United States Department of the Interior
Bureau of Land Management

Environmental Assessment DOI-BLM-NM-F010-2016-0001-EA

January 25, 2017, Competitive Oil and Gas Lease Sale

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New Mexico • Farmington Field Office

It is the mission of the Bureau of Land Management to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

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Finding of No Significant Impact

January 25, 2017, Competitive Oil and Gas Lease Sale
Rio Arriba County and Sandoval County, New Mexico

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FINDING OF NO SIGNIFICANT IMPACT

Based on the analysis of potential environmental impacts contained in the attached Environmental Assessment (EA), I have determined the Proposed Action Alternative (Alternative B) is not expected to have significant impacts on the environment. The impacts of leasing the fluid mineral estate in the areas described with this EA have been previously analyzed in the 2003 Farmington RMP and the 2002 Biological Assessment and the lease stipulations that accompany the tracts proposed for leasing would mitigate the impacts of future development on these tracts. Therefore, preparation of an Environmental Impact Statement is not warranted.

Reviewed by:

_____ Date_____

Richard A. Fields
Farmington Field Manager

Approved by:

_____ Date_____

Amy Lueders
New Mexico State Director

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1.0 INTRODUCTION

It is the policy of the Bureau of Land Management (BLM) as derived from various laws, including the Mineral Leasing Act of 1920 (MLA), as amended [30 U.S.C. 181 *et seq*.], and the Federal Land Policy and Management Act of 1976 (FLPMA), as amended, to make mineral resources available for disposal and to manage for multiple resources which include the development of mineral resources to meet national, regional, and local needs.

The BLM New Mexico State Office (NMSO) conducts a quarterly competitive lease sale to offer available oil and gas lease parcel(s) in New Mexico, Oklahoma, Texas, and Kansas. A Notice of Competitive Lease Sale (NCLS), which lists lease parcel(s) to be offered at the auction, is published by the NMSO at least 90 days before the auction is held. Lease stipulations applicable to each parcel(s) are specified in the Sale Notice. The decision as to which public lands and minerals are open for leasing and what leasing stipulations are necessary, based on information available at the time, is made during the land use planning process. Surface management of non-BLM administered land overlaying federal minerals is determined by the BLM in consultation with the appropriate surface management agency or the private surface owner.

In the process of preparing a lease sale the NMSO sends a draft parcel list to any Field Offices in which parcel(s) are located. Field office staff then review the legal descriptions of the parcel(s) to determine if they are in areas open to leasing; if new information has become available which might change any analysis conducted during the planning process; if appropriate consultations have been conducted; what appropriate stipulations should be included; and if there are special resource conditions of which potential bidders should be made aware. The parcels nominated for this sale, along with the appropriate stipulations from the 2003 Farmington Resource Management Plan (RMP) and subsequent amendments, are posted online for a two week public scoping period. Comments received are reviewed and incorporated into the Environmental Assessment (EA).

Once the draft parcel review is completed and returned to the NMSO, a list of nominated lease parcels with specific, applicable stipulations is made available online to the public through a NCLS. On rare occasions, additional information obtained after the publication of the NCLS may result in deferral of certain parcel(s) prior to the lease sale.

This EA documents the Farmington Field Office (FFO) review of four parcels nominated for the January 25, 2017, Competitive Oil and Gas Lease Sale. All four parcels are located on surface administered by the Bureau of Indian Affairs (BIA) above federal minerals. These parcels were considered for lease in the October 2014, January 2015, and October 2016 Competitive Oil and Gas Lease Sales, but deferred due to the need for additional Tribal consultation and Environmental Justice analysis. They are being reconsidered for sale as the parcels have been recently identified as being drained or to be drained by offending wells as early as July 2017. Drainage is the uncompensated loss of hydrocarbons, inert gases or geothermal resources from wells on adjacent non-jurisdictional lands or jurisdictional lands resulting in revenue losses to the Federal government. Regulations found at 43 CFR 3162.2-2 outline the BLM's responsibilities to protect leased and unleased public domain, acquired, Indian tribal and allotted mineral

interests from the loss of oil and gas or geothermal resources by drainage and the resulting loss of royalty revenues.

This EA serves to verify conformance with the approved land use plan, provides the rationale for deferring or dropping parcel(s) from a lease sale, as well as providing rationale for attaching additional notice to specific parcel(s).

The parcels and applicable stipulations were originally posted online for a two week public scoping period starting on June 6, 2016. Comments were received. These four parcels are being reconsidered for sale, and the EA was made available for public review and comment for 30 days beginning August 4, 2016. Comment letters were received from Western Environmental Law Center, Center for Biological Diversity, Sierra Club, and the Ojo Encino Chapter of the Navaho Nation.

1.1 Purpose and Need

The purpose is to consider opportunities for private individuals or companies to explore for and develop oil and gas resources on public lands through a competitive leasing process.

The need of the action is established by the BLM's responsibility under the MLA, as amended, to promote the exploration and development of oil and gas on the public domain. The MLA also establishes that deposits of oil and gas owned by the United States are subject to disposition in the form and manner provided by the MLA under the rules and regulations prescribed by the Secretary of the Interior, where consistent with the FLPMA, the National Environmental Policy Act (NEPA) of 1969, as amended (Public Law 91-90, 42 USC 4321 et seq.), and other applicable laws, regulations, and policies.

The BLM will decide whether or not to lease the nominated parcels and, if so, under what terms and conditions.

1.2 Conformance with Land Use Plan and Other Environmental Assessments

The applicable land use plan for this action is the 2003 Farmington RMP. The RMP designated approximately 2.59 million acres of federal minerals open for continued oil and gas development and leasing under Standard Terms and Conditions. The RMP, along with the 2002 Biological Assessment, also describes specific stipulations that would be attached to new leases offered in certain areas. Therefore, it is determined that the alternatives considered conform to fluid mineral leasing decisions in the 2003 Farmington RMP and subsequent amendment and are consistent with the goals and objectives for natural and cultural resources.

The RMP identifies the potential stipulations that could be attached to split-estate tracts that are proposed for leasing and requires all new leases and all expired leases that are reissued would be leased with surface resource protection stipulations. Mandatory stipulations would be incorporated into each lease where those stipulations apply. In addition, optional stipulations would be included where resource values exist that warrant special protections. The potential stipulations could include seasonal timing limitations and other controlled surface use

stipulations which were designed to minimize or alleviate potential impacts to special resource values. Leasing the split-estate parcels would also be consistent with the RMP's goals and objectives for natural and cultural resources.

Pursuant to 40 CFR 1508.28 and 1502.21, this EA is tiered to and incorporates by reference the information and analysis contained in the 2003 Farmington RMP Final Environmental Impact Statement. While it is unknown precisely when, where, or to what extent well sites or roads would be proposed, the analysis of projected surface disturbance impacts, should a lease be developed, is based on potential current well densities of two horizontal wells per 320 acres listed in the Reasonable Foreseeable Development (RFD) Scenario included in the 2003 Farmington RMP and the 2002 Biological Assessment. An appropriate level of site-specific analysis of individual wells or roads would occur when a lease holder submits an Application for Permit to Drill (APD). Assumptions based on the 2015 RFD scenario are used in the analysis of impacts in this EA.

FLPMA established guidelines to provide for the management, protection, development, and enhancement of public lands (Public Law 94-579). Section 103(e) of FLPMA defines public lands as any lands and interest in lands owned by the United States (US). For split-estate lands where the mineral estate is an interest owned by the US, the BLM has no authority over use of the surface by the surface owner; however, the BLM is required to declare how the federal mineral estate will be managed in the RMP, including identification of all appropriate lease stipulations (43 CFR 3101.1 and 43 CFR 1601.0-7(b); BLM Manual Handbook 1601.09 and 1624-1).

1.3 Federal, State or Local Permits, Licenses or Other Consultation Requirements

Purchasers of oil and gas leases are required to comply with all applicable federal, state, and local laws and regulations, including obtaining all necessary permits required should lease development occur.

Farmington Field Office biologists reviewed the proposed action and determined it would be in compliance with threatened and endangered species management guidelines outlined in the 2002 Biological Assessment for the 2003 RMP (Cons. #2-22-01-I-389). One species has been listed since 2003, the Yellow-billed cuckoo, with proposed Critical Habitat. The proposed action would have a "no effect" determination for this species due to lack of nesting habitat within 30 miles of the analysis area. A separate "effects determination" for federally-listed fish species would be made at the project level to insure that water used for drilling operations are permitted from an existing legal source (no new water depletion) and within compliance of the Endangered Species Act. No further consultation with the US Fish and Wildlife Service (USFWS) is required at this stage.

Federal regulations and policies require the BLM to make its public land and resources available on the basis of the principle of multiple-use. At the same time, it is BLM policy to conserve special status species and their habitats, and to ensure that actions authorized by the BLM do not contribute to the need for the species to become listed as threatened or endangered by the USFWS.

Compliance with Section 106 responsibilities of the National Historic Preservation Act (NHPA) is adhered to per 36 CFR Part 800. Native American consultation is conducted by mail regarding each lease sale activity. A second request for information is sent to the same recipients as needed (e.g. no response to the first inquiry). If no response to the second letter is received and no other substantial conflicts or issues are identified, the parcel(s) are offered for sale. If any responses are received, BLM cultural resources staff will discuss the information or issues of concern with the respondent to determine if all or portions of a parcel need to be withdrawn from the sale, or if stipulations need to be attached as lease stipulations.

In Section 1835 of the Energy Policy Act of 2005 (43 U.S.C. 15801), Congress directed the Secretary of the Interior to review current policies and practices with respect to management of federal subsurface oil and gas development activities and their effects on the privately owned surface. The Split Estate Report, submitted in December 2006, documents the findings from consultation on the split estate issue with affected private surface owners, the oil and gas industry, and other interested parties.

In 2007, the Legislature of the State of New Mexico passed the Surface Owners Protection Act. This Act requires operators to provide the surface owner at least five business days' notice prior to initial entry upon the land for activities that do not disturb the surface; and provide at least 30 days' notice prior to conducting actual oil and gas operations. At the New Mexico Federal Competitive Oil and Gas Lease Sale conducted on October 17, 2007, the BLM announced the implementation of this policy. Included in this policy is the implementation of a Notice to Lessees (NTL), a requirement of lessees and operators of onshore federal oil and gas leases within the State of New Mexico to provide the BLM with the names and addresses of the surface owners of those lands where the Federal Government is not the surface owner, not including lands where another federal agency manages the surface.

The BLM NMSO office would then contact the surface owners and notify them of the expression of interest and the date the oil and gas rights would be offered for competitive bidding. The BLM would provide the surface owners with its website address so they may obtain additional information related to the oil and gas leasing process, the imposition of any stipulations on that lease parcel(s), federal and state regulations, and best management practices (BMPs). The surface owners may elect to protest the leasing of the minerals underlying their surface.

If the BLM receives a protest, the parcel(s) would remain on the lease sale; however, the BLM would resolve any protest prior to issuing an oil and gas lease for that parcel(s). If the protest is upheld, the BLM would return the payments received from the successful bidder for that parcel(s). After the lease sale has occurred, the BLM would post the results on its website and the surface owner may access the website to learn the results of the lease sale.

1.4 Identification of Issues

The parcels included in the Proposed Action, along with the appropriate stipulations from the RMP and BIA, were posted online at

http://www.blm.gov/nm/st/en/prog/energy/oil_and_gas/oil_and_gas_lease.html for a two-week public scoping period.

An internal review of the Proposed Action, along with the appropriate stipulations from the RMP and BIA, was conducted by an interdisciplinary team of FFO resource specialists to identify and consider potentially affected resources and associated issues. During the review the interdisciplinary team identified and subsequently addressed any unresolved issues or conflicts related to the Proposed Action.

On March 10, 2016 a briefing for the BLM New Mexico State Director was held at the NMSO to review FFO's recommendations for the nominated parcels that were considered in the October 2016, Competitive Oil and Gas Lease Sale. The four parcels were reviewed by the State Director at that time.

Planning issues are points of disagreement, debate, or dispute with a proposed action based on some anticipated environmental effect. Based on external and internal scoping and the scoping comments that were received, the following planning issues were identified:

- Tribal consultation
- Environmental Justice

Consultation meetings to discuss the four proposed parcels, the reasons for reconsidering them, and identification of issues were held with the following entities:

- Navajo Nation Historic Preservation Division
- Navajo Nation Counselor, Torreon and Nageezi Chapters
- Bureau of Indian Affairs, Navajo Region

Based on these internal and external efforts the following issues have been determined relevant to the analysis of this action:

- *What effect will the no action have on mineral resources being drained from wells on adjacent lands?*
- *What effects will the proposed action have on the wildlife, special status species, and migratory birds?*
- *What effects will the proposed action have on air quality and climate?*
- *What effects will the proposed action have on water quality?*
- *What effects will the proposed action have on soil resources?*
- *What effects will the proposed action have on night sky resources?*
- *What effects will the proposed action have on cultural resources, including historic properties, properties listed on the National Register of Historic Places or New Mexico State Register of Cultural Properties, Chaco Protection Sites, World Heritage Sites, National Historic Trails, or other places of traditional religious and cultural importance?*
- *What effects will the no action and proposed action have on socio economics?*
- *What effects will the proposed action have on Environmental Justice?*

- *What effects will the proposed action have on the establishment and distribution of noxious weeds?*
- *What effects will the proposed action have on Visual Resource*?
- *What effects will the no action and proposed action have on Lands and Realty*?

Issues considered during project scoping, but dismissed from detailed analysis because there would be no potentially significant effects related to the issues resulting from any of the alternatives, are presented below.

- *What effects will the proposed action have on Social Cost of Carbon?*

Social cost of carbon was considered but dismissed from further analysis as discussed in Section 4.2.1.3 below.

- *What effects will the proposed action have on Rangeland Resources?*

If a decision is made to lease, individual APD's and lease actions may impact rangeland resources and impacts may be analyzed specifically when they are proposed.

- *What effects will the proposed action have on Vegetation Resources?*

If a decision is made to lease, individual APD's and lease actions may impact vegetation resources and impacts may be analyzed specifically when they are proposed.

- *What effects will the proposed action have on Recreation?*

If a decision is made to lease, there would be no effect on recreation because the area is all classified as disbursed recreation with no designated recreations areas.

1.4.3 Resources Considered but Not Analyzed

The following resources were determined by an Interdisciplinary Team of resource specialists, following their onsite visit and review of the RMP and other data sources, to not be present and not require analysis:

- Areas of Critical Environmental Concern
- Floodplains
- Wild and Scenic Rivers
- Wetlands/Riparian Zones
- Wild Horses and Burros

2.0 NO ACTION AND PROPOSED ACTION ALTERNATIVES

2.1 Alternative A – No Action

The BLM NEPA Handbook (H-1790-1) states that for EAs on externally initiated proposed actions, the no action alternative generally means that the action would not take place. In the case of a lease sale, this would mean that an expression of interest to lease (parcel nomination) would be deferred, and the four parcels would not be offered for lease during the January 25, 2017, Competitive Oil and Gas Lease Sale. Surface management and any ongoing oil and gas development on surrounding federal, private, and state leases would continue under current guidelines and practices.

Drainage of the federal mineral estate by producing wells adjacent to the federal mineral estate lands would result in the establishment of a Compensatory Royalty Agreement (CRA) to collect royalties, or in the absence of a CRA, the continuing loss of royalties to the United States and the State of New Mexico. Selection of the no action alternative would not prevent these parcels from being nominated in a future lease sale.

2.2 Alternative B – Proposed Action

The Proposed Action is to lease four nominated parcels of federal minerals administered by the Bureau of Land Management, Farmington Field Office, covering 842.66 acres. Standard terms and conditions as well as lease stipulations listed in the BLM FFO RMP (as amended) and BIA stipulations per Navajo Area Bureau of Indian Affairs Surface Management Agency Lease Stipulations for Federal Oil and Gas Lease Offerings would apply. The lease purchaser has the exclusive right to use as much of the leased mineral estate as is necessary to explore and drill for oil and gas, subject to the stipulations attached to the lease (43 CFR 3101.1-2). There are no surface uses granted with the proposed action because of the No Surface Occupancy (NSO) stipulation being applied to all proposed parcel areas.

Oil and gas leases are issued for a 10-year period and continue for as long thereafter as oil or gas is produced in paying quantities. If a lessee fails to produce oil and gas, does not make annual rental payments, does not comply with the terms and conditions of the lease, or relinquishes the lease, exclusive right to develop the leasehold reverts back to the federal government and the lease can be reoffered in another sale.

Drilling of wells is not permitted until the lease owner or operator secures approval of a drilling permit and a surface use plan specified under Onshore Oil and Gas Orders listed in 43 CFR 3162. An APD would not be authorized until site-specific NEPA analysis is conducted.

Site specific mitigation measures and Best Management Practices (BMPs) would be attached as Conditions of Approval (COAs) for each proposed exploration and development activity authorized on a lease.

The parcels recommended for leasing under the Alternative B – Proposed Action are presented below in Table 1.

Standard terms and conditions as well as lease stipulations from the BLM FFO 2003 RMP, Navajo Area BIA Surface Management Agency Lease Stipulations for Federal Oil and Gas Offerings, and Lease Notices developed through the parcel review and analysis process would apply (as required by 43 CFR 3101.3) to address site specific concerns or new information not identified in the land use planning process.

A new lease stipulation was developed to require modeling to determine “near-field” air quality impacts (see Appendix 2). Due to the close proximity of occupied buildings and residences to potential well sites, information about the air quality impacts at these locations needs to be determined and disclosed as part of the NEPA analysis prior to decision making on the APDs for wells on these parcels. Air dispersion modeling in accordance with EPA and state modeling guidelines can be used to determine "near-field" impacts. At the time of the lease sale, there is still not enough information available about how the lease will be developed to accurately determine the near-field air quality impacts. Exact locations and equipment specifications are known at the APD stage, so the APD EA would contain the disclosure of the near-field air impacts from the development of these leases. The BLM will determine the near-field air impacts based on air dispersion modeling that conforms to EPA and New Mexico Environment Department guidelines. This stipulation is consistent with BLM policy to make mineral resources available for disposal and to encourage development of mineral resources while striving to ensure that mineral development is carried out in a manner that minimizes environmental damage.

Due to occupied residences located within the four parcels, lease stipulation F-44 would apply. F-44 states that no surface occupancy is allowed within 660 feet of any occupied residences of a community to reduce impacts to the community of drilling and production activities. In addition, the BIA-5, No Surface Occupancy, would apply to the entirety of the lease in order to minimize the impacts from development on occupied residences. This would result in possible future surface disturbance being done in an approximate one-mile area around the parcels proposed for lease based off of current drilling practices within the locale. The BLM would determine impacts from surface disturbances at the APD stage.

Table 1. Alternative B: Proposed Action

Lease Parcel #	Legal Description	Acres	Lease Stipulations*
NM-201701-001	T.0220N, R.0060W, NM 23 PM, NM Sec. 006; LOTS 6, 7; E2SW; Sandoval County Farmington Field Office BIA-Navajo Nation	161.16	BIA-1 BIA-3 BIA-5 No Surface Occupancy F-15-POD Plan of Development F-44-NSO Community Residence F-41-LN F-47-CSU Air Dispersion Modeling WO-ESA-7 NM-10-LN NM-11- LN
NM-201701-002	T.0220N, R.0060W, NM 23 PM, NM Sec. 009: W2SW; Sandoval County Farmington Field Office BIA-Navajo Nation	80	BIA-1 BIA-3 BIA-5 No Surface Occupancy F-15-POD Plan of Development F-44-NSO Community Residence F-41-LN F-47-CSU Air Dispersion Modeling WO-ESA-7 NM-10-LN NM-11- LN
NM-201701-003	T.0230N, R.0070W, NM 23 PM, NM Sec. 006: Lots 5,6,7; SENW, E2SW, SWSE; Sec. 007: NE; Rio Arriba County Farmington Field Office BIA-Navajo Nation	441.5	BIA-1 BIA-3 BIA-5 No Surface Occupancy F-15-POD Plan of Development F-44-NSO Community Residence F-41-LN F-47-CSU Air Dispersion Modeling WO-ESA-7 NM-10-LN NM-11- LN
NM-201701-004	T.0230N, R.0070W, NM 23 PM, NM Sec. 035 NE; Sandoval County Farmington Field Office BIA-Navajo Nation	160	BIA-1 BIA-3 BIA-5 No Surface Occupancy F-15-POD Plan of Development F-44-NSO Community Residence F-41-LN F-47-CSU Air Dispersion Modeling WO-ESA-7 NM-10-LN NM-11- LN
* See Appendix 2 for a summary of stipulations			

2.2.1 Design Features

- The BLM encourages industry to incorporate and implement “Best Management Practices” (BMPs), which are designed to reduce impacts to air quality by reducing emissions, surface disturbances, and dust from field production and operations. Typical measures include: adherence to BLM’s Notice to Lessees’ (NTL) 4(a) concerning the venting and flaring of gas on Federal leases for natural gas emissions that cannot be economically recovered, flare hydrocarbon gases at high temperatures in order to reduce emissions of incomplete combustion; water dirt roads during periods of high use in order

to reduce fugitive dust emissions; co-locate wells and production facilities to reduce new surface disturbance; implementation of directional drilling and horizontal completion technologies whereby one well provides access to petroleum resources that would normally require the drilling of several vertical wellbores; require that vapor recovery systems be maintained and functional in areas where petroleum liquids are stored; and perform interim reclamation to re-vegetate areas of the pad not required for production facilities and to reduce the amount of dust from the pads.

- The FFO purchased an infrared camera designed to detect natural gas leaks on and around well pad and pipeline facilities. FFO inspection personnel have been trained to operate the camera and FFO is currently developing a strategy to implement the use of the camera in cooperation with oil and gas operators to detect and eliminate natural gas leaks in well pad and pipeline infrastructure.

- An APD is required for each proposed well to develop a lease. Onshore Oil and Gas Order No. 1 issued under 43 CFR 3160 authorizes BLM to attach COAs to APDs during the permitting process. As a result of recommendations from the Four Corners Air Quality Task Force, the New Mexico Environment Department, Environmental Protection Division requested FFO to attach a COA to APDs requiring new and replacement internal combustion gas field engines of between 40 and 300 horsepower to emit no more than two grams of nitrogen oxides per horsepower-hour. FFO has included a COA limiting nitrogen oxides since August of 2005.

- Required archaeological surveys would be conducted for all subsequent actions that are expected to occur from the lease sale to avoid disturbing cultural resources. All archaeological surveys would be conducted in accordance with the requirements of the surface authorizing agency. No site-specific mitigation measures for cultural resources have been recommended at this time for the proposed parcels recommended to proceed for sale. Specific mitigation measures, including, but not limited to, site avoidance or excavation/data recovery would have to be determined when site-specific development proposals are received. The surface authorizing agency (BLM, BIA, State) will not approve any ground-disturbing activities that may affect any such properties or resources until NHPA Section 106 obligations are complete. The surface managing agency may require modification to exploration or development proposals to protect such properties, or won't approve any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized, or mitigated.

- In the event that lease development practices are found in the future to have an adverse effect on Native American places of traditional religious and cultural importance, the surface authorizing agency, in consultation with the affected tribe, would take action to mitigate or negate those effects. Measures include, but are not limited to, physical barriers to protect resources, relocation of practices responsible for the adverse effects, or other treatments as appropriate.

- To be in conformance with the Native American Graves Protection and Repatriation Act of 1991 (Public Law 101-610), the terms and conditions of the lease shall contain the

following condition: In the event that the lease holder discovers or becomes aware of the presence of Native American human remains, they shall immediately notify the surface authorizing agency in writing.

- The use of plastic-lined reserve pits or closed systems or steel tanks, casing and cementing requirements, storm water management, silt traps, site recontouring, timely reseeding of disturbed areas, and soil stabilization would be implemented.

- The operator would stockpile the topsoil from the surface of well pads which would be used for interim and final reclamation of the well pads. Reserve pits would be recontoured and reseeded as described in attached COAs. Upon abandonment of the wells and/or when access roads are no longer in service the Authorized Officer would issue instructions and/or orders for surface reclamation/restoration of the disturbed areas as described in the attached COAs. During the life of the development, all disturbed areas not needed for active support of production operations should undergo “interim” reclamation in order to minimize the environmental impacts of development on other resources and uses. Site specific mitigations, determined during the onsite, such as proper project placement, storm water management, silt traps, rounding of corners and soil stabilization, would reduce erosion and sediment migration. Earthwork for interim and final reclamation must be completed within six months of well completion or well plugging (weather permitting). The operator shall submit a Sundry Notices and Reports on Wells (Notice of Intent), Form 3160-5, prior to conducting interim reclamation.

- Proposed APDs and Rights-of-Way (ROWs) on BLM managed lands will be required to follow the FFO Bare Soil Reclamation Procedure (2013).

- Road construction requirements and regular maintenance would alleviate potential impacts to access roads from water erosion damage. All access road associated with APDs shall be sited, designed, constructed, upgraded and maintained utilizing standards, requirements, guidelines and instructions specified in BLM Manual 9113 “Roads”, BLM Manual 9113-1” Roads Design Handbook”, BLM Manual 9113-2 “Roads National Inventory and Condition Assessment Guidance & Instructions Handbook” and Surface Operations and Guidelines for Oil and Gas Exploration and Development “The Gold Book”.

- Mitigation would include, as needed to protect impacts to resources, revegetation with native plant species, soil enhancement practices, direct live haul of soil material for seed bank re-vegetation, fencing of reclaimed areas, and the use of seeding strategies consisting of native and non-native grasses, forbs, and shrubs.

- In the event noxious weeds are discovered at any time during the life of the project, treatment options identified during the site specific development at the APD stage would be deferred to. BMPs would be incorporated into the COAs of an approved APD.

- A biological survey may be required to determine any impacts on individual project proposals. Any potential impacts to special status species (SSS) will be determined based

on the biological survey report. Any new water right or depletion will also require consultation with USFWS under the Endangered Species Act. Any potential impacts to SSS will be determined based on the biological survey report. Site specific stipulations may be attached to reduce impacts to any special status species. These stipulations include (but not limited to) timing stipulations, relocating the proposed project outside of identified species habitat, additional surveys, additional alternatives analyzed to decrease impacts to SSS and their habitat, and construction design stipulations. Proposed projects will adhere to current BLM FFO SSS management policies.

- Most of Township 23 North Range 07 West Section 5 (parcel NM-201701-003) is within close proximity of an active golden eagle nest territory, and within the analysis area. For this area and other identified golden eagle nest territory, the following stipulation will apply: Any proposed drilling, workovers, or construction activities are not permitted from January 15 to June 30 within ½ mile of an active or historic golden eagle nest without approval of a BLM FFO biologist. Stricter standards may apply.

- Proposed projects will adhere to the current BLM FFO migratory bird policy. Proposed projects will be designed to minimizing surface disturbance and habitat fragmentation by using existing infrastructure where feasible. Best management practices designed to protect migratory birds will be implemented to decrease direct impacts to nesting birds. These measures include designing roads and pipelines to minimize habitat fragmentation, avoid cross country travel wherever feasible, use existing infrastructure when available, and timing limitations. Active nests that could be impacted by project activities will be buffered and monitored until young has successfully fledged, the nest is no longer active, or a migratory bird take permit has been granted from the USFWS. For any proposed action that would result in more than four acres of new surface disturbance a preconstruction migratory bird nest survey will be required if any construction activities occur between May 15 – July 31. Exceptions may be waived by the authorized officer. Proposed projects will avoid creating new surface disturbances within active prairie dog towns by using existing infrastructure where reasonable. Cross country ROWs through active prairie dog towns are discouraged and alternatives may be developed during the NEPA process. Burrowing owl surveys are required for any proposed project within 100 feet of any prairie dog town.

- Proposed projects will avoid any identified pinion jay colonial nesting territory.

- Special painting schemes may be required for all facilities to closely approximate the vegetation within the setting. All facilities, including the meter building, would be painted to blend with the surrounding vegetation. If the proposed project is determined to be in a scenic area, site specific COAs, proper project placement, tree screen, or low profile equipment may be required for the proposed action.

- Vegetation removed during construction, including trees that measure less than three inches in diameter (at ground level) and slash/brush, will be chipped or mulched and incorporated into the topsoil as additional organic matter. If trees are present, all trees three inches in diameter or greater (at ground level) will be cut to ground level and de-

limbed. Tree trunks (left whole) and cut limbs will be stacked. The subsurface portion of trees (tree stumps) will be hauled to an approved disposal facility.

- Wildlife hazards associated with the proposed project would be fenced, covered, and/or contained in storage tanks, as necessary.

- Grazing permittees will be notified when construction is scheduled to begin. All hazards to livestock will be fenced or contained.

- Containment of any contaminants, fluid leaks, or hazards that could cause injury to livestock (i.e. open range and driving speeds to avoid livestock collisions).

- All existing improvements (such as fences, gates, and bar ditches) will be repaired to previous or better than pre-construction conditions. Cut fences will be tied to H-braces prior to cutting, and openings will be protected as necessary during construction to prevent the escape of livestock. A temporary closure will be installed the same day the fence is cut. Following reclamation, the fence will be reconstructed to BLM specifications.

- Backfilling operations will be performed within a reasonable amount of time to ensure that the trenches are not left open for more than 24 hours. If a trench is left open overnight, it will be temporarily fenced or a night watchman will be utilized. The excavated soils will be returned to the trenches, atop the pipe, and compacted to prevent subsidence. The trenches will be compacted after approximately two feet of fill is placed over the pipe and after the ground surface has been leveled.

- Escape ramps/crossovers will be constructed every 1,320 feet. The ends of the open trench will be sloped each night with a 4H:1V slope.

- Established livestock and wildlife trails will be left in place as crossovers. In areas where active grazing is taking place, escape ramps/crossovers will be placed every 500 feet. Crossovers will be a minimum of 10 feet wide and not fenced.

- The end of pipes will be plugged to prevent animals from crawling in.

- Before the trench is closed, it will be inspected for animals. Any trapped wildlife or livestock will be promptly removed and released at least 150 yards from the trench.

2.2.2 Reasonably Foreseeable Development

Oil and gas development may include constructing a well pad and access road, drilling a well using a conventional pit system or closed-loop system, hydraulically fracturing the well, installing pipelines and/or hauling produced fluids, regularly monitoring the well, and completing work-over tasks throughout the life of the well. In the FFO, typically, all of these actions are undertaken during development of an oil or gas well; it is reasonably foreseeable that

they may occur around the leased parcels. See Appendix 1 for a complete description of the phases of oil and gas development.

Drilling of wells for a lease would not be permitted until the lease owner or operator secures approval of a drilling permit and a surface use plan as specified under Onshore Oil and Gas Order No. 1 (43 CFR 3162). An APD would not be authorized until site-specific NEPA analysis is conducted.

Standard terms and conditions, stipulations listed in the Farmington RMP, and any new stipulations would apply as appropriate to each lease. In addition, site specific mitigation measures and BMPs would be attached as COAs for each proposed exploration and development activity authorized for a lease.

3.0 AFFECTED ENVIRONMENT

This section describes the environment that would be affected by implementation of the proposed alternatives. Elements of the affected environment described in this section focus on the relevant resources and issues.

3.1 Air Resources

Air quality and climate are components of air resources which may be affected by BLM applications, activities, and resource management. Therefore, the BLM must consider and analyze the potential effects of BLM and BLM-authorized activities on air resources as part of the planning and decision making process. Additional information on air quality in this area is contained in Chapter 3 of the FFO RMP and Final Environmental Impact Statement (FEIS; USDI BLM, 2003) which this analysis tiers to and incorporates by reference. Much of the information referenced in this section is incorporated from the Air Resources Technical Report for BLM Oil and Gas Development in New Mexico, Kansas, Oklahoma, and Texas (herein referred to as Air Resources Technical Report) (U.S. Department of Interior Bureau of Land Management, 2016). This document summarizes the technical information related to air resources and climate change associated with oil and gas development and the methodology and assumptions used for analysis.

3.1.1 Air Quality

The Air Resources Technical Report describes the types of data used for description of the existing conditions of criteria pollutants, how the criteria pollutants are related to the activities involved in oil and gas development, and provides a table of current national and state standards. EPA's Green Book web page (U.S. Environmental Protection Agency, 2016) reports that all counties in the FFO boundary are in attainment of all National Ambient Air Quality Standards (NAAQS) as defined by the Clean Air Act. The area is also in attainment of all state air quality standards (NMAAQS).

The current status of criteria pollutant levels in the FFO are described below. Total emissions of criteria pollutants from each source sector were calculated by adding together the emissions from the four counties that are located in FFO: San Juan, McKinley, Rio Arriba, and Sandoval.

"Design Concentrations" are the concentrations of air pollution at a specific monitoring site that can be compared to the NAAQS. The 2015 design concentrations of criteria pollutants are listed below in Table 2. There is no monitoring for CO and lead in San Juan County, but because the county is relatively rural, it is likely that these pollutants are not elevated. PM_{10} design concentrations are not available for San Juan County.

Table 2. 2015 Criteria Pollutant Monitored Values in San Juan County
(U.S. Environmental Protection Agency, 2015)

Pollutant	2015 Design Concentration	Averaging Time	NAAQS	NMAAQS
O_3	0.067 ppm	8-hour	0.070 ppm[1]	
NO_2	12 ppb	Annual	53 ppb[2]	50 ppb
NO_2	12 ppb	1-hour	100 ppb[3]	
$PM_{2.5}$	4.7 µg/m^3	Annual	12 µg/m^3[3,4]	60 µg/m^3[3,6]
$PM_{2.5}$	13 µg/m^3	24 hour	35 µg/m^3[3,3]	150 µg/m^3[3,6]
SO_2	0.0 ppb	1-hour	75 ppb[5]	

[1] Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
[2] Not to be exceeded during the year
[3] 98th percentile, averaged over 3 years
[4] Annual mean, averaged over 3 years
[5] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
[6] The NMAAQS is for Total Suspended Particulate (TSP)

Table 3 shows total human caused emissions for each of the counties in the FFO based on EPA's 2011 emissions inventory (U.S. Environmental Protection Agency, 2014).

Table 3. Analysis Area Emissions in Tons/Year, 2011

County	NO_X (1)	CO (2)	VOC (3)	PM_{10} (4)	$PM_{2.5}$ (5)	SO_2 (6)
McKinley	11,952.9	17,007.8	3,891.2	70,096.4	7,645.2	1,381.1
Rio Arriba	12,012.3	27,344.6	19,149.8	33,761.2	4,130.6	60.4
San Juan	42,231.5	63,568.9	26,110.8	76,638.3	9,201.0	5,559.3
Sandoval	4,143.8	19,513.9	4,373.1	39,343.0	4,510.8	109.3
La Plata	4,838.2	17,116.3	3,740.1	2,330.0	919.6	127.9
Total	**75,187.7**	**144,551.5**	**57,265.1**	**222,168.9**	**26,407.2**	**7,237.9**

(1) NO_X – nitrogen oxides
(2) CO – carbon monoxide
(3) VOC – volatile organic compounds
(4) PM_{10} – particulate matter with an aerodynamic diameter equal to or less than 10 microns
(5) $PM_{2.5}$ – particulate matter with an aerodynamic diameter equal to or less than 2.5 microns
(6) SO_2 – sulfur dioxide

While all of San Juan County is in attainment of all NAAQS including ozone, the Navajo Dam monitoring station is the most closely watched due to the current design value of 0.068 ppm. While 0.068 ppm is below the attainment value of 0.070 ppm, it is the highest design value of the three monitoring stations in San Juan County. The potential amounts of ozone precursor emissions of NO_x and VOCs from the proposed lease sale are not expected to impact the current design value for ozone in San Juan County under the Proposed Action Alternative.

In October 2012, US EPA promulgated air quality regulations for completion of hydraulically fractured gas wells. These rules require air pollution mitigation measures that reduce the emissions of volatile organic compounds during gas well completions.

In 2005, the EPA estimates that there was less than 0.01 ton per square mile of lead emitted in FFO counties, which is less than two tons total (U.S. Environmental Protection Agency, 2012). Lead emissions are not an issue in this area, and will not be discussed further.

Air quality in a given region can be measured by its Air Quality Index (AQI) value. The AQI is reported according to a 500-point scale for each of the major criteria air pollutants, with the worst denominator determining the ranking. For example, if an area has a CO value of 132 on a given day and all other pollutants are below 50, the AQI for that day would be 132. The AQI scale breaks down into six categories: good (AQI <50), moderate (50-100), unhealthy for sensitive groups (101-150), unhealthy (151-200), very unhealthy (201-300), and hazardous (301-500). The AQI is a national index, the air quality rating and the associated level of health concern is the same everywhere in the country. The AQI is an important indicator for populations sensitive to air quality changes (U.S. Environmental Protection Agency, 2016).

Mean AQI values for San Juan County were generally in the good range (AQI <50) in 2015 with 72 percent of the days in that range. The median AQI in 2015 was 44, which indicates “good” air quality. The maximum AQI in 2015 was 115, which is “unhealthy” (U.S. Environmental Protection Agency, 2016).

Although the AQI in the region has reached the level considered unhealthy for sensitive groups on several days almost every year in the last decade, there are no patterns or trends to the occurrences. On seven days in the past decade, air quality has reached the level of “unhealthy”, and on two days air quality reached the level of “very unhealthy”. In 2009 and 2014, there were no days that were “unhealthy for sensitive groups” or worse in air quality. In 2006 and 2013, there was one day that was “unhealthy” during each year. In 2010, there were five “unhealthy” days and two “very unhealthy days”. The number of days classified as unhealthy are summarized in Table 4.

Table 4. Number of Days classified as “unhealthy for sensitive groups” (AQI 101-150) or worse (U.S. Environmental Protection Agency, 2015)

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Days	23	45	3	0	13	19	12	5	0	2

3.1.2 Hazardous Air Pollutants

The Air Resources Technical Report discusses the relevance of hazardous air pollutants (HAPs) to oil and gas development and the particular HAPs that are regulated in relation to these activities (U.S. Department of Interior Bureau of Land Management, 2016). The EPA conducts a periodic National Air Toxics Assessment (NATA) that quantifies HAP emissions by county in the US. The purpose of the NATA is to identify areas where HAP emissions result in high health risks and further emissions reduction strategies are necessary. A review of the results of the 2005

NATA shows that cancer, neurological and respiratory risks in San Juan County are generally lower than statewide and national levels as well as those for Bernalillo County where urban sources are concentrated in the Albuquerque area (U.S. Environmental Protection Agency, 2012).

3.1.3 Greenhouse Gases and Climate Change

Climate change refers to any significant change in measures of climate (e.g., temperature or precipitation) lasting for an extended period (decades or longer). Climate change may result from natural processes, such as changes in the sun's intensity or within the climate system (such as changes in ocean circulation) as well as human activities that change the atmosphere's composition (such as burning fossil fuels) and the land surface (such as urbanization) (Intergovernmental Panel on Climate Change [IPCC], 2007). Climate is both a driving force and limiting factor for ecological, biological, and hydrological processes, and has great potential to influence resource management.

Secretarial Order 3285, issued on March 11, 2009, established a Department-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes, and on the land, water, ocean, fish and wildlife, and cultural heritage resources the Department manages. The Secretarial Order states that one must "consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, and/or when making major decisions affecting DOI resources." BLM does recognize the importance of climate change and the potential effects it could have on natural and socioeconomic environments. Since the assessment of GHG emissions and climate change is in its formative phase it is currently not feasible to predict the exact impacts the Proposed Action would have on climate. However, for the purpose of NEPA analysis and consistent with CEQ regulations, this EA includes a qualitative and quantitative analysis of possible greenhouse gas emissions that could occur as a result of reasonably foreseeable oil and gas development. More detailed emissions would be available and calculated at a site specific level of analysis such as those that occur at an APD stage.

It is accepted within the scientific community that global temperatures have risen at an increased rate and the likely cause is gases that trap heat in the atmosphere, referred to as greenhouse gases (GHG). GHGs are composed mostly of carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), water vapor, and ozone. The greenhouse gas effect is the process in which the radiation from the sun that heats the surface of Earth gets blocked by GHG molecules in Earth's atmosphere. Since GHGs are composed of molecules that absorb and emit infrared electromagnetic radiation (heat), they form an intrinsic part of the greenhouse effect. Some GHGs such as CO_2 and water vapor occur naturally and are emitted into the atmosphere through natural processes. Other GHGs (e.g., fluorinated gases) are created and emitted solely through human activities. However, atmospheric concentrations of both the natural and man-made gases have been rising over the last few centuries due to the industrial revolution. The primary GHGs that enter the atmosphere as a result of anthropogenic activities include CO_2, CH_4, N_2O, and fluorinated gases such as hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Fluorinated gases are powerful GHGs that are emitted from a variety of industrial

processes including production of refrigeration/cooling systems, foams and aerosols. Fluorinated gases are not primary to the activities authorized by the BLM and will not be discussed further in this document. Ongoing scientific research has identified the potential impacts of anthropogenic GHG emissions and changes in biological sequestration due to land management activities on global climate. Through complex interactions on a regional and global scale, these GHG emissions and net losses of biological carbon sinks may cause a net warming effect of the atmosphere, primarily by decreasing the amount of heat energy re-radiated by the earth back into space. However, other activities could help sequester carbon, such as managing vegetation to favor perennial grasses and increase vegetation cover, which could help build organic carbon in soils and function as "carbon sinks."

In addition, GHGs have a sustained climatic impact over different temporal scales. For example, recent emissions of CO_2 can influence climate for 100 years. In contrast, black carbon is a relatively short-lived pollutant, as it remains in the atmosphere for only about a week. It is estimated that black carbon is the second greatest contributor to global climate change behind CO_2 (Ramanathan and Carmichael, 2008). Black carbon is a highly light-absorbing component of particulate resulting from the incomplete combustion of fossil fuels, biofuels, and biomass. Most black carbon in the Unites States comes from mobile sources (diesel engines and vehicle use) or biomass burning (wildfires, residential heating, and industry) (US EPA, 2012). Without additional meteorological monitoring systems, it is difficult to determine the spatial and temporal variability and change of climatic conditions, but increasing concentrations of GHGs may accelerate the rate of climate change in either a positive or negative direction depending upon location and site specific factors.

Greenhouse gases are often presented using the unit of Metric Tons of CO_2 equivalent (MT CO_2e) or Million Metric Tons (MMT CO_2e), a metric to express the impact of each different greenhouse gas in terms of the amount of CO_2 making it possible to express greenhouse gases as a single number. For example, one ton of methane would be equal to 25 tons of CO_2 equivalent, because it has a global warming potential (GWP) 25 times that of CO_2 (EPA, 2016).

As defined by the US EPA, the GWP provides "ratio of the time-integrated radiative forcing from the instantaneous release of one kilogram of a trace substance relative to that of one kilogram of CO_2." The GWP of greenhouse gas is used to compare global impacts of different gases and used specifically to measure how much energy the emissions of one ton of gas will absorb over a given period of time (e.g. 100 years), relative to the emissions of one ton of CO_2. The GWP accounts for the intensity of each GHG's heat trapping effect and its longevity in the atmosphere. The GWP provides a method to quantify the cumulative effects of multiple GHGs released into the atmosphere by calculating carbon dioxide equivalent for the GHGs.

- **Carbon dioxide (CO_2)**, by definition, has a GWP of one regardless of the time period used because it is the gas being used as the reference. CO_2 remains in the climate system for a very long time; CO_2 emissions cause increases in the atmospheric concentrations of CO_2 that will last thousands of years (US EPA, 2016).
- **Methane (CH_4)** is estimated to have a GWP of 28 to 36 times that of CO_2 over 100 years. CH_4 emitted today lasts about a decade on average, which is much less time than CO2. But CH_4 also absorbs much more energy than CO_2. The net effect of the shorter

lifetime and higher energy absorption is reflected in the GWP. The methane GWP also accounts for some indirect effects, such as the fact that methane is a precursor to ozone, and ozone is in itself a greenhouse gas (US EPA, 2016).

- **Nitrous Oxide (N_2O)** has a GWP of 265 to 298 times that of CO_2 for a 100-year timescale. N_2O emitted today remains in the atmosphere for more than 100 years, on average (US EPA, 2016). Table 5 contains GHGs regulated by US EPA and global warming potentials.

Table 5. GHG Regulated by US EPA and Global Warming Potentials (US EPA, 2016)

Air Pollutant	Chemical Symbol / Acronym	Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	25
Nitrous Oxide	N_2O	298
Hydrofluorocarbons	HFCs	Varies
Perfluorocarbons	PFCs	Varies
Sulfur hexafluoride	SF_6	22,800

Although still debated, GHG levels have varied for millennia, and it is theorized that recent industrialization and burning of fossil carbon sources have caused CO_2e concentrations to increase dramatically, and are likely to contribute to overall global climatic changes. The IPCC (2007) concluded that "warming of the climate system is unequivocal" and "most of the observed increase in global average temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic GHG concentrations." Extensive research and development efforts are underway in the field of carbon capture and sequestration (CCS) technology, which could help direct management strategies in the future. The IPCC has identified a target worldwide "carbon budget" to estimate the amount of CO_2 the world can emit while still having a likely chance of limiting global temperature rise to 2°C above pre-industrial levels. The international community estimates this budget to be one trillion tonnes of carbon (IPCC, 2016).

Because GHGs circulate freely throughout Earth's atmosphere, climate change is a global issue. The largest component of global anthropogenic GHG emissions is CO_2. Global anthropogenic carbon emissions reached about 7,000,000,000 MT per year in 2000 and an estimated 9,170,000,000 MT per year in 2010 (Boden et al 2013). Oil and gas production contributes to GHGs such as CO_2 and methane. Natural gas systems were the largest anthropogenic source category of CH_4 emissions in the United States in 2014 with 176.1 MMT CO_2 e of CH_4 emitted into the atmosphere. Those emissions have decreased by 30.6 MMT CO_2 e (14.8 percent) since 1990 (US EPA, 2016). In 2006, natural gas production accounted for eight percent of global methane emissions, and oil production accounted for 0.5 percent of global methane emissions (URS Corporation, 2010).

Global mean surface temperatures have increased nearly 1.0°C (1.8°F) from 1890 to 2006 (National Aeronautics and Space Administration Goddard Institute for Space Studies, 2007). In 2001, the IPCC (2007) indicated that by the year 2100, global average surface temperatures would increase 1.4 to 5.8°C (2.5 to 10.4°F) above 1990 levels. The National Academy of Sciences (Hansen et al., 2006) has confirmed these findings, but also indicated that there are uncertainties regarding how climate change may affect different regions. Observations and predictive models indicate that average temperature changes are likely to be greater in the Northern Hemisphere. Data indicate that northern latitudes (above 24° N) have exhibited temperature increases of nearly 1.2°C (2.1°F) since 1900, with nearly a 1.0°C (1.8°F) increase since 1970 alone. It also shows temperature and precipitation trends for the conterminous United States. For both parameters we see varying rates of change, but overall increases in both temperature and precipitation.

Recently, pioneering research using space-borne (satellite and aircraft) determination of methane concentrations have indicated anomalously large methane concentrations may occur in the Four Corners region (Kort, Frankenberg, Costigan, Lindenmaier, Dubey, & Wunch, 2014). A subsequent study (Schneising, Burrows, Dickerson, Buchwitz, Reuter, & Bovensmann, 2014) indicated larger anomalies over other oil and gas basins in the US. Methane is 34 times more potent at trapping greenhouse gas emissions than CO_2 when considering a time horizon of 100 years (Intergovernmental Panel on Climate Change, 2013). While space-borne studies can determine the pollutant concentration in a column of air, these studies cannot pinpoint the specific sources of air pollution. Further study is required to determine the sources responsible for methane concentrations in the Four Corners region; however, it is known that a significant amount of methane is emitted during oil and gas well completion (Howarth, Santoro, & A. Ingraffea, 2011).

Methane is also emitted from process equipment, such as pneumatic controllers and liquids unloading, at oil and gas production sites. Ground-based, direct source monitoring of pneumatic controllers conducted by the Center for Energy and Environmental Resources (Allen, et al., 2014) show that methane emissions from controllers exhibit a wide range of emissions and a small subset of pneumatic controllers emitted more methane than most. Emissions measured in the study varied significantly by region of the US, the application of the controller, and whether the controller was continuous or intermittently venting. The Center for Energy and Environmental Resources had similar findings of variability of methane emissions from liquid unloading (Allen, et al., 2014a). In October 2012, US EPA promulgated air quality regulations controlling VOC emissions at gas wells. These rules require air pollution mitigation measures that reduce the emissions of volatile organic compounds. These same mitigation measures have a co-benefit of reducing methane emissions. Future ground-based and space-borne studies planned in the Four Corners region with emerging pollutant measurement technology may help to pinpoint significant, specific sources of methane emissions in the region.

The Air Resources Technical Report summarizes information about greenhouse gas emissions from oil and gas development and their effects on national and global climate conditions. While it is difficult to determine the spatial and temporal variability and change of climatic conditions; what is known is that increasing concentrations of GHGs are likely to accelerate the rate of climate change.

3.2 Heritage Resources

3.2.1 Cultural Resources

The Proposed Action is located within the archaeologically rich San Juan Basin of northwestern New Mexico. In general, the prehistory of the San Juan Basin can be divided into five major periods: PaleoIndian (ca. 10000 B.C. to 5500 B.C.), Archaic (ca. 5500 B.C. to A.D. 400), Basketmaker II-III and Pueblo I-IV periods (A.D. 1-1540), and the Historic (A.D. 1540 to present), which includes Native American as well as later Hispanic and Euro-American settlers. Detailed description of these various periods and select phases within each period is provided in the BLM FFO Final Environmental Impact Statement and Resource Management Plan (2003) and will not be reiterated here. Additional information is also included in an associated document (SAIC 2002).

BLM Manual 8100, The Foundations for Managing Cultural Resources (2004) defines a cultural resource as "a definite location of human activity, occupation, or use identifiable through field inventory (survey), historical documentation, or oral evidence. The term includes archaeological, historic, or architectural sites, structures, or places with important public and scientific uses, and may include definite locations (sites or places) of traditional cultural or religious importance to specified social and/or cultural groups (see also “traditional cultural property”). Cultural resources are concrete, material places and things that are located, classified, ranked, and managed through the system of identifying, protecting, and utilizing for public benefit described in this Manual series. They may be but are not necessarily eligible for the National Register (e.g. "historic property”).

Although the Navajo Nation has their own operational definitions regarding cultural resources on their lands as set forth by the Navajo Nation Cultural Resources Protection Act (NNCRPA), the preceding BLM definition is generally applicable. On the Navajo Nation cultural resources are managed for the benefit of the Navajo Nation and its people, not the public.

Section 106 of the National Historic Preservation Act requires federal agencies to consider what effect their licensing, permitting, or otherwise authorizing of an undertaking, such as mineral leasing, may have on properties eligible for the National Register. Pursuant to 36 CFR 800.16 (i), “Effect means alteration to the characteristics of a historic property qualifying it for inclusion in or eligibility for the National Register.”

The National Register of Historic Places (36 CFR Part 60) is the basic benchmark by which the significance of cultural resources are evaluated by a federal agency when considering what effects its actions may have on cultural resources. To summarize, to be considered eligible for the National Register a cultural resource must have integrity of location, design, setting, materials, workmanship, feeling, and association, and meet one or more of the following criteria: a) are associated with events that have significantly contributed to the broad patterns of our history; b) are associated with the lives of persons significant in our past; c) embody distinctive characteristics of the type, period, or method of construction, or represents the work of a master, or possesses high artistic value, or represent a significant and distinguishable entity whose

components may lack individual distinction; or d) have yielded, or maybe likely to yield, information is important in a pre-history or history.

Cultural resources vary considerably and may include but are not limited to simple artifact scatters, domiciles of various types with a myriad of associated features, rock art and inscriptions, ceremonial/religious features, and roads and trails. In the broadest sense cultural resources include sites, buildings, structures, objects, and districts/landscapes (NPS 1997).

A 'site' is the location of a significant event, a prehistoric or historic occupation or activity, or a building or structure, whether standing, ruined, or vanished, where the location itself possesses historic, cultural, or archeological value regardless of the value of any existing structure. A site need not be marked by physical remains if it is the location of a prehistoric or historic event or pattern of events and if no buildings, structures, or objects marked it at the time of the events.

A 'building' is created principally to shelter any form of human activity. 'Building' may also be used to refer to a historically and functionally related unit, such as a courthouse and jail or a house and barn. If a building has lost any of its basic structural elements, it is usually considered a 'ruin' and is categorized as a site.

The term 'structure' is used to distinguish from buildings those functional constructions made usually for purposes other than creating human shelter. If a structure has lost its historic configuration or pattern of organization through deterioration or demolition, it is usually considered a 'ruin' and is categorized as a site.

The term 'object' is used to distinguish from buildings and structures those constructions that are primarily artistic in nature or are relatively small in scale and simply constructed. Although it may be, by nature or design, movable, an object is associated with a specific setting or environment.

A 'district' possesses a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development. A district can contain buildings, structures, sites, objects, or open spaces that do not contribute to the significance of the district. A district can also be a grouping of archeological sites related primarily by their common components; these types of districts often will not visually represent a specific historic environment. In archeological districts, the primary factor to be considered is the effect of any disturbances on the information potential of the district as a whole.

3.2.2 Cultural Landscapes

Cultural landscapes "represent the 'combined works of nature and of man'… [and] are illustrative of the evolution of human society and settlement over time, under the influence of the physical constraints and/or opportunities presented by their natural environment and of successive social, economic and cultural forces, both external and internal" (UNESCO 2008). The term embraces a diversity of manifestations of the interaction between humans and the natural environment and often reflects specific techniques of sustainable land use, considering

the characteristics and limits of the natural environment they are established in, and a specific spiritual relation to nature.

The National Park Service (NPS) has defined cultural landscapes as “a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values” (Birnbaum 1994; Birnbaum and Peters 1996).

Landscape characteristics are the tangible evidence of the activities and habits of the people who occupied, developed, used, and shaped the land to serve human needs and they may reflect the beliefs, attitudes, traditions, and values of these people. There is no comprehensive guidance on what characteristics to evaluate with regards to the landscape, or how to “read a landscape” (Birnbaum 1994). Whatever approach is taken should provide a broad overview. The NPS (1999; Birnbaum and Peters 1996) has offered a number of character defining features and organizational elements that should be examined when considering human use or activity in a geographic area for cultural landscapes: Land uses and activities; Patterns of spatial organization; Response to the natural environment; Cultural traditions; Circulation networks (e.g. roads, paths); Topography; Water features; Boundary demarcations; Vegetation related to land use; Buildings, structures, and objects; Clusters; Archaeological sites; and Small scale elements.

Zvelebil et al. (1992) identified seven major problems associated with landscape approaches to archaeological remains. To summarize, they include 1) lack of chronological resolution, 2) the palimpsest effect, 3) definition of a regional scale, 4) biases introduced through taphonomic processes, 5) variation over the landscape, 6) paleo-environmental reconstruction, and 7) modern land use. Van Dyke (2007:8, 39) observed that “the contemporary archaeological landscape is but a distorted remnant of the ancient landscape, and interpretations of both are and were culturally situated” and that “past landscapes no longer exist.” Compounding the difficulty in defining landscapes is that they may be a composite of designed and vernacular/organic characteristics and at the same time represents a relic or fossil landscape to some and a continuing ethnographic/associative landscape to others.

A cultural landscape is also one of the categories of property qualifying for listing in the National Register as a historic site or district. A district (e.g. landscape) must be a definable geographic area that can be distinguished from surrounding properties by changes such as density, scale, type, age, style of sites, buildings, structures, and objects, or by documented differences in patterns of historic development or associations. It is seldom defined, however, by the limits of current parcels of ownership, management, or planning boundaries. The boundaries must be based upon shared relationship among the properties constituting the district. A district is usually a single geographic area of contiguous historic properties; however, a district can also be composed of two or more definable significant areas separated by nonsignificant areas. Clement (1999:17) advised that “As a general rule, it is preferable to identify a reasonably defensible smaller landscape rather than stretching boundaries to distant horizons, and perhaps threatening the credibility of the process.”

3.2.2.1 Area of Potential Affect and Cultural Resource Identification

As previously noted, pursuant to Section 106 of the NHPA and its implementing regulations (36 CFR Part 800) a federal agency is required to consider the effects of its actions or 'undertakings', such as leasing, on properties that are listed or eligible for the National Register of Historic Places. This is completed by a process of collaborative identification, normally including field surveys of some kind with subsequent evaluations of significance for any districts, sites, buildings, structures, and objects that have been identified within the Area of Potential Effect (APE).

The Proposed Action is a reduced version of a deferred October 2014, January 2015, and October 2016 lease sales and is, in whole or in part, parcels previously consulted upon. For the October 2014 sale and pursuant to 36 CFR Part 800.4(a) and 800.4(b), BLM previously consulted in March 2014 with the New Mexico SHPO, the National Park Service (Chaco Culture National Historical Park), Navajo Nation and potentially affected chapters (e.g., Counselor, Nageezi), the pueblos of Zia, Zuni, Jemez, Acoma, and Hopi, the Jicarilla Apache Nation, Ute Mountain and Southern Ute tribes, National Trust for Historic Preservation, San Juan Citizens Alliance, and the Chaco Alliance. Navajo and the other tribes and pueblos were contacted again in May 2014. Only the SHPO and the Hopi responded.

The New Mexico SHPO (April 10, 2014) pointed out the proximity of the Pueblo Pintado site to some of the parcels and indicated that they would provide more comments after BLM completed its cultural review. The Hopi (March 25, 2014) requested and were subsequently provided a cultural resources overview for review and comment. No further comments were received from the Hopi Tribe. The current parcels proposed for January 2017 are now further removed from Pueblo Pintado.

Native American tribes, including local Navajo Chapter officials were again contacted by mail April 8, 2016 regarding the now postponed October 2016 sale. Santa Clara Pueblo (May 6, 2016), the Hopi tribe (April 26, 2016), and Ojo Encino Chapter (June 12, 2016) responded. Santa Clara and Hopi requested a copy of the cultural report which was provided electronically to the tribal THPOs on June 23, 2016. Ojo Encino provided a Chapter Resolution in opposition to leasing. The Navajo Nation Historic Preservation Department was provided a copy of the cultural review on July 5, 2016.

Native American tribes including local Navajo Chapter officials were again contacted by mail in July 2016 regarding the January 2017 sale. The New Mexico SHPO was provided a copy of the cultural review on July 29, 2016.

The Navajo Nation, Hopi Tribe and Santa Clara Pueblo historic preservation offices, as well as the New Mexico SHPO, the National Park Service (Chaco Culture National Historical Park), National Trust for Historic Preservation (NTHP), the Chaco Alliance, and San Juan Citizens Alliance (SJCA) were emailed August 8, 2016 with a copy of the EA and a link to the BLM website where it could be found. Only the SHPO, SJCA, Hopi, and NTHP responded.

By letter dated August 15, 2016, SHPO offered several comments regarding the identification of historic properties or other places of traditional religious and cultural importance in the APE. SHPO suggested lease stipulations requiring ethnographic studies prior to development and consulting with the Navajo Nation to identify other places of traditional religious and cultural importance in the APE prior to leasing. The Navajo Nation was invited twice for this sale to consult on the identification of cultural resources without reply. The BLM and Navajo Nation have been consulting on fieldwork protocols for all undertakings and that protocol when implemented will accomplish the same as any lease stipulation.

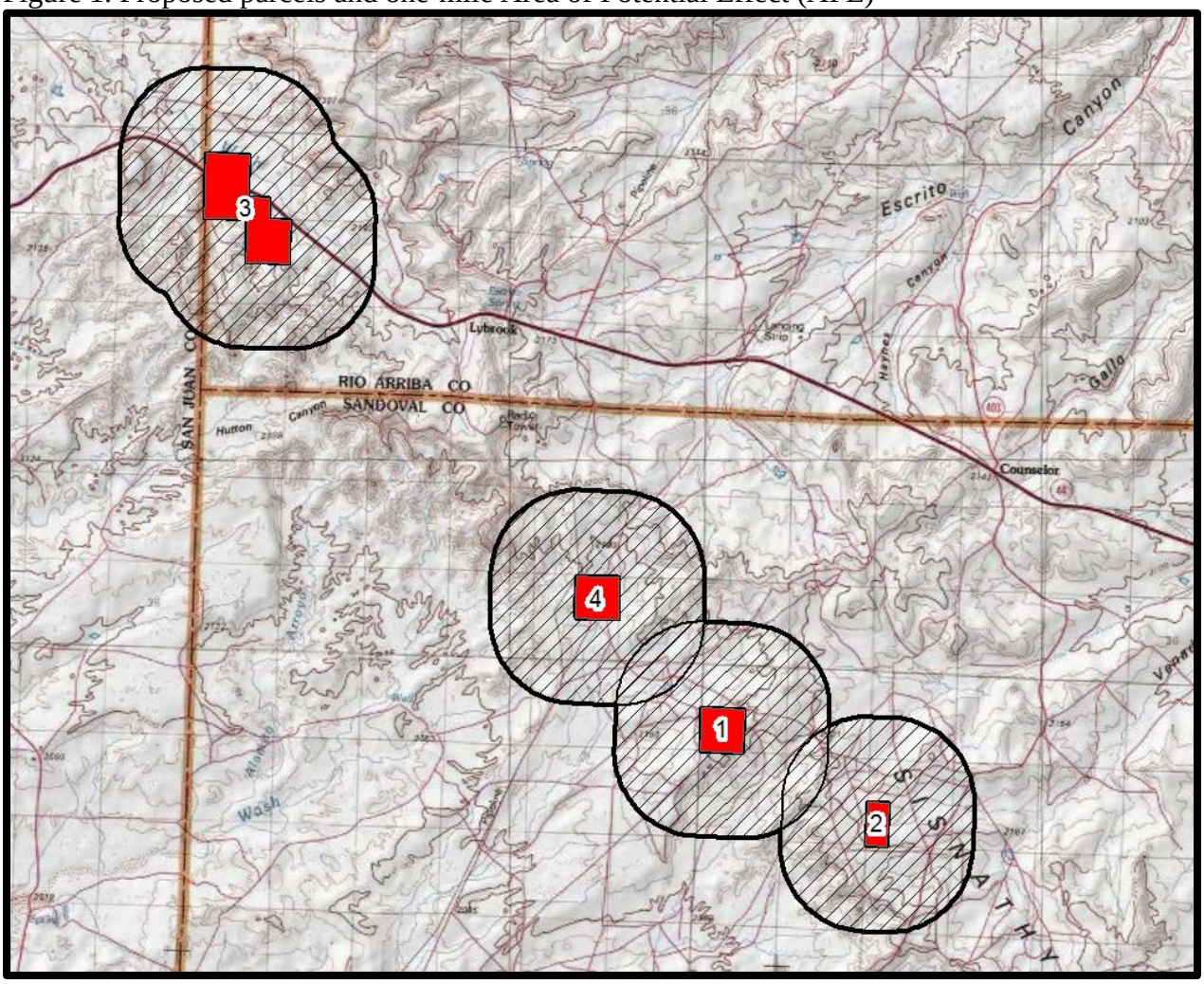
By email (August 8, 2016) SJCA commented on numerous issues. With regard to cultural resources SJCA stated "*On page 68, the claim that the Proposed Action would not* (sic) *have," no cumulative impact on historic properties, properties listed on the National Register of Historic Places or New Mexico State Register of Cultural Properties, Chaco Protection Sites, World Heritage Sites, National Historic Trails, or other places of traditional religious and cultural importance" is contradicted by the earlier disclosures in the EA concerning cultural significant areas and regions*." There is no contradiction as there are no properties listed on the National Register of Historic Places or New Mexico State Register of Cultural Properties, Chaco Protection Sites, World Heritage Sites, or National Historic Trails in proximity to the Proposed Action and potential impacts to other historic properties or other places of traditional religious and cultural importance, if any, will be addressed at the development stage through collaborative consultation between various parties (SHPO, NGOs, Tribes).

By email (September 2, 2016) Hopi supported the No Action Alternative and argued for an EIS claiming the EA was not in conformance with the 2003 RMP. In addition to some environmental issues, concerns about adverse effects to nonspecific cultural sites were also mentioned.

By email the (August 15, 2016) NTHP asked for clarification on the proximity of the Proposed Action to Chaco Canyon and a map was provided to them.

Since any development of the leases is now proposed to occur off lease via horizontal drilling, pursuant to 36 CFR 800.16(d) BLM has identified a one mile area around the lease parcels as the APE for undertakings that could affect aspects of a historic properties physical integrity including location, design, materials, and workmanship (Figure 1). It is within this area that any wells and supporting access and pipelines are likely to be constructed.

Figure 1. Proposed parcels and one-mile Area of Potential Effect (APE)



Identification of cultural resources within the nominated parcels involved use of computerized cultural resources data maintained by the New Mexico Cultural Resource Information System (NMCRIS; May 2016), BLM site location maps, ethnographic records from previously conducted small and large scale cultural resource surveys, ongoing consultation, General Land Office (GLO) records, and assorted published and unpublished records.

Previous cultural resource studies and surveys in the APE (1977-2015)(Table 6) have been generally limited to inventories related to various land use authorizations that include various public and industrial infrastructure, ranching, energy/resources extraction, and home sites. The figures may be slightly higher because not all known surveys have been electronically captured in a GIS environment on Navajo surface.

Table 6. Survey coverage and site numbers by parcel APE.

Parcel #	APE Acreage	Previous Surveys	Previous Survey Acreage	APE Survey Coverage (Percent)	Known Sites
NM-201701-001	3,290	27	247	8	18
NM-201701-002	2,973	30	519	17	16
NM-201701-003	4,620	97	1,135	25	117
NM-201701-004	3,278	35	409	12	48

Due to APE overlap a small amount of survey acreage is common to both parcel -001 and -002 and parcels -001 and -004. Collectively there is 2,288 acres of survey representing a 17 percent of overall coverage.

Collectively there are 197 sites within the APE for an overall site density of 1:12 acres. Site density will likely vary somewhat dependent upon location specific environmental variables. Due to APE overlap two sites are common to both parcel -001 and -002. One hundred-seventy of those sites have temporal or component data (Table 7). There are 177 distinct cultural or temporal components represented by the sites. The majority (n=91) are Navajo (>A.D.1500), about 47 percent of which date after 1880. “Unknown” sites (n=58) most likely indicates an absence of culturally or temporally diagnostic artifacts or features, such as a scatter of stone tool debris without any diagnostic specimens, or may represent an absence of data in the record. The majority of these unknown sites are likely to be pre-Columbian or historic Native American. Archaic (n=16), Anasazi (n=6), and unspecified historic (n=6) round out the list.

Table 7. Culture components in APE.

Culture Components	Count
Unknown Historic (>1900)	6
Anasazi, a.k.a. Ancestral Pueblo	6
Archaic	16
Unknown	64
Navajo	91
Total	**177**

There are 314 features present at the sites (Table 8). Features are a human-made component of an archaeological site and are typically non-portable and contain collections of artifacts and/or types of materials that represent special activities, such as a hearth, domicile, dump, or post holes. Features common to these sites include, but are not limited to, hogans, horno/ovens, corrals and lambing pens, dumps, ramada, house foundation, sweat lodges, artifact concentrations, and ash stains and hearths. Some of these features are restricted to the historic periods of occupation such as corral, dump etc. Features such as hearth and ash stains may appear at sites of any age and cultural affiliation. All Archaic and Anasazi sites appear to be simple artifact scatters. A description of these features may be found online at http://www.nmhistoricpreservation.org/arms.html in the NMCRIS Users Guide.

Table 8. Cultural features observed in APE.

Feature	Number Observed		Feature	Number Observed
Artifact concentration	2		Log cabin	1
Ash / charcoal stain	30		Masonry chimney	1
Bin / Cist	2		Midden	4
Fence	4		Mound (*not prehistoric*)	6
Brush piles	5		Petroglyph	3
Burial / Grave	1		Post structure, undefined	1
Hogan	75		Ramada / Shelter	4
Burned rock concentration	4		Rock alignment, undefined	4
Cairn	1		Rock cluster, possible hearth	1
Ramada / Shelter	1		Rockshelter	2
Sweat lodge	1		Shed	1
Corral	28		Soil stain, unspecified	1
Cultural deposit	1		Sweat lodge	8
Midden	1		Tent base	3
Dugout	3		Midden	1
Dump	34		Unspecified other	6
Hearth	31		Unspecified thermal feature	6
Horno/oven	17		Wall	1
House foundation	7		Water control device	1
Isolated room	1		Well	1
Juniper logs	2		Wood concentration	4
Lithic quarry	3		**TOTAL**	**314**

Historically in the FFO approximately 80 percent of sites are determined eligible or treated as eligible for the National Register of Historic Places. For the Proposed Action approximately 158 of the 197 sites within the APE are likely eligible for the National Register. Most if not all are eligible for their potential to yield information important in history or prehistory (Criterion d). There are no properties listed on the National Register or the New Mexico State Register of Cultural Properties within the APE.

3.2.2.2 General Land Office (GLO) Records

Original GLO maps covering the APEs were downloaded from http://www.glorecords.blm.gov and geo-referenced into a GIS map project. No historic features were identified in 1882 on the parcels. Whether this accurately reflects a low resident population density in the early 1880s, or reflects a bias to documenting non-Native American residential features is uncertain. No pre-Columbian features were identified on the GLO maps within the APE. Previous work with GLO maps in the area suggests that the farther a feature was from a section line the less likely it would be noticed and recorded during land surveys (Copeland 2015).

3.2.3 Native American Religious Concerns

There are several pieces of legislation or Executive Orders that are considered when evaluating Native American religious concerns; these govern the protection, access and use of scared sites,

possession of sacred items, protection and treatment of human remains, and the protection of archaeological resources ascribed with religious or historic importance. These include the following:

- **The American Indian Religious Freedom Act of 1978 (AIRFA; 42 USC 1996, P.L. 95-431 Stat. 469).** Possession of sacred items, performance of ceremonies, access to sites.
- **Executive Order 13007 (24 May 1996).** Access and use of sacred sites, integrity of sacred sites.
- **The Native American Graves Protection and Repatriation Act of 1990 (NAGPRA; 25 USC 3001, P.L. 101-601).** Protection, ownership, and disposition of human remains, associated funerary objects, unassociated funerary objects, sacred objects, or objects of cultural patrimony
- **The Archaeological Resources Protection Act of 1979 (ARPA; 16 USC 470, Public Law 96-95).** Protection or archaeological resources on Federal and Indian lands

Traditional Cultural Properties (TCPs)(Parker and King 1998) is a term that has emerged in historic preservation management and the consideration of Native American traditional concerns. TCPs are places that are eligible for the National Register of Historic Places and have cultural values, often sacred, that transcend the values of scientific importance that are normally ascribed to cultural resources such as archaeological sites and may or may not coincide with archaeological sites. Native American communities are most likely to identify TCPs, although TCPs are not restricted to those associations. Some TCPs are well known, while others may only be known to a small group of traditional practitioners, or otherwise only vaguely known. Native American perspectives on what is considered a TCP are not limited by a places National Register eligibility or lack thereof.

The identification of places of traditional religious and cultural importance (e.g. TCPs) within or near the parcels has been ongoing for decades. Most but not all of these efforts at identification were linked to land use planning efforts as well as evaluating potential energy extraction (e.g., coal, oil and gas) and rural infrastructure development (e.g., domestic water systems, power lines) in the area (e.g. Brugge 1986; Condie et al. 1982; Fransted and Werner 1975; Fransted 1979; Kelly et al. 2006; York and Winter 1988; Van Valkenburgh 1941, Van Valkenburgh 1974).

In both the published and gray literature the known places of traditional religious and cultural importance in the San Juan Basin is heavily weighted towards places of Navajo knowledge. This most likely is a byproduct of ongoing and historic occupancy of the area and retention of knowledge pertaining to that area. For example Brugge (1993:54) notes that in a research area of approximately 810 mi^2 with very minimal Navajo occupancy around Navajo Reservoir, Gobernador and Largo Canyons, only 66 place names and localities of Navajo use and knowledge had been recorded in the literature or otherwise identified by fieldwork. In a 540 mi^2 area around Chaco Canyon with significant ongoing Navajo occupation over 200 place names and localities were identified (Fransted and Werner 1975) suggesting that occupancy is an important factor in the retention of specific knowledge.

In the same area reported by Brugge (1993) there was only one specific geographical location identified through extensive and generally unproductive efforts to engage 20 pueblos in identifying and documenting places of traditional religious and cultural importance. Places like Mesa Verde, Chaco Canyon, and Aztec Ruin were often mentioned, and the precise location of a number of other named places generally attributed to northwest New Mexico remains uncertain (Brugge 1993:111). Whether or not these results indicate an absence of information, a lack of interest in the area, or a polite way of safeguarding sensitive information is unknown. Without a doubt the pre-Columbian archaeological sites of the San Juan Basin and elsewhere are culturally affiliated with pueblos (e.g. Acoma, Zuni, Hopi) and representatives from those pueblos have made it very clear that those sites and their environment are of traditional religious and cultural importance to them.

Identification of TCPs for the proposed action was limited to reviewing these existing published and unpublished literature and ongoing BLM tribal consultation efforts with tribes and local Navajo chapters and communities.

Parcel NM-201701-001 is located on a large landform variously known as Sis Naateel, Sisnathyel Mesa, or Wide Belt Mesa. It is reported to be the home of several Navajo holy individuals important in the Blessingway ceremony and to be the location of where the Navajo acquired sheep and horses. However, there is some ambiguity on the identification of this mesa. It is clearly described by Van Valkenburgh (1941:171) as a “large quasi-rectangular mesa standing isolated in the southwestern township of the Jicarilla Apache Indian reservation… 10 miles east of Counselors trading post.” See also Van Valkenburgh (1974:32-37). Brugge (1993:18) encountered the problems of Navajo toponymy and correlating names recorded on recent USGS maps. Brugge (1993:18) went on to state that “the work of Van Valkenburgh has been of value. His descriptions are usually more detailed than those of other students of Navajo culture…”. The mesa shown on the current USGS map as Sisnathyel Mesa does not seem to conform to Van Valkenburgh’s description. Other places include another named landform, a plant gathering area, an Enemy Way site, and jishchaa’ (places associated with death such as graves or places where people died; n=1).

Parcel NM-201701-002 is also located on Sis Naateel, Sisnathyel Mesa, or Wide Belt Mesa. Other places include other named landforms (n= 2), a plant gathering areas, a historic dam, springs (n=2), and jishchaa’ (n=5).

Parcel NM-201701-003 is adjacent to a land form known as Ch'eeh Dighahii or Libah Dah Yisk'id (Turtle Hill; Gray Hill) and lies in the western portion of the APE. It is associated with the Navajo Emergence history and is reportedly the home of Old Age and Poverty spared by Monster Slayer. This land form may also be related to Beesh Yaa To or Beesh Heedzo (Water Under Flint/Knife or Flint/Knife Landmark). It is described as an isolated butte with a sacred spring and possible blind for ceremonial deer hunting and was reportedly mentioned on the route of travel delineated by Navajo Emergence history. Other places include a plant gathering and offering area and jishchaa’ (n=2).

Parcel NM-201701-004 is also located on Sis Naateel, Sisnathyel Mesa, or Wide Belt Mesa. It also touches an area known as Asaa Si'a or Place of the Pot, reportedly an area of offerings and

plant gathering. Other places include another named landform, plant gathering areas (n=3), jishchaa' (n=4), and a spring.

3.2.4 World Heritage Sites

Chaco Culture National Historical Park (CCNHP), Aztec Ruins National Monument, and the BLM managed Chaco outlier sites of Pierre's, Halfway House, Twin Angels, Casamero, and Kin Nizhoni were named as United Nations Educational, Scientific, and Cultural Organization (UNESCO) World Heritage Sites on December 8, 1987. The World Heritage listing includes the 34,000 acres in CCNHP, 318 acres in Aztec Ruins National Monument, and 518 acres within the five sites managed by the BLM.

None of the APEs or parcels are physically located within 14 miles of any World Heritage Site. None are visible from any World Heritage Site. All of the parcels are greater than 14 miles from CCNHP and the Pueblo Pintado unit of CCNHP. In 2014 during earlier lease sale scoping the Superintendent of CCNHP and Aztec Ruins National Monument acknowledged this conclusion and had no other comments to offer.

3.2.4.1 Chaco Culture Archaeological Protection Sites

Pursuant to Public Law 96-550 (1980), as amended by Public Law 104 -11 (1995), 39 sites in New Mexico, Arizona, and Colorado are designated Chaco Culture Archaeological Protection Sites (Protection Site). They were designated to recognize the unique archaeological resources associated with the prehistoric Chacoan in the San Juan Basin and surrounding areas, provide for the preservation and interpretation of these resources, and to facilitate research activities associated with these resources. No activities upon the upper surface of the sites (surface to 20 meters below ground level) are permitted that would endanger the cultural values. Nothing in the Act is deemed to prevent exploration and development of subsurface oil and gas, mineral, and coal resources from without the sites which does not infringe upon the upper surface of the sites.

The parcels are located more than 13 miles from any Protection Site. Part of the legislation directs the Secretary of the Interior to continue searching for additional evidence of Chacoan sites and as needed, provide recommendations for additions or deletions to the Protection Site list. Archaeological surveys since the 1995 amendment suggest that additional Chacoan sites eligible for Protection Site status in the vicinity of the Proposed Action are unlikely.

3.2.5 Visual Resource Inventory

The BLM uses a Visual Resource Management (VRM) system to inventory and manage visual resources on public lands. The primary objective of VRM is to manage visual resources so that the quality of scenic (visual) values is protected. The VRM system uses four classes (and their associated visual resource objectives) to describe the different degrees of surface disturbance or modification allowed on the landscape (Table 9).

As part of the VRM program, the BLM is to prepare and maintain on a continual basis an inventory of visual values of all its public lands. The inventory stage identifies the visual

resources of an area and assigns them to an inventory class using the BLM's Visual Resource Inventory (VRI) process, which is described in BLM Manual H-8410-1. The VRI process consists of the following:

- A scenic quality evaluation to rate the visual appeal of an area.
- A sensitivity level analysis to assess public concern of an area's scenic quality and their sensitivity to potential changes in the visual setting.
- A delineation of distance zones to indicate the relative visibility of the landscape from primary travel routes or observation points.

Based on these three factors, BLM-administered lands are placed into one of four VRI classes (Class I, Class II, Class III, and Class IV) that represent the relative value of the visual resources and provides the basis for considering visual values in the resource management planning process. VRI Classes II, III, and IV are determined based on a combination of scenic quality, sensitivity level, and distance-zone overlays to assign the proper class. In the relative scale of visual values, Class II has a higher level of value than Class III, which is moderately valued. Class IV is least valued. VRI Class I is assigned to special management areas where a management decision has previously been made to maintain a natural landscape. These areas are the most valued landscapes. This includes areas such as Wilderness Areas or Wilderness Study Areas, the wild section of national Wild and Scenic rivers, and other congressionally and administratively designated areas where decisions have been made to preserve a natural landscape. Since these areas are assigned the highest value, the inventory process does not provide a scoring method to assign VRI Class I. However, in the inventory process Class I areas are evaluated for their existing scenic quality, sensitivity level, and distance from observation areas.

The FFO completed a VRM, Resource Management Plan Amendment in 2014 (RMPA 2014). FFO inventory classes reflect the findings in regards to scenic quality, sensitivity level, and viewshed. These findings are referenced in Table 9 and reflect BLM lands visual inventory class where probable development would occur adjacent to each proposed lease.

Table 9. Visual Resource Class Objectives of Lease Parcels

VRI Class	Proposed Lease Parcels
Class I	None
Class II	None
Class III	3
Class IV	1, 2, 3, 4

Visual resources are managed by assigning a VRM Class. The objective for each VRM Class describes how that area should be managed, as shown in Table 10. The proposed lease parcels are adjacent to BLM lands with VRM Class III and IV areas.

Table 10. BLM VRM Class Objectives.

VRM Class	VRM Objective
Class I	The objective of this class is to preserve the existing character of the landscape. This class provides for natural ecological changes; however, it does not preclude very limited management activity. The level of change to the characteristic landscape should be very low and should not attract attention.
Class II	The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.
Class III	The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.
Class IV	The objective of this class is to provide for management activities, which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repeating the basic elements of the landscape.

The area where potential development would take place adjacent to the proposed lease parcels would encompass the VRM management classes as listed in Table 11, "Lease Parcels ID and associated VRM Classes."

Table 11. Lease Parcels ID and associated VRM Classes.

VRM Class	Parcel ID
Class I	None
Class II	None
Class III	-004
Class IV	-001; -002; -003

3.2.6 Night Sky Resources

There is a long history of stargazing, starting with the Ancestral Puebloan culture that inhabited the Chaco area. There has been focus of substantial research in cultural astronomy, and there are multiple examples where manmade and natural features were used to mark the positions of the sun, moon, and other astronomical phenomena. For the past two decades, CCNHP has partnered with the astronomy community. Amateur astronomers regularly host stargazing events under the guidance of a park ranger with a background in archeoastronomy. The park built a public observatory in 1998 to help accommodate the hundreds of thousands of visitors who have enjoyed the night sky at the park. The modern connection with the night sky is a substantial

recreation interest and a way for the public to connect and better understand the ancient culture that once thrived in the canyon.

3.3 Water Resources

Aquifers in the San Juan Basin are generally considered to be confined and artesian due to the overlying low hydraulic conductivity formations and the regional geologic structure (Stone et al. 1983). Groundwater recharge occurs along the topographic high outcrops along the basin margins. Discharge from groundwater aquifers generally occurs in topographic low areas such as the San Juan River in the northwestern part of the basin and the Rio Grande in the southeast. Vertical leakage across fine-grained formations is also a source of recharge and discharge due to variations in hydraulic head. Regionally vertical leakage is assumed to be low, however fracturing in particular around structural features in the basin could result in higher rates of vertical permeability (Stone et al. 1983).

The primary aquifers in the BLM FFO area are the sandstone based San Jose, Ojo Alamo, and the Mesaverde formations. Groundwater is readily available in most of the BLM FFO area and is of fair to poor quality. A search of the New Mexico State Engineers Office, Water Administration and Technical Engineering Resource System database, for the proposed analysis area and vicinity (one-mile radius) was performed (New Mexico Water Rights Reporting System, 2010). There are currently over 3,200 water wells throughout the San Juan Basin with an average depth of 353 feet (New Mexico Water Rights Reporting System, 2010).

Groundwater is readily available in most of the FFO area and is of fair to poor quality. Generally total dissolved solids (TDS) exceed 1,000 mg/L and ranges from 400 to 4,000 mg/L. The water is hard to very hard with chemical composition dependent on location of withdrawal and the producing aquifer. Calcium or sodium is usually the predominant cation with bicarbonate or sulfate the predominant anion (USDI/BLM 2003a, page 3-30).

Hydraulic fracturing (i.e., “fracking”) is the operation conducted in an individual wellbore designed to increase the flow of hydrocarbons from the rock formation to the wellbore through modifying the permeability of reservoir rock by applying fluids under pressure to fracture it. Fracking creates pathways in the target intervals that increase the rate at which fluids can be produced from the reservoir. Stimulation techniques, such as fracking, have been used in the San Juan Basin since the 1950s. Over the last 10 years, advances in multi-stage and multi-zone hydraulic fracturing have allowed development of oil and gas fields that previously were uneconomic, including the San Juan Basin.

Nationally, it is estimated that there are 35,000 wells fracked annually and that there has been over one million wells fracked since the 1940’s (BLM Hydraulic Fracturing White Paper, June 2015). Nationwide approximately 95 percent of all new wells are hydraulically fracked in order to enhance production. Nearly all of the existing wells in the San Juan Basin have been fracked.

Most onshore produced water (water that is produced along with oil or gas from target formations) is injected deep underground for either enhanced recovery or disposal. With the passage of the Safe Drinking Water Act in 1974, the subsurface injection of fluids came under

federal regulation. In 1980, the USEPA promulgated the Underground Injection Control regulations. The program is designed to protect underground sources of drinking water. The New Mexico Oil Conservation Division (NMOCD) regulates oil and gas operations in New Mexico. The NMOCD has the responsibility to gather oil and gas production data, permit new wells, establish pool rules and oil and gas allowables, issue discharge permits, enforce rules and regulations of the division, monitor underground injection wells, and ensure that abandoned wells are properly plugged and the land is responsibly restored. The New Mexico Environment Department (NMED) administers the major environmental protection laws. The Water Quality Control Commission (WQCC), which is administratively attached to the NMED, assigns responsibility for administering its regulations to constituent agencies, including the NMOCD. The NMOCD administers, through delegation by the WQCC, all Water Quality Act regulations pertaining to surface and groundwater (except sewage not present in a combined waste stream). According to the NMOCD, produced water if predictable in salt concentration, can be used for drilling and completion and possibly cementing (Jones, pers. comm. 2012).

Historically, more than 95 percent of the produced water associated with oil and gas operations has been injected into disposal wells in the San Juan Basin (BLM Hydraulic Fracturing White Paper, June 2015). NMOCD regulates and monitors underground injection wells. NMOCD permits saltwater disposal wells (SWD) into formations that will allow water infiltration and has TDS greater than 10,000 mg/L. The majority of SWD wells are permitted in the Entrada formation; there are older SWD wells that were permitted in the Mesa Verde formation. Currently, there are over 100 SWD wells throughout the San Juan Basin with an average depth of 6,728 feet (Ongard Wells layer). The average depth of water wells in the San Juan Basin is 353 feet (New Mexico Water Rights Reporting System, 2010). In 2011, there were over 33,000,000 barrels of produced water injected into the SWD wells.

According to NMED data, there are no drinking water sources located in or near the proposed parcels. According to the NM Office of the State Engineer (OSE) data, there are no water wells within the area of potential affect (APE) of proposed parcels -001, -002, and -004. There are five water wells within the APE of the proposed parcel -003. According to the NMOSE data, three wells are used for domestic use, one well is used for irrigation, and one well is used by the NM Highway Department. All of the nominated parcels are located in the San Juan declared ground water basin.

3.3.1 Induced Seismicity

Recently, there has been concern with induced seismicity (induced earthquakes) from waste water injection. The first earthquakes induced by wastewater injection were in the 1960s. The two largest induced earthquakes are a 5.3 magnitude in Trinidad, Colorado and a 5.6 magnitude in Prague, Oklahoma. The San Juan Basin lies within the Colorado Plateau, which is a stable region. There have not been any natural or induced earthquakes in the San Juan Basin from 1973-2012 (USGS). There is less than a one percent chance to experience damage from a natural or human induced earthquake in the San Juan Basin in 2016 (USGS, Forecast for Damage from Natural and Induced Earthquakes in 2016). There are three main areas in New Mexico (Dagger Draw, Raton, and Socorro) that have seismic activity. The majority of all earthquakes in New Mexico occur within the two largest clusters (Dagger Draw and Raton) (Pursley, Bilek, Ruhl,

2013). The proposed action is in the San Juan Basin and is further than 150 miles from these areas; there will be no induced seismic activity from the proposed action. The proposed action will not directly, indirectly, or cumulatively impact or cause earthquakes; therefor induced seismicity will not be carried forward in this document.

3.4 Soils

Soils in the San Juan Basin were formed primarily from two kinds of parent material- alluvial sediment and sedimentary rock. The alluvial sediment is material that was deposited in river valleys and on mesas, plateaus, and ancient river terraces. This material has been mixed and sorted in transport and has a wide range of mineralogy and particle size. The parent material of sedimentary rock consists mainly of sandstone and shale bedrock. These shale and resistant sandstone beds form prominent structural benches, buttes, and mesas bounded by cliffs.
The Natural Resources Conservation Service (NRCS) has mapped the soils in the proposed project area. Complete soil information is available in the NRCS's Soil Survey of Rio Arriba County, San Juan County, and Sandoval County, New Mexico. The 18 soils within the proposed parcels and one mile APE are listed in Table 12 below.

Table 12. Soils within the Area of Potential Effect (APE)

Rio Arriba County	
Mapped Unit	**Soil Name**
9	Pinavetes-Florita complex
10	Sparank-San Mateo silt loams, saline, sodic
110	Vessilla-Menefee-Orlie complex
220	Rock outcrop-Vessilla-Menefee complex
230	Badland
Sandoval County	
Mapped Unit	**Soil Name**
24	Orlie-Sparham association
57	Badland
101	Blancot-Lybrook association
150	Doakum-Betonnie fine sandy loams
180	Councelor-Eslendo-Mespun complex
220	Rock outcrop-Vessilla-Menefee
270	Blancot-Councelor-Tsosie association
422	Vessilla-Menefee-Orlie association
San Juan County	
Mapped Unit	**Soil Name**
BA	Badland
BT	Blancot-Notal association
GY	Gypsiorthids-Badland Stumble complex
TA	Travessilla-Weska-Rock outcrop complex

FFO reviewed the soils and has identified the following mapping units for each lease parcel that are potentially fragile depending on percent slope. All soils have the potential of erosion once disturbed but fragile soils may be more difficult to reestablish vegetation and have increased susceptibility of erosion.

Fragile soils exhibit physical characteristics and features that affect soil behavior, as listed in Table 13. Characteristics consist of Erosion Factors (Kw's) that indicates the susceptibility and erodibility of a soil to sheet and rill erosion by water. The Kw estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and permeability. Features consist of slope length, gradient and runoff potential based on the rate of water infiltration when the soils are not protected by vegetation. Soils are assigned to one of four Hydrologic Soil Groups (A, B, C, D), with Group D soils having a very slow infiltration rate (high runoff potential) when thoroughly wet.

Table 13. Fragile Soil Types

Fragile Soil Type	Approximate Acres within APE
Rock outcrop-Vessilla-Menefee	997
Pinavetes-Florita complex	344
Sparank-San Mateo silt loams, saline, sodic	952
Gypsiorthids-Badland Stumble complex	81
Badland	1,024
Total	3,398

3.4.1 220 Rock Outcrop-Vessilla-Menefee Complex, 15 to 45 percent slopes

The Rock Outcrop-Vessilla-Menefee soil unit landform setting is associated with escarpments, ridges, and breaks. The Rock Outcrop consists of barren or nearly barren areas of exposed sandstone bedrock. The Vessilla and Menefee landform setting is associated with breaks. These soils were derived from alluvium over residuum weathered from sandstone and colluvium over residuum weathered from shale. Permeability is moderately rapid to slow with a very low available water capacity. Effective rooting depth varies from 10 to 20 inches. Runoff potential is high to very high with water erosion severe. The hazard of soil blowing is severe. This mapping unit has limitations due to lack of soil depth and slopes. Roads can be protected from erosion by construction of water bars and by seeding of cuts and fills. The major use of soil unit is wood products with a potential plant community consisting of pinyon-juniper, bottlebrush squirreltail, prairie junegrass, Indian ricegrass, mountain mahogany and various forbs. Minor components include badlands, five percent.

3.4.2 9 Pinavetes-Florita Complex

The Pinavetes-Florita complex is found on slopes of two to 10 percent on toe slopes of hills and dunes that may be encroaching on hills. The parent material for this soil is alluvium and eolian material derived from sandstone. The typical profile is up to three inches of light yellowish brown loamy sand, and then 14 to 26 inches of strong brown loamy sand. This is a deep soil with

very pale brown sand from 26 to 60 inches deep. This soil is excessively drained, has a low available water capacity, and is severely susceptible to water erosion. The major use for this soil is livestock grazing with a potential plant community of blue grama, Indian ricegreass, galleta, and western wheatgrass.

3.4.3 10 Sparank – San Mateo Silt Loam

The Sparank soils are found of zero to three percent slopes in broad valleys and flood plains. The typical profile is two inches of pale brown silt loam and two to 60 inches pale brown clay. The parent material is alluvium derived from sandstone and shale. The available water capacity is moderate and the permeability is very slow with a moderate potential for water erosion. This soil is slightly saline and strongly alkaline. The San Mateo silt loam is found in valley floodplains with slopes from zero to three percent. The parent material is alluvium derived from sandstone and shale. The typical profile is three inches of brown sandy loam, three to eight inches of pale brown fine sandy loam, eight to 15 inches of pale brown sandy loam, 15 to 46 inches of brown clay loam, and 46 to 60 inches of pale brown clay loam. The available water capacity is high and the permeability is moderately slow. Potential for water erosion is slight. The major use of this soil type is livestock grazing with a potential plant community of alkali sacaton, western wheatgrass, galleta, bottlebrush squirreltail and four with saltbush, and black greasewood.

3.4.4 GY Gypsiorthids-Badland-Stumble Complex

The Gypsiorthids-Badland-Stumble soil unit is found on hills, knolls, and breaks with slopes of 30 percent, and in valleys. This unit is about 35 percent Gypsiorthids, 35 percent badlands, 15 percent Stumble loamy sand, and 15 percent other soil inclusions. The Gypsiorthids portions of this soil unit have variable attributes and may be very shallow to deep, available water capacity is very low to high, runoff is slow to medium, and water erosion potential is slight to moderate. This soil is generally well drained, and formed in material derived dominantly from gypsum. Badland consists of nonstony, barren shale uplands that are dissected by deep, intermittent drainageways and gullies. The Stumble soil is deep and somewhat excessively drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown and pale brown loamy sand. Permeability is rapid, Available water capacity is low, is very slow, and the hazard of water erosion is slight. The potential plant communities in this soil unit include Indian ricegrass, giant dropseed, alkali sacaton, and bottlebrush squirreltail.

3.4.5 BA Badland

The Badland soil type consists of nonstony barren shale uplands that are dissected by deep intermittent drainages and gullies, and is located on slopes ranging from five to 80 percent. The badland soils do not support vegetation in significant quantities, but can be utilized by wildlife.

3.5 Special Status Species

The BLM manages certain species which are not federally listed as threatened or endangered under the ESA in order to prevent or reduce the need to list these species under the ESA in the future. BLM special status species include BLM sensitive species and BLM FFO special

management species. The New Mexico BLM State Directors have developed a list of BLM sensitive species for the State of New Mexico. In accordance with BLM Manual 6840, the BLM FFO has prepared a list of special management species to focus species management efforts toward for maintaining habitats under a multiple-use mandate. BLM FFO special management species include some BLM sensitive species and other species for which the BLM FFO has determined special management is appropriate (Table 14). The authority for this policy and guidance is established by the ESA, Title II of the Sikes Act, as amended (16 USC 670a–670o, 74 statute 1052), FLPMA, and Department of Interior Manual 235.1.1A.

Table 14. List of non-federally-listed Special Status Species with potential to be impacted by proposed activities with conservation status and habitat requirements.

Common Name (*Scientific Name*)	**Conservation Status**	**Range or Habitat Requirements**	**Potential for Occurrence in Project Area**
Plants			
Aztec gilia (*Aliciella formosa*)	State E BLM S	Occurs in salt desert shrublands/badlands on soils derived from the Nacimiento Formation.	The proposed analysis area (AA) does not contain known habitat for this species, however, habitat may exist.
Brack's fishhook cactus (*Sclerocactus cloveriae* ssp. *brackii*)	State E BLM S	Occurs in salt desert shrublands/badlands on soils derived from the Nacimiento Formation.	The proposed AA contains known habitat for this species.
San Juan milkweed (*Asclepias sanjuanensis)*	BLM S	Juniper savanna or Great Basin desert scrub.	The proposed AA contains habitat for this species.
Birds			
Bald eagle (*Haliaeetus leucocephalus alascanus*)	State T BLM S	In migration and during winter months the species is found chiefly along or near rivers and streams Bald eagles are known to migrate through and winter in the BLM FFO planning area. Roosting sites are present within the FFO Bald Eagle ACEC. One known pair nesting at Navajo Lake.	The proposed AA does not contain nesting habitat for this species.. May occasionally forage in analysis area in winter.
Bendire's thrasher (*Toxostoma bendirei*)	BLM S	Inhabits sparse, desert shrublands and open woodlands with scattered shrubs. Potential to occur in the BLM FFO planning area during the breeding-nesting season.	The proposed AA contains nesting habitat for this species. This species is not known to be common in AA.
Burrowing owl (*Athene cunicularia*)	BLM S	Found in grasslands especially in association with prairie dog colonies, in desert-scrub, and in agricultural and semi-urban environments. Depends on prairie dogs, rock squirrels, and other fossorial mammals for the availability of burrows. Known to occur in BLM FFO planning area.	The proposed AA contains nesting habitat for this species. This species is likely to occur within or in close proximity to proposed AA.
Ferruginous hawk (*Buteo regalis*)	FFO SMS	During the breeding season it is present in grasslands and badlands and along the ecotone between grasslands and piñon-juniper woodlands, especially in the vicinity of prairie dog colonies. Known to occur in the BLM FFO planning area as a permanent resident.	The proposed AA contains foraging and some nesting habitat for this species. No documented nesting in proposed AA.
Golden eagle (*Aquila chrysaetos*)	BLM SMS	In New Mexico, nests along steep-walled mountain/desert canyons. During the winter, forages in open grassland or shrubland habitat (NMPIF 2015).	The proposed AA contains known nesting habitat for this species. This species commonly nests within and in close proximity to proposed AA. Foraging habitat within proposed AA.

Common Name (*Scientific Name*)	Conservation Status	Range or Habitat Requirements	Potential for Occurrence in Project Area
		Known to occur in the BLM FFO planning area as a permanent resident.	
Gray vireo (*Vireo vicinior*)	State T	Strongly associated with piñon-juniper and scrub oak habitats. Distributed mainly across the western two-thirds of the state. Known to occur in the BLM FFO planning area during the breeding-nesting season.	Nesting habitat within proposed AA.
Peregrine falcon (*Falco peregrinus*)	State T FFO SMS	A year-round resident and local breeder throughout New Mexico. Usually observed along mountain ridges, near cliffs and canyons, and around bodies of water. All nests in New Mexico are found on cliffs. Known to occur in the BLM FFO planning area as a permanent resident.	Foraging and nesting habitat within and near proposed AA. No known nesting documented within proposed AA.
Pinyon jay (*Gymnorhinus cyanocephalus*)	BLM S	Predominately associated with the piñon-juniper woodland vegetation community. Breeding sites consist of dense, mature stands on piñon-juniper woodlands. Known to occur in the BLM FFO planning area as a permanent resident.	Nesting habitat within proposed AA.
Prairie falcon (*Falco mexicanus*)	FFO SMS	Occurs in arid plains and steppes at all elevations. Preferred nesting sites consist of cliff ledges or crevices, but it may nest in trees, on power poles and buildings, and along steep sides of arroyos. Known to occur in the BLM FFO planning area as a permanent resident.	Foraging and nesting habitat within and near proposed AA. No known nesting documented within proposed AA.
Mammals			
Gunnison's prairie dog (*Cynomys gunnisoni*)	BLM S	These populations inhabit montane shrublands and high mountain valleys and plateaus in the southern Rocky Mountains at 6,000–12,000 ft. Known to occur in the BLM FFO planning area as a permanent resident.	Known to occur within or near proposed AA.
Townsend's big-eared bat (Corynorhinus townsendii	BLM S	Roosts mostly in caves or mines; at night can roost in abandoned buildings. In summer occurs widely across state & can be found over desert-scrub, desert-mountains, oak-woodland, piñon-juniper, & coniferous forests.	Possible that this species roosts and likely this species forages within the proposed AA.

Sources: Except where otherwise noted, range or habitat information for wildlife species is taken from the BLM (2003a:3-43–3-44), the BISON-M website (BISON-M 2015), NatureServe (2015), and the USFWS New Mexico Southwest Region Ecological Services Field Office IPaC System (USFWS 2015). **:**

FFO SMS – Farmington Field Office Special Management Species

BLM - S – BLM Sensitive Species of FFO

State of New Mexico status definitions:

E = Endangered. Any species that is considered by the state (NMDGF) as being in jeopardy of extinction or extirpation from New Mexico.

T = Threatened. Any species that, in the view of the state, is likely to become endangered within the foreseeable future throughout all or a significant portion of its range in New Mexico.

S = Sensitive. Any species tracked by the state due to conservation concern.

3.6 Wildlife

The FFO contains varying densities of residential and seasonal big game populations. The northern part of the FFO provide habitat for herds of wintering and resident populations of mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*). The landscape encompassing the proposed parcel areas is dominated by residential (i.e. non-migratory) big game species. As such, these animals depend on habitats that provide summer and winter resources. The parcels being considered for leasing occur near the Crow Mesa Wildlife Specially Designated Area and include excellent habitat for big game, especially mule deer. Mule deer and elk densities north of US Highway 550 tend to be higher, providing robust opportunities for sportsmen. Although populations do extend well beyond highway 550 to the south, densities tend to be lower. Little is known about the mule deer populations south of Highway 550 or why they are lower, as these lands are predominantly administered by tribal authorities—thus limiting hunter access (and data provided by hunter surveys) and New Mexico Game and Fish's ability to monitor populations.

Several small populations of pronghorn antelope (*Antilocapra americana*) reside in the area north and east of US Highway 550 and are less common south of the highway.

Detailed information on other wildlife species and habitats in the FFO is contained on pages 3-39 to 3-42 of the PRMP/FEIS and the background biological resources analysis (SAIC 2002) prepared for the RMP.

3.6.1 Migratory Birds

A Memorandum of Understanding (MOU) between the BLM and USFWS dated April 12, 2010 calls for increased efforts to more fully implement the Migratory Bird Treaty Act of 1918 (DOI 2010a). In keeping with this mandate, the BLM FFO has issued an interim policy to minimize unintentional take as defined by the MOU and to better optimize migratory bird efforts related to BLM FFO activities (DOI 2010b). In keeping with this policy, the BLM FFO required proposed projects to analyze impacts to migratory birds through NEPA process and implement BMPs during project implementation. BMPs include several measures for the project proponent to use to minimize their surface disturbance (habitat fragmentation) and the impacts to migratory bird habitat.

3.7 Noxious Weeds

In the San Juan Basin, noxious weeds and invasive species are frequently found in areas that have been disturbed by surface activities. The re-establishment of plant communities in arid regions occurs over a longer time period than in wetter regions, which may create an increased potential for the establishment and distribution of invasive species. Invasive plant species typically develop high population densities and tend to exclude most other plant species, thereby reducing species diversity and potentially resulting in long-term effects. Some noxious and invasive weeds have been identified to change soil chemistry and some are highly toxic to livestock. Establishment and distribution of a number of designated noxious and invasive species has continued to grow within the FFO. Management of noxious weeds and invasive plant species

is mandated under several pieces of legislation, including the Lacey Act, as amended (16 U.S.C. 3371-3378); the Federal Noxious Weed Act of 1974, as amended (7 U.S.C. 2801 et seq.); the New Mexico Noxious Weed Management Act of 1998; and Executive Order (EO) 13112 regarding Invasive Species. Under EO 13112, federal agencies are ordered not to authorize or carry out actions that would cause or promote the introduction of invasive species.

The US Department of Agriculture (USDA) has designated certain plants as federally listed noxious weeds (NRCS 2010). The New Mexico Department of Agriculture (NMDA) has designated certain plants as state-listed noxious weeds (NMDA 2009). NMDA categorize the listed noxious weeds into Class A, B or C species. Class A species are currently not present in New Mexico, or have limited distribution. Preventing new infestations of these species and eradicating existing infestations is the highest priority. Class B Species are limited to portions of the state. In areas with severe infestations, management should be designed to contain the infestation and stop any further spread. Class C species are wide-spread in the state. Management decisions for these species should be determined at the local level, based on feasibility of control and level of infestation. NMDA has also identified species that fall under a 'Watch List'. Watch List species are species of concern in the state. These species have the potential to become problematic.

3.8 Environmental Justice

Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations, requires that federal agencies identify and address any disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations.

Environmental justice refers to the fair treatment and meaningful involvement of people of all races, cultures, and incomes with respect to the development, implementation, and enforcement of environmental laws, regulations, programs, and policies. It focuses on environmental hazards and human health to avoid disproportionately high and adverse human health or environmental effects on minority and low-income populations.

Guidance on environmental justice terminology developed by the President's Council on Environmental Quality (CEQ 1997) is discussed below.

- Low-income population. A low-income population is determined based on annual statistical poverty thresholds developed by the US Census Bureau. In 2015, poverty level is based on total income of $11,770 for an individual and $24,250 for a family of four (US Census Bureau 2015d). A low-income community may include either a group of individuals living in geographic proximity to one another or dispersed individuals, such as migrant workers or Native Americans.
- Minority. Minorities are individuals who are members of the following population groups: American Indian, Alaskan Native, Asian, Pacific Islander, Black, or Hispanic.
- Minority population area. A minority population area is so defined if either the aggregate population of all minority groups combined exceeds 50 percent of the total population in the area or if the percentage of the population in the area comprising all minority groups

is meaningfully greater than the minority population percentage in the broader region. Like a low-income population, a minority population may include either individuals living in geographic proximity to one another or dispersed individuals.

- Comparison population. For the purpose of identifying a minority population or a low-income population concentration, the comparison population used in this study is the state of New Mexico as a whole

3.8.1 Low-income Populations

Income and poverty data estimates for study area counties from the US Census Small Area Poverty Estimates model indicate that the percent of the population living below the poverty level in the socioeconomic study area as a whole is slightly above that of the state (21.3 percent and 20.6 percent), but it is much higher than the national average of 12.1 percent. Poverty levels ranged from 37.7 percent in McKinley County to 13.7 percent in Sandoval County. Only that of Sandoval County was below the state average (Table 15).

Table 15. Study Area County Population in Poverty (2002-2012).

	McKinley County	**Rio Arriba County**	**Sandoval County**	**San Juan County**	**Study Area Total**	**New Mexico**	**United States**
Percent of Population in Poverty 2002	21,766	7,165	19,934	22,152	71,017	421,123	34,569,951
	30.2%	17.7%	11.1%	18.2%	21.3%	20.6%	12.1%
Percent of Population in Poverty 2012	27,296	8,806	18,502	25,802	80,406	327,444	48,760,123
	37.7%	22.0%	13.7%	20.3%	21.5%	17.7%	15.9%
Median Household Income 2002	$25,197	$30,557	$45,213	$34,329	N/A	$34,827	$45,409
Median Household Income 2012	$29,821	$36,900	$57,376	$45,901	N/ A	$42,828	$51,371
Classified as Low Income Population in 2012 based on CEQ guidelines?	No	No	No	No	No	NA	NA
Source: US Census Bureau 2013b							

Similarly, estimates from 2012 indicate that Sandoval and San Juan Counties had household median incomes ($57,376 and $45,901) that were above the state level of $42,828. McKinley County ($29,821) and Rio Arriba County ($36,900) were below that of the state in 2012. While no area communities meet the CEQ definition of a low-income population area (50 percent or higher), the highest poverty rates were seen in Bloomfield (29 percent), Espanola (26.3 percent), and Bernalillo (24.1 percent) (Table 16).

Table 16. Study Area Key Community Race/Ethnicity and Poverty Data.

Community	Percent Population Racial or Ethnic Minority	Classified as Minority Population based on CEQ?	Percent of Individuals Below Poverty	Classified as Low-income Population based on CEQ?
Aztec	36.4%	N	14.4%	N
Bernalillo	78.8%	Y	24.1%	N
Bloomfield	55.8%	Y	29.0%	N
Espanola	91.6%	Y	26.3%	N
Farmington	48.8%	N	15.5%	N
Gallup	76.9%	Y	20.9%	N
Rio Rancho	46.7%	N	9.8%	N

Source: US Census Bureau 2012b
Note: American Community Survey estimates are based on data collected over a 5-year time period. The estimates represent the average characteristics of populations between January 2008 and December 2012 and do not represent a single point in time.

Census Tracts are geographic regions within the US that are defined by the US Census Bureau in order to track changes in a population over time. Census Tracts are based on population sizes and not geographic areas. The average population of a Census Tracts is about 4,000 people, so rural areas that are sparsely populated may have very large Census Tracts while densely populated urban areas may have very small Census Tracts.

When broken down by Census Tract, three out of 87 tracts in the socioeconomic study area have greater than 50 percent of individuals living below the poverty line: Census Track 9440 in eastern McKinley County had an individual poverty rate of 54.6 percent; Census Tract 9405 in southwestern McKinley County had an individual poverty rate of 59.4 percent; and Census Tract 9409 in northwestern Sandoval County had an individual poverty rate of 51.9 percent (US Census Bureau 2012b). These three Census Tracts are all relatively large, indicating a sparsely populated, rural area.

3.8.2 Minority Populations

Based on 2008 to 2012 data, minorities made up 59.5 percent of the population in New Mexico, compared to 36.3 percent in the United States as a whole. The proportion of minorities in the socioeconomic study area (65.3 percent) substantially exceeded the US and is slightly higher than the state average. At the county level, the population ranged from 89.7 percent minority in McKinley County to 52.8 percent in Sandoval County. Within relevant tribal nations, Native Americans represented the vast majority of the population. The largest minority groups were Hispanics/Latinos in Rio Arriba and Sandoval Counties and Native Americans in McKinley and San Juan Counties (Table 17).

Table 17. Study Area County Population by Race/Ethnicity (2008 to 2012).

Population	McKinley County	Rio Arriba County	Sandoval	San Juan	Study Area	New Mexico	United States	Jicarilla Apache Nation	Navaho Nation	Ute Mountain Nation
Hispanic or Latino ethnicity of any race	9,744	28,714	46,334	24,496	109,288	952,569	50,545,275	382	2,958	99
	13.6%	71.4%	35.3%	19%	29%	46.3%	16.4%	11.6%	1.7%	6.0%
White alone	7,413	5,370	61,977	54,218	128,978	831,543	196,903,968	74	3,762	47
	10.3%	28.6%	47.2%	42.2%	34.67%	40.5%	63.7%	2.3%	2.2%	2.9%
Black or African American alone	353	149	2,704	794	4000	35,586	37,786,591	0	250	5
	0.5%	0.4%	2.1%	0.6%	1.08%	1.7%	12.2%	0%	0.1%	0.3%
American Indian or Alaskan Native alone	52,358	5,629	15,964	46,676	120,627	176,766	2,050,766	2,692	162,920	1,429
	72.8%	14.0%	12.2%	36.3%	32.43%	8.6%	0.7%	82.0%	94.3%	87.0%
Asian alone	506	173	1,685	464	2828	25,411	14,692,794	73	834	14
	0.7%	0.4%	1.3%	0.4%	0.76%	1.2%	4.8%	2.2%	0.5%	0.9%
Native Hawaiian and Other Pacific Islander alone	38	7	100	72	217	989	480,063	0	209	0
	0.1%	0%	0.1%	0.1%	0.06%	<.01%	0.2%	0%	0.1%	0%
Some Other Race	7	22	437	84	550	3,623	616,191	0	102	0
	<.01%	0.1%	0.3%	0.1%	0.15%	0.2%	0.2%	0%	0.1%	0%
Two or more Races	1,469	137	2,101	1,796	5,503	28,800	6,063,063	62	1,660	49
	2.0%	0.3%	1.6%	1.4%	1.48%	1.4%	2.0%	1.9%	1.0%	3.0%
Classified as Minority Population based on	Yes	Yes	Yes	Yes		Yes	NA	Yes	Yes	Yes

Source: US Census Bureau 2012b
Note: American Community Survey estimates are based on data collected over a 5-year time period. The estimates represent the average characteristics of populations between January 2008 and December 2012 and do not represent a single point in time

Based on the CEQ definition of a minority population area (minority residents exceed 50 percent of all residents), Bernalillo, Bloomfield, Espanola, and Gallup all are considered minority communities.

When examined at the Census Tract level, there are 24 out of 87 tracts that have a minority population greater than 50 percent. These range from Census Tract 6.1 located just north of the city of Aztec with a minority population of 80.5 percent to Census Tract 107.17 located north of the city of Rio Rancho with a minority population of 50.2 percent (US Census Bureau 2012b). These Census Tracts are relatively small and are based around the city of Rio Rancho and the Aztec/Farmington/Bloomfield area.

3.8.3 Native American Populations

Study Area County Population by Race/Ethnicity (2008 to 2012) account for a substantial portion of the study area population in some areas, notably McKinley and San Juan Counties, where the population is 72.8 and 36.3 percent American Indian respectively. Three tribal governments have reservations within the planning area: the Jicarilla Apache Nation, the Navajo Nation, and the Ute Mountain Nation. The Southern Ute Nation has lands just north of the planning area in the state of Colorado, but none within the planning area. Almost one half of the planning area is tribal lands. Each tribe maintains a general concern for protection of and access to areas of traditional and religious importance, and the welfare of plants, animals, air, landforms, and water on reservation and public lands (Table 18).

In addition, the local Navajo Chapter Houses of Counselor, Ojo Encino, and Torreon are in the general area of the proposed leases. These Chapter Houses have expressed concerns about the impacts of continued oil and gas development on the condition of roads in the area, traffic safety, water quality, visual resources and air quality. The BLM received comments both from individual allottees in favor of the proposed lease sale for economic reasons, and from the Chapter Houses asking that no more lease sales be held due to potential negative impacts.

Policies established in 2006 by the BLM and US Forest Service, in coordination with federal tribes, ensure access by traditional native practitioners to area plants. The policy also ensures that management of these plants promotes ecosystem health for public lands. The BLM is encouraged to support and incorporate into their planning traditional native and native practitioner plant-gathering for traditional use (Boshell 2010).

Table 18. Tribal Nations in the Planning Area.

Tribe	Acres in Planning Area	General Location
Jicarilla Apache Nation	739,600	The majority of the Jicarilla Apache Nation is located in western Rio Arriba County, but within the eastern portion of the planning area
Navajo Nation	860,900	A portion of the Navaho Nation extends into western San Juan County and into the western portion of the planning area
Ute Mountain Nation	103,500	A portion of the Ute Mountain Nation extends into the northern portion of San Juan County, just east of the Navajo Nation, and into the northern portion of the planning area
Unknown	196,300	Lands located in the southern portion of the planning area [Note to BLM: this is due to inconsistencies between US Census Bureau tribal areas dataset and BLM land status dataset.]
Source: BLM GIS 2014, US Census Bureau 2014		

3.9 Lands and Realty

The analysis area is the four parcels nominated for the sales plus a one mile buffer surrounding the parcels. The surface ownership of the four parcels is Navajo Nation Tribal Trust and the

mineral ownership is the US, being administered by the BLM. The land was patented to the Navajo Tribe of Indians under Patent Number 30-85-0038 on April 23, 1985 as part of a 16,168.59 acre land exchange between the BLM and the Navajo Tribe of Indians. The patent reserved several ROWs to the US and of these, three ROWs remain under the jurisdiction of the BLM.

Several ROWs were transferred to the jurisdiction of the Navajo Tribe of Indians and of these, five are now administered by the Navajo Nation. The case files for those ROWs were transferred to the Navajo Nation.

The lands surrounding the parcels in the one mile buffers are a combination of BLM, Tribal Trust, Navajo Allotted, New Mexico State, and Private surface. The minerals in the surrounding one-mile buffer are leased and managed by the BLM.

4.0 ENVIRONMENTAL IMPACTS

4.1 Alternative A – No Action

Under the No Action Alternative the proposed parcels would be deferred and not offered for sale in the January 25, 2017, Competitive Oil and Gas Lease Sale. There would be no subsequent impacts from oil and/or gas construction, drilling, and production activities. The No Action Alternative would result in the continuation of the current land and resource uses in the proposed lease areas.

4.1.1 Mineral Resources

There would be no new impacts from oil and gas production on the proposed parcel land. Oil and gas development of federal, state, private, and Indian minerals would continue on the land surrounding the proposed parcels. No additional natural gas or crude oil from the proposed parcels would enter the public markets and no royalties would accrue to the federal or state treasuries. An assumption is that the No Action Alternative (no lease option) would not affect current domestic production of oil and gas. However, this would not generate Federal or State royalties and would create the potential for Federal minerals to be drained by wells on adjacent private or state land.

These four parcels are surrounded by leased Federal, Allotted and State lands. There has been active drilling around these lands targeting the Mancos/Gallup geologic horizon and a Potential Drainage Situation (PDS) analysis has been performed by a BLM Geologist and Physical Science Technician. There have been a total of eight PDS wells identified as draining the four unleased parcels. These parcels are subject to potential drainage from other adjacent State and Indian mineral interest owners.

Oil and gas consumption is driven by a variety of complex interacting factors including energy costs, energy efficiency, availability of other energy sources, economics, demography, and weather or climate. If the BLM were to forego leasing and potential development of the proposed

parcels, the assumption is that the public's demand for the resource would not be expected to change. Instead, the mineral resource foregone would be replaced in the short- and long-term by other sources that may include a combination of imports, using alternative energy sources (e.g. wind, solar), and other domestic production. This offset in supply would result in a no net gain for oil and gas domestic production.

4.1.2 Environmental Justice

By not leasing the proposed parcels under the No Action Alternative, there may be negative effects on the overall employment opportunities in the local communities related to the oil and gas and service support industry, as well as a loss of the economic benefits to state and county governments related to royalty payments and severance taxes. However, there would be no increases in activity and noise associated with areas used for other purposes.

4.1.3 All Other Resources

No other resources (soils, vegetation, wildlife, air quality, etc.) would be affected under the No Action Alternative as there would be no potential surface disturbance that could detrimentally affect these resources. The No Action Alternative would result in the continuation of the current land and resource uses around the parcels. However, the selection of the no action alternative would not preclude these parcels from being nominated and considered in a future lease sale, which would result in impacts as described under the Proposed Action Alternative.

4.2 Alternative B – Proposed Action

The act of leasing the parcels would, by itself, have no impact on any resources. All impacts would be linked to as yet undetermined future levels of lease development.

If the lease parcels were developed, short-term impacts would be stabilized or mitigated within five years and long-term impacts are those that would substantially remain for more than five years. Potential impacts and mitigation measures are described below.

Cumulative impacts include the combined effect of past projects, specific planned projects and other reasonably foreseeable future actions such as other infield wells being located within this lease. Potential cumulative effects may occur should an oil and gas field be discovered, if this parcel was drilled, other infield wells are drilled within this lease, or if this lease becomes part of a new unit. All actions, not just oil and gas development, may occur in the area, including foreseeable non-federal actions.

The Reasonable Foreseeable Development (RFD) for Northern New Mexico (2014) forecasts that the most likely oil and gas development in the area of the four unleased parcels would be horizontal drilling of the Mancos/Gallup play. These parcels are within the high potential area delineated by the RFD, where up to 1,600 potential new Mancos/Gallup wells are projected to be drilled (Engler et al., 2014). Since 2000, 338 wells on average have been drilled annually throughout the San Juan Basin.

Table 19 displays the number of wells and number of well pads that may be required to develop the parcels based on typical spacing and potential formation development considerations.

Table 19. Development Scenario by Lease Parcel.

Lease Parcel #	Acres	Estimated Development
NM-201701-001	161.16	Two horizontal wells may be required to develop this tract from one twinned well pad or two single well pads.
NM-201701-002	80	Two horizontal wells may be required to develop this tract from one twinned well pad or two single well pads.
NM-201701-003	441.5	Six horizontal wells may be required to develop this tract from three twinned well pads or six single well pads.
NM-201701-004	160	Two horizontal wells may be required to develop this tract from one twinned well pad or two single well pads.
* See Appendix 2 for a summary of stipulations		

The well pad sizes and acreages are derived from recent development in the surrounding area of the proposed lease parcel areas. The sizes and acreages are used to estimate possible disturbance caused by developing the four proposed parcels.

The average well pad size for a twinned well pad was assumed to be 500 feet by 530 feet, or 6.08 acres. An additional 0.6 acres was added to account for any associated road or pipeline development, resulting in 6.68 acres of short-term disturbance. Following completion of the well, interim reclamation of the well pad and reclamation of any pipelines would occur, resulting in 1.5 acres of long-term disturbance.

The average well pad size for a single well pad was assumed to be 500 feet by 500 feet, or 5.74 acres. Again, an additional 0.6 acres was added to account for associated road or pipeline development, resulting in 6.34 acres of short-term disturbance. Following completion of the well, interim reclamation of the well pad and reclamation of any pipelines would occur, resulting in 1.5 acres of long-term disturbance.

The proposed action could result in six twinned well pads or 12 single well pads. Six twinned well pads and associated pipelines and roads could produce an estimated 6.68 acres of short-term disturbance and 1.5 acres long-term disturbance per well; this would result in approximately 40.08 acres of short-term surface disturbance and 9.0 acres of long-term surface disturbance.

If development proceeds with 12 single well pads, the well pads and associated pipelines and roads could result in an estimated 6.34 acres of short-term surface disturbance and 1.5 acres of long-term disturbance per well; this would result in 76.08 acres of short-term surface disturbance and 18 acres of long-term surface disturbance.

4.2.1 Air Resources

Methodology and assumptions for calculating air pollutant and greenhouse gas emissions are described in the Air Resources Technical Report. This document incorporates the sections discussing the modification of calculators developed by the BLM to address emissions for one well. The calculators give an approximation of criteria pollutant, HAP, and GHG emissions to be

compared to regional and national levels. Also incorporated into this document are the sections describing the assumptions that the FFO used in developing the inputs for the calculator (U.S. Department of Interior Bureau of Land Management, 2016).

Although the hydraulic fracturing of wells for a lease parcel is hard to predict, it is anticipated that with more wells being drilled, there would be an increase in the amount of wells being hydraulically fractured and completed. Volatile organic compounds are emitted during the completion of hydraulically fractured wells. There is a higher probability of dust particulates in the atmosphere from the increase in vehicular traffic due to hydraulically fracturing wells.

4.2.1.1 Air Quality

Under the Proposed Action Alternative, leasing the subject tracts would have no direct impacts to air quality. Any potential effects to air quality from the sale of a lease parcel would occur at such time that the lease is developed. Potential indirect impacts of leasing could include increased air borne soil particles blown from the development of new well pads or roads, exhaust emissions from drilling equipment, compressors engines, vehicles, flares, and dehydration and separation facilities, and volatile organic compounds during drilling or production activities.

There are three phases in the development of a well that result in different levels of emissions. The first phase occurs during the first year of development and may include pad construction, drilling, completion, interim reclamation, and operation of the completed well. The first year results in the highest level of emissions due to the large engines required during the construction and drilling, and the potential release of natural gas to the atmosphere during completion.

The second phase begins after the well is completed and is put on line for production. Emissions during the production phase may include vehicle traffic, engines to pump oil if necessary, compressor engines to move gas through a pipeline, venting from storage tanks, and storage tank heaters. A workover of the well may occasionally be required, but the frequency of workovers is not predictable since they result from mechanical difficulties of the well bore.

The final phase is to plug and abandon the well and reclaimed the well pad and other associated disturbances (i.e. access roads and pipelines). The life of the well is unknown and emission estimates for this phase are not presented.

4.2.1.2 Greenhouse Gases

Information about GHGs and their effects on national and global climate is presented in the Air Resources Technical Report (U.S. Department of Interior Bureau of Land Management, 2016). Analysis of the impacts of the proposed action on GHG emissions are reported below.

Leasing the subject tracts under the Proposed Action Alternative would have no direct impacts to climate change as a result of GHG emissions. Any potential effects to air quality from sale of a lease parcel would occur when the lease is developed. Impacts to air quality as a result of lease development would be considered at the time of application for specific projects.

The two primary GHGs associated with the oil and gas industry are carbon dioxide (CO_2) and methane (CH_4). Because methane has a global warming potential that is 21 to 25 times greater than the warming potential of CO_2, the EPA uses measures of CO_2 equivalent (CO_2e) which takes the difference in warming potential into account for reporting greenhouse gas emissions. Emissions will be expressed in metric tons of CO_2 equivalent in this document.

Estimated Oil and Gas Production Volumes

Estimates of the oil and gas production volumes that may ultimately be produced from the four parcels are needed to quantify any potential GHG emissions associated with lease development. Based on the analysis provided in the Reasonable Foreseeable Development for Northern New Mexico (2014) and the subsequent Update to the Reasonable Foreseeable Development for Northern New Mexico (2015) (hereafter referred to as the 2014 RFD and 2015 RFD Update, respectively) provides oil and gas production estimates which were generated for the four parcels using the following criteria:

1. Since 2011, the Mancos/Gallup play in this area has been developed by horizontal drilling and any future development is anticipated to be primarily horizontal drilling of the Mancos/Gallup play.

2. The four parcels lie within the high development potential area, delineated in the 2015 RFD Update analysis of 41 horizontal Mancos/Gallup wells drilled 2011 to 2015.

3. Wells drilled in the high potential area are projected to have an Estimated Ultimate Recovery (EUR) of 140,000 barrels (bbls) of oil per well and 570,000 thousand cubic feet (Mcf) of gas per well based on the decline curve analysis of the 41 study wells.

4. The 2014 RFD and the 2015 RFD Update projects that 1,600 new Mancos/Gallup horizontal wells would be drilled in the high potential area over the next 20 years, at a density of five wells per section (1 section = 640 acres).

Using these data, the potential oil and gas production volumes (EURs) per parcel were estimated. These volume estimates assume that the majority of future activity would be horizontal development of the Mancos/Gallup play and that EURs of recent Mancos/Gallup wells would be similar to the EUR of future Mancos/Gallup wells. In addition, these calculations only present estimated volumes for oil and gas. Produced hydrocarbons for wells in New Mexico are reported in terms of oil and gas. In official production reports, all liquid volumes are accounted for in the oil category and consequently any condensate volumes produced from the well are considered oil volumes for reporting purposes. Therefore, oil and gas volumes estimated for these parcels include any potential condensate volumes in the oil category.

The estimates volumes presented here are not estimates of total well production or total wells that would be drilled; these values estimate only the potential oil and gas volumes attributable to each parcel. The values were derived by first determining the number of wells that may intersect each parcel (wells/parcel) based on the well density of five wells/section forecast in the 2014 RFD and 2015 RFD Update. This estimated wells/parcel value was then multiplied by the EUR of 140,000 bbls of oil per well and 570,000 Mcf of gas per well projected in the 2015 RFD

Update to determine the potential oil and gas volumes per parcel (EUR/parcel). The estimated oil and gas production volumes are presented in Table 20.

Table 20. Estimated Oil and Gas Production Volumes per Parcel

		EUR/parcel	
Parcel	**Acres**	**Oil (Bbls)**	**Gas (Mcf)**
NM-201701-001	161.16	176,000	718,000
NM-201701-002	80.00	88,000	356,000
NM-201701-003	441.50	483,000	1,966,000
NM-201701-004	160.00	175,000	713,000
Totals	**842.66**	**922,000**	**3,753,000**

Estimated Direct Greenhouse Gas Emissions

Table 21 shows an estimate of direct greenhouse gas emissions for oil and gas field production for New Mexico and Federal leases by basin based on the assumption that greenhouse gas emissions are proportional to production.

Table 21. 2012 Oil and Gas Field Production Emissions (U.S. Environmental Protection Agency, 2014).

	Oil		**Gas**		**Total Oil and Gas Production**
	CO_2	CH_4	CO_2	CH_4	(Metric Tons CO_2^e)
New Mexico	10,800	1,116,000	518,400	2,563,200	4,208,400
Federal leases in New Mexico	5,400	558,000	331,560	1,639,380	2,534,340
San Juan Basin	60	6,200	247,320	1,222,860	1,476,440
Permian Basin	5,400	558,000	3,240	16,020	582,660

To estimate the potential emissions from the proposed lease sale, an estimate of emissions per well is useful (Table 22). To establish the exact number of federal wells in the San Juan Basin is problematic due to the ongoing development of new wells, the abandonment of unproductive wells, land sales and exchanges, and incomplete or inaccurate data bases. To determine the most transparent and publicly accessible method of estimating the number of active federal wells in the New Mexico portion of the San Juan Basin, FFO utilized BLM New Mexico Geographic Information System (GIS) and the New Mexico Conservation Division ONGARD Data Search. ONGARD was searched for all active, new, and temporarily abandoned wells in NM.

Table 22 shows estimated annual direct emissions from San Juan Basin federal leases at 1,476,440 metric tons CO_2e. Therefore, the estimate of direct emissions per well in the San Juan Basin is 98.4 metric tons CO_2e annually. The maximum number of wells to be producing from the four parcels would be 12. In the event that 12 separate wells were completed on the proposed leases, the maximum direct emissions resulting from the lease sale would be 1,181 metric tons CO_2e per year.

Table 22. Potential Direct Greenhouse Gas Emissions Resulting from Proposed Lease Sale (Referenced to Latest Available Estimates from 2012).

Total New Mexico Emissions From Oil and Gas Field Production	4,208,400 metric tons
Total Federal Mineral Estate San Juan Basin Emissions From Oil and Gas Field Production (14,995 wells)	1,476,440 metric tons
Total Federal Mineral Estate Permian Basin Emissions From Oil and Gas Field Production (12,443 wells)	582,660 metric tons
Total Potential GHG Emissions From Oil and Gas Field Production at Full Development (12 Wells)	1,181 metric tons

Estimated Indirect Greenhouse Gas Emissions

Table 23 shows estimated indirect GHG emissions based on the EUR estimates contained in Table 20. Indirect GHG emissions are typically associated with combustion of either the oil or gas, either as direct fuel or produced fuel (e.g. gasoline from oil). EPA has developed indirect emissions calculators that can provide gross estimates based on established assumptions. With respect to the rough estimate of indirect CO_2 emissions, it should be noted that it is difficult to discern with certainty what end uses for the fuels extracted from particular leaseholds might be reasonably foreseeable. For instance, end uses of fossil fuels extracted from Federal leases could include, but are not limited to: combustion of transportation fuels, fuel oils for heating and electricity generation, as well as production of asphalt and road oil, and the feedstocks used to make chemicals, plastics, and synthetic materials. The table below is based on an approximation of these end uses on a national basis using the reference cited. While the BLM based these estimates on national data about typical end use of produced oil and gas, it is important to note that the BLM does not exercise control over the specific end use of the oil and gas produced from any individual federal lease.

Table 23. Estimated indirect GHG emissions[1] based on the Estimated Ultimate Recovery estimates. (EPA Environmental Protection Agency Greenhouse Gas Equivalencies Calculator, May 2016)

Product Category	**Estimated Product Quantity**	**Emissions Factor**	**Estimated Emissions (MT CO_2e of GHG)**
Crude Oil	922,000 bbl	0.43 MT CO_2/bbl	396,460
Natural Gas	3,753,000 Mcf	0.054717 MT CO_2/Mcf	205,353
Total			**601,813**

As it is not possible to assign a “significance” value or impact to these numbers, the emissions estimates themselves are presented as a proxy for impact. This is consistent with final CEQ guidance (CEQ, 2016).

Uncertainties of GHG Calculations

Although this EA presents a quantified estimate of potential GHG emissions associated with reasonably foreseeable oil and gas development, there is uncertainty in GHG emission estimates due to uncertainties with regard to eventual production volumes and variability in flaring, construction, and transportation. Also, there is uncertainty with regard to the net effects of

reasonably foreseeable oil and gas development on climate – that is, while BLM actions may contribute to the climate change phenomenon, the specific effects of those actions on global climate are speculative given the current state of the science. Inconsistencies in the results of scientific models designed to predict climate change on regional or local scales limits the ability to quantify potential future impacts of decisions made at this level and determining the significance of any discrete amount of GHG emissions is beyond the limits of existing science at the present time. More site-specific information on oil and gas activities resulting in GHG impacts would be described in detail at the APD stage. At the APD stage, the BLM would evaluate operations, require mitigation measures, and encourage operators to participate in the voluntary STAR program.

End Uses

The estimates above provide a complete GHG lifecycle of a well from site inspection to possible indirect emissions through combustion. A rough estimate was possible using publicly available information and using estimates from future production for reasonably foreseeable development. With respect to the rough estimates of indirect CO_2 emissions, it should be noted that it is difficult to discern with certainty what end uses for the fuels extracted from a particular leasehold might be reasonably foreseeable. For instance, end uses of fossil fuels extracted from Federal leases could include, but are not limited to: combustion of transportation fuels, fuel oils for heating and electricity generation, as well as production of asphalt and road oil, and the feedstocks used to make chemicals, plastics, and synthetic materials. At this time, there is uncertainty with regard to the actual development that may occur.

It is important to note that the BLM does not exercise control over the specific end use of the oil and gas produced from any individual federal lease. The BLM has no authority to direct or regulate the end use of the produced oil and/or gas. As a result, the BLM can only provide an estimate of potential GHG emissions using national approximations of where or how the end use may occur.

Availability of Input Data

In light of the difficulties in attributing specific climate impacts to individual projects, CEQ recommends agencies use the projected GHG emissions as a proxy for assessing a Proposed Action's potential climate change impacts. Estimates were made based on readily available data and reasonable assumptions about potential future development. There are many factors that affect the potential for GHG emissions estimates at the leasing stage: a lease may not be purchased, so no GHG emissions would be expected; a lease may be purchased but never explored, so again there would be no GHG emissions; a lease may be purchased and an exploratory well drilled that showed no development potential, so minimal GHG emissions would occur; or a lease may be purchased, explored, and developed. If developed there are notable differences in the potential for emissions related to a wide variety of variables, including the production potential of the well, economic considerations, regulatory considerations, and operator dynamics, to name a few. Further NEPA analysis would be conducted at the APD stage, when specific development details with which to analyze potential GHG emissions are known.

4.2.1.3 Monetizing Costs and Benefits: Social Cost of Greenhouse Gases

The 2016 CEQ guidance, Final Guidance for Federal Departments and Agencies on Consideration of Greenhouse Gas Emissions and the Effects of Climate Change in NEPA Reviews states that "NEPA does not require monetizing costs and benefits" and allows for agency discretion in including monetized assessment of the impacts of GHGs in NEPA documents (CEQ, 2016). In addition, the BLM finds that including monetary estimates of the social cost of GHGs (SC GHG) in its NEPA analysis for this Proposed Action would not be useful. There is no court case or existing guidance requiring the inclusion of SC GHG in the NEPA context. Estimating SC GHG is challenging because it is intended to model effects at a global scale on the welfare of future generations caused by additional carbon emissions occurring in the present. The Interagency Working Group on the Social Cost of Greenhouse Gases, convened by the U.S. Office of Management and Budget, developed estimates of the social cost of carbon dioxide, methane and nitrous oxide emissions. BLM finds that including meaningful monetary estimates of the SCC would not provide additional pertinent information to the decision maker.

Given the global nature of climate change, estimating SCC of an individual decision requires assessing the impact of the project on the global market for the commodity in question. While the BLM is able to estimate the GHG emissions associated with reasonably foreseeable oil and gas development, this EA does not estimate the net effect of this action on global GHG emissions or climate change. Depending on the global demand for oil and gas, the net effect of this project may be partially offset by changes in production in other locations. Accounting for this potential substitution effect is technically challenging.

4.2.1.4 Potential Mitigation

The EPA's inventory data describes "Natural Gas Systems" and "Petroleum Systems" as the two major categories of total US sources of GHG gas emissions. The inventory identifies the contributions of natural gas and petroleum systems to total CO_2 and CH_4 emissions (natural gas and petroleum systems do not produce noteworthy amounts of any of the other greenhouse gases). Within the larger category of "Natural Gas Systems," the EPA identifies emissions occurring during distinct stages of operation, including field production, processing, transmission and storage, and distribution. "Petroleum Systems" sub-activities include production field operations, crude oil transportation and crude oil refining. Within the two categories, the BLM has authority to regulate only those field production operations that are related to oil and gas measurement, and prevention of waste (via leaks, spills and unauthorized flaring and venting).

Between 2008 and 2012, methane and carbon dioxide emissions from oil production have increased nationally due to increases in domestic oil production. Between 2006 and 2012, methane emissions from natural gas production declined significantly due to improved practices and the use of green completions with hydraulic fracturing. However, during the same period, carbon monoxide emissions from natural gas production increased significantly due to increases in flaring (U.S. Environmental Protection Agency, 2014). The FFO would work with industry to facilitate the use of the relevant BMPs for operations proposed on Federal mineral leases where such mitigation is consistent with agency policy.

In addition to the above, a new lease stipulation was developed to require modeling to determine “near-field” air quality impacts (see Appendix 2). Due to the proximity of occupied buildings and residences to potential well sites to develop these proposed lease parcels, information about the air quality impacts at these locations needs to be determined and disclosed as part of the NEPA analysis prior to decision making on the APDs for wells on these parcels. Air dispersion modeling in accordance with EPA and state modeling guidelines can be used to determine "near-field" impacts. This modeling could not be completed at the time of the RMP because it requires very specific information about how leases are developed and locations of development. At the time of the lease sale, there is still not enough information available about how the lease will be developed to accurately determine the near-field air quality impacts. Exact locations and equipment specifications are known at the APD stage, the APD NEPA would contain the disclosure of the near-field air impacts from the development of these leases. The BLM will determine the near-field air impacts based on air dispersion modeling that conforms to EPA and New Mexico Environment Department guidelines. This stipulation is consistent with BLM policy to make mineral resources available for disposal and to encourage development of mineral resources while striving to ensure that mineral development is carried out in a manner that minimizes environmental damage.

Due to occupied residences located within the four parcels, lease stipulation F-44 would apply. F-44 states that no surface occupancy is allowed within 660 feet of any occupied residences of a community to reduce impacts to the community of drilling and production activities. Additionally, the BIA has required that a stipulation of No Surface Occupancy be added to each parcel for the purpose of lessening the impacts caused by mineral resource development on a place of residence and the occupants.

4.2.2 Heritage Resources

4.2.2.1 Cultural Resources

While the act of leasing a parcel would produce no impacts, subsequent development of the lease could have impacts/effects on cultural resources/historic properties.

Potential threats to cultural resources from leasing are variable and dependent upon the nature of the cultural resource and the nature of the proposed development. Effects normally and most often include alterations to the physical integrity of a cultural resource. The greatest potential impact to cultural resources stems from the construction of associated lease related facilities such as pipelines, power lines, roads, and well locations, as well as an increase in human activity or access to the area with the increased potential of unauthorized removal or other alteration to cultural resources in the area. These activities could affect one or more aspects of a historic properties physical integrity including location, design, materials, and workmanship. If a cultural resource is significant for other than its scientific information, effects may also include the introduction of audible, atmospheric, or visual elements that are out of character for the cultural site and diminish one or more of the historic properties aspects of integrity including setting, feeling, and association, if those aspects of integrity contribute to conveying the significance of the historic property.

Conversely, cultural resource investigations associated with development add to an understanding of the prehistory/history of the area under investigation, and cultural resources that would otherwise remain undiscovered and unevaluated are identified. Most of the cultural resources identified within the proposed action and within the APEs were identified by investigations associated with the planning of proposed development. With a projected site density of 1:12 acre, 939 additional unrecorded sites may exist in the uninventoried areas of the APE, 751 of which may be eligible for the National Register.

The BLM has applied the criteria of adverse effect as defined in 36 CFR 800.5(1) to the proposed action and proposes that the effect will not be adverse provided that the design features enumerated for the proposed action are adhered to and avoidance and protective measures associated with the preservation of cultural resources are considered the preferred course of action during individual lease development analysis and authorizations, including any effects that could reasonably involve the seven aspects of integrity for historic properties that may occur later in time, be further removed in distance or be cumulative.

4.2.2.2 Cultural Landscapes

The Proposed Action Alternative would not be expected to threaten or diminish the integrity or adversely affect the capability of considering any identified landscape characteristics of human use or activity in the APE (National Park Service 1999, Birnbaum and Peters 1996), nor would it compound the inherent problems associated with landscape approaches to archaeological remains (Zvelebil et al. 1992).

4.2.2.3 Native American Religious Concerns

The Proposed Action Alternative is not known to physically threaten the integrity of any sacred places/TCPs, prevent access to sacred sites, prevent the possession of sacred objects, or interfere or otherwise hinder the performance of traditional ceremonies and rituals pursuant to AIRFA or EO 13007. There are currently no known remains that fall within the purview of NAGPRA or ARPA that are threatened by leasing. Use of lease notices/stipulations and other design features, such as Native American consultation (including Navajo Nation Chapters) and cultural resource avoidance will help ensure that new information is incorporated and taken into account during individual lease development analysis and authorizations.

4.2.2.4 World Heritage Sites

None of the parcels are physically within 14 miles of any World Heritage Site. None are visible from any World Heritage Sites. All the parcels are greater than 14 miles from CCNHP and the Pueblo Pintado unit of CCNHP.

<u>Chaco Culture Archaeological Protection Sites</u>
None of the parcels physically intrude upon the lands or waters of any Protection Site. All of the parcels are over 13 miles from any Protection Site.

4.2.3 Visual Resources

The issuance of leases would not directly impact visual resource values. However, if issued, the proposed lease parcels would likely have NSO stipulations and development would likely occur on adjacent BLM lands.

For the purposes of this analysis, there could be future potential impacts on visual resources found in the existing inventory classification identified earlier. These impacts would include future development in the form of oil wells/pads, pipelines, compressors, power lines, constructed roads and other linear features in the areas adjacent to the proposed lease parcels due to the NSO stipulations. These impacts (form, line, color and texture) to the existing landscape found in the current VRI Classes would be allowable under the visual resource management decision which was established in the FFO RMPA (RMPA, 2014).

Further detailed analysis of these potential impacts to the VRI would be analyzed in the future as oil and gas development plans and as permits to drill are submitted. Mitigations and design features in order to reduce the potential impacts to the VRI would be addressed at that time. Management decisions made in order to manage visual resources are reflected in the visual resource management classification (VRM). These classes would be utilized to address potential effects to the visual resource for the remainder of this analysis. Impact to visual resources would be considered relevant if the impacts of the proposed project do not conform to an area's designated VRM class objectives which for this proposed action include VRM Class III and IV.

Short-term impacts are those that would affect visual resources for fewer than five years; long-term impacts would affect visual resources for more than five years. The potential direct adverse impacts to visual resources would include the visual contrasts created by construction equipment, pipelines, well pads, temporary and permanent access roads, and other forms of infrastructure associated with oil and gas exploration and development. In general, drilling rigs and equipment, construction and maintenance vehicles, development infrastructure, and surface disturbance, including roads, would impact an area's scenic quality and appearance of naturalness with human-made form, color, and linear contrasts. A visual contrast rating process would be used for the VRM analysis in areas with a VRM III classification, which involves comparing the project features with the major features in the existing landscape to determine whether the scenic values of the BLM managed lands adjacent to each parcel have been maintained.

As the proposed leases are developed, there is likely to be a visual impact for residents of tribal lands. However, those potential impacts cannot be analyzed until a site specific application is submitted to the BLM.

4.2.4 Night Sky Resources

Table 24 lists the light sources associated with drilling an oil and gas well include a light plant or generator, a light on the top of the rig, vehicle traffic, and flaring. The number of light sources and the duration of each source are identified. Flaring could occur in locations where pipelines are not available to transport gas to sale; however, the necessity for flaring and the duration of flaring varies widely from well to well and is difficult to predict.

Table 24. Light Sources by Lease Parcel under the Proposed Action Alternative.

Light Source			Duration	
Location	**Type**	**Number[1]**	**Days (average)**	**Hours[2]**
Foreground/Middleground (0-5 miles)				
Estimated light sources per 1 well				
Rig Derrick	4-foot Fluorescent (1 Explosion Proof)	12	3	24
Light Tower	Explosion Proof	4	3	24
Light Tower	Explosion Proof	2	30	24
Rig Floor	Explosion Proof	2	17	24
Sub	Explosion Proof	4	17	24
Mud Tank	Explosion Proof	9	17	24
Mud Pump	Explosion Proof	6	17	24
Catwalk	Explosion Proof	2	17	24
Tool Shed	4-foot Fluorescent	4	17	24
Housing Unit	12-Volt	10	17	12
Background/Seldom Seen (greater than 5 miles)				
Estimated light sources per 1 well				
Rig Derrick	4-foot Fluorescent (1 Explosion Proof)	12	3	24
Light Tower	Explosion Proof	4	3	24
Light Tower	Explosion Proof	2	30	24
Rig Floor	Explosion Proof	2	17	24
Sub	Explosion Proof	4	17	24
Mud Tank	Explosion Proof	9	17	24
Mud Pump	Explosion Proof	6	17	24
Catwalk	Explosion Proof	2	17	24
Tool Shed	4-foot Fluorescent	4	17	24
Housing Unit	12-Volt	10	17	12
Estimated light sources per 1 well				
Rig Derrick	4-foot Fluorescent (1 Explosion Proof)	12	3	24
Light Tower	Explosion Proof	4	3	24
Light Tower	Explosion Proof	2	30	24
Rig Floor	Explosion Proof	2	17	24
Sub	Explosion Proof	4	17	24
Mud Tank	Explosion Proof	9	17	24
Mud Pump	Explosion Proof	6	17	24
Catwalk	Explosion Proof	2	17	24
Tool Shed	4-foot Fluorescent	4	17	24
Housing Unit	12-Volt	10	17	12

[1] The number reflects the total number of light sources that may be required to drill wells necessary to develop the parcel. The total number of light sources present at any given time is likely to be lower as is unlikely that all wells will be drilled at the same time.

[2] This number reflects the number of hours the light may be on during a 24-hour period. Because the number of night-time hours varies depending on the time of year the well is drilled, lighting will not impact night skies during all of the hours identified.

The table provides the total number of light sources required for the development of a well; however, for parcels requiring more than one well, it is unlikely that all of the wells would be drilled at one time. These activities could result in minor, short-term impacts to night skies as well locations typically do not have lighting as a permanent feature upon completion.

4.2.5 Water Resources

Currently the make-up of fracking fluids varies across the San Juan Basin from the use of nitrogen in the place of water in oil prone areas to water based fluids in deeper gas prone areas. The number of chemical additives used in a typical fracture treatment varies depending on the formation and the type of well being fracked. A typical frack job will use three to 12 chemicals. Fluids, commonly made up of water (99 percent) and chemical additives (one percent), are pumped into a geologic formation at high pressure during hydraulic fracturing (US EPA 2004). Chemicals added to stimulation fluids may include friction reducers, surfactants, gelling agents, scale inhibitors, acids, corrosion inhibitors, antibacterial agents, and clay stabilizers. (GWPC, 2009) as shown below in Table 25.

Table 25. Fracturing Fluid Additives, Main Compounds, and Common Uses (GWPC, 2009).

Additive Type	Main Compound(s)	Purpose	Common Use of Main Compound
Diluted Acid (15%)	Hydrochloric acid or muriatic acid	Help dissolve minerals and initiate cracks in the rock	Swimming pool chemical and cleaner
Biocide	Glutaraldehyde	Eliminates bacteria in the water that produce corrosive	Disinfectant; sterilize medical and dental equipment
Breaker	Ammonium persulfate	Allows a delayed break down of the gel polymer chains	Bleaching agent in detergent and hair cosmetics, manufacture of household plastics
Corrosion Inhibitor	N,n-dimethyl formamide	Prevents the corrosion of the pipe	Used in pharmaceuticals, acrylic fibers, plastics
Crosslinker	Borate salts	Maintains fluid viscosity as temperature increases	Laundry detergents, hand soaps, and cosmetics
Friction Reducer	Polyacrylamide	Minimizes friction between the fluid and the pipe	Water treatment, soil conditioner
	Mineral oil		Make-up remover, laxatives, and candy
Gel	Guar gum or hydroxyethyl cellulose	Thickens the water in order to suspend the sand	Cosmetics, toothpaste, sauces, baked goods, ice cream
Iron Control	Citric acid	Prevents precipitation of metal oxides	Food additive, flavoring in food and beverages; Lemon Juice ~7 percent Citric Acid
KCl	Potassium chloride	Creates a brine carrier fluid	Low sodium table salt substitute
Oxygen Scavenger	Ammonium bisulfite	Removes oxygen from the water to protect the pipe from corrosion	Cosmetics, food and beverage processing, water treatment
pH Adjusting Agent	Sodium or potassium carbonate	Maintains the effectiveness of other components, such as crosslinkers	Washing soda, detergents, soap, water softener, glass and ceramics
Proppant	Silica, quartz sand	Allows the fractures to remain open so the gas can escape	Drinking water filtration, play sand, concrete, brick mortar
Scale Inhibitor	Ethylene glycol	Prevents scale deposits in the pipe	Automotive antifreeze, household cleansers, and de- icing agent
Surfactant	Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, and hair color

Note: The specific compounds used in a given fracturing operation will vary depending on company preference, source water quality and site-specific characteristics of the target formation. The compounds shown above are representative of the major compounds used in hydraulic fracturing of gas shales.

When the hydraulic fracturing pressure exceeds the rock strength, the fluids open or enlarge fractures that typically extend several hundred feet laterally away from the well bore, and may occasionally extend up to 1,000 feet from the well bore. After the fractures are created and held open, a propping agent (usually sand mixed in fluids) is pumped into the fractures to keep them from closing when the pumping pressure is released. After fracturing is completed, a portion of the injected fracturing fluids returns to the wellbore and is recovered for future fracturing operations (USEPA 2004) or disposal.

Produced water is brought to the surface during the drilling completion (i.e., "fracking") and production phases of a well. Water used during the drilling phase is called "drilling fluid" and is contained in the closed loop system. The fracking solution brought back to the surface during the completion phase is called "flow back". Typically only 30-70 percent of the fluid injected is recovered during the flow back. The water produced during the production phase is considered a byproduct and is called "produced water". Produced water is typically managed by temporarily storing it in an aboveground steel tank then injected into a non-freshwater formation by the use of an underground injection well (i.e., SWD).

Hydraulic fracturing is a common process in the San Juan Basin and is applied to nearly all wells drilled. The producing zone targeted by the proposed action is sandstone and siltstones which are encased or surrounded both horizontally and vertically by impermeable Mancos Shale interval which is over 2,000 feet thick and well below any underground sources of drinking water. The Mancos Shale formation is in itself a frack barrier to fluid migration and is also overlain by other continuous confining layers. There are two geological confining layers, the Lewis Shale and the Kirtland Shale formations, that are located above both the Mancos Shale and Mesaverde formations. The Lewis Shale (up to 2,000 feet thick) and the Kirtland Shale (up to 1,500 feet thick) provide impermeable layers that isolate the Mancos Shale and Mesaverde formations from both identified sources of drinking water and surface water. On average, total depth of the proposed well bore would be about 5,000 feet below the ground surface. Current fracturing in the Basin Mancos formation is not expected to occur above depths of 4,000 feet below the ground surface. Fracturing is not likely to extend into the Mesaverde formation from the lower portion of the Basin Mancos formation even though it has not been identified as an underground source of drinking water because of its depth and high relative levels of TDS.

Potential impacts to groundwater resources could occur from the proposed well bore, including groundwater depletion, contamination or cross-contamination of aquifers during drilling and completion phases. Casing specifications and the casing program would be submitted to the NMOCD. Surface casing would be set to 500 feet. The casing and cementing would stabilize the wellbore and provide protection to any overlying freshwater aquifers by isolating hydrocarbon zones from overlying freshwater aquifers. Prior to approving an APD, a BLM geologist would identify all potential subsurface formations that would be penetrated by the wellbore. This includes all groundwater aquifers and any zones that would present potential safety or health

risks that may need special protection measures during drilling, or that may require specific protective well construction measures.

Once the geologic analysis is completed, the BLM would review the company's proposed casing and cementing programs to ensure the well construction design is adequate to protect the surface and subsurface environment, including potential risks identified by the geologist and all known or anticipated zones with potential risks.

Before hydraulic fracturing takes place, all surface casings and intermediate zones are required to be cemented from the bottom of the cased hole to the surface. The cemented well would be pressure tested to ensure there are no leaks and a cement bond log is run on certain strings to confirm the cement has bonded to the steel casing stings and to the surrounding formations. The ground water is protected by this process of zonal isolation. It is highly unlikely that groundwater reservoirs will be impacted by fracking the well because of the formation depth, the Lewis Shale cap, and the casing and cementing requirements.

Typically only 30 to 70 percent of the fluid injected during the completion process is recovered during the flow back. The flow back is contained in steel tanks and is typically recycled and reused on the next well. Eventually the fluid would be injected into an underground formation once the fluid is no longer needed. Injection wells are also subject to COAs mentioned above; such as having the casing, cementing, and pressure testing, to protect the groundwater formations. Since the flow back would be disposed of at a regulated and permitted commercial facility, it is assumed that they would ensure all water quality regulations and laws are followed and that COAs are in place to prevent contamination of aquifers, thus having no impact on water quality in the aquifers from injection.

The water used for hydraulic fracturing in the FFO generally comes from permitted groundwater wells, although surface water sources may occasionally be used. Because large volumes of water are needed for hydraulic fracturing, the use of groundwater for this purpose might contribute to the drawdown of groundwater aquifer levels. Groundwater use is permitted and managed by the NM OSE, and these water rights have already been designated. The NM OSE regulates and monitors the use of groundwater for industrial use. In addition, the use of water for hydraulic fracturing is one of many uses of groundwater in the FFO. Approximately 1.02 million gallons (approximately 3.13 acre-feet) of water would be used for drilling and completions per well (Engler, et al., 2014). The use of groundwater for hydraulic fracturing is in compliance with all federal and state laws and regulations. Other uses include irrigation, industrial mining operations, and domestic livestock use.

During operation, pipelines could potentially leak or rupture, which could impact groundwater quality. In the event of a leak or rupture, the BLM and NMOCD would work collaboratively to clean up the spill and protect groundwater. Any proposed pipelines would be tested to ensure integrity prior to operation. Cathodic protection systems are installed to protect pipelines and also well head casing from corrosion, which could affect the integrity of the pipe. Potential impacts to groundwater quality from leaks or ruptures during pipeline and well operation would be long term.

4.2.6 Soil

While the act of leasing a tract would produce no direct impacts under the Proposed Action Alternative, subsequent development of the lease would physically disturb the topsoil and would expose the substratum soil on subsequent project areas. Direct impacts resulting from the oil and gas construction of well pads, access roads, and reserve pits include removal of vegetation, exposure of the soil, mixing of horizons, compaction, loss of top soil productivity, and susceptibility to wind and water erosion. Wind erosion would be expected to be a minor contributor to soil erosion with the possible exception of dust from vehicle traffic. These impacts could result in increased indirect impacts such as runoff, erosion, and off-site sedimentation. Activities that could cause these types of indirect impacts include construction and operation of well sites, access roads, gas pipelines, and facilities.

Contamination of soil from drilling and production wastes mixed into soil or spilled on the soil surfaces could cause a long-term reduction in site productivity. Some of these impacts can be reduced or avoided through proper design, construction and maintenance and implementation of best management practices.

Additional soil impacts associated with lease development would occur when heavy precipitation causes water erosion damage. If a water saturated segment on an access road becomes impassable, vehicles may still be driven over the road. Consequently, deep tire ruts would develop. Where impassable segments are created from deep rutting, unauthorized driving may occur outside the designated route of access roads. Due to the potential for increased road traffic if additional lands are leased, roadways may be further degraded, causing other indirect affects (dust, noise, etc). If deteriorated conditions occur, the jurisdiction with oversight would take necessary actions. For BLM managed lease roads, this would be resolved through inspection and enforcement actions as authorized in 43 CFR § 3160.

The impact to the soil would be remedied upon reclamation of well pads when the stockpiled soil that was specifically conserved to establish a seed bed is spread over well pads and vegetation re-establishes.

Fragile soils may be difficult for the project proponent to stabilize and establish vegetation. The proponent is required to follow the FFO Bare Soil Reclamation Procedure (procedure) for all projects that result in bare soil in areas of 0.1 acre or more that have an onsite visit after February 5, 2013. The procedure utilizes eight habitat community descriptions; each community description contains recommendations for effective reclamation. Some additional recommendations for fragile soils include:

- Provide temporary stabilization of disturbed areas that are not actively under construction.
- Apply erosion controls such as excelsior netting, geotextile materials, silt fences, and silt traps to prevent/minimize soil erosion from vehicular traffic and during construction activities.
- Minimize the amount of land disturbed as much as possible and minimize vegetation removal.

- Design runoff control features to minimize soil erosion.

Regulations and policy require a project proponent to submit a plan for surface reclamation, and the FFO Bare Soil Reclamation Procedure requires a revegetation plan to be incorporated into the site specific project EA. FFO reviews permit applications and site specific project EAs for adequate plans for soil stabilization and revegetation for all proposed projects, including proposed projects located on fragile soils.

4.2.7 Special Status Species

Direct and indirect impacts for Brack hardwall cactus, ferruginous hawk, golden eagle, and loggerhead shrike are described below.

4.2.7.1 Brack hardwall Cactus

The proposed analysis area contains suitable and occupied habitat Brack hardwall cactus for two of the proposed parcels:

NM-201701-003 – this analysis area contains approximately 1,000 acres of suitable and occupied Brack's cactus habitat on BLM administered lands. BLM GIS data show that the high habitat quality occurs in the southwest part of the proposed AA of this parcel. Also, a transplant site for Brack's cactus, from a 2013 project, is located in the northwest area of the proposed AA of this parcel. The BLM FFO estimates that this lease will require at least five wells from three well pads. There is a possibility that all three well pad are constructed within this habitat area. Each well pad is approximately 6.0 acres with associated infrastructure adding another 0.6 acres. With a disturbance buffer of 100 feet, an estimated 34 acres of habitat removal/alteration (3.5 percent within proposed AA) would be expected from the proposed action. The disturbance buffer is an impact buffer that accounts for more indirect impacts such as invasive weeds, fugitive dust, decrease in pollinators, and an increase in OHV access. However, the impact estimates do not factor in any habitat fragmentation, which is difficult to estimate at the lease sale level. Currently, the suitable habitat within the proposed AA is moderately fragmented, with no continuous habitat extending longer than 0.5 miles. The proposed action will undoubtedly increase the amount of habitat fragmentation, however, by proper planning and use of current technology, proposed well projects should be able to decrease fragmentation and other impacts to Brack's cactus habitat. Further analysis will be conducted at the project level stage to further document potential impacts and apply the appropriate management to minimize or eliminate impacts.

NM-201701-004 - this analysis area contains approximately 600 acres of suitable and occupied Brack's cactus habitat on BLM administered lands. The proposed lease is located on eastern region of FFO's newly mapped habitat. BLM GIS data show that the high habitat quality occurs in the western portion of the proposed AA of this parcel. This lease can be drained with two wells from one well pad. If constructed in Brack's habitat, an estimated 11 acres of habitat would be removed or altered (approximately two percent of habitat in proposed AA). Habitat fragmentation is relatively small currently. Fragmentation is expected to increase with proposed action but impacts are expected to be relatively small if proposed projects use the existing

infrastructure. Further analysis will be conducted at the project level stage to further document potential impacts and apply the appropriate management to minimize or eliminate impacts.

4.2.7.2 Golden Eagles and Other Raptors

The proposed analysis area contains nesting and foraging habitat for the golden eagle, peregrine falcon, prairie falcon, ferruginous hawk, and the burrowing owl. One parcel has an active eagle territory, NM-201701-003, within the AA. The BLM FFO has a policy that protect raptors from impacts from proposed projects. Due to the close proximity to the proposed lease and potential impacts from development, a 0.5 mile protection buffer around golden eagles from January 15 – June 30 to eliminate any impacts during the nesting season. Further analysis will be conducted at the project level stage to further document potential impacts and apply the appropriate management to minimize or eliminate impacts.

There are no known nests for any other raptor within the AA, however, nesting habitat exist. Biological surveys at the project level stage should detect any undocumented raptor nest. If any raptor nest is found, the appropriate disturbance buffer and timing stipulation will be applied to eliminate or minimize impacts to nesting activities.

Due to the mobility of adult birds, it is unlikely that golden eagles would be directly harmed by the proposed project. Temporarily, noise and visual disturbances associated with proposed project construction could deter golden eagles from utilizing the proposed project area and immediate adjacent lands.

No other special status species is expected to be directly impacted by the action alternatives. The proposed parcels may include undocumented Gunnison's prairie dog towns and of special status species. Project specific analysis will be conducted on any new ground disturbing activity to eliminate or minimize impacts to these species. Management measures, as written in the FFO Special Management Species policy, will apply to the proposed new lease parcels.

4.2.8 Wildlife

Removal of habitat features, including foraging, watering and security areas, directly affect the ability of many wildlife species to exist, including larger species like deer and elk. Should these leases be developed, the footprint of infrastructure, including roads, pads and pipelines will result in a measurable loss of habitat (Watkins et. al 2007). Invasion of competitive, non-palatable or noxious weed species can be exacerbated by removal of native vegetation, blading, pipeline construction, road building, or any other disturbances. These invasions can expand loss of habitat beyond directly disturbed areas.

Big game species have demonstrated varying degrees of avoidance around areas of energy development. The influence of each facility (e.g. well pad, road, pipeline) extends to surrounding areas. For mule deer, alert and flight reactions have been detected up to 0.3 mile from the source of disturbance, whereas habitat avoidance responses might extend to distances of 2.5-4.3 miles (Sawyer et al. 2009). Elk have exhibited zones of disturbance from 0.5-0.9 mile of disturbance (Riley et al. 2012). Extended zones of disturbance, reduced or increased by habitat and

topography, has varying impacts on lost habitat and habitat fragmentation that results from facility development and activity levels. It is assumed that these impacts will be greatest during initial well drilling and completion activities and that impacts will decline as activity associated with production declines.

Animals that remain within developed, or increasingly developed areas, are subject to increased physiological stress and energy expenditures. Energy expenditures in response to disturbance are of greatest concern during winter months, when energy conservation is fundamental to survival and reproduction.

The assumed APE encompassed by the proposed parcels includes existing oil and gas infrastructure, including roads, well pads and pipelines. As densities of well pads, roads and facilities increases, habitat within and near well fields become progressively less attractive, sometimes correlating with reduced populations (Riley et al. 2012). The magnitude of existing direct and indirect effects will be exacerbated by each additional development. The duration of current, long-term impacts associated with current development and existing production facilities will be increased at the landscape scale with the inclusion of new developments.

4.2.8.1 Migratory Birds

Potential effects on birds from the Proposed Action Alternative is difficult to predict. Ongoing studies have shown mixed effects of oil and gas development, including compressor noise on nesting migratory birds. Frances and Ortega (2006 unpublished report to BLM FFO) found no significant difference in nest density or nest success between sites with or without wellhead compressors. Some species, such as black-chinned hummingbird and house finch were more common on sites with compressors while others, such as mourning dove and spotted towhee, appeared to either avoid or nest further from compressors. Holmes *et al.* (2003) found that sage sparrow had lower nest survival in an area with ongoing gas development, while Brewer's sparrow had higher survival rates when compared with populations in an undeveloped control area.

Site-specific analysis will be conducted to determine the impacts on migratory birds as proposed projects are submitted to the BLM. The BLM FFO bird policy requires migratory bird nest surveys for any proposed project (and related activities) with new disturbance that exceeds 4.0 acres. The bird policy also has other protective measures to reduce bird risks once a project is completed (Instruction Memorandum No. 2013-033). Impacts to migratory birds will be reduced significantly with these management measures in place. However, not all impacts will be eliminated. Impacts such as habitat fragmentation and habitat loss will continue to impact birds and their habitat. The BLM FFO will apply BMPs to reduce impacts on migratory birds. Examples of these BMPs can be found in the BLM FFO bird policy and the MOU between USFWS and BLM (DOI 2010a).

4.2.9 Noxious and Invasive Weeds

While the act of leasing a tract would produce no direct impacts under the Proposed Action Alternative, subsequent development of the leases would physically disturb the topsoil and

would expose the substratum soil on subsequent project areas. Disturbance of soil through construction and maintenance activities directly creates an environment conducive to the establishment of noxious and invasive weeds and allows for the encroachment and expansion of possible existing infestations. Noxious and invasive weeds may be transported on construction equipment, and indirectly by truck and public traffic utilizing infrastructure created for the development of the leases. Site-specific analysis will determine any additional design features, BMPs and COAs that are not included in the standard COAs helping to minimize possible impacts at the time of the APD.

4.2.10 Environmental Justice

While the act of leasing federal minerals itself would result in no social impacts, subsequent development of a lease may generate impacts to people living near or using the area in the vicinity of the lease. Oil and gas exploration, drilling, or production could create a disruption to these people due to increased traffic and traffic delays, air pollution, noise, and visual impacts. This could be especially noticeable in rural areas where oil and gas development has been minimal. The amount of disruption would depend on the activity affected, traffic patterns within the area, noise levels, length of time, and season these activities occurred. In addition, any nearby residents may be disturbed while hydraulic fracturing or other completion and stimulation operations are occurring, as these activities involve many vehicles, heavy equipment, and a workover rig. These impacts would be limited to the period of time during which drilling operations associated with hydraulic fracturing occur.

Creation of new access roads into an area could allow increased public access and exposure of private property to vandalism. For leases where the surface is privately owned and the subsurface is BLM managed, surface owner agreements, standard lease stipulations, and BMPs could address many of the concerns of private surface owners. If leased, and an APD is submitted, BLM resource specialists would invite the surface estate holder to the onsite inspection (as specified in Onshore Oil and Gas Order Number 1). The onsite inspection is where stakeholders meet on location to discuss the proposed application. During that time stakeholders would be able to discuss any issues related to the proposed APD such as well location, access road, water source, etc. Furthermore, this would enable the surface owner and BLM to better evaluate the specific proposal for development and what effects it may have.

Employment and associated population increases would be more likely to occur in the larger communities where the social effects would be less noticeable. Any new employment and population would probably be welcomed in the very small communities that are currently losing population. There would also be an increase in revenues that accrue to the counties where production occurs. Depending on where production actually occurs, these revenues would benefit any receiving county but would be more notable in counties with smaller populations and lower current property and tax revenue.

A new lease stipulation was developed to require modeling to determine “near-field” air quality impacts (see Appendix 2). Due to the close proximity of occupied buildings and residences to potential well sites for these lease parcels, information about the air quality impacts at these locations needs to be determined and disclosed as part of the NEPA analysis prior to decision

making on the APDs for wells on these parcels. Air dispersion modeling in accordance with EPA and state modeling guidelines can be used to determine “near-field” impacts. This modeling could not be completed at the time of the RMP because it requires very specific information about how leases are developed and locations of development. At the time of the lease sale, there is still not enough information available about how the lease will be developed to accurately determine the near-field air quality impacts. Exact locations and equipment specifications are known at the APD stage, so the APD EA needs to contain the disclosure of the near-field air impacts from the development of these leases. The BLM will determine the near-field air impacts based on air dispersion modeling that conforms to EPA and New Mexico Environment Department guidelines. This stipulation is consistent with BLM policy to make mineral resources available for disposal and to encourage development of mineral resources while striving to ensure that mineral development is carried out in a manner that minimizes environmental damage.

Due to occupied residences located within the four parcels, lease stipulation F-44 would apply. F-44 states that no surface occupancy is allowed within 660 feet of any occupied residences of a community to reduce impacts to the community of drilling and production activities. Additionally, the BIA has required that a stipulation of No Surface Occupancy be added to each parcel for the purpose of lessening the potential impacts caused by mineral resource development on a place of residence and the occupants.

4.2.11 Lands and Realty

The No action alternative would result in the leases not being issued. There would be no increase in ROWs related to lease activities on the lands surrounding the parcels. Management of existing ROWs would not change.

The Proposed Action Alternative would require that ROWs be granted for the lands surrounding the parcels nominated for leasing. The No Surface Occupancy stipulation attached to the lease would require all exploration activities to be conducted off lease primarily within the surrounding area. These activities would require ROW grants to be issued by the appropriate Surface Management Agency.

Management of existing ROWs would continue by the appropriate Surface Management Agency. New rights of way related to off-lease development for the lease parcels would not be able to utilize existing infrastructure within the lease parcels.

5.0 CUMULATIVE IMPACTS

The NMSO manages approximately 41 million acres of Federal mineral estate. Of the 41 million acres, 35 million acres are available for oil and gas leasing. Approximately 15 percent of the 35 million acres of federal oil and gas mineral ownership in NM is currently leased (79 percent of the leases are in production and 78 percent of the lease acres are in production), as shown in Table 26. The NMSO received five parcel nominations (2,802.56 acres) for consideration in the January 25, 2017, Competitive Oil and Gas Lease Sale, and is proposing to lease four (842.66

acres)(Table 27). If these four parcels were leased, the percentage of Federal minerals leased would not significantly change, as shown in Table 28, since several leases in the San Juan Basin have already expired and others will expire this calendar year under their primary term.

Table 26. Actual - Acres of Federal Minerals/Acres Available/Acres Leased.

State	Federal Oil and Gas Mineral Ownership	Acres Available	Acres Leased	Percent Leased
KS	744,000	614,586	119,994	20%
NM	34,774,457	29,751,242	4,587,311	15%
OK	1,998,932	1,668,132	252,871	15%
TX	3,404,298	3,013,207	418,767	14%
Totals/Average	40,921,687	35,047,167	5,378,943	15%

Table 27. Parcels Nominated and Offered in the January 2017 Oil and Gas Lease Sale.

Field Office	Number of Nominated Parcels	Acres of Nominated Parcels	Number of Parcels to be Offered	Acres of Parcels to be Offered
Farmington	4	842.66	4	842.66

Table 28. Foreseeable - Acres of Federal Minerals/Acres Available/Acres Leased.

State	Federal Oil and Gas Mineral Ownership	Acres Available	Acres Leased	Percent Leased
KS	744,000	614,586	119,994	20%
NM	34,774,457	29,751,242	4,588,154	15%
OK	1,998,932	1,668,132	252,871	15%
TX	3,404,298	3,013,207	418,767	14%
Totals/Average	40,921,687	35,047,167	5,379,786	15%

The cumulative impacts fluctuate with the gradual reclamation of well abandonments and the creation of new additional surface disturbances in the construction of new access roads and well pads. The on-going process of reclamation of abandonments and creating new disturbances for drilling new wells gradually accumulates as the minerals are extracted from the land. Conserving as much land as possible and applying appropriate mitigation measures will alleviate the cumulative impacts. Appendix 2 outlines a number of lease stipulations which can be used to alleviate cumulative impacts.

5.1 Effects on Air Resources

The following analysis of cumulative impacts of the proposed action on air quality would be limited to the Four Corners area of New Mexico. The cumulative impacts of GHG emissions and their relationship to climate change are evaluated at the national and global levels in the Air Resources Technical Report (U.S. Department of Interior Bureau of Land Management, 2016).

Even though the Proposed Action of leasing would not contribute to cumulative effects on air resources, future foreseeable development could contribute to cumulative GHG emissions. The primary sources of emissions include the following:

- Fossil fuel combustion for construction and operation of oil and gas facilities – vehicles driving to and from production sites, engines that drive drill rigs, etc. These produce CO_2 in quantities that vary depending on the age, types, and conditions of the equipment as

well as the targeted formation, locations of wells with respect to processing facilities and pipelines, and other site-specific factors.

- Fugitive CH_4 – CH_4 that escapes from wells (both gas and oil), oil storage, and various types of processing equipment. This is a major source of global CH_4 emissions. These emissions have been estimated for various aspects of the energy sector, and starting in 2011, producers are required under 40 CFR § 98, to estimate and report their CH_4 emissions to the EPA.
- Combustion of produced oil and gas – it is expected that operations will produce marketable quantities of oil and/or gas. Combustion of the oil and/or gas would release CO_2 into the atmosphere. Fossil fuel combustion is the largest source of global CO_2.

Increases in GHGs are thought to be related to climate change, which may affect various resources and contribute to changes such as earlier "greening" of vegetation in the spring and longer thermal growing seasons (IPCC, 2007). Climate change may combine with other human-induced stress to further increase the vulnerability of ecosystems to other pests, invasive species, and loss of native species. Climate change may also affect breeding patterns, water and food supply, and habitat availability to some degree. Sensitive species could experience additional stressors as a result of climate change.

The assessment of GHG emissions, their relationship to global climatic patterns, and the resulting impacts, however, is still an ongoing scientific process. It is not known with certainty the net impacts that reasonably foreseeable mineral development could have on climate – that is, while BLM actions may contribute to the climate change phenomenon, the specific effects of those actions on global climate are speculative given the current state of the science. The BLM does not have the ability to directly associate a BLM action's contribution to climate change with effects in any particular area. Inconsistencies in the results of scientific models designed to predict climate change on regional or local scales limits the ability to completely quantify potential future effects of decisions made at this level and determining the significance of any discrete amount of GHG emissions is beyond the limits of existing science (see also Section 4.2.3, Uncertainties of GHG Calculations). When further information on the effect to climate change is known, such information would be incorporated in the BLM's planning and NEPA documents as appropriate.

In recent years, many states, tribes, and other organizations have initiated GHG inventories, tallying GHG emissions by economic sector. The EPA provides links to statewide GHG emissions inventories (USEPA, 2015c). Guidelines for estimating project-specific GHG emissions are available (URS Corporation, 2010), but some additional data, including the volume of oil produced and the number of wells, are not available for the Proposed Action. Uncertainties regarding the numbers of wells and other factors result in a moderate to high degree of uncertainty and speculation with regard to GHG estimates at the leasing stage. At the APD stage, more site-specific information on oil and gas activities resulting in GHG impacts would be described in detail. Also at the APD stage, the BLM would review and evaluate operations, require mitigation measures, and encourage operators to participate in the voluntary STAR program.

Although the Proposed Action of leasing, in itself, would not result in any air quality or climate change effects, potential reasonably foreseeable mineral development could increase GHGs that may influence climate change within the region and result in cumulative effects when combined with other past, present, and future actions in the area. For instance, as previously acknowledged in this EA, it is possible that there could be additional oil and gas development on private surface and private minerals in the future. These activities could result in additional air emissions. Reclamation and other stipulations and best management practices, as described earlier in this EA, would help to minimize the potential for significant adverse cumulative effects.

5.1.1 Effects of Other Past, Present, and Reasonably Foreseeable Actions on Air Resources

The primary activities that contribute to levels of air pollutant and GHG emissions in the Four Corners area are electricity generation stations, fossil fuel industries and vehicle travel. The Air Resources Technical Report includes a description of the varied sources of national and regional emissions that are incorporated here to represent the past, present and reasonably foreseeable impacts to air resources. It includes a summary of emissions on the national and regional scale by industry source. Sources that are considered to have notable contributions to air quality impacts and GHG emissions include electrical generating units, fossil fuel production (nationally and regionally) and transportation.

5.1.2 Cumulative Effects of the Proposed Action on Air Quality

The very small increase in emissions that could result from approval of the action alternatives would not result in any county in the FFO area exceeding the NAAQS for any criteria pollutants. The applicable regulatory threshold for HAPs is the oil and gas industry National Emissions Standards for Hazardous Air Pollutants, which are currently under review by the EPA. The emissions from any wells drilled in the leased areas are not expected to impact the 8-hour average ozone concentrations, or any other criteria pollutants in the Southern San Juan Basin.

5.1.3 Cumulative Effects of the Proposed Action on Climate Change

The very small increase in GHG emissions that could result from approval of the Proposed Action Alternative would not produce climate change impacts that differ from the No Action Alternative. This is because climate change is a global process that is impacted by the sum total of GHGs in the Earth’s atmosphere. The incremental contribution to global GHGs from the proposed action cannot be translated into effects on climate change globally or in the area of this site-specific action. It is currently not feasible to predict with certainty the net impacts from the proposed action on global or regional climate.

The Air Resources Technical Report discusses the relationship of past, present and future predicted emissions to climate change and the limitations in predicting local and regional impacts related to emissions. It is currently not feasible to know with certainty the net impacts from particular emissions associated with activities on public lands.

5.2 Cumulative Effects of the Proposed Action on Cultural Resources

The Proposed Action Alternative APE lies within five watersheds: Blanco Canyon, Escavada Wash, Headwaters Canon Largo, Canada Alemita-Chaco Wash, and Outlet Canon Largo. Watersheds can be viewed as a naturally defined landscape and impacts to cultural resources in one part of that landscape could, theoretically, affect a broader understanding of the interrelationships between sites in the landscape as a whole. The boundaries are distinguished by hydrographic and topographic criteria that delineate an area of land upstream from a specific point on a river, stream or similar surface waters (USGS 2013, NRCS 2013). The next to smallest hydrologic unit area, typically from 40,000 – 250,000 acres (62 – 390 mi²; HUC 10) or combination thereof is used for the analysis.

The five watersheds encompass 945,636 acres. Based on New Mexico Cultural Resource Information System data (NMCRIS; May 2016), there are 5,471 recorded sites and approximately 13 percent of the watershed (126,087 acres) has been inventoried for cultural resources by 4,652 unique investigations since 1972. This is an overall site density of 1:23 acres although site density will likely vary somewhat dependent upon location specific environmental variables. The current cultural inventory coverage is higher as not all survey and site data is digitally available (e.g., tribal lands, additional surveys since May 2016). Approximately 80 percent of the sites (n≈4,377) are historic properties (eligible for the NRHP).

According to NMCRIS data approximately 14 percent of the sites (n≈789) have some disturbance attributed to “construction”, presumably from actions conducted prior to the NHPA and regular implementation in the early-mid 1970s of cultural resources studies in advance of development.

Within the watersheds on Jicarilla Apache lands there are an unknown number of places of traditional religious and cultural importance. Within the watershed on BLM and adjacent Navajo lands there are approximately 307 known places of traditional religious and cultural importance, of which 109 (36 percent) are burials or places associated with death. The remainder includes traditional plant gathering locales, offering places, old ceremonial grounds, springs, antelope and eagle traps, battle sites, pre-Columbian sites, and named landscape often associated with origin history. Current data does not provide information on condition and most have not been evaluated for the NRHP. Certain examples such as historic graves are typically not considered historic properties.

Within the watersheds there are 68 properties listed on the National Register or New Mexico State Register of Cultural Properties, two Chaco Protection Site (Raton Well, Bis ani), one World Heritage site (Chaco Culture National Historic Park), and one National Historic Trail (Old Spanish Trail, Armijo Route).

For the Proposed Action Alternative there will be no cumulative impact on historic properties, properties listed on the National Register of Historic Places or New Mexico State Register of Cultural Properties, Chaco Protection Sites, World Heritage Sites, National Historic Trails, or other places of traditional religious and cultural importance.

5.3 Cumulative Effects of the Proposed Action on Visual Resources

The cumulative impact area considered for visual resources is the applicable inventory units of the FFO VRI (March 2009). The rationale for this boundary is that the visual resource inventory serves as the baseline information for assessing potential effects to visual resources within the proposed projects. Cumulative impacts are incorporated by reference to Section 4.2 of the FFO RMPA (RMPA 2014). The past, current and future activities in the inventory unit would cumulatively increase the cultural modification done to the landscape. This is viewed as negative impact when assessing the scenic quality of an area. The proposed action would contribute to these cumulative impacts by making four parcels available for lease. Visual contrast analysis would be conducted to determine if development is in compliance with VRM standards when the project proponents begin the work of developing any infrastructure on BLM lands adjacent to or within the viewshed. When a site specific project is proposed, VRM analysis would be conducted. Development resulting from the NSO requirement of lease parcel four that may be proposed in the area designated VRM III would require a site specific VRM analysis. Cumulatively these developments could change the overall character of the VRM classification. The No Action alternative would not contribute any cumulative impacts.

5.4 Cumulative Effects of the Proposed Action on Water Resources

Within the five watersheds (945,636 acres), 4,540 oil and gas wells currently exist. These wells have resulted in 3,405 acres of long-term surface disturbance, or 0.005 percent of total surface area. Based on the RFD (Engler, et al., 2014), oil and gas development in the five watersheds may result a total of 10,393.26 acres of potential new surface disturbance in which 8,201.76 acres is considered short-term disturbance and 2,191.5 acres long-term disturbance. This disturbance would have the same impacts as described for direct and indirect impacts.

Approximately 12.24 million gallons (approximately 37.56 acre-feet) of water would be used for drilling and completing the 12 potential wells. Using the 30 to 70 percent recovery rate from fracking, approximately 3.67 to 8.57 million gallons of the fluid would be recovered during the flow back. The 1,461 potential wells in the five watersheds, would use approximately 1,490,220,000 gallons of water for drilling and completions. The water demand to complete these wells is not expected to exceed past development demands (RFD [Engler, et al., 2014]). This fluid along with water produced during the production phase managed by temporarily storing it in an aboveground steel tank then injected into a non-freshwater formation by the use of an underground injection well (i.e., SWD).

The development that potentially would occur associated with the Proposed Action Alternative would contribute approximately 39.74 acres of short-term disturbance and nine acres of long-term disturbance. Site specific and watershed specific impacts would be analyzed when an APD is received.

Other impacts which may also cumulatively impact water depletions includes residential water use, livestock water use, and commercial water use.

5.5 Cumulative Effects of the Proposed Action on Soil Resources

Within the five watersheds (945,636 acres), 4,540 oil and gas wells currently exist. These wells have resulted in 3,405 acres of long-term surface disturbance, or 0.005 percent of total surface area. Based on the RFD (Engler, et al., 2014), oil and gas development in the five watersheds may result a total of 10,393.26 acres of potential new surface disturbance in which 8,201.76 acres is considered short-term disturbance and 2,191.5 acres long-term disturbance. This disturbance would have the same impacts as described for direct and indirect impacts.

The development that potentially would occur associated with the Proposed Action would contribute approximately 39.74 acres of short-term disturbance and nine acres of long-term disturbance. Site specific and watershed specific impacts would be analyzed when an APD is received.

Other impacts which may also cumulatively impact soils resulting from surface disturbance includes land development, vegetation treatments, livestock grazing, and recreation.

Livestock grazing is expected to continue at the same rate and manner as it currently occurs and no change is expected in the reasonable foreseeable future. No vegetation treatments are planned for this area currently, or in the reasonable foreseeable future. Community development in the area is likely to increase in the future. This increase has not been quantified; however, it is expected to be deminimis based on the surrounding community development.

5.6 Cumulative Effects of the Proposed Action on Noxious Weeds

Current noxious weed data for these watersheds are limited by land ownership and personnel availability. Efforts for further collect data are continuously being made as well as treatment efforts. Table 29 provides current information on noxious weed infestations within the five watersheds. Data is not complete and there are likely un-mapped infestations within the Proposed Action APE.

Table 29. Current information on noxious weed infestations.

Watershed (HUC10)	Total Watershed Acres	Identified Infestations (acres)
Blanco Canyon	169,907.08	71
Canada Alemita-Chaco Wash	212,349.52	23.9
Headwaters Canon Largo	181,117.45	0
Escavada Wash	147,282.25	43
Outlet Canon Largo	235,499.03	79.8

Livestock grazing and level of intensity may impact the establishment and spread of noxious weeds in the analysis area. Livestock grazing is closely managed by both land owners and land management agencies. Livestock grazing is expected to continue at the same rate and in the same

manner as it currently occurs. As such, impacts would be similar to those currently experienced and would not likely increase beyond the current state.

Vegetation manipulation and management activities, such as sagebrush clearing and prescribed fires, impact vegetation and are often implemented by land managers. These activities are likely to occur at varying levels in the analysis area in the future, however it is not possible to predict when and to what extent with any certainty.

Within the five watersheds (945,636 acres), 4,540 oil and gas wells currently exist. These wells have resulted in 3,405 acres of long-term surface disturbance, or 0.005 percent of total surface area. Based on the RFD (Engler, et al., 2014), oil and gas development in the five watersheds may result a total of 10,393.26 acres of potential new surface disturbance in which 8,201.76 acres is considered short-term disturbance and 2,191.5 acres long-term disturbance. This disturbance would have the same impacts as described for direct and indirect impacts.

Noxious and invasive weeds thrive when any action is surface disturbing. Reclamation aids in competing against noxious and invasive weeds, but even short-term disturbance can create an environment that allows noxious and invasive weeds to gain presence in areas they previously did not exist. Past and present disturbance actions have contributed to 217.7 acres of identified noxious and invasive species in the five watersheds. The development that potentially would occur associated with the Proposed Action Alternative would contribute approximately 39.74 acres of short-term disturbance and nine acres of long-term disturbance. Site specific and watershed specific impacts would be analyzed when an APD is received.

5.7 Cumulative Effects of the Proposed Action on Lands and Realty

There are several existing ROWs in the APE and the surrounding lands. New ROWs would be similar in nature to the existing ROWs, be analyzed individually during the NEPA process for a specific project, and would not cumulatively impact the management of Lands and Realty resources.

6.0 CONSULTATION/COORDINATION

This section includes individuals or organizations from the public, external agencies, and the interdisciplinary team (Table 30) contacted during the development of this document.

Table 30. List of Preparers.

ID Team Member	Title	Organization
Jim Copeland	Archaeologist	BLM-FFO
John Kendall	Threatened and Endangered Species Biologist	BLM-FFO
Sarah Scott	Realty Supervisor	BLM-FFO
Dave Mankiewicz	Assistant Field Manager, Minerals	BLM-FFO
Shane Trautner	Range Management Specialist	BLM-FFO
Mark Ames	Project Manager	BLM-FFO
Doug McKim	Outdoor Recreation Planner	BLM-FFO
Neil Perry	Wildlife Biologist	BLM-FFO
Marcella Martinez	Planning and Environmental Specialist	BLM-FFO
Jeff Tafoya	Supervisor, Range and Multiple Resource	BLM-FFO
Heather Perry	Natural Resource Specialist (Weeds)	BLM-FFO
Sherrie Landon	Paleontologist	BLM-FFO
Maureen Joe	Assistant Field Manager, Resources	BLM-FFO
Craig Willems	Environmental Protection Specialist	BLM-FFO
Craig Townsend	Riparian	BLM-FFO
Joe Hewitt	Geologist	BLM-FFO
Troy Salyers	Petroleum Engineer	BLM-FFO
Scott Hall	Realty Specialist	BLM-FFO
Tony Gallegos	Mining Engineer	BLM-FFO
Ross Klein	Natural Resource Specialist	BLM-NMSO
David Herrell	Soil, Water, Air Specialist	BLM-NMSO
Molly Cobbs	Planning and Environmental Coordinator	BLM-NMSO
James Glover	Geologist	BLM-NMSO
Leonard Herr	Air Resource Specialist	BLM-UTSO

Agencies

- Michael Davis, US Forest Service, Carson National Forest
- New Mexico State Historic Preservation Officer, State of New Mexico, Department of Cultural Affairs - Historic Preservation Division
- Bureau of Indian Affairs – Navajo Region

Tribes

- Navajo Nation Historic Preservation Office
- Navajo Chapters: Nageezi, Counselor, Torreon
- 10 Southern Pueblos Governors Council
- Pueblo of Santa Ana

6.1 Public Involvement

The parcels and applicable stipulations were initially posted online for a two-week public scoping period starting on June 7, 2016. A 30-day public review and comment period started on August 4, 2016. Several unique comments were received, and were addressed throughout the EA analysis. Many electronic form comments were submitted during, and outside of, the 30-day public review period; these lacked new information not already considered within the analysis.

In addition, the following consultation and outreach meetings were held with Chapter House residents to discuss concerns about the impacts of further development:

1. June 15, 2016 at Ojo Encino for the chapters of Ojo Encino, Torreon, and Counselor;
2. September 28, 2016, at Counselor for the chapters of Ojo Encino, Torreon, and Counselor;
3. October 4, 2016, at the Nageezi chapter.

The Chapter House residents expressed concerns about increased traffic, road conditions, safety, flaring, venting, and the protection of cultural sites.

7.0 REFERENCES

Boden, T. A., Marland, G., and Andres, R. J.Global, regional, and national fossil-fuel CO2 emissions. U.S. Department of Energy. Oak Ridge, TN: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory. doi:10.3334/CDIAC/00001_V2013.

Birnbaum, Charles A. 1994. Preservation Brief 36. Protecting Cultural Landscapes: Planning, Treatment and Management of Historic Landscapes. U.S. Department of the Interior. National Park Service.

Birnbaum, Charles A. and Christine Capelle Peters. 1996. Guidelines for the Treatment of Cultural Landscapes. U.S. Department of the Interior. National Park Service.

Brugge, David M. 1986. Tsegai: An Archaeological Ethnohistory of the Chaco Region. U.S. Department of the Interior.

Brugge, David M. 1993. An Investigation of AIRFA Concerns Relating to the Fruitland Coal Gas Development Area. Office of Contract Archaeology, University of New Mexico. Ms. on file, Bureau of Land Management, Farmington, New Mexico.

CCSP, 2008: *Climate Models: An Assessment of Strengths and Limitations*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research [Bader D.C., C. Covey, W.J. Gutowski Jr., I.M. Held, K.E. Kunkel, R.L. Miller, R.T. Tokmakian and M.H. Zhang (Authors)]. Department of Energy, Office of Biological and Environmental Research, Washington, D.C., USA, 124 pp.

Clement, Dorene. 1999. General Guidelines for Identifying and Evaluating Historic Landscapes. Environmental Program, California Department of Transportation, Sacramento.

Condie, Carol J. and Ruthan Knudson (editors). 1982. The Cultural Resources of the Proposed New Mexico Generating Station Study Area, San Juan Basin, New Mexico. Quivira Research Center Publication 39. Albuquerque.

Copeland, James M. 2015. Ranches, Springs, and Old Stone Towers: The General Land Office Surveys In and Near Dinétah. In, The Multifaceted Forester, Papers in Honor of John S. Hayden. Papers of the Archaeological Society of New Mexico 41:57-67.

Council on Environmental Quality. 1997. Environmental Justice Guidance under the National 1281 Environmental Policy Act. December 10, 1997.

de la Torre, Marta, Margaret G. H. MacLean, and David Myers. 2003. Chaco Culture National Historical Park, U.S. National Park Service: A Case Study. The Getty Conservation Institute. Los Angeles, CA.

Enquist, Carolyn and Gori, Dave. Implications of Recent Climate Change on Conservation Priorities in New Mexico. April 2008.

Fransted, Dennis. 1979. An Introduction to the Navajo Oral History of Anasazi Sites in the San Juan Basin Area. Unpublished manuscript, Navajo Aging Services, Fort Defiance, Arizona.

Fransted, Dennis and Oswald Werner. 1975. Ethnogeography of the Chaco Canyon Navajo. Unpublished manuscript, Northwestern University. On file at Division of Chaco Research, Albuquerque.

Freimund, Wayne and Douglas Dalenberg. Chaco Culture National Historical Park: 2009 Visitor Survey. The University of Montana. January 1, 2010.

Goddard Institute for Space Studies. 2007. Annual Mean Temperature Change for Three Latitude Bands. Datasets and Images. GISS Surface Temperature Analysis, Analysis Graphs and Plots. New York, New York. (Available on the Internet: http://data.giss.nasa.gov/gistemp/graphs/Fig.B.lrg.gif.)

Hebblewhite, M. 2008. A literature review of the effects of energy development on ungulates: implications for central and eastern Montana, Montana Fish, Wildlife and Parks, Miles City, USA.

Holmes, A.L., D.C. Barton, and A. King. 2003. Sagebrush Bird Monitoring Handbook, Version 2.0. Point Reyes Conservation Science: Stinson Beach, CA.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: The Physical Basis (Summary for Policymakers). Cambridge University Press. Cambridge, England and New

York, New York. Available on the Internet: http://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

Intergovernmental Panel on Climate Change (IPCC). Climate Change 2007, Synthesis Report. A Report of the Intergovernmental Panel on Climate Change.

Karl, Thomas L., Jerry M. Melillo, and Thomas C. Peterson, (eds.). Global Climate Change Impacts in the United States, Cambridge University Press, 2009.

Kelly, Klara, Rena Martin, Richard Begay, Ted Neff, and Clifford Werito. 2006. "We Will Help You With What We Know": Diné Traditional Cultural Places In Dinétah. Museum of Northern Arizona Environmental Solutions, Inc, Flagstaff. Ms. on file, Bureau of Land Management, Farmington, New Mexico.

National Academy of Sciences. 2006. Understanding and Responding to Climate Change: Highlights of National Academies Reports. Division on Earth and Life Studies. National Academy of Sciences. Washington, D.C. (Available on the Internet: http://dels.nas.edu/basc/Climate-HIGH.pdf.)

National Aeronautics and Space Administration Goddard Institute for Space Studies. (2007). GISS surface temperature analysis. Retrieved from http://data.giss.nasa.gov/gistemp/2007/.

National Park Service. 1997. How to Apply the National Register Criteria for Evaluation. National Register Bulletin 15. Washington.

National Park Service. 1999. Guidelines for Evaluating and Documenting Rural Historic Landscapes. National Register Bulletin 30. Washington.

Natural Resource Conservation Service. 2013. http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/watersheds/dataset/. Accessed July 30, 2013.

Parker, Patricia L. and Thomas F. King. 1998. Guidelines for Evaluating and Documenting Traditional Cultural Properties. National Park Service, National Register Bulletin 38. Washington.

Petroleum Recovery Research Center. (2015, May 7). All Wells Data. Retrieved May 7, 2015, from Go-Tech: http://octane.nmt.edu/gotech/Petroleum_Data/allwells.aspx

Pursley, Bilek, Ruhl, Earthquake catalogs for New Mexico and bordering areas: 2005-2009. *N.M. Geol.* 35, 3–12 (2013).

Ramanathan, V., Carmichael, G., 2008. Global and regional climate changes due to black carbon. Nat. Geosci. 1 (4), 221e227.

Riley, Terry Z., E. M. Bayne, B. C. Dale, D. E. Naugle, J. A. Rodgers, and S. C. Torbit. 2012 Impacts of crude oil and natural gas developments on wildlife and wildlife habitat in the Rocky Mountain region. The Wildlife Society Technical Review 12-02. The Wildlife Society, Bethesda, Maryland, USA.

Sawyer, H., M. J. Kauffman, and R. M. Nielson. 2009. Influence of well pad activity on winter habitat selection patterns of mule deer. Journal of Wildlife Management 73:1052-1061.

Science Applications International Corporation. 2002. Cultural Resources Technical Report: Background Information on Cultural Resources for the Farmington Draft RMP/EIS. Ms. on file, Bureau of Land Management, Farmington, New Mexico.

UNESCO. 2008. Operational Guidelines for the Implementation of the World Heritage Convention. United Nations Educational, Scientific and Cultural Organization. Paris.

URS Corporation. 2010. Climate change supplementary information report, Montana, North Dakota and South Dakota Bureau of Land Management. Denver Co. Retrieved from http://www.blm.gov/mt/st/en/prog/energy/oil_and_gas/leasing/leasingEAs.html

USA. 1987. Chaco Culture National Historical Park World Heritage List Nomination.

U.S. Census Bureau 2012b. American Community Survey, 2012 American Community Survey 1367 5-Year Estimates, 1368 Tables DP-02, DP-03, DP-04, DP-05; generated by Lauren Zielinski; using American FactFinder; 1369 http://factfinder2.census.gov. Accessed February 17, 2014.

U.S. Census Bureau 2014. US Census Bureau GIS data. Tiger Products. Internet Web Site: 1380 http://www.census.gov/geo/maps-data/data/tiger.html. Accessed on February 2014.

U.S. Department of Energy. (2008, November 26). Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum-Based Fuels. Washington, D.C.: U.S. Department of Energy.

U.S. Department of Energy. (2011). Life Cycle Greenhouse Gas Inventory of Natural Gas Extraction, Delivery and Electricity Production. Washington, D.C.: U.S. Department of Energy.

U.S. Department of Energy/National Energy Technology Laboratory (US DOE, NETL). 2008. Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum Based Fuels. http://www.netl.doe.gov/energy-analyses/pubs/NETL%20LCA%20Petroleum-Based%20Fuels%20Nov%202008.pdf

U.S. Department of Interior Bureau of Land Management. (2016). Air Resources Technical Report for Oil and Gas Development. Santa Fe: Bureau of Land Management, New Mexico State Office.

U.S. Department of the Interior, Bureau of Land Management and U.S. Fish and Wildlife Service (DOI). 2010a. Memorandum of Understanding: To Promote the Conservation of Migratory Birds.

U.S. Department of the Interior, Bureau of Land Management. 2008. Manual 6840: Special Status Species Management.

U.S. Department of the Interior, Bureau of Land Management. 1986. Manual 8410: Visual Resource Inventory.

U.S. Department of the Interior, Bureau of Land Management, Farmington Field Office. 2010b. Instruction Memorandum No. NM-F00-2010-001. Migratory Bird Treaty Act – BLM/FFO Interim Management Policy. February 22, 2010.

U.S. Department of the Interior, Bureau of Land Management, New Mexico State Office. 2011. BLM Sensitive Species List for Farmington Field Office. July/Aug. 2011.

U.S. Department of the Interior, Bureau of Land Management. September 2003a. Farmington Proposed Resource Management Plan and Final Environmental Impact Statement. Farmington, New Mexico.

U.S. Department of the Interior, Bureau of Land Management. September 2003. Farmington Approved Resource Management and Plan Record of Decision. Farmington, New Mexico.

USDI. BLM. 2011. Air Quality Technical Report. New Mexico State Office. http://www.blm.gov/nm/st/en/prog/more/air_resources/air_resources_technical.html.

U.S. Environmental Protection Agency, 2006. EPA Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency, Natural Gas Star Program (2006 data) at: http://www.epa.gov/gasstar/accomplish.htm. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency, 2010. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2008. EPA 430-R-10-006, http://www.epa.gov/climatechange/emissions/usinventoryreport.html.

U.S. Environmental Protection Agency, 2010. FACT SHEET--PROPOSAL TO REVISE THE NATIONAL AMBIENT AIR QUALITY STANDARDS. Retrieved August 9, 2010, from http://www.epa.gov/air/ozonepollution/pdfs/fs20100106std.pdf

U.S. Environmental Protection Agency, 2010a. The Green Book Non Attainment Areas for Criteria Pollutants. http://www.epa.gov/airquality/greenbk/ (Accessed 3/03/2011).

U.S. Environmental Protection Agency, 2010b. Air Trends. http://www.epa.gov/airtrends/ (Accessed 3/14/11).

U.S. Environmental Protection Agency, 2011. Technology Transfer Network: Clearinghouse for Inventories and Emissions Factors. http://www.epa.gov/ttn/chief/eiinformation.html.

U.S. Environmental Protection Agency, 2011a. 2005 National-Scale Air Toxics Assessment. Summary of Results. http://www.epa.gov/ttn/atw/nata2005.

U.S. Environmental Protection Agency, 2011b. 2008 National Emissions Inventory. http://www.epa.gov/ttn/chief/net/2008inventory.html.

U.S. Environmental Protection Agency. (2012). 2005 National-Scale Air Toxics Assessment. Retrieved February 27, 2014, from U.S. Environmental Protection Agency: http://www.epa.gov/ttn/atw/nata2005/

U.S. Environmental Protection Agency. (2013). The Green Book Nonattainment Areas for Criteria Pollutants. Retrieved February 25, 2014, from U.S. Environmental Protection Agency: http://www.epa.gov/airquality/greenbook/

U.S. Environmental Protection Agency. (2014, February 7). Air Trends: Design Values. Retrieved February 25, 2014, from U.S. Environmental Protection Agency: http://www.epa.gov/airtrends/values.html

U.S. Environmental Protection Agency. (2014, February 3). The 2011 National Emissions Inventory. Retrieved February 27, 2014, from U.S. Environmental Protection Agency: http://www.epa.gov/ttn/chief/net/2011inventory.html

U.S. Environmental Protection Agency. (2015). Air Quality Index Report. Retrieved October 2016 from U.S. Environmental Protection Agency: http://www.epa.gov/airdata/ad_rep_aqi.html

U.S. Environmental Protection Agency. (2016). Air Quality Index. Retrieved October 6, 2016, from the U.S. Environmental Protection Agency: https://airnow.gov/index.cfm?action=pubs.index

U.S. Environmental Protection Agency. Retrieved from https://www.epa.gov/ghgemissions/understanding-global-warming-potentialsUnderstanding global warming potentials.

U.S. Environmental Protection Agency. U.S. greenhouse gas inventory report, 1990-2014. Retrieved from https://www.epa.gov/sites/production/files/2016-04/documents/us-ghg-inventory-2016-main-text.pdf.

U.S. Environmental Protection Agency, February 2, 2016, Greenhouse Gas Equivalencies Calculator. https://www.epa.gov/energy/ghg-equivalencies-calculator-calculations-andreferences,

U.S. Environmental Protection Agency (EPA) Inventory of U.S. Greenhouse Gas Emissions and Sinks.

USGS. 2013. http://water.usgs.gov/GIS/huc.html. Accessed July 30, 2013.

Van Dyke, Ruth M. 2007. The Chaco Experience: Landscape and Ideology at the Center Place. School for Advanced Research, Santa Fe.

Van Valkenburgh, Richard F. 1941. Diné Bikeyah. Department of the Interior, Office of Indian Affairs, Navajo Services, Window Rock. Ms. on file, Bureau of Land Management, Farmington, New Mexico.

Van Valkenburgh, Richard F. 1974. Navajo Sacred Places. Edited by Clyde Kluckhohn. Garland American Indian Ethnohistory Series, Navajo Indians, 3 Vols. Garland Publishing. New York.

York, Frederick F., Joseph C. Winter. 1988. Report of an Ethnographic Study and Archaeological Review of Proposed Coal Lease Tracts In Northwestern New Mexico. Office of Contract Archaeology, University of New Mexico

Zvelebil, Marek, Stanton W. Green, Mark G. Macklin. 1998. Archaeological Landscapes, Lithic Scatters, and Human Behavior. In, Space, Time, and Archaeological Landscapes, edited by Jacqueline Rossignol and LuAnn Wandsnider, pp. 193-226. Plenum Press, New York.

For a map of the four proposed parcels see the following website:

http://www.blm.gov/pgdata/etc/medialib/blm/nm/programs/0/og_sale_notices_and/2017/january_2017.Par.96743.File.dat/NM_OG_DRAFT_Sale_Parcels_January_2017.pdf

Appendix 1: Phases of Oil and Gas Development

Construction Activities

Clearing of the proposed well pad and access road would be limited to the smallest area possible to provide safe and efficient work areas for all phases of construction. First all new construction areas need to be cleared of all vegetation. All clearing activities are typically accomplished by cutting, mowing and/or grading vegetation as necessary. Cut vegetation may be mulched and spread on site or hauled to a commercial waste disposal facility.

Next, heavy equipment including but not limited to bulldozers, graders, front-end loaders, and/or track hoes are used to construct at a minimum the pad, but other features, as needed for development, may include, but is not limited to an access road, reserve pit, pipeline, and/or fracturing pond. Cut and fills may be required to level the pad or road surfaces. If a reserve pit is authorized, it would be lined using an impermeable liner or other lining mechanism (i.e. bentonite or clay) to prevent fluids from leeching into the soil. Access roads may have cattle guards, gates, drainage control, or pull-outs installed, among a host of other features that may be necessary based on the site specific situation. Long-term surfaces are typically dressed with a layer of crushed rock or soil cemented. Construction materials come from a variety of sources. Areas not needed for long-term development (i.e. portions of the pipeline or road right-of-way) are reclaimed by recontouring the surface and establishing vegetation.

If a pipeline is needed, the right-of-way would be cleared of all vegetation. The pipeline would be laid out within the cleared section. A backhoe, or similar piece of equipment, would dig a trench at least 36 inches below the surface. After the trench is dug, the pipes would be assembled by welding pieces of pipe together and bending them slightly, if necessary, to fit the contour of the pipeline's path. Once inspected, the pipe can be lowered into the trench and covered with stockpiled subsoil that was originally removed from the hole. Each pipeline undergoes hydrostatic testing prior to natural gas being pumped through the pipeline. This ensures the pipeline is strong enough and absent of any leaks.

Drilling Operations

When the pad is complete, the drilling rig and associated equipment would be moved onsite and erected. A conventional rotary drill rig with capability matched to the depth requirements of the proposed well(s) would be used. The well could be drilled as a vertical or horizontal well to target the desired formation. The depth of the well is entirely dependent on the target formation depth and could be several hundred feet vertical depth to over 20,000 feet vertical depth.

When a conventional reserve pit system is proposed, drilling fluid or mud is circulated through the drill pipe to the bottom of the hole, through the bit, up the bore of the well, and finally to the surface. When mud emerges from the hole, it enters into the reserve pit where it would remain until all fluids are evaporated and the solids can be buried.

A closed-loop system, operates in a similar fashion except that when the mud emerges from the hole, it passes through a series of equipment used to screen and remove drill cuttings (rock chips) and sand-sized solids rather than going into the pit. When the solids have been removed, the mud would be placed into holding tanks, and from the tank, used again.

In either situation the mud is maintained at a specific weight and viscosity to cool the bit, seal off any porous zones (thereby protecting aquifers or preventing damage to producing zone productivity), control subsurface pressure, lubricate the drill string, clean the bottom of the hole, and bring the drill cuttings to

the surface. Water-based or oil-based muds can be used and is entirely dependent on the site-specific conditions.

Completion Operations

Once a well has been drilled, completion operations would begin once crews and equipment are available. Well completion involves setting casing to depth and perforating the casing in target zones.

Wells are often treated during completion to improve the recovery of hydrocarbons by increasing the rate and volume of hydrocarbons moving from the natural oil and gas reservoir into the wellbore. These processes are known as well-stimulation treatments, which create new fluid passageways in the producing formation or remove blockages within existing passageways. They include fracturing, acidizing, and other mechanical and chemical treatments often used in combination. The results from different treatments are additive and complement each other.

Hydraulic Fracturing
Hydraulic fracturing (HF) is one technological key to economic recovery of oil and gas that might have been left by conventional oil and gas drilling and pumping technology. It is a formation stimulation practice used to create additional permeability in a producing formation, thus allowing gas to flow more readily toward the wellbore. Hydraulic fracturing can be used to overcome natural barriers, such as naturally low permeability or reduced permeability resulting from near wellbore damage, to the flow of fluids (gas or water) to the wellbore (GWPC 2009). The process is not new and has been a method for additional oil and gas recovery since the early 1900s; however, with the advancement of technology it is more commonly used.

Hydraulic fracturing is a process that uses high pressure pumps to pump fracturing fluid into a formation at a calculated, predetermined rate and pressure to generate fractures or cracks in the target formation. For shale development, fracture fluids are primarily water-based fluids mixed with additives which help the water to carry proppants into the fractures, which may be made up of sand, walnut hulls, or other small particles of materials. The proppant is needed to “prop” open the fractures once the pumping of fluids has stopped. Once the fracture has initiated, additional fluids are pumped into the wellbore to continue the development of the fracture and to carry the proppant deeper into the formation. The additional fluids are needed to maintain the downhole pressure necessary to accommodate the increasing length of opened fracture in the formation.

Hydraulic fracturing of horizontal shale gas wells is performed in stages. Lateral lengths in horizontal wells for development may range from 1,000 feet to more than 5,000 feet. Depending on the lengths of the laterals, treatment of wells may be performed by isolating smaller portions of the lateral. The fracturing of each portion of the lateral wellbore is called a stage. Stages are fractured sequentially beginning with the section at the farthest end of the wellbore, moving uphole as each stage of the treatment is completed until the entire lateral well has been stimulated.

This process increases the flow rate and volume of reservoir fluids that move from the producing formation into the wellbore. The fracturing fluid is typically more than 99 percent water and sand, with small amounts of readily available chemical additives used to control the chemical and mechanical properties of the water and sand mixture (see discussion about Hazardous and Solid Wastes below). Because the fluid is composed mostly of water, large volumes of water are usually needed to perform hydraulic fracturing. However, in some cases, water is recycled or produced water is used.

Before operators or service companies perform a hydraulic fracturing treatment, a series of tests is performed. These tests are designed to ensure that the well, casing, well equipment, and fracturing

equipment are in proper working order and will safely withstand the application of the fracture treatment pressures and pump flow rates.

To ensure that hydraulic fracturing is conducted in a safe and environmentally sound manner, the BLM approves and regulates all drilling and completion operations, and related surface disturbance on Federal public lands. Operators must submit Applications for Permit to Drill (APDs) to the agency. Prior to approving an APD, a BLM Field Office geologist identifies all potential subsurface formations that would be penetrated by the wellbore. This includes all groundwater aquifers and any zones that would present potential safety or health risks that may need special protection measures during drilling, or that may require specific protective well construction measures.

Once the geologic analysis is completed, the BLM reviews the company's proposed casing and cementing programs to ensure the well construction design is adequate to protect the surface and subsurface environment, including the potential risks identified by the geologist and all known or anticipated zones with potential risks.

During drilling, the BLM is on location during the casing and cementing of the ground water protective surface casing and other critical casing and cementing intervals. Before hydraulic fracturing takes place, all surface casing and some deeper, intermediate zones are required to be cemented from the bottom of the cased hole to the surface. The cemented well is pressure tested to ensure there are no leaks and a cement bond log is run to ensure the cement has bonded to the casing and the formation. If the fracturing of the well is considered to be a "non-routine" fracture for the area, the BLM would always be onsite during those operations as well as when abnormal conditions develop during the drilling or completion of a well.

Production Operations

Production equipment used during the life of the well may include a three-phase separator-dehydrator; flow-lines; a meter run; tanks for condensate, produced oil, and water; and heater treater. A pump jack may be required if the back pressure of the well is too high. Production facilities are arranged to facilitate safety and maximize reclamation opportunities. All permanent above-ground structures not subject to safety considerations are painted a standard BLM or company color or as landowner specified.

Workovers may be performed multiple times over the life of the well. Because gas production usually declines over the years, operators perform workover operations which involve cleaning, repairing and maintaining the well for the purposes of increasing or restoring production.

Hazardous or Solid Wastes Associated with Oil and Gas Development

Anticipated use or produced hazardous materials during the development may come from drilling materials; cementing and plugging materials; HF materials; production products (natural gas, condensates, produced water); fuels and lubricants; pipeline materials; combustion emissions; and miscellaneous materials. Appendix 1, Table 1 includes some of the common wastes (hazardous and non-hazardous) that are produced during oil and gas development.

Appendix 1, Table 1. Common wastes produced during oil and gas development.

Phase	Waste
Construction	• Domestic wastes (i.e. food scraps, paper, etc.) • Excess construction materials • Used lubricating oils • Solvents • Woody debris • Paints • Sewage
Drilling	• Drilling muds, including additives (i.e. chromate and barite) and cuttings • Well drilling, completion, workover, and stimulation fluids (i.e. oil derivatives such as polycyclic aromatic hydrocarbons (PAHs), spilled chemicals, suspended and dissolved solids, phenols, cadmium, chromium, copper, lead, mercury, nickel) • Equipment, power unit and transport maintenance wastes (i.e. batteries; used filters, lubricants, oil, tires, hoses, hydraulic fluids; paints; solvents) • Fuel and chemical storage drums and containers • Cementing wastes • Production testing wastes • Excess construction materials • Scrap metal • Sewage • Rigwash • Excess drilling chemicals • Processed water • Contaminated soil • Domestic wastes
HF	See below
Production	• Power unit and transport maintenance wastes (i.e. batteries; used filters, lubricants, filters, tires, hoses, coolants, antifreeze; paints; solvents, used parts) • Discharged produced water • Production chemicals • Workover wastes (e.g. brines) • Tank or pit bottoms • Contaminated soil • Scrap metal
Abandonment/Reclamation	• Construction materials • Decommissioned equipment • Contaminated soil • Insulating materials • Sludge

Hydraulic Fracturing

Chemicals serve many functions in hydraulic fracturing, from limiting the growth of bacteria to preventing corrosion of the well casing. Chemicals are needed to insure the hydraulic fracturing job is effective and efficient. The fracturing fluids used for shale stimulations consist primarily of water but also include a variety of additives. The number of chemical additives used in a typical fracture treatment varies depending on the conditions of the specific well being fractured. A typical fracture treatment will use very low concentrations of between three and 12 additive chemicals depending on the characteristics of the water and the shale formation being fractured. Each component serves a specific, engineered purpose. The predominant fluids currently being use for fracture treatments in the shale gas plays are water-based fracturing fluids mixed with friction-reducing additives, also known as slickwater (GWPC 2009).

Figure 1. Typical Chemical Additives Used In Fracturing Fluids

Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring

The make-up of fracturing fluid varies from one geologic basin or formation to another. Because the make-up of each fracturing fluid varies to meet the specific needs of each area, there is no one-size-fits-all formula for the volumes for each additive. In classifying fracture fluids and their additives it is important to realize that service companies that provide these additives have developed a number of compounds with similar functional properties to be used for the same purpose in different well environments. The difference between additive formulations may be as small as a change in concentration of a specific compound (GWPC 2009).

Typically, the fracturing fluids consist of about 99 percent water and sand and about 1 percent chemical additives. The chemical additives are essential to the process of releasing gas trapped in shale rock and other deep underground formation.

NORM

Some soils and geologic formations contain low levels of radioactive material. This naturally occurring radioactive material (NORM) emits low levels of radiation, to which everyone is exposed on a daily basis. When NORM is associated with oil and natural gas production, it begins as small amounts of uranium and thorium within the rock. These elements, along with some of their decay elements, notably radium$_{226}$ and radium$_{228}$, can be brought to the surface in drill cuttings and produced water. Radon$_{222}$, a gaseous decay element of radium, can come to the surface along with the shale gas. When NORM is brought to the surface, it remains in the rock pieces of the drill cuttings, remains in solution with produced water, or, under certain conditions, precipitates out in scales or sludges. The radiation is weak and cannot penetrate dense materials such as the steel used in pipes and tanks.

Appendix 2: Farmington Field Office Lease Stipulation Summary

Stipulation	Description/Purpose
NM-10-LN	**LEASE NOTICE- DRAINAGE** All or part of the lands contained in this lease is subject to drainage by well(s) located adjacent to this lease. The lessee shall be required within 60 days of lease issuance to submit to the authorized officer plans for protecting the lease from drainage. Compensatory royalty will be assessed effective the expiration of this 60-day period if no plan is submitted. The plan must include either an Application for Permit to Drill (APD) a protective well, or an application to communitize the lease so that it is allocated production from a protective well off the lease. Either of these options may include obtaining a variance to State spacing for the area. In lieu of this plan, the lessee shall be required to demonstrate that a protective well would have little or no chance of encountering oil and gas in quantities sufficient to pay in excess the costs of drilling and operating the well. In the absence of either an acceptable plan for protecting the lease from drainage or an acceptable justification why a protective well would be uneconomical, the lessee shall be obligated to pay compensatory royalty to the Office of Natural Resources Revenue at a rate to be determined by the authorized officer.
NM-11- LN	**LEASE NOTICE – CULTURAL RESOURCES** All development activities proposed under the authority of this lease are subject to compliance with Section 106 of the NHPA and Executive Order 13007. The lease area may contain historic properties, traditional cultural properties (TCP's), and/or sacred sites currently unknown to the BLM that were not identified in the Resource Management Plan or during the lease parcel review process. Depending on the nature of the lease developments being proposed and the cultural resources potentially affected, compliance with Section 106 of the National Historic Preservation Act and Executive Order 13007 could require intensive cultural resource inventories, Native American consultation, and mitigation measures to avoid adverse effects—the costs for which will be borne by the lessee. The BLM may require modifications to or disapprove proposed activities that are likely to adversely affect TCP's or sacred sites for which no mitigation measures are possible. This could result in extended time frames for processing authorizations for development activities, as well as changes in the ways in which developments are implemented.
F-9-CSU Paleo	**CONTROLLED SURFACE USE STIPULATION** **PALEONTOLOGY** Surface occupancy or use is subject to the following special operating constraints: Restrict vehicles to existing roads and trails and require a paleontological clearance on surface disturbing activities.
F-15-POD	**PLAN OF DEVELOPMENT (POD) STIPULATION** A plan of development (POD) for the entire lease must be submitted for review and approval, including NEPA analysis, by the Bureau of Land Management (BLM) authorized officer, prior to approval of development (APD, Sundry Notices) actions. The POD must indicate planned access to well facilities (roads,

	pipelines, power lines), and the approximate location of well sites. Should it become necessary to amend the POD, the amendment must be approved prior to the approval of subsequent development action. Deviations from a current POD are not authorized until an amended POD has been approved by BLM.
F-41-LN	**LEASE NOTICE - BIOLOGICAL SURVEY** A biological survey may be required prior to any surface disturbing activity on BLM managed lands. Proposed activities may be subject to seasonal closures within sensitive species habitat. Federal land management agencies are mandated to manage special status species so they should not need to be listed under Endangered Species Act (ESA) in the future.
F-44-NSO	**NO SURFACE OCCUPANCY-COMMUNITY & RESIDENCE** No surface occupancy is allowed within 660 feet of any occupied residences of a community to reduce impacts to the community of drilling and production activities. This stipulation may be waived, excepted, or modified by BLM, if such action is consistent with the Resource Management Plan.
WO-ESA-7	**ENDANGERED SPECIES ACT-** **SECTION 7 CONSULTATION STIPULATION** The lease area may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or other special status species. BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activity that will contribute to a need to list such a species or their habitat. BLM may require modifications to or disapprove proposed activity that is likely to result in jeopardy to the continued existence of a proposed or listed threatened or endangered species or result in the destruction or adverse modification of a designated or proposed critical habitat. BLM will not approve any ground-disturbing activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 U.S.C. § 1531 et seq., including completion of any required procedure for conference or consultation.

F-47-CSU: CONTROLLED SURFACE USE STIPULATION - AIR DISPERSION MODELING

Due to the close proximity of occupied dwellings to potential well sites on the lease parcel, information about the air quality impacts at the dwellings must be determined and disclosed as part of the NEPA analysis. In order to determine the impacts, the lessee will be responsible for conducting air dispersion modeling for all wells proposed and within one mile of occupied dwellings prior to BLM making a decision on any proposed wells and associated operations and infrastructure. The BLM will determine the near-field air impacts based on air dispersion modeling that conforms to EPA New Mexico Environment Department guidelines. Based on modeling results, the BLM may have mitigation requirements, with a potential for moving the proposed well and associated operations and infrastructure away from the occupied dwelling(s). A Plan of Development (POD) will be required.

Air dispersion modeling in accordance with EPA and state modeling guidelines can be used to determine “near-field” impacts. This modeling could not be completed at the time of the Resource Management Plan because it requires very specific information about how leases are developed and the locations of development. At the time of the lease sale, there is still not enough information available about how the lease will be developed to accurately determine the near-field air quality impacts. Exact locations and equipment specifications are known at the time of the Application for Permit (APD) to Drill, so the NEPA analysis associated with the APD must contain the disclosure of the near-field air impacts from the development of these leases.

For the purpose of:

1. fulfilling the objective of the Farmington Resource Management Plan (2003) to “ensure that mineral development is carried out in a manner that minimizes environmental damage and provides for the rehabilitation of affected lands”;

2. comply with the requirements of the Federal Land Policy and Management Act of 1976, 43 U.S.C. 1701-1785 to “provide for compliance with applicable pollution control laws, including State and Federal air, water, noise or other pollution standards”;

3. ensuring that federal agency activities and actions comply with all applicable air quality laws, regulations, standards and implementation plans, per the 1990 Clean Air Act Amendments Section 118; and

4. to promote efforts which will prevent damage to the environment and promote human health and welfare (NEPA Section 2). Any changes to this stipulation, will be made in accordance with the land use plan and/or regulatory provisions for such changes.

BIA-1 - THE NAVAJO NATION STIPULATIONS

1. The surface ownership of lands contained in this lease may be all or partly managed by the Navajo Tribe. Site specific rights-of-way clearances and/or inventories may be required prior to entry upon the surface for operation of the lease holdings. Prior contact with the Navajo Nation will be required prior to operations beginning. All applicable laws of the Navajo Nation (including tax laws, water codes, requirements of Environmental Protection Administration, etc.) shall be complied with by the lessee.

2. The Navajo Nation requires a copy of complete exploration and development data (drilling logs, seismic data, etc.) obtained by the lessee on the subject lands will be provided to the Navajo Nation at no cost. All materials data will be held confidential as described in 43 CFR 3162.8.

3. Navajo grazing rights to the surface of the lands so leased shall be protected, and the Nation's rights respecting the use of water shall be unimpaired.

4. Lessee shall not obtain water for use in drilling from Indian-owned wells, tanks, springs, or stockwater reservoirs without prior written permission from the Navajo Nation. Lessee shall not drill any water wells for its use without prior written consent of the Navajo Nation and the Area Director.

5. Lessee shall compensate the Navajo Nation and its grazing permittees (if any), for all surface use(s) as well as damages to crops, buildings, and other improvements of surface landowner, including loss of grazing lands, occasioned by the lessee's operations except the Lessee's control. Compensation for surface use shall be negotiated by Lessee and the Navajo Nation and will be based upon the duration of activity on the land.

6. Lessee shall not drill any well within 500 feet of any house, structure, or reservoir of water without the Navajo Nation's written consent.

7. Lessee shall bury all pipelines crossing tillable lands below plow depth unless other arrangements are made with the Navajo Nation.

8. Upon the request of the Navajo Nation or if so required by the Area Director or his authorized representative, and under the direction of the Field Manager, Bureau of Land Management, the Lessee shall condition any well drilled which does not produce oil or gas in paying quantities, but which is capable of producing water satisfactorily for domestic, agricultural, or livestock use by the Navajo Nation. Otherwise, after the expiration or termination of the lease, the Lessee shall remove all pumping equipment installed by Lessee at any well.

BIA-3 - NAVAJO AREA, BUREAU OF INDIAN AFFAIRS SURFACE MANAGEMENT AGENCY LEASE STIPULATIONS FOR FEDERAL OIL AND GAS LEASE OFFERING

The pipeline will be so installed that it will not interfere with the construction and/ or development of the area for agricultural purposes and/ or operation of same in connection with the Navajo Indian Irrigation Project. Any changes or relocations found to be necessary during said construction and/ or development will be accomplished at the Company's expense.

In addition, the pipeline will be buried to a depth of 48 inches and any permanent metering and production equipment installed at the actual site will conform to "no well and/or production equipment within irrigable fields of the Navajo Indian Irrigation Project will exceed two feet above natural surface elevation and be adequately barricaded for safety." Further, if crops are planted prior to accomplishment of the pipeline work, surface damages must be negotiated with Navajo Agricultural Products Industry.

BIA-5 - NAVAJO AREA, BUREAU OF INDIAN AFFAIRS SURFACE MANAGEMENT AGENCY – NO SURFACE OCCUPANCY OR USE

All or a portion of the lease contains dwellings or structures occupied by one or more persons. No Surface Occupancy or use is allowed on the portion of the lease described. These restricted lands may be developed by directional drilling from outside the restricted area. This No Surface

Occupancy or use restriction may be waived if written consent of such waiver is received from the Navajo Nation with concurrence from the Navajo Regional Director. This stipulation was added for the purpose of lessening the impacts caused by mineral resource development on a place of residence and the occupants within.