30[2]; 291[8]	1300
(H2H) 1 hour SO_2	28 (694[12])	Not modeled	666[8]	1300
Annual PM_{10}	14 (44[12])	Not modeled	14 and 29[3]; 30[8]	50
24 hour PM_{10}	107 (212[12])	Not modeled	41 and 170[3]; 105[8]	150
Visibility Impairment – Class I[6]	13 days @ Yellowstone NP	Not modeled	7.3 dV; SVR 182 km (119 mi)[4]	
Visibility Impairment – Class II[6]	92 days @ NCIR & 116 days @ CIR	Not modeled		
Atmospheric Deposition[7]	1.8 ueq/L	Not modeled	5.24 ph[5]; 5.8 ueq/L[13]	

1 – Monitored values from the MDEQ and used in the Badger Hills EA.
2 – Monitored values on the NCIR from data in the Roundup Power Project 2002.
3 – Monitored values from two tribal monitors in 2003 (includes one violation measured at Lame Deer).
4 – Monitored values from 2001 average readings at Yellowstone NP.
5 – Monitored value from Little Bighorn NM in 2002.
6 – There are no applicable local, state, tribal, or federal visibility standards. The analysis assumed that a 1.0 dV change would be a reasonably foreseeable significant adverse impact. Thus, the # of days > 1 dV are shown.
7 – There are no applicable local, state, tribal, or federal acid deposition standards. The analysis assumed that a "limit of acceptable change" is a 10 percent (1 ueq/L) change in the acid neutralizing capacity (ANC) for lakes with a background ANC > 25 ueq/L. The only lake meeting these criteria in the modeling domain is the Upper Frozen Lake in the Bridger WA.
8 – Montana background concentrations used in the Argonne analysis.
9 – Predicted value is a 3.3 percent change of the ANC for the Upper Frozen Lake.
10 – Predicted value in Yellowstone NP.
11 – Total modeled concentration = modeled concentration + background concentration (see note 1).
12 - Total modeled concentration = modeled concentration + background concentration (see note 8).
13 – Monitored value of ANC is based upon only 6 samples between 1997 and 2002.

Table 17: EPA Air Quality Report of Criteria Pollutant Data for 3 Counties in Montana.

Data represents EPA's air quality monitoring results for three counties near the Badger Hills Project.

YEAR	CO (ppm)		NO_2 (ppm)	O_3 (ppm)		SO_2 (ppm)		$PM_{2.5}$ ($\mu g/m^3$)		PM_{10} ($\mu g/m^3$)		MONTANA COUNTY
	2nd Max 1-hr	2nd Max 8-hr	Annual Mean	2nd Max 1-hr	4th Max 8-hr	2nd Max 24-hr	Annual Mean	98th Percentile	Annual Mean	2nd Max 24-hr	Annual Mean	
2005										42	24	Big Horn Co
2005								38	15.6	80	27	Rosebud Co
2005	4.4	2.3	0.003	0.07	0.058	0.018	0.004	22	7.4	59	17	Yellowstone Co
2004										82	25	Big Horn Co
2004			0.003			0.004	0.001	17	5.9	48	22	Rosebud Co
2004	6.8	3.7				0.044	0.006	19	8.2	38	21	Yellowstone Co
2003						0.001	0.001			43	11	Big Horn Co
2003			0.003			0.009	0.003	19	7.1	169	28	Rosebud Co
2003	7.5	4.4				0.032	0.006	22	8	45	17	Yellowstone Co
2002						0.002	0.001			67	19	Big Horn Co
2002			0.004			0.014	0.003	25	6.2	137	28	Rosebud Co
2002	8.5	4.3				0.052	0.007	14	6.6	26	14	Yellowstone Co
2001												Big Horn Co
2001			0.003			0.027	0.003	14	8.5	135	35	Rosebud Co
2001	8.6	5.2				0.037	0.007	23	7.6	32	16	Yellowstone Co

In general, this historical comparison (Table 17) illustrates that the significant air impacts that were modeled in support of either the Badger Hills EA or the MT FEIS have not been observed in monitored data. The predicted significant air impacts from the cumulative source group models have not appeared in recent monitoring data. The Badger Hills Project as it currently exists does not appear to be contributing the air quality impacts in and around the PRB that modeling efforts from the MT FEIS and Badger Hills EA predicted.

F. CULTURAL RESOURCES

Cultural resources include sites, remains, or structures that are of value to a community of people or that are of historic importance. A comparison of impacts to paleontological resources, which encompasses fossils and other records of past life, is also included in this discussion.

DIRECT AND INDIRECT IMPACTS TO CULTURAL RESOURCES

According to the Badger Hills EA, no cultural resources on federally owned surfaces would be affected by the CBNG wells and associated facilities because of BLM required mitigation measures. On private surface portion of the Badger Hills project, two eligible sites may be affected by a proposed private well and an infrastructure corridor (Melton, 2004).

The MT FEIS predicted that 629 cultural sites would be identified for the preferred alternative (BLM, 2003b). Big Horn County is estimated to contain about 80 of these sites assuming that Big Horn County comprises 12.6 percent of the acreage for the MT FEIS planning area, and about nine sites would be identified within the first two years based on the MT FEIS assumption that 11 percent of the total CBNG development would be completed at this point in time. The number of sites in the project area that would be eligible for the National Register of Historic Places is predicted to be between 119 and 170 or between 15 and 22 in Big Horn County using the same assumption of proportionality.

Another method of assessing the anticipated impacts to cultural resources from the MT FEIS is to use the assumption that there would be one cultural site for every 100 acres surveyed for cultural resources (BLM 2003b). Based on this assumption and the prediction that each of the 6,300 total producing wells in Big Horn County would disturb 3.25 acres per well for a total of 20,475 acres, about 205 sites would be expected to be encountered. Within the first two years of development, 23 sites would be expected to be found based on the MT FEIS prediction that CBNG development would be at 11 percent completion. However, development has not progressed as quickly as predicted, so fewer sites would most likely be encountered. If one assumes the total acreage disturbed from the Badger Hills EA (298 acres) is applied to the cultural resource density defined by the FEIS, three cultural resource sites would be predicted to be impacted by the Badger Hills project.

The MT FEIS stated that impacts to paleontological resources would occur if these resources were encountered unexpectedly, while the Badger Hills Project Area is not expected to have significant paleontological resources (BLM, 2003b) (Melton, 2004).

CUMULATIVE IMPACTS TO CULTURAL RESOURCES

When estimating cumulative impacts to cultural resources, the Badger Hills EA provided predictions from the MT FEIS that an estimated 5,135 cultural sites could be identified with between 517 and 735 sites eligible for listing on the National Register of Historic Places (Melton, 2004). This would equate to 647 sites in Big Horn County with between 65 and 93 eligible for listing.

The Badger Hills EA also accounted for nearby development in its cumulative analysis, including Yates Petroleum's proposed 14 exploratory wells northwest of the Plan of Development, the Dry Creek project, the Coal Creek Plan of Development, and the Spring Creek and Decker Mines (BLM, 2004c).

The Badger Hills EA states that the proposed project would not impact any large or conspicuous paleontological remains on Federal surface or minerals (BLM, 2004c). The MT FEIS also assessed cumulative impacts to paleontological resources, predicting an increase in vandalism or fossil removal with greater CBNG Development and increased access to remote areas (BLM, 2003b).

ACTUAL IMPACTS TO CULTURAL RESOURCES

Previous inventories conducted in the coal mine and Tongue River Dam has identified 17 cultural resource sites. To date, two of these sites have been determined to be eligible for the National Register of Historic Places, three have been determined not eligible for listing, and status has not been determined for the remaining 12 sites (Melton, 2004). Class III cultural resource inventories for all of the Federal wells and associated infrastructure developments completed between December 2002 and August 2003 found no cultural sites and one isolated find location (Melton, 2004). In addition, no sites were found when an infrastructure corridor was inventoried. The State of Montana prepared a cultural resource inventory that addressed portions of the project in which no cultural resources were found (Melton, 2004). Actual impacts to cultural resources based on the surveys conducted for CBNG development in the project area compare well to predicted impacts based on the recent inventories (Melton, 2004). However, due to the fact that mitigation measures are being implemented on federal mineral development areas it is likely that fewer cultural or paleontological sites will be loss than predicted.

G. LANDS AND REALTY

Both the Badger Hills area and the MT FEIS planning area have mixed ownership of surface and mineral estate between the federal government, the State of Montana, and private individuals or companies.

DIRECT AND INDIRECT IMPACTS TO LANDS AND REALTY

The Badger Hills EA did not predict many impacts to Lands and Realty from proposed CBNG development. No gains or losses in acreage due to change in ownership of federal, state, or private surface/minerals were predicted to occur. However, it was noted that land within federal, state, or private categories may pass between owners (BLM, 2004c). The county road which necessitates this right-of-way would be more heavily traveled by vehicles and could deteriorate faster than if CBNG development was not present in the area (BLM, 2004c).

The MT FEIS detailed more potential impacts from CBNG development than the Badger Hills EA; these included such things as increased fire hazard, increased motorized access to the area, generation of dust, increased noise levels, physical intrusion by CBNG crews and equipment, and displacement of land uses from roads and utility lines. The MT FEIS also predicted that cropland could be affected during the construction phase of CBNG development due to changes in irrigation patterns and the introduction of noxious weeds. Forest land was also expected to sustain impacts due to commercial harvest of trees in the right-of-way and a decrease in timber growth during production due to the right-of-way, well pads, and roads. Lastly, impacts that may result from construction related surface disturbances include noxious weed introduction, increases in insect populations from slash buildup, and increased access for forest and fire management.

CUMULATIVE IMPACTS TO LANDS AND REALTY

According to the Badger Hills EA, there were no cumulative impacts that were predicted to affect land and/or mineral ownership in the Badger Hills project area (BLM, 2004c). The MT FEIS, however, did predict some cumulative impacts relating to land use, including loss of cropland, as well as decreased property value, decreased opportunity for community development, and increased average daily traffic.

ACTUAL IMPACTS TO LANDS AND REALTY

Actual impacts to lands and realty have not been compared to predicted impacts because no recent surveys have been made and no new data was made available since development began in the area. It is assumed that current actual impacts are less than those predicted in the MT FEIS because development has not occurred at the rate that had been expected.

H. SOCIAL AND ECONOMIC CONDITIONS

Social and Economic Conditions analysis encompasses employment, personal income, demographics, social organization, and government revenues and taxes in a project area. Big Horn County includes parts of the Crow Reservation and Northern Cheyenne Reservation and has a population base that is comprised of 59.7 percent Native Americans. Unemployment was high in the county when it was assessed at 14.4 percent in the year 2000 and represented the highest level for any county in Montana (BLM, 2003b). Due to the large Native American population and number of individuals considered low-income in Big Horn County, environmental justice issues are of concern.

DIRECT AND INDIRECT IMPACTS TO SOCIAL AND ECONOMIC CONDITIONS

Employment

There is a large difference between the Badger Hills EA and the MT FEIS employment predictions. The Badger Hills EA predicted that there would be little impacts to employment beyond the temporary jobs created by development, drilling, and production. The MT FEIS predicted total jobs created for the project life of CBNG development to be 17,013 (BLM, 2003b). Utilizing the assumption that Big Horn County will account for 38.3 percent of total CBNG development in Montana, 6,516 jobs could be predicted to be created over the first 20 years of CBNG development in Big Horn County. It was predicted that by this point in time (it is currently year 2 since the completion of the MT FEIS) there would be 766 new CBNG wells, 295 jobs created, and approximately $9 million in wages earned in Big Horn County based on the above assumption. During the abandonment phase (years 21-40), an estimated additional 404 jobs would have been created in the County (BLM, 2003b). These numbers were predicted to potentially be about 10 percent higher based on water management practices that would require extra jobs. (BLM, 2003b). The MT FEIS also predicted the need to bring in people from outside areas to develop CBNG.

Personal Income

The Badger Hills EA states that CBNG development under Alternative C could potentially increase personal income in the project area (BLM 2004c). The MT FEIS predicted for its preferred alternative that over the first 20 years, wages paid for all phases of the project would total approximately $598 million (BLM, 2003b). Calculated wages paid to residents of Big Horn County would be about $229 million based on Big Horn County containing 38.3 percent of projected development.

Demographics

Population demographics were not specifically analyzed in the Badger Hills EA. The MT FEIS differed from the Badger Hills EA as its preferred alternative required workers from outside the area to relocate to the area, with the greatest potential for new population in Big Horn, Powder River, and Rosebud counties (BLM, 2003b).

Government Revenues and Taxes

Although not quantified, the Badger Hills EA predicted annual increases in government revenues, including property, production, and income taxes and state and federal production royalties (BLM, 2004c). The MT FEIS similarly predicted increases in government revenues and taxes. Using the assumption stated in the MT FEIS that each producing well generates about $182,500 in gross production income per year of operation, it is estimated that 663 producing wells in Big Horn County would result in $121 million in gross production income in Big Horn County within the first two years. CBNG production would also provide revenue from natural resource taxes and sales of goods and services to oil and gas employees (BLM, 2003b).

Environmental Justice

No adverse impacts would be expected to disproportionably affect minority or low-income populations for either the Badger Hills EA or the MT FEIS.

CUMULATIVE IMPACTS TO SOCIAL AND ECONOMIC CONDITIONS

The Badger Hills EA predicted that some of the jobs and taxes and royalties gained from CBNG development could replace coal mining jobs and taxes and royalty lost due to coal production declines (BLM, 2004c). The Badger Hills EA did not predict cumulative impacts concerning environmental justice issues. The MT FEIS predicted that CBNG would not have a very large socioeconomic effect except for those discussed in Big Horn, Powder River, and Rosebud counties. Additional wells that may be developed on the Northern Cheyenne Reservation, the

Crow Reservation, and Forest Service Lands and the expansion of coal mining in the area could have social and economic impacts as well (BLM, 2003b).

ACTUAL IMPACTS TO SOCIAL AND ECONOMIC CONDITIONS

Actual impacts to social and economic conditions cannot be compared to predicted impacts for social and economic conditions because no recent studies have been prepared since development has begun in the area. However, comparisons between neighboring counties in Wyoming can provide come insight into what the actual impacts are to the lack of development in Big Horn County. Government revenues and taxes from CBNG development can make a substantial difference to a local economy. For example, Campbell County in Wyoming has adopted a budget of over $88 million in 2005, compared to a $4 million budget for the same year in Powder River County in Montana, which it borders (RMER Staff, 2005). This difference in budgets is due to the fact that Campbell County has had over 10 years of CBNG production whereas Powder River County only has limited production.

I. SOILS

Analysis of impacts to soils encompasses soil erosion, contamination, compaction, surface disturbance, and impacts to soil chemistry. Impacts to soils are generally equivalent to the amount of surface disturbance.

DIRECT AND INDIRECT IMPACTS TO SOILS

Productivity

The predicted acreage that could be disturbed by Land Application Disposal in the Badger Hills area of emphasis is 152 acres (BLM, 2004c). Land Application Disposal has the potential to impact soil productivity. Data from the Badger Hills EA indicates that during times of irrigation, productivity can increase and post-irrigation, soil productivity could decrease. Impacts to soil productivity on roads were accounted for in the Badger Hills EA. Productivity on two-track roads could decrease 700 lbs/acre while productivity on improved roads would be markedly less, with a decline of 1400 lbs/acre. There would be no capability of productivity on improved all-season roads, 100 lbs/acre on two track roads, and 0 lbs. /acre on improved roads (BLM, 2004c).

The MT FEIS suggests that produced water would be managed per a site-specific water management plan which would reduce the impacts to soil productivity caused by the application of water having high- Sodium Absorption Ratio (SAR) to soils. Under these conditions, the impacts to productivity would be less than predicted in the MT FEIS. The discharge of produced

water, as opposed to the use of impoundments, allows for fewer disturbances at the surface, directly impacting soil productivity locally, but does not account for potential downstream soil productivity impacts.

Surface Disturbance

The Badger Hills EA suggests that 298 acres have the potential to experience surface disturbance (BLM, 2004c). All 85 of the federal wells and the 92 fee and state wells have been located at sites which can be drilled without a well pad. As such, minor surface disturbance would occur with the drilling of these wells (BLM, 2004c). In the Badger Hills area of emphasis, approximately 4.4 miles of improved roads would be constructed to provide access to facilities and infrastructure. Approximately 10 miles of new and 12 miles of existing 2-track trails would be used to access well sites.

Predictions in the MT FEIS suggest that a total of 55,400 acres would be disturbed from CBNG development (BLM, 2003b). Big Horn County encompasses 12.6 percent of the total acreage analyzed in the MT FEIS (BLM, 2003b). Assuming the total surface disturbance is 6,980 acres, 768 acres would be disturbed after two years. However, if acreage impacts calculated based on the percent of CBNG development that is expected to occur in the county then impacts to grasslands in Big Horn County then the total surface disturbance is 21,218 acres, 2,334 acres would be predicted to have been disturbed by year two. The acreage of surface disturbance per well, as stated in the MT FEIS, is 1.0 acres for exploration, 3.25 acres for construction, and 2.0 acres for operations (BLM, 2003b). The Badger Hills project proposes a total of 178 wells. This would equate to a total surface disturbance of 178 acres for exploration, 578 acres for construction, and 356 acres for operations.

Another consideration when discussing surface disturbance is roads. The Badger Hills EA predicts that 3 acres of disturbance will occur from all weather roads and 12 acres of disturbance will occur from two-track roads, totaling 15 acres. However, the MT FEIS proposes that 20.5 acres of soil would be disturbed by all weather roads, 53.1 acres would be disturbed by two-track roads, for a total of 73.6 acres of impacts to soils. Clearly, the MT FEIS CBNG development scenario provides a scenario in which surface disturbance predictions are greater than the disturbance predicted in the Badger Hills area by a factor of almost 400 percent.

CUMULATIVE IMPACTS TO SOILS

Although most of the direct effects to soils would end once production facilities were removed and rehabilitated, some impacts could still be sustained in managed irrigation areas. After

managed irrigation has ceased, future soil failure and loss of vegetation or surface soil stabilization can occur due to changes in salinity and soil chemistry from precipitation. Under the preferred alternative of the MT FEIS, disturbances from CBNG development, conventional oil & gas development, coal mining, among other projects occurring in the region over the next 20 years would result in the disturbance of about 50,700 acres of soil in Big Horn County (BLM, 2003b). If only the production phase of CBNG, conventional oil & gas development, and coal mining projects occurring in the region are considered, the amount of disturbance would be reduced to 30,500 (BLM, 2003b). There would be minimal unavoidable and irreversible impacts to soils. There would be a temporary increase in soil erosion, runoff, and sedimentation, mostly during construction activities (BLM, 2003b). Development of the Crow and Northern Cheyenne reservations would disturb between 7,200 acres and 12,100 acres per reservation (BLM, 2003b).

The MT FEIS predictions are greater than what was predicted in the Badger Hills EA because the level of development predicted is far greater than that for the Badger Hills EA. The rate of development predicted in the MT FEIS is not being met and analysis of the surface disturbance impacts from the Badger Hills EA indicate that even on a field scale, the impacts predicted in the MT FEIS are not occurring.

ACTUAL IMPACTS TO SOILS

Development of CBNG and other activities within the Badger Hills project area surface impacts are noted to be less than the MT FEIS predictions. Actual development impacts may vary slightly from what the Badger Hills EA predicted, but for the most part, disturbed acres related to well pads, roadways, and other infrastructure should be near the levels indicated in the Badger Hills EA (BLM, 2004c).

J. WATER RESOURCES

Predicted water related impacts discussed under the Preferred Alternative (Alternative C) in the Badger Hills EA were compared to predicted impacts as detailed under the Preferred Alternative (Alternative E) in the MT FEIS (BLM, 2003b and BLM, 2004c). In addition, there are several sources of monitored data which can be used to evaluate actual conditions for both surface water and groundwater, including US Geological Survey (USGS) surface water gauging stations, Montana Bureau of Mines and Geology (MBMG) monitoring wells, and Fidelity's own monitoring system.

DIRECT AND INDIRECT IMPACTS TO SURFACE WATER

Direct impacts to surface water are predicted in the Badger Hills EA as a result of Fidelity utilizing their existing discharge permit to discharge produced water into the Tongue River; none of the other water management practices proposed for the Badger Hills project are expected to have direct impacts to surface water. Similarly, the MT FEIS and accompanying Surface Water Quality Technical Report assessed the quality of surface water that would result from discharges associated with CBNG production. Mixing models for both document predicted approximate similar values for the flow, and EC at two of the three gauging stations (data was not calculated for the Dam station for the MT FEIS). While SAR impacts are shown to be more conservative for the 7Q10 values (5.34 and 6.79) calculated for the MT FEIS than the values calculated in the Badger Hills EA (2.37 and 1.90). Indirect impacts to surface water were predicted to have a low chance of occurring in the Badger Hills EA because of monitoring requirements for the proposed off-channel impoundments and the land application disposal area. Since both of these systems would be monitored to ensure they function as designed, i.e. impoundments are lined and irrigation application rates are monitored, the Badger Hills EA predicts the likelihood of these water management practices to be low. The MT FEIS considered indirect impacts surface water to be greater because the impoundments would be unlined and designed for infiltration. Unlined infiltration impoundments have the potential for water to seep downward to a confining zone and then migrate laterally to surface waters.

CUMULATIVE IMPACTS TO SURFACE WATER

The cumulative impact discussion from the Badger Hills EA includes additional discharges of treated CBNG produced water into the Tongue River from another CBNG development project. This treated water has lower EC and SAR concentrations than the water that is currently within the river and thus is predicted to result in an increased flow but with decreased EC and SAR at both the Tongue River Dam and Birney Day School stations.

ACTUAL IMPACTS TO SURFACE WATER

In order to attempt quantification of observed impacts, data from each of the gauging stations was acquired post CBNG development at a discharge approximating the evaluated flow rate. In comparing the data from the predicted models to monitored data from the USGS gauging stations located at these modeled points, the monitoring data indicates that at the time the samples were collected from the gauging stations the anticipated impacts were not discernible from pre-development existing conditions.

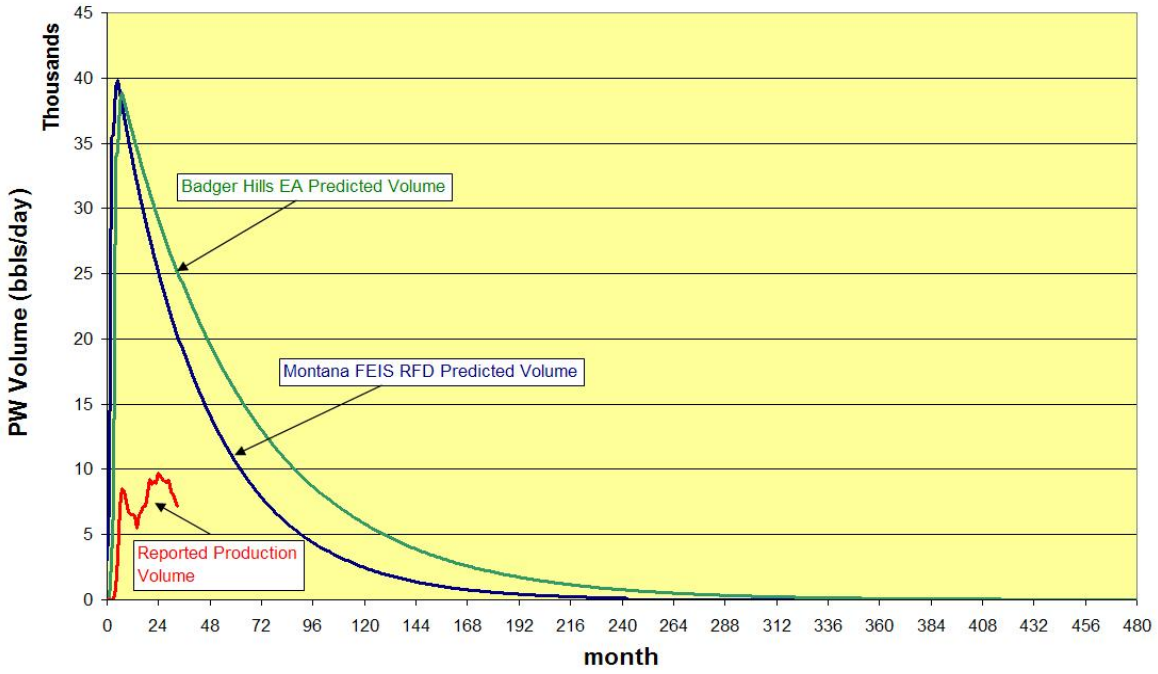
DIRECT AND INDIRECT IMPACTS TO GROUNDWATER

The direct groundwater impacts predicted in both the MT FEIS and the Badger Hills EA are a result of extraction of coal seam groundwater associated with the production of CBNG. There are some basic assumptions that differ between the MT FEIS and Badger Hills EA related to density of the wells and the rate of water production. Figure 30 shows that the assessment approach used in the Badger Hills EA and the MT FEIS has predicted a higher initial production rate than what is currently being reported for these wells. There may be extraneous factors that are resulting in the rate of production being less than what the wells are capable of producing such as ongoing testing, water management limitations or the current regulatory and legal environment of CBNG development in Montana.

The other direct impacts associated with CBNG development assessed in both the Badger Hills EA and MT FEIS is the extent of the drawdown within a coal seam aquifer as a result of production, which for comparison purposes will be determined by the 20 foot drawdown contour within the producing coal seam aquifers. A groundwater model was developed for the MT FEIS by the MBMG, which evaluated the extent of drawdown which would result from 1,082 CBNG wells producing from three coal seams in a single field (Wheaton and Metesh, 2002). This model predicted the extent of the 20 foot drawdown area to extent up to 5 miles from the edge of a producing field. The Badger Hills EA used a simpler approach to assess the extent of drawdown using a Theis equation and regional aquifer characteristics to assess the extent of drawdown from the proposed Badger Hills production by treating all the producing wells from each coal seam as if they were a single well.

Figure 30 Comparison of the Water Produced in Association with CBNG

Predicted CBNG produced water volumes from MT FEIS and Badger Hills EA plotted against actual production reported to the MBOGC.



CUMULATIVE IMPACTS TO GROUNDWATER

Cumulative impacts assessed for groundwater in the Badger Hills EA and MT FEIS include development of other CBNG projects in Montana and Wyoming, and the impacts of the coal mines located near this development project. The Badger Hills EA estimates a cumulative impact to groundwater drawdown to be up to 3.6 miles from the producing field, while the MT FEIS model predicted up to 5 miles of drawdown from a CBNG field (BLM, 2004c and Wheaton and Metesh, 2002).

ACTUAL IMPACTS TO GROUNDWATER

For comparison purposes, data from Fidelity's annual groundwater modeling reports was compared to the drawdowns predicted in the Badger Hills EA (Fidelity, 2000 and Fidelity, 2005). The monitoring data suggests that the predicted impacts from the Badger Hills EA have over-predicted the first year and the 5 yr radius of drawdown near the CX Field. The Fidelity monitoring data indicates that groundwater drawdown has not extended outward to the extent that the Badger Hills EA had predicted, nor to the extent that MBMG has indicated.

K. VEGETATION

Impact prediction for vegetation resources involves a comprehensive discussion of the potential introduction of invasive species, potential changes to species compositional characteristics, and the relative amount of acreage that can potentially be impacted from construction and surface disturbing activities related to CBNG production.

DIRECT AND INDIRECT IMPACTS TO VEGETATION

Surface Disturbance

The Badger Hills EA suggests that 297 acres have the potential to experience surface disturbance (BLM, 2004c). Vegetative productivity can be affected by irrigation and the construction of roads. The total area that was estimated to be impacted from all activities proposed in the MT FEIS is approximately 73,860 acres, of which 66,457 acres is considered to be native vegetation (BLM, 2003b). Big Horn County encompasses approximately 12.6 percent of the total acreage analyzed in the MT FEIS (BLM, 2003b). If the total acreage impact predicted in the MT FEIS was distributed proportionally across the area, then the vegetative acres within Big Horn County that would be disturbed are approximately 8,355 acres of native vegetation. If acreage impacts are calculated based on the percent of CBNG development that is expected to occur within each county then native vegetative impacts for Big Horn County would be closer based on 38.3 percent and would be estimated at approximately 25,450 acres with full field development (BLM, 2003b). The disturbance data could then be extrapolated to the second year of field development at which time the MT FEIS projected 11 percent of the total number of CBNG wells would have been drilled within the PRB (BLM, 2003b). Assuming that this development was occurring uniformly across the PRB CBNG producing areas, then 11 percent of the total disturbance within Big Horn County would be approximately 919 acres of native vegetative disturbance. However, assuming that the acreage impacts are calculated based on the percent of CBNG development that is expected to occur within each county, the total disturbance within Big Horn County would be approximately 2,800 acres.

Impacts to vegetation resources can largely result from the creation of roads, trails, and access ways. As discussed in the soils section, the Badger Hills EA predicts that 3 acres of disturbance will occur from all weather roads and 12 acres of disturbance will occur from two-track roads, totaling 15 acres in all. However, the MT FEIS proposes that 20.5 aces of vegetation would be disturbed by all weather roads while 53.1 acres would be disturbed by two-track roads, for a total of 73.6 acres of impacts to vegetation.

Predictions in the MT FEIS suggest a much larger amount of vegetative surface will be disturbed, than what is described in the Badger Hills EA. The assumptions used in the development of the MT FEIS acreage disturbances when compared to the plans from Fidelity's Badger Hills POD are the reason for these differences.

Species Composition

Direct effects to plant species at the irrigation sites would be a change in species composition to those that can tolerate higher soil moisture and salt levels (BLM, 2004c).

Plant productivity and morphological characteristics would be directly affected due to increased salt levels in the irrigated areas. As well plant and soil micronutrient imbalances could result indirectly as a consequence of elevated soil solution salinity levels (BLM, 2004c). Fidelity has indicated that present native rangeland sites would be planted with domestic species (BLM, 2004c).

Noxious Weed Invasion

Other considerations discussed in the Badger Hills EA are the removal of vegetation and the introduction of invasive species. However, measures proposed by Fidelity to control noxious weeds would ensure that potential impacts from noxious weeds and invasive plants would be minimal. Other potential indirect impacts from the activities proposed in the MT FEIS include noxious weed invasion, loss of habitat, and changes in wildlife and livestock distribution (BLM, 2003b). A lack of requirements for the reclamation of roadbed reclamation and/or abandoned reservoirs creates an increased potential for vegetative habitat loss and the introduction of noxious weeds. As well, species of concern that are not federally protected may be impacted by the removal of vegetation. Due to the greater acreage disturbances predicted in the MT FEIS, the conclusion can be drawn that the introduction of noxious weeds is predicted on a larger scale than what is predicted by the Badger Hills EA.

CUMULATIVE IMPACTS TO VEGETATION

Vegetation in the area of concern addressed in the Badger Hills EA would recover in a short time after removal of production facilities and rehabilitation outside of irrigated areas. Irrigated areas may continue to be affected by salt loading or numerous years. Overall, regional development of methane is anticipated to have limited effects on the vegetation of the Badger Hills project area.

Cumulative impacts within the area of emphasis in the MT FEIS are expected to occur from coal mining operations occurring within the PRB (BLM, 2003b). About 92 percent of the coal volume located in the PRB occurs within Wyoming. Therefore, some rivers entering Montana from Wyoming would be expected to have higher flows, resulting in potential erosion or wetland and riparian communities and further habitat degradation (BLM, 2003b). Again, the cumulative impacts predicted in the MT FEIS are greater than those predicted in the Badger Hills EA. This can be attributed to the inclusion of coal mining activities, which have the potential to disturb riparian communities.

ACTUAL IMPACTS TO VEGETATION

It is not possible to compare actual impacts to all of the predicted vegetative impacts at this time due to the lack of available monitoring data for construction related disturbances, and long term Land Application Disposal. Data from Fidelity's managed irrigation activities indicates that land application of produced water is resulting in increased vegetative productivity (up to 4 tons/acre) than what the NEPA assessments had predicted (Harvey and Brown, 2005).

L. WILDLIFE

Predicted wildlife impacts discussed in the Badger Hills EA were compared to predicted impacts as detailed under the Preferred Alternative in the MT FEIS. It is noted in the Badger Hills EA that quantifying the actual number of wildlife mortalities or the amount of disturbance to wildlife is extremely difficult and thus, was not attempted. Quantification of impacts to wildlife in the MT FEIS was also not attempted however; a vulnerability analysis was performed in the MT FEIS to aid in the prediction of CBNG related impacts to certain susceptible wildlife species. It is noted in the Badger Hills EA that impacts to wildlife resources from CBNG development, as detailed in the MT FEIS, directly apply to the Badger Hills Project and provide a basis for the site specific assessment of impacts to individual species.

DIRECT AND INDIRECT IMPACTS TO THREATENED AND ENDANGERED SPECIES

The only threatened and endangered (T/E) species or habitat discussed in the Badger Hills EA is the bald eagle. The primary direct impacts to bald eagles are predicted to result in injuries or deaths from vehicle collisions and electrocution from power lines. Indirect impacts discussed in the Badger Hills EA include habitat fragmentation and human disturbance from construction of infrastructure and operational activities. The MT FEIS discusses expected CBNG related impacts for many listed species of concern but, for comparative purposes only the bald eagle is discussed in this section. Impacts to the bald eagle are predicted to be minor since protective stipulations are required.

DIRECT AND INDIRECT IMPACTS TO WILDLIFE

Direct impacts to wildlife resources in the Badger Hills area are predicted to include loss of habitat through construction activities, the presence of necessary infrastructure and facilities, and mortalities resulting from collisions with vehicles and power lines. The most notable species predicted to be impacted include deer, upland and passerine birds, small mammals and reptiles/amphibians. It was concluded that mortalities would not have a noticeable impact on the local populations of the affected species.

Direct impacts, as presented in the MT FEIS, include loss of habitat to accommodate project features and are predicted to persist for the duration of CBNG related activities and, in the case of loss of habitat value, beyond that time. It was noted that the species that would be affected by direct habitat loss would depend on the location of CBNG exploration and development and the types of habitat affected. Direct impacts on wildlife is also predicted to include mortality as relatively less mobile small mammals, reptiles, and amphibians are killed during road and other site construction during development of CBNG facilities. Direct impacts from collision and crushing are expected to continue for the duration of the project along roads until they are successfully closed and reclaimed.

Additional direct impacts discussed in the MT FEIS are related to those impacts which may occur on non-Federal lands and the subsequent lack of required BLM protective stipulations (only recommended). These impacts include potential loss of riparian vegetation and other floodplain habitats valuable for wildlife, abandonment of raptor nests because of direct habitat loss and disturbance, and habitat loss for a wide range of species that occupy prairie dog towns. Indirect impacts are predicted in the Badger Hills EA to include habitat fragmentation and human disturbance resulting from construction of infrastructure and operational activities. Additional indirect impacts discussed in the Badger Hills EA include the unintentional introduction of invasive and/or non-native vegetative species, which would affect wildlife foraging behaviors and habitat by changing pre-existing vegetative conditions.

Displacement from habitat because of roads, CBNG facilities, and human disturbance are expected to result in any of a number of individual and population level impacts on wildlife. These include stress, disruption of normal foraging and reproductive habits, abandonment of unique habitat features, and increased energy expenditure. In addition, the MT FEIS notes that roads can function as barriers to population dispersal and movement of species of small mammals and amphibians.

Overhead power lines constructed for production wells are also predicted to indirectly impact a variety of wildlife species since raptors and other species of birds occasionally collide with power lines. Indirect impacts due to electrocution are not expected in the MT FEIS because BLM and State will require that all power lines and poles be constructed to standards that will avoid raptor electrocution. Indirect impacts are also predicted to result during crossing of streams or construction of roads through riparian areas since roads create drier conditions in the vicinity of the road, thereby altering habitat for many species. Impacts could also result from noise from compressors and impacts from noxious weeds.

DIRECT AND INDIRECT IMPACTS TO AQUATIC SPECIES

Direct discharge of produced water to the Tongue River is predicted to have no negative impact to aquatic resources since the amount of discharge into the river would not exceed MDEQ surface water standards for beneficial uses, according to the Badger Hills EA.

Impacts to aquatic species are predicted in the MT FEIS as a result of sediment delivery to nearby water systems. Sediment impacts to water systems are predicted to be minor, as well as short-term, and include possible impedance of fish movements, potential for accidental spills of petroleum products, and possibly increased fish harvest. The MT FEIS also predicts minor long-term increases in river flow and total dissolved solids concentration from production water discharge that ultimately, are not be expected to impact aquatic resources. Lastly, produced water from CBNG under the Preferred Alternative would not be discharged into surface drainages and thus, there are no predicted impacts to aquatic resources from this type of activity.

CUMULATIVE IMPACTS TO WILDLIFE

Direct cumulative impacts are predicted in the Badger Hills EA to include wildlife injuries and mortalities, and the loss of habitat. Predicted indirect cumulative impacts in the Badger Hills EA include disturbance to, or displacement of, certain wildlife species from human activities, habitat loss or possible degraded water quality. Cumulative impacts predicted in the MT FEIS include the direct loss of wildlife habitat, fragmentation, and wildlife mortality from collisions and noise, disturbance to wildlife due to human presence, and impacts to riparian habitat.

Cumulative impacts to groundwater are also predicted as drawdown would likely dry up many springs and reduce flows or dry up intermittent streams. This was expected to result in the direct loss of habitat and degrade habitat values on lands around springs and intermittent streams because natural water sources would be eliminated.

ACTUAL IMPACTS TO WILDLIFE

Although data is not available for actual impacts to wildlife, under the preferred alternative of the Badger Hills EA, it is noted in the wildlife discussion that reclamation would not always recreate pre-disturbed conditions or values. Therefore, it was concluded that some wildlife populations would not recover to pre-disturbance levels. Some species, such as sage grouse and probably mule deer, are not predicted to recover to the population levels that were present prior to disturbance.

The Preferred Alternative in the MT FEIS predicts some degree of habitat loss and degradation would continue in the long-term following CBNG abandonment because of ecological differences between reclaimed sites and native vegetation.

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