U.S. Department of the Interior
Bureau of Land Management

Carlsbad Field Office November 2019 Oil and Gas Lease Sale EA: DOI-BLM-NM-P020-2019-0797-EA

Location:
Eddy and Lea Counties, New Mexico

U.S. Department of the Interior
Bureau of Land Management

Carlsbad Field Office
620 East Greene
Carlsbad, New Mexico 88220

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APPENDICES

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LIST OF ACRONYMS AND ABBREVIATIONS

APD	Application for Permit to Drill
AQI	Air Quality Index
AQRV	Air Quality Related Value
ARTSD	Air Resources Technical Support Document
bbl	barrel(s)
BLM	Bureau of Land Management
CCNP	Carlsbad Caverns National Park
CEQ	Council on Environmental Quality
CFO	Carlsbad Field Office
CFR	Code of Federal Regulations
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	CO_2 equivalent
COA	condition of approval
DAT	N DAT threshold
DSL	dunes sagebrush lizard
EA	Environmental Assessment
EIS	Environmental Impact Statement
EOI	Expression of Interest
EPA	U.S. Environmental Protection Agency
EUR	estimated ultimate recovery
FLAG	Federal Land Managers' Air Quality Related Values Work Group
FLPMA	Federal Land Policy and Management Act of 1976
GHG	greenhouse gas
GIS	geographic information system
GUMO	Guadalupe Mountains National Park
HAP	hazardous air pollutant

IMPROVE	Interagency Monitoring for Protected Visual Environments
IPaC	Information for Planning and Consultation
kg/ha/yr	kilogram per hectare per year
LPC	lesser prairie-chicken
MLA	Mineral Leasing Act of 1920
N_2O	nitrous oxide
NAAQS	National Ambient Air Quality Standards
NATA	National Air Toxics Assessment
NEPA	National Environmental Policy Act of 1969
NHPA	National Historic Preservation Act of 1966
NMAAQS	New Mexico Ambient Air Quality Standards
NMOCD	New Mexico Oil Conservation Division
NMOSE	New Mexico Office of the State Engineer
NO_2	nitrogen dioxide
NO_x	nitrogen oxide(s)
NPS	National Park Service
NRHP	National Register of Historic Places
O_3	ozone
ONGARD	Oil and Natural Gas Administration and Revenue Database
PA	Programmatic Agreement
Pb	lead
PFYC	Potential Fossil Yield Classification
PL	Public Law
$PM_{2.5}$	particulate matter equal to or less than 2.5 microns in diameter
PM_{10}	particulate matter equal to or less than 10 microns in diameter
ppb	parts per billion
ppm	parts per million
PSD	Prevention of Significant Degradation
RFD	Reasonable Foreseeable Development Scenario for the BLM New Mexico Pecos District

RFFA	reasonably foreseeable future action
RMP	Resource Management Plan
RMPA	Resource Management Plan Amendment
ROW	right-of-way
SHPO	State Historic Preservation Office
SO_2	sulfur dioxide
SVR	standard visual range
SWReGAP	Southwest Regional Gap Analysis Project
T&E	threatened and endangered
TCP	traditional cultural property
TXHS	Texas hornshell mussel
USC	United States Code
USEIA	U.S. Energy Information Administration
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

CHAPTER 1. INTRODUCTION

1.1. Background

This Environmental Assessment (EA) documents the Bureau of Land Management's (BLM) Carlsbad Field Office (CFO) review of (10) parcels (3,415.52 acres) nominated for auction in the CFO November 7, 2019, Competitive Oil and Gas Lease Sale. Of these ten parcels, seven (7) include surface managed by BLM (2,574.44 acres), and three (3) are on private surface (841.19 acres). All parcels contain Federal minerals. For detailed information on the Leasing Process see the following website: https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/leasing/parcel-nominations.

1.2. Purpose and Need

The BLM's purpose is to respond to Expressions of Interest (EOIs) to lease Federal oil and gas resources through a competitive leasing process. The need for the action is established by the BLM's responsibility under the Mineral Leasing Act of 1920 (MLA), as amended, to promote the exploration and development of oil and gas on the public domain.

1.3. Decision to Be Made

The BLM Authorized Officer will decide whether or not to lease the nominated lease parcels with constraints, in the form of lease stipulations, as provided for in the approved land use plans (LUPs). If the decision is to lease, standard terms and conditions under Section 6 of the BLM Lease Form (Form 3100-11, Offer to Lease and Lease for Oil and Gas), herein referred to as standard terms and conditions, would apply. The BLM Authorized Officer also has the authority to selectively lease, or to defer parcels, in the light of the analysis of potential impacts presented in this EA. The decision record will identify if the BLM has selected all parcels under consideration for lease or has selected only certain parcels to lease. The decision record will also provide rationale for the decision.

1.4. Conformance with BLM Land Use Plans, Other Statutes, Regulations, and Plans

It is the policy of the BLM as derived from various laws, including the MLA and the Federal Land Policy and Management Act of 1976 (FLPMA), as amended, to promote the exploration and development of oil and gas on the public domain. Additionally, the Federal Onshore Oil and Gas Leasing Reform Act (FOOGLRA) of 1987 states that lease sales shall be held for each State where eligible lands are available at least quarterly and more frequently if the Secretary of the Interior determines such sales are necessary.

Under FLPMA, the BLM must manage for multiple uses of public lands in a combination that will best meet the present and future needs of the public and their various resources based on an approved Land Use Plan or Resource Management Plan (RMP). For split-estate lands where the mineral estate is an interest owned by the United States, 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 Resource Management Plan (RMP), including identification of all appropriate lease stipulations (43 Code of Federal Regulations [CFR] 3101.1 and 43 CFR 1601.0-7(b); BLM Manual Handbook 1601.09 and 1624-1). Specifically, this Proposed Action aligns with the following RMPs:

- Carlsbad Approved RMP (BLM 1988), as amended (BLM 1997, BLM 2008) and
- Roswell Approved RMP and Record of Decision (BLM 1997), as amended (BLM 2008).

All nominated lease parcels fall within areas that are open to leasing under the RMPs indicated above, as amended. All nominated lease parcels are also subject to certain Controlled Surface Use (CSU) stipulations on a lease parcel specific basis. Lease parcels, lease parcel surface ownership, lease parcel

legal descriptions and total acreage, and lease stipulations and notices that apply are detailed in Appendix A.

1.4.1. Relationship to Statutes, Regulations, and Other Plans

Purchasers of oil and gas lease parcels are required to comply with all applicable Federal, State, and local laws and regulations, including obtaining all necessary permits prior to any lease development activities. Ten (10) parcels were nominated. A listing of applicable statutes, regulations, and other plans is provided in Table 1.1.

Table 1.1. Relationship to Statutes, Regulations, and Other Plans

Relevant Statute, Regulation, or Plan	Relationship to the Proposed Action
Federal Land Policy and Management Act (FLMPA)	FLPMA established guidelines to provide for the management, protection, development, and enhancement of public lands (Public Law [PL] 94-579). Section 103(e) of FLPMA defines public lands as any lands and interest in lands owned by the United States. For split-estate lands where the mineral estate is an interest owned by the United States, the BLM has no authority over use of the surface by the surface owner; however, the BLM is required to disclose potential impacts connected to the authorization to lease and develop Federal mineral estate and to declare how Federal mineral estate is 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).
Mineral Leasing Act (MLA)	The MLA 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 FLPMA, the National Environmental Policy Act of 1969, as amended (PL 91-90, 42 United States Code [USC] 4321 et seq.) (NEPA), and other applicable laws, regulations, and policies.
43 CFR 3100	These regulations govern onshore oil and gas leasing, development, and production of Federal minerals.
Federal Onshore Oil and Gas Leasing Reform Act of 1987	This Act directs the BLM to conduct quarterly oil and gas lease sales whenever eligible lands are available for leasing.
New Mexico Surface Owner Protection Act	This Act requires operators to provide the surface owner at least 5 business days' notice prior to initial entry upon the land for activities that do not disturb the surface; and at least 30 days' notice prior to conducting actual oil and gas operations. Included in this policy is the implementation of a Notice to Lessees, 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.
Endangered Species Act of 1973 (ESA)	The ESA requires all Federal departments and agencies to conserve threatened, endangered, and critical and sensitive species and the habitats on which they depend as well as consult with the U.S. Fish and Wildlife Service (USFWS) on all actions authorized, funded, or carried out by the agency to ensure that the action will not likely jeopardize the continued existence of any threatened and endangered species or adversely modify critical habitat.
National Historic Preservation Act	Leasing is considered an undertaking under Section 106 of the National Historic Preservation Act of 1966 (NHPA). Agencies may follow a phased approach to Section 106 compliance. At the leasing level, existing records reviews and consultation drive identification of historic properties. Class III field inventories are an important part of identification at the lease development level. See the text of stipulation WO-NHPA for details.
Federal Cave Resource Protection Act of 1988	Secures and protects significant caves on federal land for the benefit and enjoyment of all people and directs the secretary to inventory and list significant caves on federal lands. Details regarding general cave management, the significant cave nomination, evaluation, and designation process, and cave and karst resource confidentiality noted within the Federal Cave Resource Protection Act are located in 43 CFR 37 (Cave Management)

1.5. Scoping and Issues

1.5.1. Internal Scoping

BLM CFO interdisciplinary team conducted internal scoping to identify issues, potential alternatives and data needs by reviewing the leasing actions within the context of the applicable RMPs under the NEPA framework. Interdisciplinary team meetings in the CFO were held May 17, 2019, May 23, 2019, and June 12, 2019.

1.5.2. External Scoping

A summary web page for the Carlsbad Field Office November 7, 2019, Competitive Oil and Gas Lease Sale was posted on the BLM's National NEPA Register website (https://eplanning.blm.gov). The nominated lease parcels were posted online for a 10-day public scoping period from May 28, 2019-June 10, 2019.

During the public scoping period, the BLM did not received any external scoping letters. A public comment period on the draft November 2019 EA is being held from July 15, 2019 to July 26, 2019. Comments received were read and examined, with substantive comments extracted. These comments were then responded to systematically.

A 10-day protest period of the Sale Notice will run from September 9, 2019 to September 20, 2019. If any changes are necessary to the lease parcels as a result of the protest letters received, an erratum to the Sale Notice would be posted to the BLM website to notify the public of the change.

1.5.3. Issues

The Council on Environmental Quality (CEQ) regulations state: "NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail" (40 CFR 1500.1(b)). The regulations at 40 CFR 1500.4(g) direct that the scoping process should be used "not only to identify significant environmental issues deserving of study but also to deemphasize insignificant issues narrowing the scope of the [NEPA] process accordingly."

Through scoping, four issues were identified for detailed analysis in this EA:

- How would air quality (particularly with respect to National Ambient Air Quality Standards [NAAQS] and volatile organic compounds [VOCs]) in the analysis area be affected by emissions generated as a result of the future potential development of nominated lease parcels?
- How would future potential development of the nominated lease parcels contribute to greenhouse gas (GHG) emissions?
- What are the impacts of oil and gas leasing to Air Quality Related Values (AQRVs) (visibility and deposition) at the Carlsbad Caverns National Park?
- How would future potential development of the nominated lease parcels impact groundwater quantity?

An additional 24 issues were raised during scoping, considered and analyzed in brief (AIB) and in the light of these assessments were dismissed from further, detailed analysis. These issues are presented in Chapter 3, Table 3.2.

The following resources or concerns were determined to either not occur in or adjacent to the nominated lease parcels, or not be in conflict with oil and gas development:

- Geologic, riparian, recreation, and wildlife focused specially designated areas or Areas of Critical Environmental Concern;
- Farmlands (prime or unique);
- Solid and other leasable minerals including potash;
- Lands with wilderness characteristics;
- Environmental Justice;
- Quality of Life (No occupied dwellings exist within 2 miles of any proposed lease parcel);
- Realty actions;
- Land disposals;
- Fire and fuels management; and
- Travel and travel management.

CHAPTER 2. PROPOSED ACTION & ALTERNATIVES

2.1. Proposed Action

Under the Proposed Action, the BLM would offer to lease all of the ten (10) nominated lease parcels of Federal minerals administered by the BLM Carlsbad Field Office. Under the Proposed Action, the BLM Authorized Officer also has the authority to selectively lease, or to defer parcels, in the light of the analysis of potential impacts presented in this EA. Upon review of the ten (10) parcels (3,415.52 acres) nominated for the November 2019 Competitive Oil and Gas Lease Sale within the Carlsbad Field Office, all ten (10) parcels (3,415.52 acres) with associated stipulations (see Appendix A) are proposed for lease under the Proposed Action within the Carlsbad Field Office (Map 2.1). See Appendix C for a complete description of stipulations.

While leasing itself would not result in any oil and gas development, oil and gas leasing is a reasonable outcome from a granted lease right. The following sections outline: 1) the methodology for estimating the number of wells, production volumes and surface disturbance associated with the future potential development of the nominated lease parcels and 2) the process by which lease parcels would be developed, including how resource concerns would be addressed through lease development conditions of approval (COA).

2.1.1. Methodology for Estimating Number of Oil and Gas Wells and Production Volumes

Oil and natural gas resources within the nominated lease parcels could be developed within multiple formations, including the Bone Springs, Wolfcamp, Delaware Mountain, and Yeso/Leonard plays based on the horizontal well spacing rules established by the NMOCD (2016). In addition, the Abo, San Andres, Devonian, Glorieta, Grayburg, Pennsylvanian, Strawn, Mississippian, Blinebry, Atoka, Morrow, and Tubb plays were grouped as "Other", and this "Other" group was also assigned a density of seven (7) wells per section. Estimated ultimate recoveries (EURs) per well for the various plays were determined through decline curve analysis of existing oil and gas production data.

Based on the spatial location of lease parcels within play boundaries, projected well densities, and EURs per well for each play, the total number of wells and the total volume of oil production (in bbl) associated with the Proposed Action was estimated (see Table 2.2). Estimates of future potential development, as well as oil, natural gas, and water production volumes that could reasonably occur on these parcels, were derived as described in Section 3.5.2.1. EURs of oil, natural gas, and produced water, based on the type of well and geologic formation, are listed in Table 2.1. The estimated number of wells and associated oil, natural gas, and water production for the nominated lease parcels is summarized in Table 2.2.

The Reasonable Foreseeable Development Scenario for the BLM New Mexico portion of the Permian Basin (Engler and Cather 2012, 2014) (the RFD) is a reasonable estimate of oil and gas development in the Pecos District (which encompasses the Carlsbad and Roswell Field Offices) over the next 20 years. The RFD is a comprehensive study of all existing plays and an analysis of recent activity, historical production, emerging plays for future potential, and completion trends and is used to inform decision-makers and policymakers about oil and gas development in the Pecos District.

Based on the spatial delineation of play boundaries in the RFD, BLM estimated the projected well densities, the EUR per well for each play, the number of wells, and the total oil, gas, and water production volumes associated with the lease parcels. The BLM projected a well density of six horizontal wells per section (640 acres) per play for the Delaware, Bone Spring, Yeso, and Wolfcamp plays based on the horizontal well spacing rules established by the NMOCD. In addition, the other significant oil and gas–

producing formations were grouped as “Other” and assigned a density of six wells per section. EURs per well for the various plays were determined through type curve analysis of existing production data.

The projected number of wells for each lease parcel was determined first by spatially intersecting the lease parcels with the RFD play potential boundaries. Only those plays that intersected the lease parcels were considered in the well number calculation. The total number of wells for each parcel was then generated by allocating the well densities per play to each parcel on an acreage basis and summing the resulting wells per play. Total oil, gas, and produced water production per parcel was estimated by multiplying the projected wells per play for each parcel by the corresponding play EUR per well and then summing the resulting EURs.

Table 2.1. Estimated Ultimate Recoveries of Oil, Natural Gas, and Produced Water by Formation

Wellbore Direction	Geologic Formation	Oil Production (bbl)	Gas Production (mcf)	Produced Water Production (bbl)
Horizontal	Delaware	213,000	539,000	1,335,000
Horizontal	Bone Spring	204,000	1,002,000	380,000
Horizontal	Yeso	139,000	359,000	381,000
Horizontal	Wolfcamp	156,000	2,640,000	424,000
N/A	Other	128,000	358,000	387,000

Table 2.2. Estimated Well Count and Production for the Nominated Lease Parcels

Parcel (Acres)	Total Horizontal Wells	Surface Disturbance (acres)	Oil Production (bbl)	Gas Production (mcf)	Produced Water Production (bbl)
1 (1,533.92)	43	193.5	7,020,000	57,520,000	17,130,000
2 (80)	2	9	370,000	3,000,000	890,000
3 (80)	2	9	370,000	3,000,000	890,000
4 (640)	18	81	2,930,000	24,000,000	7,150,000
5 (159.89)	3	13.5	400,000	1,070,000	1,150,000
6 (40.52)	1	4.5	190,000	1,520,000	450,000
7 (40)	2	9	260,000	1,700,000	950,000
8 (681.19)	19	85.5	3,120,000	25,540,000	7,610,000
9 (40)	1	4.5	180,000	1,500,000	450,000
10 (120)	3	13.5	550,000	4,500,000	1,340,000
Total: (3,415.52)	**94**	**423**	**15,390,000**	**123,350,000**	**38,010,000**

2.1.2. Methodology for Estimating Surface Disturbance

It is unknown when, where, or to what extent any subsequent well sites, roads, and associated infrastructure would be proposed in the event the BLM decides to lease the nominated parcels. Future potential development of the nominated lease parcels could include the following phases (Appendix D provides a summary of the phases of oil and gas development):

- pad construction
- drilling of a well using a conventional pit system or closed-loop system

- hydraulically fracturing a well
- potential flaring of gas
- construction of new access roads or expansion of existing roads
- installation of pipeline
- production, including vehicle traffic, hauling of produced fluids like oil or produced water, compression to move gas through pipeline systems, potential venting from storage tanks, regular well monitoring, and work-over tasks for the life of the well
- well plugging and abandonment/reclamation

Based on recent oil and gas development in the Pecos District, the BLM estimates 4.5 acres of surface disturbance for new horizontal wells, containing two wells on one pad (twinned), and their corresponding access road and pipeline. Assuming future potential development of 94 horizontal wells, approximately 423 total acres of new surface disturbance is anticipated. Estimated surface disturbance from future potential development on a parcel-by-parcel basis is provided in Table 2.2. Disturbance would remain on the landscape until final abandonment and reclamation of facilities (generally assumed to occur after 20 years). Interim/ongoing reclamation procedures would be used to limit impacts by restoring disturbed areas as soon as they are no longer required for operations.

2.1.3. Process for Future Potential Development of Lease Parcels

The drilling of wells on parcels leased by BLM is not permitted until the leaseholder submits, and the BLM approves, a complete APD package (Form 3160-3) following the requirements specified under Onshore Oil and Gas Orders listed in 43 CFR 3162. Under the authority granted in standard terms and conditions attached to each lease, measures to reduce impacts to or avoid resource values, land uses or users that are not addressed in the lease stipulations specifically would be attached as conditions of approval (COA) to the APD. Under 43 CFR 3101-1-2, such reasonable measures may include, but are not limited to, modification to siting or design of facilities, timing of operations, and specification of interim and final reclamation measures. At a minimum, measures shall be deemed consistent with lease rights granted provided that they do not: require relocation of proposed operations by more than 200 meters; require that operations be sited off the leasehold; or prohibit new surface disturbing operations for a period in excess of 60 days in any lease year.

2.2. No Action Alternative

Under the No Action Alternative, the BLM Pecos District would not offer the nominated parcels for competitive leasing in the November 7, 2019 Competitive Oil and Gas Lease Sale. As a result, there would not be future potential development on the nominated lease parcels. The BLM would continue to manage this mineral estate under current management practices. Parcels would have the potential to be nominated again for a future oil and gas lease sale.

2.3. Alternatives Considered and Dismissed from Detailed Analysis

The BLM considered analyzing an alternative that would include a smaller number of lease parcels. This alternative was dismissed because the BLM Authorized Officer also has the authority to selectively lease, or to defer parcels, in the light of the analysis of potential impacts presented in this EA.

CHAPTER 3. AFFECTED ENVIRONMENT AND ENVIRONMENTAL IMPACTS

3.1. Introduction

Chapter 3 contains the impacts analysis related to the issues. Section 3.2 describes the effects of the No Action Alternative for all issues. Section 3.3 presents an overview of past, present, and reasonably foreseeable future actions (RFFAs) that are considered in the cumulative impact analysis. Section 3.4 presents the issues that were analyzed in brief. Section 3.5 presents the issues that were analyzed in detail.

3.2. No Action Alternative for all Issues

Under the No Action Alternative, the BLM would not lease the nominated lease parcels and the existing conditions and trends related to each issue would continue. Potential impacts associated with the Proposed Action would not occur under this alternative and current land and resource uses would continue. Oil and gas development would continue on leased land surrounding the nominated lease parcels. No natural gas or crude oil from the nominated lease parcels would be produced, and no royalties would accrue to Federal or State treasuries. Employment and revenue opportunities in local communities related to the oil and gas and service support industry could be lowered under this alternative.

3.3. Cumulative Impacts Scenario

As defined in 40 CFR 1508.7 (CEQ regulations for implementing NEPA), a cumulative impact is an impact on the environment that results from the incremental impact of the action when combined with the effects of past, present, and reasonably foreseeable future actions (RFFAs), regardless of which agency (Federal or non-Federal) or person undertakes such other actions. The following section outlines past, present and RFFA actions that would affect the same resources as the proposed action and are within the temporal and geographic boundaries of the analysis. For the purposes of this analysis, the temporal scope of analysis is the range presented in the RFD (up 20 years). The geographic scope of analysis (analysis area for cumulative impacts) is the New Mexico portion of the Permian Basin and includes Eddy, Lea, and Chaves counties. The total area of the three counties is approximately 9.3 million surface acres.

The analysis area comprises approximately 4.3 million acres of Federal mineral estate within the three counties. The Permian Basin has been a producing oil and natural gas field since the early 1900s. New Mexico ranks fifth in the United States in the production of oil (Statista 2019). In 2017, it produced 171 million barrels of oil. Most of the Permian Basin that is open to oil and gas leasing is already leased for fluid mineral development.

Past and present actions: There is no reliable estimate for past wells that are no longer in use, and were either plugged, reclaimed, and abandoned or in some cases abandoned without full reclamation. The BLM NM has worked with the State of New Mexico, ranchers, industry, and other local partners on a restoration initiative called Restore New Mexico. Since 2005, the initiative has restored over 3 million acres of grasslands, woodlands, and riparian areas across the State that had been degraded by invasive species and woodland encroachment (USGS 2019). This program has also resulted in the reclamation of some oil and gas legacy well pads, roads and caliche pits within the analysis area (CSWCD 2019). Other past and present development within the district includes urban development associated with the communities such as Artesia, Carlsbad and Roswell; roads, pipelines and transmission lines; and surface disturbance associated with potash mining such as tailings piles and mine development.

According to data provided by the Petroleum Recovery Resource Center (PRRC), there are currently approximately 38,500 active wells (primarily vertical wells) within the New Mexico portion of the Permian Basin, of which approximately 17,735 are federal (BLM 2018a). The PRRC is a publicly available data resource that has been providing historical oil and gas production data for New Mexico for

over 10 years. Oil and gas production data on the PRRC website is provided primarily by the New Mexico Oil Conservation Division and is updated regularly (PRRC 2018). Assuming an average disturbance of 4.5 acres per well, there would be approximately 173,250 acres of existing surface disturbance in the New Mexico portion of the Permian Basin from oil and gas well pads and related infrastructure including roads, electric lines and pipelines. This is approximately 2.5% of the New Mexico portion of the Permian Basin.

In total, impacts from past and present actions within the 9.3-million acre New Mexico portion of the Permian Basin, including all disturbance types, is estimated to be approximately 317,000 acres including past construction of gas plants, potash mines, oil and gas well pads, access roads, transmission lines, and other linear features (BLM 2018b). This is approximately 4.5% of the New Mexico portion of the Permian Basin.

RFFAs: The following RFFAs are considered in this cumulative impact scenario:

- **Oil and gas:** An RFD scenario for oil and gas was developed in 2012, and updated in 2014, for the analysis area (Engler and Cather 2012, and 2014). The 2012 and 2014 RFD scenario projects 800 new oil and gas wells would be completed within the analysis area each year for the 20-year scenario (2015–2035), for a total of approximately 16,000 new wells (federal and nonfederal). The majority of these wells are expected to be horizontally drilled. New surface disturbance from potential wells in this RFD scenario is estimated at 4.5 acres per well, for a total of approximately 72,000 acres of reasonably foreseeable future surface disturbance).
- **Mining**: approximately 2,400 acres of surface disturbance from the proposed Ochoa Mine (BLM 2014).
- **Infrastructure:** approximately 4,200 acres of surface disturbance from development of transmission lines and pipelines / associated infrastructure (BLM 2018b);
- **Seismic**: approximately 32,000 acres of short-term disturbance, with reclamation occurring within 3 years; (BLM 2018b); and
- **Land farms**: approximately 140 acres of surface disturbance (BLM 2018b).

Grazing, which is currently occurring on 88 percent of the analysis area, is assumed to continue at existing levels. Restore New Mexico's rehabilitation efforts would be considered a countervailing impact to the landscape as legacy well development is gradually restored. The BLM and non-BLM agencies would also continue to treat the landscape with prescribed fire, mechanical treatments, and herbicide. Table 3.1 presents a summary of quantifiable surface disturbances associated with past, present, and reasonably foreseeable future actions within the analysis area.

Table 3.1 Past, Present and Reasonably Foreseeable Future Estimated Landscape Disturbance within the Analysis Area

	Number of Wells	Acreage
Total Analysis Area (three counties)	–	9,300,000
Past and Present Development	38,500	317,000*
Reasonably Foreseeable Future Oil and Gas Development (RFD, Engler 2012, 2014)	16,000	72,000
Other RFFAs (mining, land farms and other infrastructure)	NA	38,740
Total	**54,500**	**427,740**

	Number of Wells	Acreage
Contribution of Future Potential Development under the Proposed Action	94	423
Percentage Contribution of Future Potential Development under the Proposed Action	0.17%	0.10%

*Includes estimates of existing disturbance from past oil and gas development as well as non-oil and gas development.

3.4. Issues Analyzed in Brief

The Council on Environmental Quality (CEQ) regulations state: "NEPA documents must concentrate on the issues that are truly significant to the action in question, rather than amassing needless detail" (40 CFR 1500.1(b)). The regulations at 40 CFR 1500.4(g) direct that the scoping process should be used "not only to identify significant environmental issues deserving of study but also to deemphasize insignificant issues narrowing the scope of the [NEPA] process accordingly." Following internal and external scoping, Twenty-four (24) issues were considered and analyzed in brief (AIB) and in the light of these assessments were dismissed from further, detailed analysis. Each of these issues are outlined in Table 3.2 with a concise discussion regarding the context and intensity of the impact related to each issue. WO-ESA, WO-NHPA, and NM-11-LN would apply to all nominated lease parcels, as well as standard terms and conditions as described in the lease form. For all issues analyzed in brief that follow, it is assumed that cumulative impacts to relevant elements of the human environment that involve landscape disturbance impacts would be consistent with the acreage of cumulative impacts calculations presented above in Table 3.1.

Table 3.2. Issues Considered and Analyzed in Brief (AIB).

Issue #	Issue and Context Discussion
AIB-1	**How would future potential development of the nominated lease parcels impact groundwater quality?** Leasing and future potential development of the nominated lease parcels would result in oil and gas activities, including well pad construction, drilling, and completion for an estimated 94 wells. All wells would be horizontal wells that would employ standard industry practices related to well completion (i.e., perforation and hydraulic fracturing). As noted in Appendix D, hydraulic fracturing is intended to change the physical properties of producing formations by increasing the flow of water, gas, and/or oil around the wellbore, resulting from the introduction of water, proppant (sand) and chemical additives into the producing formations. Types of chemical additives used in completion activities may include acids, hydrocarbons, thickening agents, gelling agents, lubricants, and other additives that are operator- and location-specific. The largest components in hydraulic fracturing fluid are water and sand. If the proposed parcels are drilled, wells would most likely pass through usable groundwater aquifers currently or potentially supplying stock and irrigation water. Potential impacts to groundwater resources could occur if proper cementing and casing programs are not followed. This could include loss of well integrity, surface spills, or loss of fluids in the drilling and completion process, with the introduction of chemical additives to be used in drilling and completion activities to be introduced into usable water (total dissolved solids >10,000 ppm) zones. If contamination of aquifers from any source occurs, changes in groundwater quality could impact springs and water wells that are sourced from the affected aquifers. The BLM's 2019 New Mexico Water Support Document (BLM 2019b) contains a detailed summary of the regulatory program associated with hydraulic fracturing and measures to protect groundwater quality. Since the advent of hydraulic fracturing, more than 1 million hydraulic fracturing treatments have been conducted, with perhaps only one documented case of direct groundwater pollution resulting from injection of hydraulic fracturing chemicals used for shale gas extraction (Galleos and Varela 2015) and there have not been any documented past instances of groundwater contamination in the analysis area attributed to well drilling. This is an indication of how effective the use of casing and cement is at preventing leaks and contamination. With consideration of these design features, a detailed analysis is not necessary. In addition, the BLM has authority under standard terms and conditions to require additional measures to protect water quality if site-specific circumstances require them. Finally, spills could also occur that affect groundwater. As noted in the Water Support Document (BLM 2019b), there were a total of 1,261 spills in Eddy, Lea and Chaves counties. Roughly half of all spills are not recovered,

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	but rather remediated, which may include removal of contaminated soil. However, no spills occurring in the analysis area were reported as having affected groundwater. Should a spill occur, the BLM would work with the NMOCD to immediately remediate spills on BLM lands in accordance with federal and state standards, including NMAC 19.15.29.11. See the Water Support Document (BLM 2019b) for more information on spills. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur in the analysis area. The RFD projects 16,000 new wells over the next 20 years (Engler and Cather 2012, and 2014). These new wells would pose risks to groundwater similar to those discussed above, including potential contamination of freshwater aquifers from well integrity failures, spills, or loss of fluids during the drilling and completion processes. The regulatory program discussed in the Water Support Document (BLM 2019b) and standard terms and conditions would greatly reduce risks, including cumulative impacts, to groundwater from the projected future well development.
AIB-2	**How would future potential development of the nominated lease parcels impact watershed hydrology and surface water quality?** The tri-county analysis area encompasses 12 watersheds, as shown by hydrologic unit codes (HUC). There are approximately 38,500 well bores of all well types within the analysis area and current surface disturbance is estimated at 319,000 acres (BLM 2018b). This comprises about 9% of all watersheds in the analysis area. The lease parcels fall within 8 HUC-10 watersheds that collectively total 1,280,729 acres. Total lease acreage (3,415.52 acres) comprises between 0.02 and 0.8 percent of each of HUC-10 watershed. Parcel 1 includes approximately 76 acres of playas, 0.2 miles of ephemeral streams and 3.5 acres of riparian areas. Parcel 4 includes approximately 14 acres of floodplains, 1.8 miles of ephemeral streams and 42.4 acres of riparian areas. There are no surface water features on Parcel 7, but there are approximately 2.5 acres of playas inside the parcel and two playas immediately outside of lease parcel boundaries. Future potential development of the lease parcels would disturb the vegetation, soils, and mineral substrate; which would create dust and increase runoff rates during precipitation events. By increasing runoff and removing vegetation, disturbed areas would become more susceptible to erosion. Soil that is carried down gradient by runoff due to upslope erosion and may create sedimentation issues in streams. Impacts would be most likely to occur during construction of stream crossings for access roads and flowlines, and at well pad locations nearest streams. Future potential development of the lease parcels also carries a risk of spills that could affect surface water either directly or indirectly. Future potential development would result in approximately 423 acres of surface disturbance (approximately 12% of the total lease parcel acreage). Estimated surface disturbance within each HUC-10 watershed would be between 0.004 and 0.106 percent of each affected watershed. Lease parcels containing playas, floodplains, ephemeral streams, and/or riparian areas (Parcel 1 and 4) would be assigned controlled surface use stipulations that include buffers for the protection of these features. Additionally, Parcel 7 also would also be assigned a controlled use stipulation for protection of playas located immediately outside the lease; see also Issue AIB-3 regarding impacts to playas. See Appendix C for a full description of the stipulations. Additionally, standard terms and conditions would allow for measures to avoid and mitigate accelerated soil erosion and sedimentation to water bodies. For more information on measures that may be required, see the 2019 BLM New Mexico Water Support Document, hereafter referred to as the Water Support Document (BLM 2019c). Should a spill occur, the BLM would work with the NMOCD to immediately remediate spills on BLM lands. The Water Support Document (BLM 2019c) contains a summary of 2018 spill data within the Tri-County analysis area and procedures for remediation. As noted in the Water Support Document, none of the 1,261 spills in the Tri-County analysis area were reported as having affected waterways. The leasing stipulations; the BLM's authority to require additional protective measures; and the low level of surface disturbance (423 acres) relative to the total watershed would all serve to minimize the risk of impacts to watershed hydrology and surface water quality. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the analysis area. The resulting cumulative acreage impacts to surface waters and the overall watershed would be consistent with these calculations. These impacts include similar risks to surface waters from dust deposition, erosion and sedimentation, and spills as discussed above. Leasing stipulations and other laws and regulations placed to reduce watershed impacts would be followed to minimize risk to surface water features and the same spill response and remediation measures described above would also be required for RFFAs. Many of the cumulative adverse impacts resulting from surface disturbances associated with well pads, access roads, and minerals infrastructure would be long term.
AIB-3	**How would future potential development of parcels 4, 5 and 14 affect function of playa wetlands in these locations?** Playa wetlands are relatively small, round, shallow depressions. Their basins are lined with clay soil, which collects and holds water from rainfall and runoff, creating temporary lakes. Properly functioning playas have

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	intact clay basins, are encompassed by grassy buffer strips or prairie, and collect water runoff from the surrounding area after large rain events. Despite their small size and relatively simple structure, playas are relevant to the landscape because they provide important ecological and hydrological functions. In this grassland landscape, playas are the main source of water and are the center of biodiversity on the plains—supporting 185 bird species, 450 plant species, 13 amphibian species, and 37 mammal species at some point in their lifecycle (Smith 2003). They are important because they are a source for migratory and wintering shorebirds, waterfowl and other game and nongame wildlife, as well as contribute to groundwater recharge. Past development in southeast New Mexico has resulted in disturbance to 1/3 of wetlands (Fretwell et al. 1996). Playa wetlands have been identified using desktop aerial photography, USGS National Hydrology Dataset and USFWS National Wetland Inventory data within Parcel 1 and Parcel 7. Lease stipulation SENM-S-19 has been assigned to these parcels with the intent of not allowing oil and gas operations within 200 meters of the identified playa wetlands and buffered area, but still allowing for waivers and exceptions if playa loss would be mitigated by protecting or developing another playa exhibiting the potential for improvement. Based on review of satellite imagery, Parcel 1 has approximately 120 playas occupying approximately 76 acres amounting to 5% of the lease parcel; with the added buffer, a total of 139 playas in and around the parcel create an exclusion zone within Parcel 7 which would occupy 1,433 acres and amount to 93% of the lease parcel. Based on review of satellite imagery, Parcel 7 has approximately 1 playa occupying approximately 2.5 acres amounting to 6% of the lease parcel; with the added buffer, a total of 3 playas in and around the parcel create an exclusion zone within Parcel 7 which would occupy 29 acres and amount to 73% of the lease parcel. Future potential development of Parcel 1 and Parcel 7 is anticipated to be 45 wells and associated infrastructure, approximating to 203 acres of surface disturbance. Anthropogenically accelerated dust and sediment accumulation, which is the result of increased transport of dust and sediments from the upland through airborne particles and water erosion, could degrade function of the playa wetlands. Land disturbances near a playa exacerbate the accelerated sedimentation problem: 1) through movement of sediments into the playa basin and 2) mixing of sediments with the underlying clay layer. The additional sediments may interfere with the shrinking and swelling of the clay layer, which is vital to aquifer recharge, and reduce playa volume which decreases hydroperiod. Hydroperiod reduction greatly alters the plant and wildlife community supported by the playa (LaGrange et al. 2011). Oil and gas operations could result in land disturbance within the drainage basin that would introduce sediments through erosion from heavy rains or wind. Additional sediments can fill the playa preventing water from pooling and reducing the capacity of the playa to recharge an aquifer (Gurdak and Roe 2010). Spills can occur as a result of development (see Appendix F for discussion of spills) resulting in degraded playa function. There are no methods for remediation that wouldn't disrupt the hydrologic connectivity, natural hydrology and benefits that playas provide to people and wildlife within the analysis area. The BLM has the authority under standard terms and conditions to attach conditions of approval at the lease development level to minimize adverse impacts to resource values not addressed in the lease stipulations. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. As more and more wells and associated infrastructure are developed it is possible this development would encroach into areas that include playas. Although the BLM strives to minimize impacts to playas by siting wells and infrastructure away from aquatic resources, overall increased development would contribute to the introduction of sediments through erosion from heavy wind and rain. Spills can migrate into playas causing degraded playa function and the risk of this occurrence increases with the ongoing cumulative development. Many of the adverse impacts to playas resulting from disturbances to the landscape would be long term.
AIB-4	**How would future potential development of the nominated lease parcels impact the potential for induced seismicity in the Permian Basin?** Disposal of wastewater (fluids that are a byproduct of oil production) is the primary cause of anthropogenic felt earthquakes in New Mexico. Hydraulic fracturing is a very minor for inducing felt earthquakes. Even relatively-extreme seismic incidents associated with hydraulic fracturing are well below the damage threshold for modern building codes (Ellsworth 2013). The two main areas of concern are the Dagger Draw (approximately 15 miles northwest of Carlsbad) and Raton Basin (near Raton), which may be linked to specific nearby wastewater injection wells (Sanford et al. 2006; Pursley et al. 2013). Between 2010-2017 eight earthquakes with a magnitude of 2.5 or greater were felt around the Permian Basin (Table 1; USGS 2019c). The risks for induced seismicity increases with high-volume injections into deep wells carried out through wastewater injections or saltwater disposal (SWD) (Ellsworth 2013) and enhanced oil recovery (EOR) techniques. A combination of many factors is necessary to induce felt earthquakes; the injection rate and total volume injected, the presence of faults that are large enough to produce felt earthquakes, stresses that are large enough to produce earthquakes, and the presence of pathways for the fluid pressure to travel from the injection point to faults (USGS 2019a; Machette 2000). High injection rates of

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	>300,000 barrels per month are much more likely to be associated with earthquakes and any earthquake within 15 km of an active injection well could be associated with that well (Weingarten 2015). Aside from induced earthquakes, New Mexico has naturally occurring earthquakes. These mainly occur near Socorro within the Socorro Seismic Anomaly, a naturally-occurring earthquake cluster predating oil and gas development. The majority of the faulting and folding in New Mexico is distributed within the Rio Grande rift (Machette et al. 2000). The closest quaternary faults related to the Rio Grande Rift in the CFO/PDO are the Guadalupe faults to the southwest (USGS 2019b). Earthquakes caused by wastewater injections are declining because of New Mexico's Underground Injection Control (UIC) Program which monitors and regulates the injection of fluids into the subsurface. New Mexico regulations set limits on maximum allowable injection pressures and require mechanical integrity testing of the boreholes, pressure monitoring, and reporting. All injection wells permitted by the Division are subject to limitations on surface-injection pressure. Wells are required to be equipped with a pressure-limiting device which will ensure that the maximum surface injection pressure is not exceeded (NMOCD 2004). Compliance officers from the district office periodically inspect wells and surface facilities to ensure to wells and related surface equipment are in good repair and meet regulations (NMOCD 1993). Currently, within the Permian basin area none of the active injection wells are injecting into the Ellenberger limestone and none exceed an average monthly injection rate of 300,000 barrels. The well with the highest average monthly injection rate (231,480 barrels) is 49.7 km from Dagger Draw. Future oil and gas development of the lease parcels would result in approximately 38,010,000 barrels of produced water for the life of the wells as compared to a total number of 1,049,328,026 barrels of produced water in 2018 from New Mexico (NMOCD 2019). When considering how New Mexico regulates its injection wells, the low amount of produced water resulting from the lease sales, and the current risk of earthquakes in the Permian Basin outside of the Dagger Draw area, development of the leases is not expected to result in induced seismicity. See Appendix F for more information on induced seismicity.
AIB-5	**How would future potential development of the nominated lease parcels impact the physical and biological integrity of soils, particularly gypsum soils?** Future potential development of nominated lease parcels would occur on approximately 423 acres across all parcels. These 423 acres of disturbance affect the physical and biological integrity of soils. Soil movement disrupts the existing structure of the soil horizons, to the depth of disturbance. Soil forming processes are halted, compaction of underlying horizons, and loss or degradation of soil microbes may occur. Disturbing 423 acres would result in potential impact to less than 0.1% of the 9.3 million-acre NM portion of the Permian Basin. Parcels 1, 3 and 4 are located in mapped gypsum soils (100% of parcel 1, 17% of parcel 3, and 75% of parcel 4 is mapped gypsum soils), a fragile soil type managed by the Carlsbad Field Office. Gypsum soils are difficult to reclaim to their pre-disturbance condition. As a result, Stipulation SENM-S-17 Controlled Surface Use – Slopes or Fragile Soils is applied to these parcels to minimize impacts to gypsum soils. This stipulation has also been applied to parcel 2, 5, and 8 to protect areas of steep slopes and dune complexes within those parcels. Stipulation SENM-S-17 prevents disturbance on slopes 20% or greater and provides for mitigation of soils impacts based on an approved plan of operations. The BLM's authority under standard lease terms and conditions would result in the application of measures to further mitigate impacts to the physical and biological integrity of soils during the development of a lease. Such measures include topsoil stockpiling and pad placement in respect to topography and other factors. Site specific analysis would occur at the lease development level, and the lessee would be required to follow COAs and reclamation measures as outlined by the BLM. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the analysis area. The resulting cumulative acreage impacts to soils across the landscape would be consistent with these calculations, and impacts would be similar in type to those discussed above. Sensitive gypsum soils are found scattered throughout the analysis area and comprise approximately 156,479 acres, or about 2 percent of the 9.3 million-acre analysis area (BLM 2018). The potential for adverse impacts to gypsum soils (or other sensitive soils) would depend on site-specific locations.
AIB-6	**How would future potential development of the nominated lease parcels impact vegetation?** Surface disturbance associated with oil and gas development would directly remove surface vegetation, thereby substantially altering the plant community composition, increasing potential for erosion and soil compaction and increasing the likelihood for the invasion of noxious weeds (see AIB-7). Small portions of desert shrub or grassland communities may temporarily be destroyed or disrupted by future development on the nominated lease parcels. These vegetation communities are extremely common throughout the analysis area. Average annual precipitation is 14 inches across the area where parcels were nominated for lease. In these arid plant

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	communities, low rainfall combined with minimal soil organic matter contributes to communities with low disturbance level thresholds and lack of resilience. Removal of vegetation through the development of lease parcels may leave segmented plant communities that would not recover to pre-disturbance levels without reclamation measures, which may take years to achieve (BLM 2018b). The potential loss of 423 acres of vegetation is minimal relative to the amount of desert shrub or grassland communities present within the 9.3 million-acre analysis area. Standard lease terms and conditions provide the BLM with the authority to develop measures to address potential impacts during lease development either through project design or by implementing reclamation measures. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the analysis area. The resulting cumulative acreage impacts to vegetation across the landscape would be consistent with these calculations. Qualitatively, vegetation resources would be cumulatively impacted through increased fragmentation of vegetative types, the introduction of invasive species, and the potential for monocultures to develop. Many of the adverse impacts to landscape vegetation density and type resulting from surface disturbances associated with well pads, access roads, and minerals infrastructure would be long term.
AIB-7	**How would future potential development of the nominated lease parcels impact the introduction and/or spread of noxious weeds and invasive plants?** Surface disturbance, construction equipment, and source materials brought on-site (e.g. caliche, gravel) from future potential development of nominated lease parcels would likely increase the spread and density of invasive plants and noxious weeds. Invasive and noxious weeds invade disturbed sites, spread into adjacent areas, compete with and potentially displace native vegetation and can contribute to the degradation of soil health by over utilizing soil nutrients. The PDO has observed an increase in noxious weed/invasive plant populations in recent years, and there appears to be a direct correlation between development and associated disturbed areas and the establishment/spread of noxious and/or invasive plants. African rue (*Peganum harmala*), a perennial deep-rooted noxious weed, has proven especially difficult to control because it will colonize every soil type and easily outcompetes native plants for soil nutrients and available water (BLM 2018). It is estimated that 423 acres would be disturbed as a result of future potential development of the ten parcels. Due to the projected disturbance, these 423 acres would be vulnerable to the establishment/spread of noxious weeds/invasive plants. Within the PDO there are prior and ongoing efforts to reduce the presence and spread of these unwanted species by way of prevention and treatment. The most common treatment method is the application of herbicides. In general, the effectiveness of treatments is variable depending on location, species, treatment type, timing of treatment, and size of population. In the event that noxious weeds are discovered at any time during future potential development, standard lease terms and conditions hold the operator responsible for weed treatment and prevention activities such as herbicide application and washing vehicles coming from areas with known weed populations. Reclamation is intended to restore previously disturbed sites to a properly functioning natural ecological state. The effectiveness of reclamation efforts varies based upon a number of factors such as soil type, precipitation, herbicide treatments, and additional disturbance. Once physical reclamation of the site has taken place, seeding of native species is intended to re-establish the native plant community and protect the disturbed area from potential establishment of noxious weeds. While reclamation has been shown to increase and restore the health of disturbed sites, the complete eradication of noxious weed species is challenging, and initiation of large-scale control efforts on African rue are not feasible at this time (BLM 2018). The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the analysis area. The resulting cumulative acreage would cumulatively increase the spread of noxious or invasive species. Grazing also contributes to the spread of noxious weeds as livestock traverse the landscape. On a landscape level the Carlsbad Soil and Water Conservation District has operated a joint county venture (Lea and Eddy counties) to target certain species for eradication (CSWD 2019). Together with the standard lease terms and conditions and site-specific approval requirements that require permit holders to treat weeds, there is a countervailing effect that limits the spread of noxious weeds across Eddy and Lea counties and contributes to controlling the spread on a landscape level. Some of the adverse impacts from development remain, including potential introduction of new species. These remaining impacts would be long term if full eradication of certain introduced species is not achieved. These remaining impacts would likely be long term as full eradication of introduced species is difficult.
AIB-8	**How would future potential development of the nominated lease parcels impact threatened and endangered (T&E) species?** The location of the parcels was compared to the county-level lists of T&E species in the U.S. Fish and Wildlife Service's (USFWS) Information for Planning and Consultation (IPaC) on-line system. Except for the species listed below, no other federally listed, proposed or candidate T&E species or their habitats are known to occur

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	within the nominated lease parcels. No critical habitat for any species occurs within the nominated lease parcels. The nearest critical habitat is for gypsum wild-buckwheat, located approximately 8.5 miles southwest of Parcels 2, 3, and 4. Under the future potential development scenario, the following species and potential habitat could be impacted based on IPaC data: least tern, Mexican spotted owl, northern aplomado falcon, piping plover, southwestern willow flycatcher, yellow-billed cuckoo, Pecos bluntnose shiner, Pecos Gambusia, Texas hornshell, Guadalupe fescue, gypsum wild-buckwheat, Kuenzler's hedgehog cactus, Lee's pincushion cactus, Sneed's pincushion cactus, and Wright's marsh thistle. All of the parcels potentially contain flyover habitat for the avian species listed above, particularly Parcels 1, 4, and 7 which contain riparian vegetation and/or playas. Biological evaluations would be conducted at the lease development level for any future actions within the lease parcels to determine whether impacts to T&E species would occur. Avoidance, minimization, and/or mitigation measures would also be determined at that time. Additionally, standard terms and conditions and lease notice WO-ESA-7, would be applied to all parcels. WO-ESA-7 informs the lessee that BLM may require modifications to or disapprove development proposals that would contribute to a need to list such species or their habitat; result in jeopardy to the continued existence of such species; or result in the destruction or adverse modification of a designated or proposed critical habitat. See Chapter 4 for additional details regarding Endangered Species Act consultation and coordination. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the Analysis area. The resulting cumulative acreage impacts across the landscape would cumulatively contribute to additional potential for habitat loss, and fragmentation that could affect species listed above. The BLM is working with other land management agencies to restrict and manage development near habitat for the species listed above through candidate conservation agreements, species-specific studies, and other requirements ahead of locating well pads and infrastructure. These methods to reduce or minimize impacts to habitat for the species listed above would be applied to RFFAs as well, and the resulting cumulative impacts from landscape wide development would be minimized or restricted from protected habitat areas.
AIB-9	**How would future potential development of the nominated lease parcels impact BLM Sensitive Species?** BLM sensitive species habitat terms employed in this analysis include occupied habitat, suitable habitat and potential habitat. These are defined as: • Potential Habitat: Habitat that has been modeled or assessed through mapping (i.e., GIS) to identify specific substrates (i.e., formation, soil units), ecotypes (i.e., plant associations or communities), elevation range, and other environmental factors associated with the subject species, plus up to a 1000-meter (0.62-mile) buffer for plants to account for imprecise mapping. • Suitable Habitat: Areas which contain or exhibit the specific components or constituents necessary for the species' (in question) persistence; as determined by field inspection, soil survey, existing data, and confirmed by on-site observations. • Occupied Habitat: The physical space occupied by the species. In the case of annual plants or species in areas that are difficult to survey (e.g. cliffs), where surveys may not include the full distribution of the species, suitable habitat may be the equivalent of occupied habitat. Areas also historically occupied by plant species to account for viable seed bank. For plants, occupied habitat includes immediately adjacent areas where additional undetected individuals, including seeds, are likely to occur (an additional 100 meters for the plant species in this analysis). Under future potential development of these lease parcels, the following BLM sensitive species and/or their habitats could be disturbed: **Dunes sagebrush lizard (DSL; *Sceloporus arenicolus*)** potential habitat occurs in parcels 5, 6, 8, 9, and 10.. To address potential impacts to DSL, a lease notice (SENM-LN-2) has been attached to parcels 5, 6, 8, 9, and 10informing the lessee that presence/absence surveys may be required prior to any surface disturbance activities. In addition, stipulation SENM-S-23, which restricts surface disturbance in documented occupied habitat or within up to 200 meters of suitable habitat associated with occupied habitat areas has been applied to parcels 5, 6, 8, 9, and 10. Stipulation SENM-S-34, which requires a plan of development to be submitted for review and approval prior to approval of site development, has been applied to parcels 5 and 8. Surface disturbance would likely result in a decrease in habitat quality from human presence and loss of vegetation. Following reclamation, these effects are expected to decrease over time; however, the degree and speed of recovery is anticipated to vary depending on site-specific ecological conditions and environmental factors. In addition, standard lease terms and conditions provide the BLM with the authority to require additional measures to address resource issues at the lease development level.

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	Lesser prairie-chicken (LPC; *Tympanuchus pallidicinctus*) potential habitat occurs in parcels 5 through 10. Future potential development of these nominated lease parcels could reasonably be expected to disturb 130.5 acres within the Pecos District-designated Isolated Population Area, representing 4% of the available potential habitat within 0.25 mile (totaling approximately 3,328 acres). This amount of surface disturbance would result in a decrease in habitat quality from human presence and loss of vegetation. Following reclamation, these effects are expected to decrease over time; however, the degree and speed of recovery is anticipated to vary depending on site-specific ecological conditions and environmental factors. Parcels 6 through 10 are also located within the Pecos District-designated Timing Restriction Zone. Stipulation SENM-S-22, which limits construction activity during nesting and mating periods to facilitate LPC reproduction success is attached to parcels 5 through . None of the nominated lease parcels are known to contain perennial surface water features. All parcels other than Parcels 2, 3, and 4 are located over ten miles away from the nearest known occupied habitat for the following aquatic species: bigscale logperch, blue sucker, greenthroat darter, headwater catfish, Mexican tetra, Pecos pupfish, Rio Grande cooter, Rio Grande chub, Rio Grande shiner, and speckled chub. Parcels 2, 3, and 4 are between 1.2 miles and 2.9 miles from the Pecos River which is potential habitat for many of the species listed above. Due to proximity with the Pecos River and/or ephemeral surface water features, Parcels 1, 3, 4, and 5 have been assigned stipulation S-18 which conveys controlled surface use for streams, rivers, and floodplains. **Scheer's beehive cactus (*Coryphantha robustispina* ssp. *scheeri*)** potential habitat occurs in lease parcels 1 and 4. Future potential development for lease parcels 1 and 4 estimates a minimum of 274.5 acres of surface disturbance. Lease parcels 1 and 4 intersects 2140 acres of potential habitat and 0 acres of known occupied habitat for Scheer's beehive cactus. Future potential development within the nominated lease parcels could reasonably be expected to directly impact up to 274.5 acres of potential habitat and 0 acres of known occupied habitat for Scheer's beehive cactus. **Tharp's bluestar (*Amsonia tharpii*)** potential habitat occurs in parcel 1 and 4. Future potential development for lease parcels 1 and 4 estimates a minimum of 274.5 acres of surface disturbance. Lease parcels 1 and 4 intersects 11.4 acres of potential habitat and 0 acres of known occupied habitat for Tharp's bluestar. Future potential development within the nominated lease parcels could reasonably be expected to directly impact up to 11.4 acres of potential habitat and 0 acres of known occupied habitat for Tharp's bluestar. **Gypsum milkvetch (*Astragalus gypsodes*)** potential habitat occurs in parcel 1. Future potential development for lease parcel 1 estimates a minimum of 193.5 acres of surface disturbance. Lease parcels 1 intersects 1,476 acres of potential habitat and 0 acres of known occupied habitat for gypsum milkvetch. Future potential development within the nominated lease parcels could reasonably be expected to directly impact up to 193.5 acres of potential habitat and 0 acres of known occupied habitat for gypsum milkvetch. **Gypsum wild buckwheat (*Eriogonum gypsophilum*), Allred's Flax (*Linum allredii*), gypsum milkvetch, and Tharp's blue-star (Amsonia tharpii)** known occupied habitat is in close proximity to parcel 1. **Scheer's beehive cactus** known occupied habitat is in close proximity to parcels 2, 3, and 4. While small percentages of total potential habitat are noted as intersecting lease parcels 1 and 4 in this analysis, impacts to species health, abundance, distribution, and potential for expansion may be substantially less than the estimated percentage for potential habitat or substantially more than the estimated percentage for occupied habitat, depending on actual species occurrences and actual suitability and connectivity of habitats. While small percentages of potential habitat are noted in this analysis, the actual impacts to occupied or suitable habitat could be much higher, depending on the extent of occupied habitat detected during biological evaluation surveys. In all cases, known occupied habitat is only a fraction of the potential habitat. As an example, current representation of Scheer's beehive cactus occupied habitat is 860 acres (or 0.003%) of 263,296 acres of potential habitat. Depending on the proximity of ground disturbance to special status plant species habitat, there could be impacts to special status plant species and the ecological processes that sustain them related to changes in the following habitat conditions: ground cover, soil nutrient flows and processes, hydrological flows and processes, solar exposure, thermal cover, fugitive dust loads, non-native species dispersal, habitat connectivity, and pollinator and dispersal agents' visitation behaviors. Such adverse impacts should be avoided or mitigated at the lease development level. Even small habitat disturbances can create adverse impacts to rare plants. If detected and avoided, actual impacts to special status plant species would be much less than estimated as potential in this analysis. It is not certain that detected occupied habitat could be avoided, given valid existing lease rights and other resource uses in the vicinity of lease development locations. Impacts may also be lower than estimated in this analysis when multiple wells are drilled from a single well pad. Standard terms and conditions would apply to all lease parcels. Lease notice (NM-1-LN) is attached to parcels 1-4 which notifies the lessee that pre-disturbance surveys may be required prior to approving surface disturbing activities. The surveys would locate special status species occurrences for avoidance during lease development activities. In addition, biological evaluations would be conducted at the lease development level for any future

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	actions within the lease parcels to determine whether impacts to BLM sensitive species would occur. Avoidance, minimization, and/or mitigation measures would also be determined at that time. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the analysis area. The resulting acreage impacts across the landscape would cumulatively contribute to additional potential for habitat loss, and fragmentation that could affect BLM sensitive species. The BLM is working with other land management agencies to restrict and manage development through establishment of management protocols to identify and map potential and occupied habitat areas, requiring species-specific inventories and studies, and other requirements ahead of locating well pads and infrastructure. Methods to minimize impacts to individuals and habitats would be applied into the future for RFFAs as well, and the resulting cumulative impacts from landscape wide development would be minimized or restricted from protected habitat areas. The remaining cumulative impacts from landscape level development leads to long-term habitat loss and fragmentation.
AIB-10	**How would future potential development of the nominated lease parcels impact migratory birds?** These nominated lease parcels fall within the North American Bird Conservation Initiative Bird Conservation Regions (BCR) 18 (Shortgrass Prairie) and 35 (Chihuahuan Desert). The six migratory bird species of conservation concern listed for BCRs 18 and 35 are McCown's Longspur, Lark Bunting, Horned Lark, Chestnut-collared Longspur, Sprague's Pipit, and Baird's Sparrow (Partners in Flight 2016). The New Mexico Avian Conservation Partners developed two conservation lists based on distribution, threats, global population size, NM population trend, and importance of NM to breeding or wintering. The two lists contain species that are of the highest conservation concern in NM. Level one species that have the potential to occur within the lease parcels include Chestnut-collared Longspur, Juniper Titmouse, Pinyon Jay, McCown's Longspur and Scaled Quail. Level two species potentially occurring in the lease parcels include Cassin's Finch, Clark's Grebe, Sagebrush Sparrow, Cassin's Sparrow, Crissal Thrasher, Lark Bunting, Mountain Bluebird, Sage Thrasher, Western Grebe, Brewer's Sparrow, Cactus Wren, Canyon Towhee, Green-tailed Towhee, Loggerhead Shrike, Northern Pintail, Pyrrhuloxia, Rock Wren, Rufous-crowned Sparrow, Townsend's Solitaire, Vesper Sparrow, Violet-green Swallow and Western Bluebird. Habitat fragmentation and loss have changed how birds move through landscapes and use the remaining habitat. Loss and fragmentation of habitat are among the main reasons why biodiversity is decreasing in many places worldwide. The primary drivers of habitat loss and fragmentation within this area are oil and gas development, livestock grazing, and mining. This regional habitat continues to provide for the life cycles of these birds notwithstanding known drivers of habitat loss as described above. Under the proposed action the BLM would lease 10 parcels and future potential development would result in approximately 423 acres of disturbance. This disturbance would result in migratory bird habitat loss or modification in BCRs 18 and 35. Most impacts would occur at the initial stages of lease development. These disturbances include construction and drilling, human presence, traffic, heavy equipment and noise associated with lease development activities. Bird species not tolerant of these activities may leave and avoid the area altogether for the duration of construction or move into nearby undisturbed habitat patches. The BLM's authority under standard terms and conditions would result in the application of measures to mitigate effects on migratory birds at the lease development level. Developmental constraints during spring and fall migrations and nesting seasons, as well as nest surveys, may be required prior to implementation of lease development activities. Some of these include the application of netting over open tanks, raptor-safe power line construction standards, and sound mufflers. In addition, avoidance of active avian nests and burrows or delays of development activities may be required. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present and reasonably foreseeable development that has or would occur within the analysis area. The resulting acreage impacts across the landscape would cumulatively contribute to additional potential for migratory bird habitat loss, and fragmentation. Habitat loss impacts would be long term and, in some cases, reclamation would not fully rehabilitate migratory bird habitat to pre-development conditions.
AIB-11	**How would future potential development of the nominated lease parcels impact paleontological resources?** There are 10 nominated parcels in the November 2019 lease sale. There are no known paleontological localities within any of the lease parcels. Additionally, the lease parcels fall within areas identified as Potential Fossil Yield Classification (PFYC) of 2. The PFYC is a tool that allows the BLM to predict the likelihood of a geologic unit to contain paleontological resources. The PFYC is based on a numeric system of 1-5. An area identified as PFYC 1 has little likelihood of containing paleontological resources, whereas an area identified as PFYC 5 is a geologic unit that is known to contain abundant scientifically significant paleontological resources.

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	Within areas identified as PFYC 2, paleontological resource management concern is usually negligible because the likelihood of encountering scientifically significant fossils is relatively low. Currently the Carlsbad FO area is geologically mapped at the 1:500k scale. At this scale many of the smaller outcrops that do contain scientifically important fossils are not represented. Spread throughout the FO area are smaller outcrops of late-Pleistocene deposits associated with ancient lakes that have produced scientifically important paleontological resources.. Direct impacts would result in the immediate physical loss of fossils and their contextual data. Impacts indirectly associated with ground disturbance could subject fossils to damage or destruction from erosion, as well as creating improved access to the public and increased visibility, potentially resulting in unauthorized collection or vandalism. Ground disturbance can also reveal scientifically significant fossils that would otherwise remain buried and unavailable for scientific study. Such fossils can be collected properly and curated into the museum collection of a qualified repository making them available for scientific study and education. In areas where the lease parcels are fully or partially located in PFYC 2o, pedestrian survey for paleontological resources would not be required. Impacts to paleontological resources would be minimized by standard lease terms, which require a lessee to conduct inventories or special studies at the discretion of the BLM. If in the conduct of operations paleontological resources are discovered the lessee must cease any operations that would result in the destruction of such specimens and contact the BLM Authorized Officer. Paleontological surveys may be required at the lease development level in areas where there is a higher probability to impact paleontological resources before work is authorized. Additional mitigation measures may be applied based on the results of the survey and would be applied as COAs. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. The risk of impacts to paleontological resources from the RFFAs outlined in Table 3.1 would depend on the locations of proposed disturbance relative to PFYC class. As currently mapped, almost all of the analysis area is mapped at PFYC 2 and 3, and there are no PFYC 5 areas identified in the area. As such, the cumulative risk would be low and the same measures for minimizing impacts at the site-specific level as described above would be followed for RFFAs as well.
AIB-12	**How would future potential development of the nominated lease parcels impact fluid minerals and energy production?** Depending on the success of oil and gas well drilling, future potential development would result in the extraction of non-renewable natural gas and/or oil from the lease parcels and delivery to market. Production of oil or gas would result in the irretrievable loss of these resources (i.e., they would no longer be available for future development). Current production within the analysis area is estimated to be 278,000,000 bbl of oil and 425.6 billion cubic feet (bcf) of gas. In addition, 1,933,183 acres of the analysis area is leased. Estimated production from the 10 lease parcels is 15,390,000 barrels (bbl) of oil and 123,350,000 thousand cubic feet (mcf) of gas (see Table 2-2). The 10 lease parcels would add 3,415.52 acres to the total amount of the analysis area that is leased (0.177% more). These lease parcels would contribute 5.53% and 0.029% more oil and gas production within the analysis area. The cumulative impact scenario described in Section 3.3 would result in potential for development of 16,000 wells in addition to other mineral development. This development is consistent with various laws, including FLPMA (43 USC 1701, et seq.), that mandate that the BLM administer the exploration for and development of these mineral resources on public lands for the benefit of the citizens of the United States.
AIB-13	**How would future potential development of the nominated lease parcels impact livestock grazing?** The table below lists 9 grazing allotments and corresponding acreage of those allotments that contain nominated lease parcels. It is assumed that Parcel No. 9 and 10 are grazed although neither is located within a BLM-administered grazing allotment.

Grazing Allotment(s)	Parcel Number(s)	Estimated Acres of Disturbance within Allotment from Future Potential Development of Parcels	Estimated Acres of Grazing Allotment (via GIS)
Hay Hollow No. 78107	Parcel 1	193.5	10,278

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	Dipper No. 77011	Parcel 2, 3, 4	20	11,313
	Dagger Draw No. 77016	Parcel 4	79	8,635
	Loco Hills No. 77004	Parcel 5	13.5	16,760
	Little Lake No. 77043	Parcel 6	4.5	7,399
	Sand Trap No. 76004	Parcel 6	<0.1	3,565
	Antelope Ridge No. 77032	Parcel 7	9	77,508
	Maljamar II No. 76107	Parcel 8	19.2	15,927
	Maljamar South No. 76007	Parcel 8	66.3	18,219
	Fee Surface	Parcel 9	4.5	N/A
	Fee Surface	Parcel 10	13.5	N/A
	Future potential development of the lease parcels would potential decrease the amount of available forage for livestock within allotments and contribute to cumulative disturbance within the lease parcels owing to pre-existing oil and gas development. Based on review of aerial imagery it is estimated that the existing level of disturbance within these allotments is between 0 and 6%. Interim vegetative reclamation would decrease the impacts to available forage. Grazing patterns and distribution may be temporarily disrupted at the time of development due to vehicle traffic and linear construction activities such as pipeline installation or road construction. The BLM's authority under standard terms and conditions would result in the application of measures to mitigate livestock grazing related impacts including possible re-routes to avoid damage to range improvements. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. The cumulative impact scenario described in Section 3.3 would result in a cumulative loss of forage across the allotments within the analysis area. Proposed vegetation treatments and reclamation projects would ultimately contribute to cumulatively long-term countervailing impacts as new forage for livestock grazing is made available through revegetation.			

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AIB-14	**How would future potential development of the nominated lease parcels impact dispersed public recreation?** Oil and gas related disturbances have the potential to modify recreation opportunities and the recreation experience primarily as a result of changes in the landscape (viewshed), soundscape (noise), habitat loss, and presence of oil and gas development related activities (construction, traffic, etc.). Future potential development under the proposed action would result in approximately 423 acres of disturbance within the nominated lease parcels (or about 0.1 percent of the acreage available for dispersed recreation on public lands). Oil and gas development related equipment and structures would be present in the areas of development. This disturbance is unlikely to change overall dispersed recreation opportunities or the experience of dispersed recreation because of the limited scale of the proposed development and the presence of substantial existing oil and gas development (see Table 3.1). There may be some small increases in access for dispersed recreation due to new roads. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. The resulting cumulative impacts to dispersed public recreation would be consistent with these calculations.
AIB-15	**How would future potential development of the nominated lease parcels impact wildlife, including game and non-game species?** The analysis area contains populations of big-game species, including mule deer and pronghorn, as well as a multitude of other non-game species. Carnivores include bobcat, coyote, badger, swift fox and striped skunk. Two upland game bird species, mourning dove and scaled quail, are prevalent throughout the area as well. New oil and gas developments can temporarily displace localized species or populations while construction and drilling activities are taking place. These activities could result in loss of vegetation, burrows and nest, and could also cause habitat loss and fragmentation, wildlife avoidance of the area, and mortalities. Future potential development under the proposed action would result in approximately 423 acres of disturbance within the nominated lease parcels (<0.00001% of the acreage in the analysis area). Impacts would be reduced at the lease development level by applying a combination of the following mitigation measures based on standard terms and conditions: modification of open-vent exhaust stacks to prevent perching and entry from birds and bats; nets on open top production tanks; interim reclamation; closed loop systems; exhaust mufflers; berming collection facilities; minimizing cut and fill; avoidance of wildlife waters, stick nests, drainages, playas, and dunal features. These practices reduce mortality to wildlife and allow habitat to be available in the immediate surrounding area thus reducing stressors on wildlife populations at a localized level. The cumulative impact scenario in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development within the analysis area. The resulting cumulative acreage impacts would be consistent with these calculations and would impact wildlife habitat. The past and future vegetation restoration projects outlined in Section 3.3. would have some countervailing impacts through reclaiming legacy well pads, roads and caliche pits within the analysis area. Additionally, New Mexico's Department of Game and Fish's Habitat Stamp Program is using reclaimed oil and gas development areas to construct wildlife water catchments to enhancing habitat using revenue from the purchase of hunting licenses. Overall, the landscape habitat fragmentation and human presence is the cumulative impact for wildlife that is long-term and presents potential for a decline in species numbers or use of the analysis area.
AIB-16	**How would the visual landscape be affected by future potential development of the nominated lease parcels?** The BLM reviewed aerial photography and records of existing oil and gas development to determine whether new development would have visual impact. All 10 parcels were found to be adjacent to other lands with a high degree of oil and gas development. Visual effects from oil and gas development include structures, surface disturbances, and linear features, all of which create contrast to the natural landscape. This may reduce the quality of the recreational experience. Future potential development of the lease parcels would be visually consistent with the surrounding landscape which is already highly modified in character. All 10 parcels in the November 2019 lease sale occur in Visual Resource Management (VRM) Class IV, which provides for management activities that may require major modifications of the existing character of the landscape and where 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 landscape elements of color, form, line, and texture. Standard terms and conditions allow the BLM to consider further mitigation for visual resources at the lease development level. Such mitigation could include painting of oil field equipment and structures to minimize visual contrasts (Notice to Lessee 87-1 New Mexico - Painting of Oil Field Facilities to Minimize Visual Impact), utilization of low profile structures and siting of well sites, roads and associated infrastructure to follow the contour of the landform, mimicking the lines in vegetation and to screen and hide

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	locations. In addition, per Onshore Order 1 (OO1 - XII. Abandonment, B. Reclamation), interim reclamation (reclamation of surface disturbance not necessary for production) and final reclamation (reclamation following well plugging and abandonment) is required within six months of well completion and well plugging, respectively. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. The RFFAs would create surface disturbances and visual contrasts with the surrounding landscape and adversely contribute to the existing scenic quality impacts on the analysis area's landscapes. The degree of impact would depend upon the location of proposed infrastructure relative to sensitive viewsheds and areas already highly modified in character. Oil and gas development is generally not compatible with VRM Class I designated areas and visual mitigation is often needed to comply with Class II areas. As the landscape level vegetation rehabilitation efforts such as Restore New Mexico continue, and existing and active wells are plugged and reclaimed to former visual condition, a countervailing impact to visual resources would also occur.
AIB-17	**How would future potential development of the lease parcels impact the quality of night skies at the Carlsbad Caverns National Park (CCNP)?** The darkness of the night sky is a valuable aspect of the CCNP. Those who visit the park often seek an experience of solitude and the wilderness experience dark night skies provide. Sky glow is the result of scattered artificial light in the atmosphere; it raises night sky luminance and creates the most visible negative effect of light pollution. The Sky Quality Index (SQI) is an index of light pollution from sky glow with a range of 0 to 100, where 100 is a sky free from artificial sky glow. The SQI for the CCNP monitoring station within CCNP in 2008 was between 89 and 91 (NPS 2019a). These values show skies in the analysis area retain their natural characteristics throughout most of the sky. Note that the SQI data has limitations as described in the source that "bright unshielded lights in the land portion of the mosaic will not be accurately measured for two reasons: they commonly are so bright their recorded luminescence exceeds the dynamic range of the detector so they become clipped or saturated at the maximum ADU value, and the median filter will remove most of the light from these sources since they resemble stars or point sources" (NPS 2019b). The limitations of the SQI data indicate that point source lights from oil and gas development may not be completely accounted for. The main sources of sky glow in the analysis area are the following: the communities of Artesia, Carlsbad, Roswell, Dexter, Hagerman, and Hobbs; artificial lighting associated with areas of consolidated oil and gas development (particularly at Loco Hills); and infrastructure lighting, flaring, and traffic. At present, there are approximately 38,500 well bores of all well types in the New Mexico portion of the Permian Basin (BLM 2018a). Future potential development on the nominated lease parcels could introduce additional artificial lighting that would contribute to sky glow. The degree to which artificial lighting contributes to sky glow would be generally temporary and transient in nature and would vary based on conditions such as cloud cover, weather, wind speed or direction. For example, most artificial lighting would occur during the drilling, completion, and potential flaring of a well, which could last for approximately 45 to 60 days. Lighting from the other phases of development and production would occur from vehicle traffic or safety lighting. Given that the NPS reports that the primary sources that contribute to an increase in night sky effects (sky glow) are cities (NPS 2019a), contributions to sky glow from potential development of the 10 parcels (94 wells) would be a small contribution to the existing sources. Additionally, the impact could be lesser in scope because the lease parcels are unlikely to be developed simultaneously and the closest lease parcels are 14 and 31 miles away from the CCNP monitoring site. Under standard terms and conditions, the BLM has the authority to require mitigation measures to reasonably reduce resource impacts at the lease development level. The BLM may require mitigation measures which could include flare shields, the type of lighting (limited to downcast lighting with covers for safety purposes only), and project alignment. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. Cumulatively, while NPS monitoring data indicates that dark sky conditions in the area currently retain their natural characteristics, SQI ratings could be impacted by sky glow associated with community and urban growth as well as reasonably foreseeable future oil and gas development (up to 16,000 wells over the next 20 years). Future potential development of the proposed action would comprise an incremental contribution to this overall cumulative effect.
AIB-18	**How would future potential development of the nominated lease parcels impact cultural resources?** The CFO cultural heritage resources staff conducted a review of existing data in CFO and New Mexico Cultural Resource Information Systems (NMCRIS) paper and digital archaeological records to assess potential effects to

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	cultural resources resulting from the proposed oil and gas lease sale as well as the feasibility of avoiding, minimizing, or mitigating effects to cultural resources during future lease development (i.e. APDs, pipelines, overhead electric lines, access roads). For each parcel, the archaeological records review identified historic properties, traditional cultural properties (TCPs), sacred sites, and traditional use areas within the areas of potential effect (APE) for direct and indirect effects. As drilling in the CFO is generally vertical rather than directional or horizontal, there is no expectation that direct or indirect impacts would extend much beyond the nominated lease parcels. As such the APE for the oil and gas lease sale is defined as the boundaries of the nominated lease parcels. Approximately 9.3 percent of the 3415.52 acres nominated have been inventoried for cultural resources. A total of 15 previously recorded archaeological sites are documented within the nominated 10 lease parcels. According to available records, one (1) site is eligible for listing in the NRHP under criteria D, 9 need further evaluation, and five (5) are not eligible for listing in the NRHP. As such, 10 sites are currently managed as historic properties. Based on current inventory, known cultural resources occur at a rate of approximately one (1) historic property per every 318.06 acres. Based on the density of currently known historic properties as well as the fact that the proposed oil and gas lease sale does not directly authorize ground disturbance, the CFO cultural heritage resources specialists determined that there would be no Historic Properties affected at this time in the 10 parcels as a result of the proposed lease sale. State Historic Preservation Officer (SHPO) concurred with our effects finding on July 1, 2019. Please refer to Section 4.3 for additional detail. The determination of effect for the proposed oil and gas lease sale is contingent on conducting future compliance with Section 106 of the NHPA (54 U.S.C. 306108) for all actions proposed partially or entirely within the nominated lease parcels. Future Section 106 compliance would allow for identification, evaluation, and treatment of cultural resources, thereby allowing for avoidance, minimization, and/or mitigation of effects to cultural resources. This can include moving and/or siting well pads and attendant infrastructure away from historic properties. As proponents may use directional and horizontal drilling to access desired resources, avoidance is preferred and should be possible. In addition, Parcels 5, 6, 7, and 8 are within an area encompassing approximately 1,550,000 acres identified in the Permian Basin Programmatic Agreement (PBPA). The PBPA is an alternative Section 106 compliance process available to lessees operating within the 1,550,000 acres. Contingent on avoidance of cultural resources managed as historic properties, the lessee may expedite project implementation by paying into an archaeological research fund instead of completing an archaeological inventory. All parcels assessed under this EA have been assigned the National WO-NHPA Lease Notice and the NM-11-LN Lease Notice. Combined, these notify lessees that all proposed actions shall comply with Section 106 of the NHPA (54 U.S.C. 306108) and Executive Order 13007, which require the lessee to ensure additional cultural resources analyses are completed prior to implementation. Such analyses shall be completed at the cost of the lessee. These analyses may include (but are not limited to) inventory and identification, evaluation, determinations of effect, SHPO consultation, Native American consultation, and resolution of adverse effects as necessary. The notices also inform the lessee that the BLM may require modifications to or not approve the proposed actions that are likely to adversely affect historic properties, TCPs, sacred sites, or traditional use areas for which no mitigation measures are possible. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. Such effects may include, but are not limited to, loss of or damage to cultural resources or contextual information (such as distribution of cultural resources) due to the development of oil and gas facilities and related industrial development, increased vehicular traffic, unauthorized ground disturbances, inadvertent oil spills, erosion, and unauthorized collection. The magnitude of cumulative impacts would generally depend upon the location of reasonably foreseeable development relative to the location of cultural resources and the degree to which the setting has already been impacted. Impacts from some reasonably foreseeable development would be addressed through the PBPA; other reasonably foreseeable development would require separate NHPA processes to avoid, minimize, and/or mitigate effects to cultural resources.
AIB-19	**How would future potential development on the nominated lease parcels impact Native American Traditional Cultural and Religious Concerns?** The BLM CFO initiated government-to-government consultation under NEPA and NHPA on May 21, 2019, as described in Section 4.2 of this EA. No specific Native American traditional cultural and religious concerns have been identified on the subject lease parcels. However, this consultation is considered ongoing. If the nominated lease parcels are leased, future potential development would go through separate NEPA and NHPA processes as directed by regulation and current policy.

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	The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. Such effects may include, but are not limited to, loss of or damage to Native American religious use or gathering areas, or access to these areas due to the development of oil and gas facilities and related industrial development, increased vehicular traffic, unauthorized ground disturbances, inadvertent oil spills, or erosion. The magnitude of cumulative impacts would generally depend upon the location of reasonably foreseeable development relative to areas of concern to Native Americans. Reasonably foreseeable development on federal lands would undergo the same type of consultation process discussed above.
AIB-20	**How would future potential development on the nominated lease parcels contribute risks to human health and safety?** Within the PDO there are approximately 38,500 well bores of all well types across all land jurisdiction. That level of development has resulted in the following public health and safety related risks: occasional fire starts; spills of hazardous materials, hydrocarbons, produced water or hydraulic fracturing fluid (See Appendix F) and corresponding potential contamination of air, soil, or water; traffic congestion and collisions from commercial vehicles and heavy use especially south and east of Carlsbad along NM State Road 128 and U.S. Route 285; infrequent industrial accidents, presence of hydrogen sulfide (H_2S); or increased levels of fugitive dust (PM_{10}). When authorizing development, federal and state laws, regulations, and policy are applied to reduce effects or respond to incidents. These include: • Federal, state, county and municipal fire managers coordinate on fire response and mitigation. • Developers installing and operating oil and gas wells, facilities, and pipelines would be responsible for complying with the applicable laws and regulations governing hazardous materials and following all hazardous spill response plans and stipulations. The NMOCD requires similar spill response measures after release of hydrocarbons, produced water, or hydraulic fracturing fluids (see Appendix F for more information on spills). • All well pads, vehicles, and other workplaces must comply with worker safety laws as stipulated by OSHA • Vehicular traffic and pipelines are regulated according to safety laws as stipulated by the Department of Transportation. • Risks related to H2S exposure include measures to flare or vent gas and require the use of stock tank vapor recovery systems. • See Air Quality analysis (Section 3.5.1) for more information regarding projected levels of fugitive dust and relevant mitigation. Future potential development on the nominated lease parcels is estimated to be 94 new wells for this lease sale. This is a 0.244% increase in addition to 38,500 wells. This incremental addition would proportionately sustain or increase risks to safety and human health within the PDO. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. No formal human health assessment for past, present, or future development has been performed. Ongoing and future development would continue to present cumulative risks to human health as detailed above. When wells reach the end of their useful life and are properly plugged and reclaimed, they would no longer contribute to these effects.
AIB-22	**What are the potential impacts from oil and gas leasing and future potential development on socioeconomics?** In general, socioeconomic impacts are of a cumulative nature. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. The oil and gas industry has been a substantial contributor to the social setting and economic basis of the BLM Pecos District for decades. While the act of leasing Federal minerals itself would not result in direct social impacts, subsequent development of a lease may generate impacts to communities and individuals in the vicinity of the lease. At the lease sale stage, it is unknown where, or if, development will occur in any given lease parcel. Potential impacts could include impacts to employment opportunities related to the oil and gas and service support industries in the region, as well as impacts to Federal, State and County governments related to taxes, royalty payments, and other revenue streams. For example, the revenue collected from the lease sale auction is split between the U.S. Treasury and the state in which the auction is held and can be used for improvements to transportation networks and education systems. Oil and gas lease sales may contribute to employment for area residents, continued demand for oil and gas industry related goods and services, and continued demand for support goods and services. This continued

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	demand may contribute to stability in employment in sectors outside of the oil and gas industry. To the extent that additional oil and gas development impacts recreational and tourism opportunities in the area of the lease parcels, there may be related impacts in these economic sectors. Continued expansion of the oil and gas industry may be perceived as having a negative effect on quality of life considerations for people who value undeveloped landscapes, opportunities for isolation, and activities such as wildlife viewing and cattle ranching.
AIB-23	**How would future potential development of the nominated lease parcels contribute to the social cost of carbon?** The EA does not undertake an analysis of the social cost of carbon because 1) it is not engaged in a rulemaking for which the protocol was originally developed; 2) the interagency working group, technical supporting documents, and associated guidance have been withdrawn; 3) NEPA does not require cost-benefit analysis; and 4) the full social benefits of coal-fired energy production have not been monetized, and quantifying only the costs of GHG emissions but not the benefits would yield information that is both potentially inaccurate and not useful. See Appendix E for further explanation.
AIB-24	**How would future potential development of the nominated lease parcels impact cave and karst resources?** Lease parcels 1, 2, 3, and 4 are located within the mapped high karst occurrence potential zone, which is defined as an area that contains a high frequency of significant caves and karst features such as sinkholes and bedrock fractures that provide rapid recharge of karst aquifers. No documented caves or karst features have been identified within lease parcels 2-4. Within Parcel 1, over 50 known features have been documented within Section 27 and 5 features have been documented in Section 26; satellite imagery suggests Parcel 1 may contain over 120 karst and/or playa features. Approximately 561 acres (37%) of Parcel 1 overlaps the CFO Critical Karst Resource Area. However, full surveys have not been conducted and unknown features and undocumented caves are likely to exist due to the distribution of soluble rocks in the shallow subsurface. The remainder of the lease parcels are located in low karst occurrence potential area and have a low likelihood of encountering karst features during activities associated with future potential development. The PDO has identified lease parcels 1-4 as potential high cave or karst occurrence areas and the PDO assigned the attendant Cave and Karst Lease stipulation (SENM-S-21) and Lease Notice-1 (LN-1) to those parcels. Development in the area of cave and karst resources on these lease parcels would be further reviewed and mitigated at the lease development level per standard terms and conditions. See Appendix A for lease stipulations. Past oil and gas development in high and medium karst occurrence potential zones has resulted in the intersection of subterranean voids during construction resulting in damage to equipment, loss of infrastructure, bit drops, losses of drilling medium and cement during drilling and casing, respectively. Losses of circulation during drilling and cementing introduces foreign materials into the subterranean environment, while the opening of subterranean voids could change airflow patterns within a cave system that negatively impact the cave ecosystem and compromise the structural integrity of the cave passage. Past oil and gas development within the analysis area for cave and karst resources has been fairly limited to date. Section 3.3 presents an overall cumulative effect scenario for the larger analysis area of the New Mexico portion of the Permian Basin. While it is not possible to reliably predict exactly where that future development would occur, it is likely that development will continue to encroach on cave and karst resources. Effects from reasonably foreseeable future development are anticipated to be the same as the effects documented above. The cumulative impact scenario described in Section 3.3 provides a quantitative overview of past, present, and reasonably foreseeable development that has or would occur within the analysis area. Future potential development under the proposed action would contribute 0.1%, incrementally, to the combined effects of past, present, and reasonably foreseeable future actions. As noted above, oil and gas development within a karst terrain has the potential to create both short-term and long-term negative impacts to freshwater aquifers and cave systems. While a number of measures can be implemented to mitigate many impacts, it is still possible for impacts to occur from containment failures, well blowouts, accidents, spills, and structural collapses. It is therefore necessary to implement long-term monitoring studies to determine if current mitigations are sufficient enough to prevent long-term impacts. Mitigation measures could include changes in drilling operations, special casing and cementing programs specific to cave and karst features, and modifications in surface activities. A complete list of mitigation measures can be found in Appendix 3, Practices for Oil and Gas Drilling and Production in Cave and Karst Areas, within the Carlsbad Resource Management Plan Amendment of 1997. In the past year, the Carlsbad Field Office (CFO) has received five (5) reports of subsurface voids opening during construction (powerline, pipeline and facility pad) and exploration activities (two seismic surveys) in

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	areas where there were no known sinkholes or caves. None of these events resulted in reported contamination events of groundwater.

3.5. Issues Analyzed in Detail

The four issues identified for detailed analysis in this EA were developed in accordance with CEQ regulations and the guidelines set forth in the BLM NEPA Handbook H-1790-1) (BLM 2008) using input from internal and external scoping. Issues were retained for detailed analysis if that analysis is necessary to make a reasoned choice between alternatives; to determine significance; or if there is disagreement about the best way to use a resource, or conflict between resource impacts or uses.

3.5.1. Issue 1: How would air quality (particularly with respect to National Ambient Air Quality Standards [NAAQS] and volatile organic compounds [VOCs]) in the analysis area be affected by emissions generated as a result of the future potential development of nominated lease parcels?

The analysis area for this issue is the entirety of Lea, Eddy, and Chaves counties. This analysis area was selected because data on air quality emissions are collected at a county level, and the nominated lease parcels fall within these three counties. Much of the information 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) (BLM 2018a).

Methodology and assumptions for calculating air pollutants 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 horizontal oil well. The calculators give an approximation of criteria pollutant, hazardous air pollutants (HAPs), and GHGs emissions to be compared with regional and national emissions levels. Also incorporated into this document are the sections describing the assumptions used in developing the inputs for the calculator (BLM 2018a).

Affected Environment

The U.S. Environmental Protection Agency (EPA) has the primary responsibility for regulating air quality, including six nationally regulated ambient air pollutants of carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O3), particulate matter equal to or less than 10 microns in diameter (PM_{10}), particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). The EPA has established NAAQS for criteria pollutants that are protective of human health and the environment. The EPA has approved New Mexico's State Implementation Plan and the State enforces State and Federal air quality regulations on all public and private lands.

"Design Values" are the concentrations of air pollution at a specific monitoring site that can be compared to the NAAQS. The most recent design values for criteria pollutants within Eddy and Lea Counties are listed below in Table 3.3 (EPA 2018a). These counties do not have monitoring data for CO, Pb, and particulate matter concentrations, but because the counties are relatively rural, it is likely that these pollutants are not elevated. Between 2014 and 2017, average estimated concentrations of PM_{10} in Lea County were not listed and it is assumed that monitoring has been discontinued with approval from EPA because the affecting sources have been shut down.

Table 3.3. 2017 Design Values in Eddy and Lea Counties (EPA 2018a)

Pollutant	2017 Design values	Averaging Time	NAAQS	NMAAQS[e]
O_3	0.068 parts per million (ppm) (Eddy County) 0.067 ppm (Lea County)	8-hour	0.070 ppm[a]	
NO_2	3 parts per billion (ppb) (Eddy County) 4 ppb (Lea County)	Annual	53 ppb[b]	50 ppb
NO_2	24 ppb (Eddy County), 32 ppb (Lea County)	1-hour	100 ppb[c]	
$PM_{2.5}$[d]	9 micrograms per cubic meter (µg/m^3) (Lea County)	Annual	12 µg/m^3[d]	
$PM_{2.5}$[d]	17 µg/m^3 (Lea County)	24-hour	35 µg/m^3[c]	

a Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years

b Not to be exceeded during the year

c 98th percentile, averaged over 3 years

d Annual mean, averaged over 3 years

e The New Mexico Ambient Air Quality Standards (NMAAQS) standard for Total Suspended Particulates (TSP), which was used as a comparison for PM_{10} and $PM_{2.5}$, was repealed as of November 30, 2018.

h While there are no NAAQS for hydrogen sulfide (H_2S), New Mexico has set 1/2-hour standards for H_2S at 0.100 ppm within Pecos-Permian AQ Control Region and 0.030 pp, for municipal boundaries and within five miles of municipalities with populations greater than 20,000 in areas of the state outside of the area within 5 miles of the (BLM 2018a).

While all of the analysis area is in attainment of all NAAQs, including ozone, the site at 2811 Holland Street in Eddy County is the most closely watched due to the current design value of 0.068 ppm. The Carlsbad Caverns National Park is listed as having a monitor; however, the design value was not considered valid. While 0.68 is considered below the attainment value of 0.070 ppm, it is the highest design value of the monitoring stations in Eddy and Lea Counties. The potential amounts of ozone precursor emissions of nitrogen oxide(s) (NOx) and VOCs from the proposed lease sale are not expected to impact the current design value for ozone in Chaves, Eddy, and Lea Counties under the Proposed Action; however, more information at the development stage will provide more information to better estimate air emissions from a specific project.

The Ozone Attainment Initiative is a project authorized by State Statute, 74-2-5.3 New Mexico Statutes Annotated 1978. This statute directs the New Mexico Environment Department to develop plans that may include regulations more stringent than Federal rules for areas of the state in which ambient monitoring shows ozone levels at or above 95% of the NAAQS. Currently, both Lea and Eddy Counties are within 95% of the 2015 ozone standard of 70 ppb.

Air quality in a given region can also 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 (100–150), unhealthy (>150), very unhealthy, and hazardous. The AQI is a national index; therefore, the air quality rating and the associated level of health concern is the same throughout the country. The AQI is an important indicator for populations sensitive to air quality changes (EPA 2018b).

AQI values for Chaves County were mainly in the good range (AQI <50) in 2017, with 94% of the days that had an AQI in that range. The median AQI in 2017 was 14, which indicates “good” air quality. The maximum AQI in 2015 was 112, which is “unhealthy for sensitive groups,” and the 90th percentile was 31.5, which is “good” air quality (EPA 2018b).

AQI values for Eddy County were generally in the good range (AQI <50) in 2017, with 67% of the days in that range and 30% of the days in the “moderate” air quality range. The median AQI in 2017 was 45,

which indicates "good" air quality. The maximum AQI in 2015 was 140, which is "unhealthy for sensitive groups," and the 90th percentile was 80, which is "moderate" air quality (EPA 2018b).

AQI values for Lea County were generally in the good range (AQI <50) in 2017, with 67 percent of the days in that range and 32% of the days in the "moderate" air quality range. The median AQI in 2017 was 45, which indicates "good" air quality. The maximum AQI in 2015 was 133, which is "unhealthy for sensitive groups," and the 90th percentile was 68, which is "moderate" air quality (EPA 2018b). Table 3.4 lists the days where the AQI was "unhealthy for sensitive groups" or worse for the past 10 years. While there are some exceedances, the exceedances do not represent a trend of degrading AQIs.

Table 3.4. Number of Days Classified as "Unhealthy for Sensitive Groups" (AQI 101–150) or Worse (EPA 2018b)

Location	Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Chaves County	Days	0	0	0	0	0	1	0	0	0	1
Eddy County	Days	9	2	2	7	10	2	4	0	0	10
Lea County	Days	0	3	0	7	1	2	3	1	0	4

The primary sources of air pollution in the PDO are dust from blowing wind on disturbed or exposed soil, exhaust emissions from motorized equipment, oil and gas development, agriculture, and industrial sources. Table 3.5 shows total human-caused emissions for each of the counties in the PDO based on EPA's 2014 emissions inventory in tons/year (EPA 2014).

The Western States Air Resources Council -Western Air Regional Partnership (WESTAR-WRAP) conducted an oil and gas emissions inventory report for base year 2014 to further clarify the contributions of oil and gas activities to human-caused emissions within the Permian and San Juan basins. The results indicate there are non-point sources, including fugitive components, pneumatic devices, pumps, and well blowdown events, that may not be reported through the state and federal inventories. These nonpoint sources could represent greater criteria, HAPs, and GHG emissions within these basins, in particular VOC and NOx emissions that contribute to ozone formation. It is therefore believed that the 2014 NEI data in Table 3.5 related to petroleum and related industries is underreported in terms of VOC and NOx emissions. Table 3.5 provides a comparison of NEI and WESTAR-WRAP datasets. As shown in the table, a comparison of datasets indicates that oil and gas development-related NOx and VOC emissions may be underreported by approximately 58 and 7 percent, respectively.

Table 3.5. Human-Caused Emissions in the Counties of the Analysis Area (EPA 2014 and WESTAR-WRAP Data)

County (Chavez, Eddy and Lea)	NOX	CO	VOC	PM_{10}	$PM_{2.5}$	SO_2
2014 NEI -All sources	29,482	50,227	115,793	42,085	6,021	1,886
2014 NEI -Petroleum & related industries	12,261	-	107,705	-	-	-
WESTAR-WRAP 2014 O&G Sources	30,351	-	115,793	-	-	-

Source: EPA 2014 and Ramboll Environ 2017.

Note: Values include Tier 1 summaries for each county, including combustion, industrial, onroad/nonroad, and miscellaneous sectors. Biogenic sources are not included.

Only precursor pollutants to ozone formation compared in this analysis (NOx and VOC).

The Air Resources Technical Report discusses the relevance of HAPs to oil and gas development and the particular HAPs that are regulated in relation to these activities (BLM 2018a). The EPA conducts a periodic National Air Toxics Assessment (NATA) that quantifies HAP emissions by county in the United States. The purpose of the NATA is to identify areas where HAP emissions result in high health risks and further emissions reduction strategies are necessary. The EPA has identified 187 toxic air pollutants as HAPs.

The 2005 NATA identifies census tracts with estimated total cancer risk greater than 100 in a million. There are no census tracts in New Mexico with estimated total cancer risk greater than 100 in a million. Southeastern New Mexico has a total respiratory hazard index that is among the lowest in the United States.

Environmental Impacts

Future potential development of the nominated lease parcels would include increased criteria pollutant emissions, including increased particulate matter released from new well pads or roads, exhaust emissions from drilling equipment, compressor engines, vehicles, flares, dehydration and separation facilities, and VOCs during drilling and production activities. As stated above, the most substantial criteria pollutants emitted by oil and gas development and production are VOCs, particulate matter, and NO_2. Future potential development on the nominated lease parcels is estimated at approximately 94 horizontal wells across all nominated lease parcels (see Table 2.2 for a listing of the number of horizontal wells anticipated per parcel). Table 3.6 shows estimated emissions and percent increase from existing conditions resulting from future development of the lease parcels.

Table 3.6 Percent Increase from Future Potential Development of the Lease Parcels

	Lease Sale Emissions (Tons per Year)					
	PM_{10}	**$PM_{2.5}$**	**NOx**	**SO_2**	**CO**	**VOC**
Human-caused Current Emissions (Chaves, Eddy and Lea counties)	40,085	6,021	29,482	1,886	50,227	115,793
One well emissions	*5.31*	*0.81*	*6.19*	*0.11*	*2.63*	*1.17*[b]
Total Emissions from Lease Sale (94 wells)	499.14	76.14	581.86	10.34	247.22	109.70
Percent Increase	1.25%	1.26%	1.97%	0.55%	0.49%	0.09%

[a] The representative well used to calculate emissions is a horizontal oil well. Emissions for vertical wells were not used from this analysis due to current predominance in horizontal technological drilling methods and because presenting horizontal oil wells emissions estimates represents a more conservative summary of emissions, compared with emissions from a vertical well, with the exception of SO_2, which could be 4 to 5 times greater in a vertical well scenario. However, sulfur dioxide emissions are still estimated to be within the same magnitude and less <1 ton per year of SO_2 emissions per well. See Appendix G for additional discussion of emission factors.

[b] VOC emissions at the operational phase represent a 95% control efficiency and estimates potential emissions representing the contribution for "one oil well" from the emissions at storage tanks, gathering facilities, etc.

To facilitate quantification in the analysis, this analysis assumes that all parcels would be developed concurrently and in the same year, though it is more likely that future potential development would not occur in this manner. Emission estimates for construction, operations, maintenance and reclamation are included in Table 3.6 for a one-well scenario. Construction emissions for both an oil and gas well include well pad construction (fugitive dust), heavy equipment combustive emissions, commuting vehicles and wind erosion. Emissions from operations for an oil well include well workover operations (exhaust and fugitive dust), well site visits for inspection and repair, recompletion traffic, water and oil tank traffic, venting, compression and well pumps, dehydrators and compression station fugitives. Operations emissions for a gas well include well workover operations (exhaust and fugitive dust), wellhead and

compressor station fugitives, well site visits for inspection and repair, recompletions, compression, dehydrators, and compression station fugitives. Maintenance emissions for both oil and gas wells are for road travel, and reclamation emission activities are for interim and final activities and include truck traffic, a dozer, blade, and track hoe equipment.

Emissions are anticipated to be at their highest level during the construction and completion phases of implementation (approximately 30 days in duration) because these phases require the highest degree of earth-moving activity, heavy equipment use, and truck traffic, compared with the operations and maintenance phases of implementation. Emissions are anticipated to decline during operations and maintenance as the need for earth-moving and heavy equipment declines. This incremental addition would not be expected to result in an exceedance of the NAAQS or State air quality standards for any criteria pollutants in the analysis area because the addition of criteria pollutants and VOCs, as shown in Table 3.6, represent less than or equal to a 1.97% increase.

VOCs and NO_2 contribute to the formation of O_3, which is the pollutant of most concern in northwestern New Mexico and because O3 is not a direct emission, emissions of NOx and VOCs are used as a proxy for estimating O_3 levels. Under the Proposed Action, the additional NO_2 and VOCs emitted from any oil and gas development on these specific lease parcels (as quantified in Appendix G) are anticipated to be too small in quantity to result in exceedances of O_3 in the analysis area. For many processes it is assumed that emission of HAPs will be equivalent to 10% of VOC emissions. Therefore, the estimated HAP emissions of 10.97 tons/year should be considered a very gross estimate.

Under the Proposed Action, one of the primary sources of particulate matter emissions would be from construction of future potential development of the nominated lease parcels where dust and fine particulates are generated by on-site equipment and activities, as well as off-site vehicles (Araújo et al. 2014; Reid et al. 2010). How particulate matter interacts with the environment is dependent on a variety of factors, with the size and chemical composition of the airborne particles being the most important in terms of dispersion (distance from the source) and deposition from the atmosphere. Impacts of particulate matter emissions would not be confined to the construction site because $PM_{2.5}$ (fine particles) can travel farther in terms of distance than PM_{10} (dust) and other total suspended particulates (particles of sizes up to 50 micrometers) and therefore can impact local residents in the surrounding area (Araújo et al. 2014).

While impacts to air quality on a broad-scale in the analysis area would be small, the Proposed Action would result in localized impacts to air quality for nearby residences from emissions of particulate matter, VOCs, and HAPs. In the absence of precipitation, $PM_{2.5}$ can travel great distances (thousands of kilometers) can remain in the atmosphere for several days, while PM_{10} (and larger) settles within hours of being released into the atmosphere and is generally dispersed over much shorter distances (i.e., closer to the source) due to larger particle size (Araújo et al. 2014). As stated above, air quality is dependent not only on the quantity of air pollutants, but also environmental conditions (humidity, wind direction and speed, temperature) that influence concentration and/or dispersion of particulate matter.

Because the primary source of criteria pollutants, VOC, and HAP emissions would be from construction and completion from future potential development of the nominated lease parcels, the Proposed Action would result in short-term increases in these emissions, lasting an average of 30 days. Exposure to criteria pollutant emissions—particularly $PM_{2.5}$ and PM_{10}—VOCs, and O3 (as a secondary emission) would pose a temporary nuisance for those living near the future oil and gas development. While levels of HAPs would also increase during construction and completion activities under the Proposed Action, these levels would be low relative to the distance from the source and would not pose a risk to human health (including cancer) because there would be no long-term exposure to elevated levels of toxic air pollutants.

Cumulative Impacts

Current estimated emissions across the analysis area are reported above and air quality across the analysis area is generally good based on AQI ratings over the last decade (see Table 3.4). Current estimated emissions and AQI ratings are reflective of the effects of past and present actions. While there are other sources of emissions in the PDO, oil and gas development is one of the most prominent source of emissions. There are approximately 38,501 active oil and gas wells in the New Mexico Permian Basin. About 17,735 of the wells are Federal wells with the remainder falling in other jurisdictions (BLM 2018).

Over the last 5 years, there have been a total of 2,269 federal well completions in the Pecos District (Table 3.7).

Table 3.7 Past and Present Federal Well Completions

Number of Federal Well Completions	2014	2015	2016	2017	2018
Pecos District	584	400	389	378	518

As with past and present actions, continued oil and gas development is the most prominent reasonably foreseeable future action affecting air quality in the PDO. The 2012 and 2014 RFD scenario estimates that there could be an additional 16,000 wells drilled by 2035 (Engler and Cather 2012, 2014). The supplemental white paper Cumulative BLM New Mexico Greenhouse Gas Emissions (BLM 2019) provides information related to the reasonably foreseeable development for the PDO Planning area. Reasonable foreseeable development (2016-2035) shows well development with an average of 320 federal wells per year and 6,400 cumulative federal wells. The number of average wells, 320, is multiplied by the pollutant emission factor from Appendix G for a gas well scenario to calculate reasonably foreseeable emissions related to well development in 2019 (Table 3.8). HAP emissions are generally estimated at about 10% of VOCs, or about 37.4 tons/year. HAP emissions reported should be considered a very gross estimate and likely an overestimate. The emissions are a combination of HAP constituents existing in natural gas and released during the completion and operation process. Most gas vented during the completion process is flared, which substantially reduces the quantity of HAPs released.

Table 3.8 Percent Increase from RFD Oil and Gas Well Development

	Lease Sale Emissions (Tons per Year)					
	PM_{10}	**$PM_{2.5}$**	**NOx**	**SO_2**	**CO**	**VOC**
Human-caused Current Emissions (Chaves, Eddy and Lea counties)	40,085	6,021	29,482	1,886	50,227	115,793
One-well emissions[a]	*5.31*	*0.81*	*6.19*	*0.11*	*2.63*	*1.17*[b]
Total Emissions for 2019 Reasonably Foreseeable Well Development (320 wells)	1,699.2	259.2	1,980.8	35.20	841.6	374.4
Percent Increase	4.23%	4.30%	6.72%	1.87%	1.68%	0.32%

[a] The representative well used to calculate emissions is a horizontal gas well. Emissions for vertical wells were not used from this analysis due to current predominance in horizontal technological drilling methods and because presenting horizontal gas wells emissions estimates represents a more conservative summary of emissions, compared with emissions from a vertical well, with the exception of SO_2, which could be 4 to 5 times greater in a vertical well scenario. However, sulfur dioxide emissions are still estimated to be within the same magnitude and less <1 ton per year of SO_2 emissions per well. See Appendix G for additional discussion of emission factors.

[b] VOC emissions at the operational phase represent a 95% control efficiency and estimates potential emissions representing the contribution for "one oil well" from the emissions at storage tanks, gathering facilities, etc.

The future potential development of the nominated lease parcels associated with the Proposed Action comprises 0.39 percent of the RFD. When combined with the impacts of past, present, and reasonably foreseeable future actions, the future potential development of the nominated lease parcels under the Proposed Action would incrementally contribute to increases in air quality emissions. As with the Proposed Action, emissions are anticipated to be at the most acute level during the construction and completion phases of implementation; however, because the timing of well development varies. Localized and short term impacts to air quality for nearby residences from emissions of particulate matter, NOx, VOCs, and HAPs is expected. However, because well development varies (i.e. permit approval, well pad construction, spudding, and completion) the phases of development may not occur in succession but may be spread out in development over time. As such. the incremental addition of criteria pollutants and VOCs would not be expected to result in any exceedances of the NAAQS or NMAAQS for any criteria pollutants in the analysis area.

An Air Resources Technical Support Document (ARTSD; URS 2013) was prepared to analyze potential air quality impacts resulting from the RFD. This effort included atmospheric dispersion and photochemical grid modeling to predict concentrations of specific pollutants in and around the Carlsbad Field Office (in which most of the Pecos District oil and gas activity occurs). The results of ARTSD analysis indicate that air quality impacts from the RFD, while noticeable, are generally acceptable. Most predicted criteria pollutant concentrations are well below the NAAQS throughout the extensive modeling domains included in this analysis. While no exceedances of NAAQS were predicted from the modeling of federal wells associated with the RFD (6,400 wells), consideration of the entire RFD and other reasonably foreseeable future actions (i.e., cumulative impacts) in the ARTSD included predictions of pollutant concentrations approaching or exceeding the NAAQS (for ozone, PM2.5 and potentially SO2) and indicate the need for additional ambient monitoring data, refined modeling, and consideration of additional mitigation measures. Most of the areas where NAAQS would be exceeded are out of the Carlsbad Field Office (URS 2013).

Mitigation Measures and Residual Effects

The EPA has promulgated air quality regulations for completion of hydraulically fractured gas wells. These rules require air pollution mitigation measures that reduce the emissions of VOCs during gas well completions. Based on its authority under the standard terms and conditions, the BLM requires 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 a requirements for watering of dirt roads during periods of high use to reduce fugitive dust emissions, collocation of wells and production facilities to reduce new surface disturbance, implementation of directional and horizontal drilling and completion technologies whereby one well provides access to petroleum resources that would normally require the drilling of several vertical wellbores, suggestions that vapor recovery systems be maintained and functional in areas where petroleum liquids are stored, and performing of interim reclamation to revegetate areas not required for production facilities and reduce the amount of fugitive dust.

In addition, the BLM encourages industry to participate in the Natural Gas STAR program that is administered by the EPA. The Natural Gas STAR program is a flexible, voluntary partnership that

encourages oil and natural gas companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce natural gas emissions (EPA 2006).

3.5.2. Issue 2: How would the future potential development of nominated lease parcels contribute to greenhouse gas (GHG) emissions?

The analysis areas associated with this issue are the state of New Mexico, the United States, and the globe. These geographic scales are used in this analysis to provide multiple levels of context associated with GHG emissions as a result of leasing and future potential oil and gas development of the nominated lease parcels. In addition, the effects of GHG emissions are global in nature.

Affected Environment

Climate change is a statistically significant and long-term change in climate patterns. The terms climate change and "global warming," though often used interchangeably, are not the same. Climate change is any deviation from the average climate via warming or cooling and can result from both natural and human (anthropogenic) sources. Natural contributors to climate change include fluctuations in solar radiation, volcanic eruptions, and plate tectonics. Global warming refers to the apparent warming of climate observed since the early twentieth century and is primarily attributed to human activities such as fossil fuel combustion, industrial processes, and land use changes.

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 a proposed land management action cannot be accurately translated into effects on climate change globally or in the area of any site-specific action. Currently, Global Climate Models are unable to forecast local or regional effects on resources (IPCC 2013). However, there are general projections regarding potential impacts to natural resources and plant and animal species that may be attributed to climate change from GHG emissions over time; however, these effects are likely to be varied, including those in the southwestern United States (Karl 2009).

Climate change projections are based on a hierarchy of climate models that range from simple to complex, coupled with comprehensive Earth System Models. Additional near-term warming is inevitable due to the thermal inertia of the oceans and ongoing GHG emissions. A more detailed discussion of climate change and the relationship of GHGs to climate change as well as the intensity and effects on national and global climate is presented in the Air Resources Technical Report (BLM 2018) and the supplemental white paper, Cumulative BLM New Mexico Greenhouse Gas Emissions Report (BLM 2019).

The following information about GHGs, their relationship to climate change, and their effects on national and global climate is presented in the Air Resources Technical Report (BLM 2018), and briefly summarized here: Findings indicate that warming of the climate system is unequivocal and many of the observed changes are unprecedented over decades to millennia. It is certain that Global Mean Surface Temperature (GMST) has increased since the late 19th century and virtually certain that maximum and minimum temperatures over land have increased on a global scale since 1950. Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes. It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. Additional near-term warming is inevitable due to the thermal inertia of the oceans and ongoing GHG emissions, and the GMST is expected to continue rising over the 21st century under all of the projected scenarios. Climate change will impact regions differently and warming will not be equally distributed. Data indicate that in the region encompassing southern Colorado and New Mexico, average

temperatures rose just under 0.7 degrees Fahrenheit per decade between 1971 and 2011, which is approximately double the global rate of temperature increase. Climate modeling suggests that average temperatures in this region may rise by 4-6 degrees Fahrenheit by the end of the 21st century, with warming increasing from south to north. By 2080-2090, the southwestern U.S. will see a 10-20% decline in precipitation, primarily in winter and spring, with more precipitation falling as rain. A recent Bureau of Reclamation report made the following projections through the end of the 21st century for the Upper Rio Grande Basin (Southern Colorado to central southern New Mexico) based on the current and predicted future warming:

- There will be decreases in overall water availability by one quarter to one third.
- The seasonality of stream and river flows will change with summertime flows decreasing.
- Stream and river flow variability will increase. The frequency, intensity and duration of both droughts and floods will increase (BLM 2018).

The natural greenhouse effect is critical to the discussion of climate change. The greenhouse effect refers to the process by which GHGs in the atmosphere absorb heat energy radiated by Earth's surface. Water vapor is the most abundant GHG, followed by carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), and several other trace gases. These GHGs trap heat that would otherwise be radiated into space, causing Earth's atmosphere to warm and making temperatures suitable for life on Earth. Water vapor is often excluded from the discussion of GHGs and climate change since its atmospheric concentration is largely dependent upon temperature rather than emissions by specific sources. The two primary GHGs associated with the oil and gas industry are CO2 and CH4. Because CH4 has a global warming potential that is 21 to 28 times greater than the warming potential of CO2, the EPA uses measures of CO2 equivalent (CO2e), which take the difference in warming potential into account for reporting GHG emissions (BLM 2018). Oil and gas field production activities do not substantially contribute to N2O levels and are therefore not included in estimating potential emissions in this EA.

The following information regarding 2014 GHG national and New Mexico GHG emissions are is presented in the *Cumulative BLM New Mexico Greenhouse Gas Emissions Report* (BLM 2019), and briefly summarized here:

- In 2014, end-use combustion & extraction (C&E) of fossil fuels produced on U.S. federal lands was 1,332 million metric tons (MMT) of carbon dioxide equivalent (CO_2e). This reported value includes emissions from the combustion of coal, oil and natural gas from fossil fuels produced on U.S. federal lands as well as extraction emissions from activities occurring on federal lands (Merrill et al. 2018).
- When compared to global and national total CO_2e emissions (48,257 and 6,870.5 MMT respectively, from all sources), the CO_2e emissions from these activities (end-use combustion and extraction activities) of fossil fuels produced on federal lands comprise 2.8% and 19.4% respectively of global and national emissions (World Resources Institute & EPA 2016).
- Of the 1,332 MMT CO2e, 80.53 MMT were exported end-use combustion emissions, 752.50 MMT represented emissions from coal sources while 498.76 MMT were the result of oil and natural gas sources (Merrill et al. 2018).
- In 2014 the U.S. federal lands on a national basis provided 283.2 MMT of carbon storage. U.S. federal lands sequestered an average of 195 MMT of CO2e between 2005 and 2014 offsetting approximately 15 percent of the CO2 emissions resulting from the extraction of fossil fuels on Federal lands and their end-use combustion (Merrill et al. 2018).
- In 2014, end-use combustion & extraction (C&E) of fossil fuels produced on New Mexico federal lands was 91.63 (MMT) of carbon dioxide equivalent (CO_2e). This reported value includes emissions from the combustion of coal, oil and natural gas from fossil fuels produced on federal

lands as well as extraction emissions from activities occurring on federal lands. When compared to 2005 emissions this results in increased emissions throughout all the three prominent GHG emissions. From 2005-2014 GHG emissions from end-use C&E of fossil fuels produced on federal lands have resulted in an average annual of 81.95 MMT of CO_2e). When compared to global and national total CO_2e emissions, CO_2e emissions from these activities (end-use combustion and extraction activities) of fossil fuels produced on New Mexico federal lands is 0.19% and 1.33% respectively (World Resources Institute 2017 & EPA 2016).

- In 2014 New Mexico federal lands provided 12 MMT of carbon storage. Federal lands sequestered an average of 9.5 MMT of CO2e between 2005 and 2014 (Merrill et al. 2018).

Table 3.11 shows estimated global emissions as well as GHG emissions for the United States, New Mexico, and the major oil and gas basins of New Mexico. Emissions are expressed in metric tons of CO_2e.

Environmental Impacts

Methodologies and Assumptions

Well Construction- Appendix D describes the phases associated with oil and gas development. As noted in the appendix, the construction phase includes development of the wellpad, roads, and associated infrastructure such as reserve pits, pipelines or fracturing ponds; well drilling and completion, which may include flaring. Based on past experience within oil and gas development in New Mexico, the BLM has determined that construction of an oil well would result in 578.89 metric tons CO_2e; and construction of a gas well would result in 1,125.79 metric tons CO_2e. The difference between the emissions associated with oil and gas wells is largely associated with the need additional venting during well completion.

Operation - Emissions from operations include well workover operations (exhaust and fugitive dust), well site visits for inspection and repair, recompletion traffic, water and oil tank traffic, venting, compression and well pumps, dehydrators, and compression station fugitives. The BLM used a top-down approach to estimate greenhouse gas emissions from oil and gas field operations based on EPA's national Greenhouse Gas Emissions Inventory and local oil and gas production as a percentage of U.S. production. This approach is outlined in detail in the BLM's Air Resources Technical Report (BLM 2018). It is assumed that the percentage of total U.S. oil and gas field operations is comparable to the percentage of total U.S. emissions from the oil and gas field operations sector. Therefore, annual emissions were estimated by taking the total oil and gas field operation emissions for the United States and total GHG emissions for the United States and applying field operation emission percentages to estimate annual emissions for the federal wells in the Permian Basin of New Mexico (see Table 3.10). This total of estimate emissions for the Permian Basin of New Mexico was then divided by the number of active wells (Federal) within the Permian Basin of New Mexico (17,735), which was estimated using GIS and the data from the Petroleum Recovery Research Center (BLM 2018a). The resulting estimated average annual GHG emissions per well in the Permian Basin of New Mexico is 126.81 metric tons of CO2e.

Well Development and Operation - Table 3.9 presents annual emission associated with historical federal well completions. Over the last 5 years, there have been a total of 2,269 new federal well completions in the Pecos District. Table 3.10 presents GHG emissions associated with lease development assuming full development of the nominated lease parcels (94 oil and natural gas wells). Table 3.10 also presents an average of estimated annual GHG emissions associated with historical federal well construction and operation from the number of well completions.

Table 3.9 Historical O&G Well Completions the Pecos District

Number of Well Completions	2014	2015	2016	2017	2018
Carlsbad Field Office	384	238	141	184	238
Roswell Field Office	7	1	4	2	8
Hobbs Field Office	193	161	244	192	272
Total	584	400	389	378	518
Metric Tons of CO_2e/year	731,517	501,039	487,260	473,482	648,846

Table 3.10. Estimated Annual GHG Emissions from O&G Well Construction and Operation

Annual GHG Emissions	Metric Tons (CO_2e)
Potential GHG Emissions from well Development (94 wells, Year 1 only)	105,824
Potential GHG Emissions from Production Phase (94 wells)	11,920
Total	117,744
Average GHG Emissions 2014-2018 Pecos District Planning Area (Includes Carlsbad, Roswell and Hobbs FOs)	568,429

Table 3.11. 2016 Estimated Annual GHG Emissions from Well Construction and Operation (World Resources Institute 2017, EPA 2018e).

Annual GHG Emissions	Million Metric Tons-per-year (MMT CO_2e)	% US Emissions	% of NM O&G Emissions
Global emissions, All sources	48,257	NA	NA
U.S emissions from All Sources	6,511	100	NA
U.S. emissions from O&G Field Production Activities	164	2.52	NA
New Mexico emissions from O&G Field Production Activities	6.8	0.10	100.00
BLM New Mexico emissions from O&G Field Production Activities	3.96	0.06	58.21
BLM San Juan Basin emissions from O&G Field Production (16,139 wells) *	1.68	0.03	24.71
BLM Permian Basin emissions from O&G Field Production (17,735 wells) †	2.25	0.03	33.10
Average GHG Emissions 2014-2018 Pecos District Office Planning Area (Includes Carlsbad, Roswell and Hobbs FOs)	0.57	0.88	8.38
GHG emissions associated with Proposed Action (Well Construction and Operation)	0.12	0.0018	1.76

* Includes federal mineral development in McKinley, Rio Arriba, Sandoval, and San Juan Counties (BLM 2018)

† Includes federal mineral development in Chaves, Eddy, Lea, and Roosevelt Counties (BLM 2018)

Note the value used for U.S. emissions from All Sources has different reporting values of 6,511 MMT of CO2e/year and 6,870 MMT of CO2e depending on the data year of the other data being compared. The differences will not change the order of magnitude of comparison.

Using the average annual gas well development emission value of 1,125.79 metric tons CO_2e per well as a maximum emissions scenario (see Methodologies and Assumptions, *Well Construction*), development of the wells associated with the leases would result in 105,824 metric tons of GHG emissions. Using the average annual oil and gas operation emission value of approximately 126.81 metric tons of CO_2e per well in the Permian Basin of New Mexico (see Methodologies and Assumptions, *Operation*), and multiplying by 94 wells yields an estimate of 11,920 metric tons CO_2e of annual production GHG emissions. Together, well construction and operation emissions would result in an increase of 0.0018% in the total annual U.S. GHG emissions and 1.76% of New Mexico O&G Field Production Activities (Table 3.11).

Downstream/End Use - Estimates of downstream/end use GHG emissions are dependent on projected oil and gas production volumes. The BLM does not direct or regulate the end use of produced oil and/or gas. The challenge for estimating downstream emissions comes with understanding when and how oil and gas would be distributed and used for energy. It can though be reasonably assumed that the oil and gas produced on the lease parcel will be combusted for energy consumption and use. End uses of hydrocarbons extracted from the potential development of the nominated lease parcels could include the combustion of transportation fuels, fuel oils for heating and electricity generation, the production of asphalt and road oil, and the manufacturing of chemicals, plastics, and other synthetic materials. The BLM can only provide an estimate of potential GHG emissions using national approximations of where or how the end use may occur.

The BLM has used a method of calculating downstream GHG emissions based on estimated production data developed for the proposed lease sale. GHG combustion emission factors, metric tons/bbl and metric tons/mcf for oil and gas respectively were applied to production volumes and converted to metric tons of CO_2 and CH_4. A global warming potential was then applied to CH_4 and finally a conversion to metric tons of CO_{2e} was made. GHG combustion emission factors for natural gas and petroleum were obtained from 40 CFR Part 98, Subparts A and C. Global warming potentials align with the IPCC and EPA 100-year GWPs.

Potential effects from GHG emissions would occur from any oil and gas development of the nominated lease parcels. These GHG emissions would contribute to documented ongoing and reasonably foreseeable climate-related effects. As discussed in Affected Environment, these effects include the following: long-term global temperature change; intensified droughts impacting agricultural, rural, and urban communities and resulting in changes in land cover and land use; intensified and more frequent of wildfires; sea level rise, ocean warming, and reduced ocean oxygen, impacting global weather patterns, and flora and fauna; intensified flooding impacting infrastructure, natural resource–based livelihoods, and cultural resources; and human health, such as heat-associated deaths and illnesses, chronic diseases, and other health issues associated with poor air quality (Gonzalez et al. 2018).

GHG emissions from the future potential development of the proposed lease parcels include emissions from development of any potential wells on the nominated lease parcels, production associated with the wells, and downstream/end use emissions from the consumption of oil and natural gas products.

Potential downstream/end use GHG emissions from the Proposed Action are estimated using oil and gas production values summarized in Table 2.2 (15,390,000 bbl of oil and 123,350,000 mcf of natural gas). Table 3.12 shows estimated downstream/end use GHG emission contributions for the Proposed Action

using the EPA's GHG equivalencies calculator (EPA 2018d). As noted in Methodologies and Assumptions, *Downstream/End Use*, the BLM does not direct or regulate the end use of produced oil and/or gas.

Table 3.12. Estimated Downstream/End-Use GHG Emissions for the Proposed Action

Product Category	Emission Factors	Estimated Product Quantity	Estimated Emissions (MT CO_2e of GHG)
Crude Oil (bbl)	0.43 MT CO_2/bbl	15,390,000	6,617,700
Natural Gas (mcf)	0.055 MT CO_2/mcf	123,350,000	6,749,481.94
Total			13,367,181.94

Source: EPA 2018c.

Table 3.13. Historical O&G production

Oil and Gas Production	2014	2015	2016	2017
U.S. Oil Production (Mbbls)	3,196,889	3,442,188	3,232,025	3,413,376
New Mexico Oil Production (Mbbls)	125,021	147,663	146,389	171,440
PDO Oil Production (Mbbls)	62,007	73,344	74,810	76,307
BLM Mancos Gallup Planning Area Oil Production (Mbbls)	5,755	8,457	6,889	5,980
U.S. Gas Production (MMcf)	25,889,605	27,065,460	26,592,115	27,291,222
New Mexico Gas Production (MMcf)	1,140,626	1,151,493	1,139,826	1,196,514
BLM Mancos Gallup Planning Area Gas Production (MMcf)	245,550	281,713	287,347	293,094
FFO Gas Production (MMcf)	664,211	642,211	596,747	464,709
GHG Emissions				
Total U.S. O&G GHG Emissions (MMT) CO2e	2791.29	2961.11	2844.84	2961.08
Total New Mexico O&G GHG Emissions (MMT CO2e)	116.17	126.50	125.32	139.19
Total PDO O&G GHG Emissions (MMT CO2e)	40.10	46.95	47.89	48.85
Total BLM Mancos Gallup Planning Area O&G GHG Emissions (MMT CO2e)	38.82	38.78	35.62	28.00

Cumulative Impacts

The following sections outline past, present and reasonably foreseeable future actions or trends within the U.S. and State of New Mexico with potential to affect GHG emissions. The temporal analysis area focuses on year 2020 estimates, and more specifically wells that might be developed as a result of reasonably foreseeable lease sales. This temporal analysis area was chosen because it represents the best available information on reasonably foreseeable annual development (the context in which GHG emissions are usually reported).

Past and Present Actions

The result of past and present action on climate and current GHG emissions are discussed in Affected Environment, with a summary in Table 3.11. In 2013, annual global GHG emissions were 48,257 million metric tons of CO_2e, including land-use change and forestry (BLM 2018a). Estimated annual GHG emissions in 2016 for the United States are 6,511 million metric tons CO_2e (EPA 2018l). The BLM Air Resources Technical Report (BLM 2018a) provides an overview of past and present GHG emissions. Relevant statistics include the following:

- Fossil fuel combustion is the largest source of global CO_2e.
- Within the U.S.:
    - Electricity generation and transportation are the largest sources of GHGs, accounting for 30% and 25.6% of emissions since 1990, respectively. In 2013, fossil fuel combustion associated with transportation contributed 1,801.7 million metric tons CO_2e to total U.S. GHG emissions, which accounted for 27% of U.S. GHG emissions that year.
    - U.S. GHG emissions increased by 3.5 percent from 1990 to 2015 but decreased from 2014 to 2015 by 2.3 percent due in large to a decrease in fossil fuel combustion. Fossil fuel combustion decreases were a result of: 1) substitution from coal to natural gas consumption in the electric power sector; 2) warmer winter conditions in 2015 resulting in a decreased demand for heating fuel in the residential and commercial sectors; and 3) a slight decrease in electricity demand (BLM 2018a).
    - In 2013, GHG from oil and gas refineries accounted for 177 million metric tons CO_2e emitted, which is 5.6% of the total GHG emissions reported to EPA. Emissions from processing, transmission and storage and distribution in the U.S. totaled 98 million metric tons of CO_2e in 2013, which was about 3% of total U.S. GHG emissions reported to EPA in 2013. For natural gas, extraction accounts for 55% of total life cycle CO_2e emissions, processing accounts for 27% and transmission accounts for 18% of life cycle CO_2e emissions. For oil, drilling and development is responsible for 8% of the total life cycle CO_2e emissions, whereas transportation of the petroleum to refineries represents about 10% of the emissions, and final consumption as transportation fuel represents fully 80% of emissions.
    - In 2013, coal mining in the U.S. contributed 10.8% of total U.S. CH_4 emissions, and 1.1% of total U.S. GHG emissions).
- Within the State of New Mexico:
    - Oil and gas field operations in New Mexico comprise about 0.10 percent of the annual U.S. GHG emissions (see Table 3.11).
    - The New Mexico Greenhouse Gas Inventory and Reference Case Projection 1990-2020 projected that approximately 17.3 million metric tons of GHGs from the natural gas industry and 2.3 million metric tons of GHGs from the oil industry were produced in 2010 as a result of oil and natural gas production, processing, transmission and distribution. This represented 22% of the total gross New Mexico 2010 emissions.
    - Of that total, about 29 percent (5.6 million metric tons of CO_2e) is associated with oil and gas production; the remaining emissions are associated with processing, transmission, and distribution.

Reasonably Foreseeable Future Actions (RFFAs)

Overall, total New Mexico statewide gross GHG emissions are expected to increase (BLM 2018a). The New Mexico Greenhouse Gas Inventory and Reference Case Projection 1990-2020 (CCS 2005) projects

the following for year 2020 in New Mexico for emissions produced within the State (i.e., production-based emissions):

- Gross GHG emissions of 101.7 million metric tons of CO_2e— an increase of 48 percent relative to 1990 and 23 percent relative to 2000. New Mexico's emissions are well above the national average largely because of coal-based electricity generation and natural gas production activities.
- Top sources of GHG emissions: electricity production (38.1 million metric tons of CO_2e,) transportation fuel use (22.3 million metric tons of CO_2e,) and fossil fuel industry (20.7 million metric tons of CO_2e,). All have increased over 2010 estimates, but electricity and transportation fuel use increased at a higher rate than oil and gas development.
- Within the fossil fuel industry, approximately 20 million metric tons of CO_2e are projected as a result of oil and natural gas production, processing, transmission and distribution. This is 20 percent of the gross New Mexico emissions (a slight decrease over the relative contribution of oil and gas production in 2010, see past and present activity, above). About 28 percent (5.6 million metric tons of CO_2e) of the fossil fuel total is associated with oil and gas production; the remaining emissions are associated with processing, transmission, and distribution.

Although it is expected that vehicle fuel efficiency and increased use of public transportation will reduce vehicle emissions, these reductions may eventually be offset by an increased number of vehicles in use due to population growth in the region (BLM 2018a).

Continued oil and gas development is a prominent reasonably foreseeable future action affecting greenhouse gas development and the 2012 Reasonable Foreseeable Development Scenario (RFD) for Oil and Gas Activities in the Pecos District (Engler et al 2012) estimates that there could be an additional 16,000 wells drilled within the analysis area form 2016—2035. Of that number, 6,400 are federal new well development. The methodology for estimating new well development as well as the volumes for oil and gas is described in Engler 2012 and SENM 2014.

Estimated Cumulative Emissions

Well Construction and Operation - As shown in Table 3.13, historical oil and gas production in the Pecos District has resulted in between 473,482 (2017) and 731,517 (2014) metric tons of CO_2e annually. Over the next 20 years, it is estimated that the development of 6,400 federal wells would result in an additional 8,016,624 metric tons of CO_2e (BLM 2019). Annual emissions would vary based on the number of wells that would be completed or would be in production any given year. Emissions associated with development and production of the Proposed Action would comprise about 1% of the RFD emissions.

Downstream/End Use - Table 9 of the Cumulative BLM New Mexico Greenhouse Gas Emissions Report (BLM 2019) provides the reasonably foreseeable future GHGs (CO2e emissions) associated with end-use oil and gas CO_2e combustion emissions for the Pecos District RFD. Over the 20-year period, cumulative federal well scenario would produce 1,163.64 million metric tons (MMT) of CO_2e emissions from end-use combustion of oil and gas fossil fuels from 6,400 wells. Annual CO_2e emissions would range between 47.9 MMT/year (in 2016) to 69.77 MMT/year of CO2e (in 2035).

Under the all development scenario (includes Federal, Indian, state and fee minerals), cumulative emissions during the 20-year period is estimated to produce 5,574 MMT of CO2e from the end-use combustion of oil and gas from 16,000 wells. Annual CO_2e emissions would range between 47.9 MMT/year (in 2016) to 595.21 MMT/yr of CO2e (in 2035). Downstream emissions associated with development and production of the Proposed Action would comprise about 0.2% of all downstream emissions associated with the RFD.

Mitigation Measures and Residual Effects

The BLM BMPs are designed to reduce impacts to air quality (see Issue #1) would also reduce methane and GHGs. In addition, the BLM encourages industry to participate in the Natural Gas STAR program that is administered by the EPA. The Natural Gas STAR program is a flexible, voluntary partnership that encourages oil and natural gas companies to adopt proven, cost-effective technologies and practices that improve operational efficiency and reduce natural gas emissions (EPA 2006).

3.5.3. Issue 3: What are the impacts of future potential development of the proposed lease parcels to Air Quality Related Values (visibility and deposition) at the Carlsbad Caverns National Park?

The analysis for this issue examines the Class I areas within the Carlsbad planning area. This area is chosen because these areas are afforded a higher level of protection under the Clean Air Act. The analysis considers oil and gas development within the Carlsbad planning area as well as other sources outside of the planning area that might affect these Class I AQRVs.

Affected Environment

Air Quality Related Values (AQRVs) are resources sensitive to air quality and can include a wide variety of atmospheric-chemistry related indicators. Monitoring and modeling of AQRVs help to provide a level of protection to sensitive areas such as Class I park and wilderness areas. For purposes of this analysis, the following AQRVs have been considered: visibility, nitrogen deposition, and sulfur deposition. Congress established certain national parks and wilderness areas as mandatory Class I areas where only a small amount of air quality degradation is allowed. Defined by the Clean Air Act, Class I areas include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks. These areas must have been in existence at the time the Clean Air Act was passed by Congress in August 1977.

There are three Class I areas in or near the Carlsbad planning area: Carlsbad Caverns, Guadalupe Mountains National Park, and Salt Creek Wilderness. The most closely watched Class I area near the planning area is the CCNP and the Guadalupe Mountains National Park (GUMO). GUMO has monitoring data representative of the CCNP. The National Park Service (NPS) is responsible for managing the CCNP and the GUMO. The two nearest parcels are approximately 12 miles and 29 miles from the CCNP.

The goal of Class I management is to protect natural conditions, rather than the conditions when first monitored. That is, if initial monitoring in a Class I area identifies human-caused changes, appropriate actions should be taken to remedy them, in order to move toward a more natural condition. The goal of Class I management is to protect not only resources with immediate aesthetic appeal (i.e., sparkling clean streams) but also unseen ecological processes (such as natural biodiversity and gene pools) (Federal Land Managers' Air Quality Related Values Work Group [FLAG] 2010). BLM's goals includes managing the PDO activities and development to protect and improve air quality and, within the scope of the BLM's authority, minimize emissions that cause or contribute to violations of air quality standards or that negatively impact AQRVs (e.g., acid deposition, visibility).

Visibility - Visibility impairment is a result of regional haze that is caused by the accumulation of pollutants from multiple sources in a region. Emissions from industrial and natural sources may undergo chemical changes in the atmosphere to form particles of a size that scatter or absorb light and result in reductions in visibility.

A network of monitoring stations in or near Class I areas are operated by land management agencies under the Interagency Monitoring for Protected Visual Environments (IMPROVE) program. The network collects data to identify and evaluate patterns and trends in regional visibility and the pollutants which contribute to reductions in visibility. Visibility is quantified using either standard visual range (SVR) or deciviews. SVR is the farthest distance one can see a dark object against a light background as measured in kilometers or miles; higher values are better. Conversely, each change in deciview is roughly equivalent to just noticeable change in visibility; higher deciview values indicate hazier conditions while lower values are clearer. Visibility on worst days at GUMO may have diminished. A careful analysis of fire activity in the area would be necessary in order to draw conclusions about the cause of some peaks in recent years (Colorado State University 2014). A study of Air Pollutant Emissions and Cumulative Air Impacts done for the Carlsbad Field Office (CFO) indicates that pollutants contributing to reductions in visibility are largely coming from outside the region (Applied EnviroSolutions 2011).

In most cases visibility trends have been flat or improving. Implementation of Best Available Retrofit Technology strategies as required under the Federal Regional Haze Rule over the next few years should result in further improvements. Table 3.13 displays SVR visibility ranges in kilometers for the GUMO representing the CCNP in most recent years.

Table 3.13. SVR Visibility Ranges for the GUMO Park, Representing the CCNP

Standard Visual Ranges From *Improve* Monitors Near The Planning Area			
Monitor	**Standard Visual Range (Km)***		
	Average of Highest Visibility Days	**Average of Intermediate Visibility Days**	**Average of Lowest Visibility Days**
Guadalupe Mountains National Park†‡	224	143	87

Source: IMPROVE (2018).

* Standard visual range represents the maximum distance at which one can identify a black object against the horizon.

† The averaging period was 2006 to 2016 for monitoring data.

‡ This site also represents CCNP, which is within the Planning Area.

km = kilometers

Deposition -Deposition of pollutants through direct or dry atmospheric transport and precipitation can result in acidification of water and soil resources in areas far removed from the source of the pollution, as well as in harm to terrestrial and aquatic species. The Acid Rain Program has resulted in greatly reduced levels of the most damaging pollutants. There are currently four wet deposition monitors in New Mexico including Gila Cliff Dwellings, Mayhill, Bandelier National Monument, and Capulin Volcano National Monument. Deposition data for nitrogen and sulfur deposition can be accessed through the National Atmospheric Deposition Network website.

Environmental Impacts, Including Cumulative

Visibility - Visibility modeling was performed using the CFO RFD potential oil and gas well development scenario and with mitigation using EPA's on-the books emission controls and additional management controls. This analysis tiers to the modeling that was performed in the Air Resources Technical Support Document (ARTSD) for the CFO for results of visibility impairment indicating that for the Carlsbad region, visibility impacts to CCNP at the project levels are minimal and not expected to be of concern for the CCNP (Engler and Cather 2012; URS 2013). The visibility screening analysis followed the recommendations in the FLAG Phase I Report - Revised Guidelines (FLAG 2010). The analysis relies on a 0.5 and 1.0 delta-deciview (change in visibility) threshold, calculated for base year 2008, base case 2017 and future RFD years. Non-project, cumulative emissions are driving the overall visibility impacts. A refinement of the cumulative emissions would reduce the number of days of total visibility impacts and

would likely be closer to baseline and future visibility impacts. Any refinement down to a smaller scope of development or project-specific level would likely reduce the number of days of total visibility impacts that would be likely closer to matching actual base and future visibility impacts/baseline conditions (URS 2013). Further refinement of the URS 2013 visibility modeled results was performed to show relative impacts. The results indicate that there are no days in which the threshold is exceeded at the project level for the CCNP.

Deposition -Deposition modeling was performed using the CFO RFD potential oil and gas well development scenario and with mitigation using EPA's on-the books emission controls and additional management controls. This analysis tiers to the modeling that was performed in the ARTSD for results of nitrogen and sulfur deposition impairment (Engler and Cather 2012; URS 2013).

To access potential nitrogen and sulfur deposition impacts in the planning area, deposition impacts were compared to the NPS screening deposition analysis thresholds (DATs), which are defined as 0.005 kilogram per hectare per year (kg/ha/yr) in the western United States for both nitrogen and sulfur. A DAT is the additional amount of nitrogen or sulfur deposition within a Class I area, below which estimated impacts from a proposed new or modified source are considered to be insignificant. The DAT is a screening threshold that was developed primarily to assess impacts from a single stationary source (FLAG 2008, 2010). Modeling results showing deposition greater than a DAT do not strictly indicate the need for mitigation. If a DAT is exceeded, cumulative modeling may be required to demonstrate that cumulative deposition is below the level of concern (LOC). The LOC for the nitrogen and sulfur deposition values, defined by the NPS and U.S. Forest Service (USFS) is 3 kg/ha/yr for N and 5 kg/ha/yr for S (Fox et al. 1989).

Results of analysis showed that the maximum annual N DAT threshold at the project level was exceeded for CCNP but may be below the LOC at specific receptors. Cumulatively, the LOC for nitrogen was found to be below the LOC value of 3 kg/ha/yr for CCNP (Table 3.14 [URS 2013]). Both the maximum annual S DAT at the project and cumulative level (not shown) was below the DAT and LOC thresholds, respectively, for CCNP. Deposition rates that are below the level of concern are believed to cause no adverse impacts. Appendix R and S of the ARTSD provide detailed N deposition results for cumulative impacts, respectively (URS 2013). It should be noted that for a large aggregate project that includes thousands of sources (such as oil and gas development in the CFO), deposition greater than the DAT is typical. For the lease parcels identified as being within closest proximity of the CCNP degradation of air quality related to nitrogen deposition could occur, depending on the number of sources present during development and any mitigation applied.

Table 3.14. Maximum Annual N Deposition

Area with Greatest Predicted Impact	Max. Modeled Project Deposition (kg/ha/yr)	DAT* (kg/ha/yr, %)	Background Deposition (kg/ha/yr)	Total Project Deposition (kg/ha/yr)	LOC† (kg/ha/yr, %)
Class I		*0.005*			*3.0*
Salt Creek Wilderness Area	0.29	5800%	2.59	2.88	93%
Carlsbad Caverns National Park	0.19	3800%	2.59	2.77	92%
Sensitive Class II		*0.005*			*3.0*
Bitter Lake National Wildlife Refuge	0.29	5800%	2.59	2.88	93%
Grulla National Wildlife Refuge	0.11	2200%	2.59	2.70	90%

* The DAT is shown in italics, while the maximum modeled deposition is provided as a percentage of the DAT.

† The LOC is shown in italics, while the maximum total deposition is shown as a percentage of the LOC.

In 2016, Chevron developed a Master Development Plan in which 436 oil and gas wells were projected to be developed on over 106 well pads. Although it is not anticipated that all wells will be developed concurrently during this lease sale, similar results of AQRVs can be expected for large well development projects. The Chevron analysis extends the URS (2013) modeling that was performed and updates NO_x emissions in the project area. The results of acid deposition monitoring showed incremental exceedances of the N DAT threshold (DAT) of 0.005 kilogram per hectare per year (kg/ha/yr) in the CCNP during drilling operations, but would be well below the DAT once drilling has completed (BLM 2016).

It is expected that a refined analysis may be required at the APD stage for well development that could potentially impact nitrogen deposition at the CCNP. A refined analysis of acid deposition must address the following criteria:

- Is the affected area sensitive to deposition?
- Is the affected area currently impacted by deposition?
- Have critical loads or target loads been developed for the affected area?
- Does current deposition exceed the critical load or target load?

This refined analysis should be in consultation with the NPS as prescribed in FLAG guidance (USFS et al. 2011). The Federal Land Managers (FLMs) will do their best to manage and protect resources at every area that they administer. Where possible, the most intrusive monitoring and instrumentation should be conducted adjacent to the Class I area if such areas adequately represent the area of concern. FLMs believe that the need to minimize potential impacts on a Class I area should be a major consideration in the best available control technology (BACT) determination for a project proposed near such an area. Therefore, if a source proposes to locate near a Class I area, additional costs to minimize impacts on sensitive Class I resources may be warranted, even though such costs may be considered economically unjustified under other circumstances (FLAG 2010).

Potential Mitigation Measures and Residual Effects

Under the Prevention of Significant Degradation (PSD) provisions, an FLM has several tools he/she may use to protect AQRVs. A State may not issue a PSD permit to allow construction or modification of a major emitting facility when the applicable FLM files a notice alleging the facility may cause or contribute to a change in the Class I area's air quality and by identifying the potential adverse impact of such a change, unless the facility owner demonstrates that the facility's emissions of particulate matter, sulfur dioxide, and nitrogen oxides will not cause or contribute to concentrations that will exceed the maximum allowable increases for that Class I area.

If the available information is insufficient for the FLM to determine whether the Proposed Action will cause or contribute to an adverse effect on AQRVs, the FLM may ask for deposition and deposition effects monitoring and/or research in the FLM area. If the Proposed Action will likely cause or contribute to an adverse effect on AQRVs, the FLM may recommend permit conditions that ensure mitigation, including stricter emissions controls and effective emissions offsets. If no mitigation is possible, the FLM may recommend denial of the permit. Questions regarding these recommendations should be resolved through consultation with the appropriate FLM and the appropriate State and/or EPA modeling representative (FLAG 2010).

3.5.4. Issue 4: How would future potential development of the nominated lease parcels impact surface and groundwater quantity?

The analysis area established to analyze groundwater is the total area of the three counties (Lea, Eddy, and Chaves) that make up the New Mexico portion of the Permian Basin, where water use associated with

oil and gas development is mostly likely to occur. The following analysis summarizes information contained in the 2019 BLM New Mexico Water Support Document, hereafter referred to as the Water Support Document (BLM 2019b). Water use for development of the nominated lease parcels is assumed to primarily come from groundwater sources based on previous oil and gas development in the area.

Affected Environment

Current Total Water Use in the Analysis Area

The 2015 USGS Report, *Estimated Use of Water in the United States in 2015* (Dieter et al. 2018), lists total water withdrawals across eight water use categories: aquaculture, domestic, industrial, irrigation, livestock, mining, public water supply, and thermoelectric power. 2015 water use is summarized in Table 3-15 for the eight water use categories in each of the three counties within the analysis area. *Irrigation* is the largest category of water use in all counties, accounting for an average of 75 percent (466,784 acre-feet ([AF]) of the total water withdrawal for the analysis area (620,416 AF). Approximately 88 percent (545,154 AF) of the total water use is from groundwater. *Mining* (which includes oil and gas development) comprises approximately 15 percent of water withdrawals. All mining-related water use (94,758 AF) is from groundwater. Of that total, 99 percent of withdrawals are from saline sources. Most (87 percent) of mining-related water use occurs in Lea County, where mining comprises 31 percent of the total county withdrawals.

Table 3-15. Tri-County Analysis Area 2015 Water Use by Category (AF)

Category	Total Withdrawals					
	AF Fresh	Percent Total Use	AF Saline	Percent Total Use	AF Total	Percent Total Use
Public Water Supply	39,470	100%	0	0	39,470	6%
Industrial	1,121	100%	0	0%	1,121	0%
Irrigation	466,784	100%	0	0%	466,784	75%
Livestock	10,851	100%	0	0%	10,851	2%
Aquaculture	1,782	100%	0	0%	1,782	0%
Mining	1,573	1%	24,227	99%	95,800	15%
Thermoelectric power	1,827	100%	0	0%	1,827	0%
Domestic	2,780	100%	0	0%	2,780	0%
District Totals	**526,195**	**85%**	**24,227**	**15%**	**620,416**	**100%**

Source: Dieter et al. 2018.
Note: AF is acre-feet.

See the Water Support Document (BLM 2019b) for graphical representation of this data, as well as comparison's with water use across the State of New Mexico.

Current Actual Water Use by the Oil and Gas Industry

Oil and gas operators are required by the State of New Mexico to disclose water use to FracFocus (per New Mexico Administrative Code [NMAC] 19.15.16), a national hydraulic fracturing chemical registry managed by the Ground Water Protection Council and Interstate Oil and Gas Compact Commission to provide objective information on hydraulic fracturing. The BLM examined FracFocus data reported for the calendar years of 2014 to 2018 (FracFocus 2019) to ascertain actual water use in the analysis area (Table 3-16).

Table 3-16. Actual Water Use in the Tri-County Analysis Area for Calendar Years 2014-2018.

Year	Federal Water Use (AF)	Non-Federal Water Use (AF)	Total WU (AF)	Federal Water Use (%)	Average Water Use per Well (AF)	Total # of Wells Reported to FracFocus
2014	1,307	2,509	3,816	34%	6.82	559
2015	4,033	4,336	8,369	48%	15.82	529
2016	710	6,091	6,801	10%	21.66	314
2017	2,964	11,418	14,382	21%	26.44	544
2018	8,411	19,681	28,092	30%	31.04	905
Total	**17,425**	**44,035**	**61,460**	--	--	**2,851**

Source: FracFocus 2019
Note: Tri-County Analysis Area is Lea, Chaves, and Eddy counties.

Water use has increased from 3,816 AF in 2014 to 28,092 AF in 2018, with a corresponding basin-wide average water use per well increase from 6.82 AF per well to 31 AF per well (FracFocus 2019). This is due to the higher volume of well, the likelihood that the horizontal wells have become longer in the intervening time, and the continued use of hydraulic fracturing technologies in well drilling and completion.

Environmental Impacts

Drilling and completion of 94 horizontal wells in the nominated lease parcels is estimated to use approximately 2,933 AF of groundwater. This calculation is based on a factor of 31.2 AF per horizontal well, which the BLM considers to be the best current estimate of water use associated with drilling and completion of a single horizontal well within the analysis area (BLM 2019b). If more water-intensive stimulation methods (e.g., slickwater fracturing) are implemented or if laterals become longer, water use could increase from estimates provided in the Water Support Document (BLM 2019b). Alternatively, water use estimates could be lower if produced water is reused or recycled for use in hydraulic fracturing.

If all wells were developed in a single year, groundwater water use associated with projected future potential development of the leases would result in an increase of 0.4 percent increase of the Pecos District total water use (620,416 AF), 0.5 percent of the Pecos District total groundwater use (546,195 AF), and would result in a 3 percent increase over 2015 water use in the mining category for Pecos District (95,800 AF). The total estimated water use for drilling and completion of the 94 horizontal wells in the nominated lease parcels (2,933 AF) in a single year represents approximately 10 percent of the 2018 oil and gas water use reported to FracFocus (28,092 AF), and would result in an increase in water use associated with oil and gas development of 72 percent over 2015 statewide oil and gas water use (4,032 AF). The percent contribution of oil and gas development to total statewide mining water use would increase from 2.5 percent to 3.6 percent).

Assuming a 20-year development scenario (consistent with the RFD time frame), the water use associated with development of the lease parcels would be approximately 147 AF for any given year. As compared to 2015 oil and gas industry water use in the analysis area (3,994 AF), this would result in a minor increase in water use associated with oil and gas development (to a total of 4,141 AF per year). The percent contribution of oil and gas development to total statewide mining water use would remain at approximately 2.5 percent. Water use associated with development of the 94 horizontal wells in the lease parcels would require approximately 147 AF of water in any given year, which is about 0.5% of the 2018 oil and gas water use reported to FracFocus (28,092 AF).

Water used for the purpose of oil and gas drilling and completion would be purchased legally from those who hold water rights in or around the Permian Basin. The transaction would be handled by the New Mexico Oil Conservation Division, as well as the New Mexico Office of the State Engineer. All water uses would be evaluated at the APD stage in site-specific NEPA analysis and subject to standard lease terms and conditions. Table 2-9 of the Water Support Document (BLM 2019b) identifies the potential sources of groundwater in the analysis area.

Produced water associated with development of the lease parcels is estimated at approximately 38,010,000 barrels of water. Produced water would be disposed of at regulated and permitted commercial facilities (such as saltwater disposal wells) or would be used in the drilling and completion of wells. Water sourced from outside of the geological formation that is used in hydraulic fracturing, which remains in the geological formation after hydraulic fracturing is complete, is likely lost to the hydrological water cycle (Kondash et al. 2018).

Cumulative Impacts

Past and Present Actions - Past and present use is discussed in Section 3.7.1, Affected Environment. As noted in this section, Pecos District total water usage (620,416 AF) accounted for about 19 percent of the total state withdrawals (3,249,667 AF). Mining (which includes oil and gas development) comprises approximately 15 percent of tri-county water withdrawals. Total state water use associated with oil and gas development (4,032 AF) comprises approximately 2.5 percent of the statewide Mining water use (163,901 AF), 4.3 percent of the analysis area Mining water use (95,800 AF), and 0.7 percent of tri-county total water usage (620,416 AF). In 2018, the statewide oil and gas water use reported to FracFocus was 28,092 AF (BLM 2019b). The largest water use category within the analysis area and within the state of New Mexico is agricultural, comprising 75% of all water use within the Pecos District and 82% percent of all water use within the state. This trend is expected to continue.

Reasonably Foreseeable Future Actions - Between 2012 and 2014, the BLM developed an RFD scenario for the New Mexico portion of the Permian Basin that projected approximately 800 new wells per year, for a total of 16,000 wells over a 20-year period. With consideration of the revised water use estimates discussed in the Water Support Document (31.2 AF per well), development of the RFD would require 499,2000 AF water, or 24,960 AF of water in any given year if all wells were drilled horizontally (BLM 2019b). Note that this includes both federal and non-federal wells. This is about 4 percent of Pecos County 2015 total water withdrawals (620,416 AF, which already includes past and present water use). Agriculture would remain by far the largest water use within the county (currently 75% of all water use within the Pecos District and 82% percent of all water use within the state). Well development projected as a result of ongoing BLM and state lease sales are included in this RFD. Well development associated with recent or reasonably foreseeable APDs or master development plans are also included in the RFD. Annual water use associated with potential future development of the proposed lease parcels (94 wells, resulting in 2,933 AF of water, or 147 AF of water in any given year) would comprise 0.6 percent of the cumulative impact.

There are no reasonably foreseeable mining projects that would contribute to cumulative water withdrawals within the Pecos District. Some water use would be required during construction and operation of reasonably foreseeable transmission lines and pipelines, these uses are addressed in the Water Support Document (BLM 2019b). Future water use for the other reported water use categories in the Pecos District is assumed to continue at current levels.

Potential Mitigation Measures and Residual Effects

Public concern about water use from hydraulic fracturing is especially high in semiarid regions, where water withdrawals for hydraulic fracturing can account for a significant portion of consumptive water use

within a given region. Overall, there have been calls to increase the use of alternative water sources such as brackish water or recycling produced water, minimizing the strain on local freshwater resources (Kondash et al 2018). The BLM encourages the use of recycled water in hydraulic fracturing techniques. Recent studies indicate that the water used for hydraulic fracturing may be retained within the shale formation, with only a small fraction of the fresh water injected into the ground returns as flowback water; water returning to the surface is highly saline, is difficult to treat, and is often disposed through deep-injection wells (Kondash et al. 2018). Thus, the ability to recycle water may be more limited than previously reported.

CHAPTER 4. CONSULTATION AND COORDINATION

The following consultation and coordination efforts with tribes, individuals, organizations, and agencies were conducted for the proposed leasing actions.

4.1. ESA Consultation

BLM CFO biologists have reviewed the proposed leasing and determined it would comply with threatened and endangered species management guidelines outlined in the 1988 RMP as amended in 1997 (Consultation #2-22-96-F-128). In April 2008, the BLM PDO SSS RMPA amended both of these land use plans in portions of Chaves, Roosevelt, Eddy and Lea Counties, to ensure continued habitat protection of two BLM special status species; the LPC and the DSL. This action is in compliance with T&E species management outlined in the September 2006 (Cons. #22420-2007-TA-0033) Biological Assessments and in accordance with the requirements under the Federal Land Management and Policy Act and NEPA. No further consultation with the United States Fish and Wildlife Service (USFWS) is required at this stage.

Gypsum wild-buckwheat (*Eriogonum gypsophilum*) was listed as threatened in 1981. The proposed leasing action in this EA would have a "no effect" determination for this species due to a lack of suitable gypsiferous soil habitat for gypsum wild-buckwheat. The closest designated critical habitat for this species is approximately 8.5 miles southwest of Parcels 2, 3, and 4. The closest known occupied habitat for this species is approximately 4 miles northwest from the nearest parcel (Parcel 1).

Guadalupe fescue (*Festuca ligulata*) was listed as endangered in 2017. The proposed leasing action in this EA would have a "no effect" determination for this species due to a lack of suitable conifer-oak woodlands above 5,905 feet. Additionally, all parcels are outside the known range of this species. The closest proposed critical habitat for this species is approximately 237 miles south of the nearest parcel (Parcel 1). The closest known occupied habitat for this species is approximately 237 miles south from the nearest parcel (Parcel 1). The USFWS federal register documents indicate that this species has not been observed in New Mexico since 1952 (50 CFR Part 17).

Kuenzler's hedgehog cactus (*Echinocereus fendleri* var. *kuenzleri*) was listed as threatened in 1979. The proposed leasing action in this EA would have a "no effect" determination for this species due to lack of suitable habitat within the nominated parcels. This species does not have designated critical habitat because it was concluded that the publication of critical habitat had the potential to make the species more vulnerable to collection. The closest known occupied habitat for this species is approximately 40 miles west from the nearest parcel (Parcel 4).

Lee's pincushion cactus (*Coryphantha sneedii* var. *leei*) was listed as threatened in 1979. The proposed leasing action in this EA would have a "no effect"determination for this species due to lack of suitable habitat within the area. This species does not have designated critical habitat because it was concluded that the publication of critical habitat had the potential to make the species more vulnerable to collection. The closest known occupied habitat for this species is approximately 25 miles northwest from the nearest parcel (Parcel 1).

Sneed's pincushion cactus (*Coryphantha sneedii* var. *sneedii*) was listed as endangered in 1979. The proposed leasing action in this EA would have a "no effect" determination for this species due to lack of suitable habitat within the area. This species does not have designated critical habitat because it was concluded that the publication of critical habitat had the potential to make the species more vulnerable to collection. The closest known occupied habitat for this species is approximately 21 miles northwest from the nearest parcel (Parcel 1).

Least Tern (*Sterna antillarum*) was listed as endangered in 1985. The proposed leasing action in this EA would have a "no effect" determination for this species because nesting in NM is only known to occur at Bitter Lake NWR (Roswell FO), and since 2004 at Brantley Reservoir, managed by the BOR. This species does not have designated critical habitat because the FWS concluded that the tern's nesting habitat was ephemeral by nature and nesting colonies can change locations from year to year. The closest known occupied habitat for this species is approximately 5 miles southwest from the nearest parcel (Parcel 3).

Mexican Spotted Owl (*Strix occidentalis lucida*) was listed as threatened in 1993. The proposed leasing action in this EA would have a "no effect" determination for this species due to a lack of mature mixed-conifer, pine-oak, and riparian forests or canyon habitat dominated by vertical-walled rocky cliffs. The closest designated critical habitat for this species is approximately 30 miles southwest of Parcels 3. The closest known occupied habitat for this species is approximately 30 miles southwest from the nearest parcel (Parcel 3).

Northern Aplomado Falcon (*Falco femoralis septentrionalis*) was listed as endangered in 1986, with an experimental, non-essential population established in NM and AZ in 2006. The proposed leasing action in this EA would have a "no effect" determination for this species due to mitigation measures that would be put into place at the project level, should sightings of birds and/or nests be detected in the area. No critical habitat has been designated for this species. Currently, no known occupied habitat for this species exists within the Carlsbad Field Office area.

Piping Plover (*Charadrius melodus*) was listed as threatened (Atlantic Coast and Northern Great Plains populations) in 1985. The proposed leasing action in this EA would have a "no effect" determination for this species due to its rarity in New Mexico (only 9 documented occurrences) and the lack of mudflat and sandbar habitat within the nominated parcels. The closest designated critical habitat for this species is over 1004 miles north of Parcel 5. The closest known potential habitat for this species is approximately 16 miles northwest from the nearest parcel (Parcel 7).

Southwestern Willow Flycatcher (*Empidonax traillii extimus*) was listed as endangered in 1995. The proposed leasing action in this EA would have a "no effect" determination due to lack of suitable nesting riparian habitat within the nominated parcels. There is no designated critical

habitat for this species on the Pecos River or tributaries. The closest known potential habitat for this species is approximately 12 miles northeast from the nearest parcel (Parcel 1).

Yellow-billed Cuckoo (*Coccyzus americanus*), Western Distinct Population Segment (DPS) was listed as threatened in 2014. The proposed leasing action in this EA would have a "no effect" determination for this DPS due to it not being present in the CFO. The Western DPS includes those birds found west of the crest of the Rocky Mountains and Continental Divide, therefore the Yellow-billed Cuckoos found in the CFO are considered the Eastern DPS.

The Pecos bluntnose shiner (*Notropis simu*s) was listed as threatened in 1987. The proposed leasing action in this EA would have a "no effect" determination for this species due to a lack of perennial aquatic habitat within the nominated lease parcels. The closest critical habitat for this species is approximately 6 miles west of the nearest parcel (Parcel 3). The closest known occupied habitat for this species is approximately 6 miles west from the nearest parcel (Parcel 3).

The Pecos gambusia (*Gambusia nobilis*) was listed as endangered in 1970. The proposed leasing action in this EA would have a "no effect" determination for this species due to a lack of perennial aquatic habitat within the nominated lease parcels. Critical habitat has not been designated for this species. The closest known occupied habitat for this species is approximately 6 miles northeast from the nearest parcel (Parcel 3).

The Texas hornshell (*Popenaias popeii*) was listed as endangered in 2018. The proposed leasing action in this EA would have a "no effect" determination for this species due to a lack of perennial aquatic habitat within the nominated lease parcels. Critical habitat has not been designated for this species. The closest known occupied habitat for this species is approximately 12 miles south from the nearest parcel (Parcel 1).

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. Official species lists, whether obtained via IPaC or local USFWS offices, are valid for 90 days. After 90 days, project proponents should confirm their results on IPaC by requesting an "updated" official species list for their project.

4.2 Tribal Consultation

Tribal consultation for the leasing actions is done on a government-to-government basis. BLM CFO has initiated consultation with Pueblos and Tribes of New Mexico, Arizona, Texas, and Oklahoma, including Isleta Pueblo, Mescalero Apache Tribe, Ysleta Del Sur Pueblo, Kiowa Tribe of Oklahoma, Apache Tribe of Oklahoma, Comanche Nation, and Hopi Tribe, on May 21, 2019, with a request for a response within 30 days of receipt. Tribal and Pueblo leaders were invited to participate in government-to-government consultation regarding the lease parcels nominated for the November 2019 oil and gas lease sale, and were provided a letter and map describing the proposed lease sale parcels. The CFO received responses from Ysleta del Sur Pueblo and the Hopi tribe. On July 10, 2019 the CFO received email correspondence from Ysleta del Sur Pueblo indicating that they did not have any comments but would like to be consulted should human remains or artifacts be identified. Correspondence from the Hopi Tribe was received on July 2, 2019 that requested the cultural resources records review to be sent to the Hopi Cultural Preservation Office. No additional responses were received at this time; however, consultation is ongoing.

4.3 SHPO and THPO Consultation

Section 106 of the NHPA and its implementing regulations (36 CFR Part 800) require Federal agencies to consider what effect their licensing, permitting, funding, or otherwise authorizing an undertaking, such as an APD or ROW, may have on properties on or eligible for listing in the National Register of Historic Places (NRHP). 36 CFR Part 800.16 gives specific definitions for key cultural resource management concepts such as undertakings, effects, and areas of potential effect.

The New Mexico BLM has a two-party agreement with the New Mexico State Historic Preservation Office (SHPO) (Protocol) that implements an authorized alternative to 36 CFR Part 800 for most undertakings (BLM New Mexico and SHPO 2014). This agreement offers a streamlined process for reporting and review that expedites consultation with the SHPO. However, certain circumstances, including intense public controversy over an undertaking, may result in SHPO's or BLM's requiring use of the standard Section 106 consultation procedures outlined in 36 CFR Part 800 rather than the Protocol.

The Protocol details how the New Mexico BLM and SHPO regulate their relationship and consult. The protocol also outlines when case-by-case SHPO consultation is or is not required for specific undertakings, the procedures for evaluating the effects of common types of undertakings, and details how to resolve adverse effects to historic properties. These common types of undertakings regularly include actions undertaken by the BLM.

The CFO sent a letter to the SHPO detailing the results of the literature review, tribal consultation, and statement of use of the Protocol on all 10 parcels. The SHPO consultation was initiated concurrently with tribal consultation and, as such, did not include the results of tribal consultation in the letter to the SHPO. A finding of No Historic Properties affected was determined based on the records review. The use of Protocol Appendix C.I.a for this undertaking is appropriate because the lease sale itself does not directly authorize surface disturbance. Rather, leaseholders are granted future right of development to the leased mineral estate that is subject to site-specific analysis under NEPA and Section 106 of the National Historic Preservation Act (54 USC § 306108) at the APD stage of lease development. Such lease development activities are considered undertakings separate from the lease sale. SHPO concurred with the effect determination and use of appendix C on July 1, 2019.

The CFO also entered into the Permian Basin Programmatic Agreement (PA) as an option for compliance with Section 106 of the NHPA for energy-related projects in the PA project area. Of the 10 parcels available for lease, parcels 5, 6, 7, and 8 are within the PA area, and development on this parcel would comply with the provisions of the PA. See the PA fact sheet for more information: https://ipanm.org/wp-content/uploads/2017/01/Permian-Basin-PA-Fact-Sheet-January-2017-to-December-2017.pdf

CHAPTER 5. LIST OF PREPARERS

Table 5.1 contains a list of individuals that contributed to preparation of this EA.

Table 5.1. List of EA Preparers

NAME	AREA OF EXPERTISE	ORGANIZATION
Jim Stovall	District Manager	BLM CFO
Bob Ballard	Supervisor Natural Resource Specialist	BLM CFO
Chelsie Dugan	Hydrologist	BLM CFO

Rolando Hernandez	Cartographic Technician	BLM CFO
Hector Gonzalez	Carlsbad RMP Team Lead	BLM CFO
Tracie Hughes	Outdoor Recreation Planner	BLM CFO
Cassandra Brooks	Wildlife Biologist	BLM CFO
James Rutley	Solid Minerals Geologist (Potash)	BLM CFO
Kyle Rybacki	Cave Specialist / Outdoor Recreation Planner	BLM CFO
Katie Sandbom	Botanist	BLM CFO
Garrett Leitermann	Archaeologist	BLM CFO
Laura Hronec	Archaeologist	BLM NMSO
Lisa Bye	Fuels Specialist	BLM NMSO
Nathan Combs	Rangeland Management Specialist	BLM NMSO
Zoe Davidson	Botanist/Ecologist	BLM NMSO
Marikay Ramsey	Threatened and Endangered Species Biologist	BLM NMSO
Idu Opral C. Ijeoma	Geologist	BLM NMSO
Ross Klein	Natural Resource Specialist	BLM NMSO
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Lillis Urban	Planning and Environmental Coordinator (Detail)	BLM NMSO
David Herrell	Hydrologist	BLM NMSO
Sharay Dixon	Air Specialist	BLM NMSO
Catie Brewster	Planning & Environmental Coordinator Assistant	BLM NMSO
Michael Johnson	Socio-Economic Zone Scientist	BLM NMSO
Paige Marchus	NEPA Reviewer	SWCA Environmental Consultants
Janet Guinn	NEPA Reviewer	SWCA Environmental Consultants
Max Wiegmann	NEPA Reviewer	SWCA Environmental Consultants
Benjamin Gaddis	NEPA Facilitator and Reviewer	Gaddis Consulting, LLC

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APPENDICES

Appendix A – Nominated Lease Parcels and EA Analysis Status for Carlsbad Field Office November 2019 Competitive Oil and Gas Lease Sale

Table 7.1 Nominated Lease Parcel Descriptions

LEASE PARCEL #	SURFACE OWNERSHIP	LEGAL DESCRIPTION	ACRES	LEASE STIPULATIONS
NM-201911-001	BLM	T. 26 S., R. 26 E., NMPM EDDY COUNTY, NM SEC. 26: ALL; SEC. 27: ALL; SEC. 35: LOTS 1-4, N2N2.	1533.92	LN-1 NM-LN-11 SENM-LN-1 SENM-S-17 SENM-S-18 SENM-S-19 SENM-S-21 WO-ESA 7 WO-NHPA
NM-201911-002	BLM	T. 19 S., R. 27 E., NMPM EDDY COUNTY, NM SEC. 21: SWNE, NWSE.	80.00	LN-1 NM-LN-11 SENM-LN-1 SENM-S-17 SENM-S-21 WO-ESA-7 WO-NHPA
NM-201911-003	BLM	T. 19S., R., 27E., NMPM EDDY COUNTY, NM SEC.21: SWNE, NWSW.	80.00	LN-1 NM-LN-11 SENM-LN-1 SENM-S-17 SENM-S-18 SENM-S-21 WO-ESA-7 WO-NHPA

LEASE PARCEL #	SURFACE OWNERSHIP	LEGAL DESCRIPTION	ACRES	LEASE STIPULATIONS
NM-201911-004	BLM	T. 19S., R. 27E., NMPM EDDY COUNTY, NM SEC. 34: ALL.	640.00	LN-1 NM-LN-11 SENM-LN-1 SENM-S-15 SENM-S-17 SENM-S-18 SENM-S-21 WO-ESA-7 WO-NHPA
NM-201911-005	BLM	T. 17S., R. 30 E., NMPM EDDY COUNTY, NM SEC. 01: LOTS 1, 2, S2NE.	159.89	NM-LN-11 SENM-LN-2 SENM-S-17 SENM-S-18 SENM-S-22 SENM-S-23 SENM-S-34 WO-ESA-7 WO-NHPA
NM-201911-006	BLM	T. 18 S., R. 32 E., NMPM LEA COUNTY, NM SEC. 04: LOT 1.	40.52	NM-LN-11 SENM-LN-2 SENM-S-22 SENM-S-23 WO-ESA-7 WO-NHPA
NM-201911-007	BLM	T. 22 S., R. 32 E., NMPM LEA COUNTY, NM SEC. 10: SENW.	40.00	NM-LN-11 SENM-LN-6 SENM-S-1 SENM-S-19 SENM-S-22 WO-ESA- 7 WO-NHPA

LEASE PARCEL #	SURFACE OWNERSHIP	LEGAL DESCRIPTION	ACRES	LEASE STIPULATIONS
NM-201911-008	PRIVATE SURFACE ON SEC. 04 FEDERAL ON SEC. 03	T. 18S., R. 33 E., NMPM LEA COUNTY, NM SEC. 03: LOT 4; SEC. 04: LOTS 1-3, S2N2, S2; SEC. 05: SWNW.	681.19	NM-LN-11 SENM-LN-2 SENM-S-17 SENM-S-22 SENM-S-23 SENM-S-34 WO-ESA-7 WO-NHPA
NM-201911-009	PRIVATE	T. 20S., R. 35E., NMPM LEA COUNTY, NM SEC. 15: SWNE.	40.00	NM-LN-11 SENM-LN-2 SENM-S-22 SENM-S-23 WO-ESA-7 WO-NHPA
NM-201911-010	PRIVATE	T. 20S., R. 35 E., NMPM LEA COUNTY, NM SEC. 22: SWNW, W2SW.	120.00	NM-LN-11 SENM-LN-2 SENM-S-22 SENM-S-23 WO-ESA-7 WO-NHPA

Appendix B – Maps

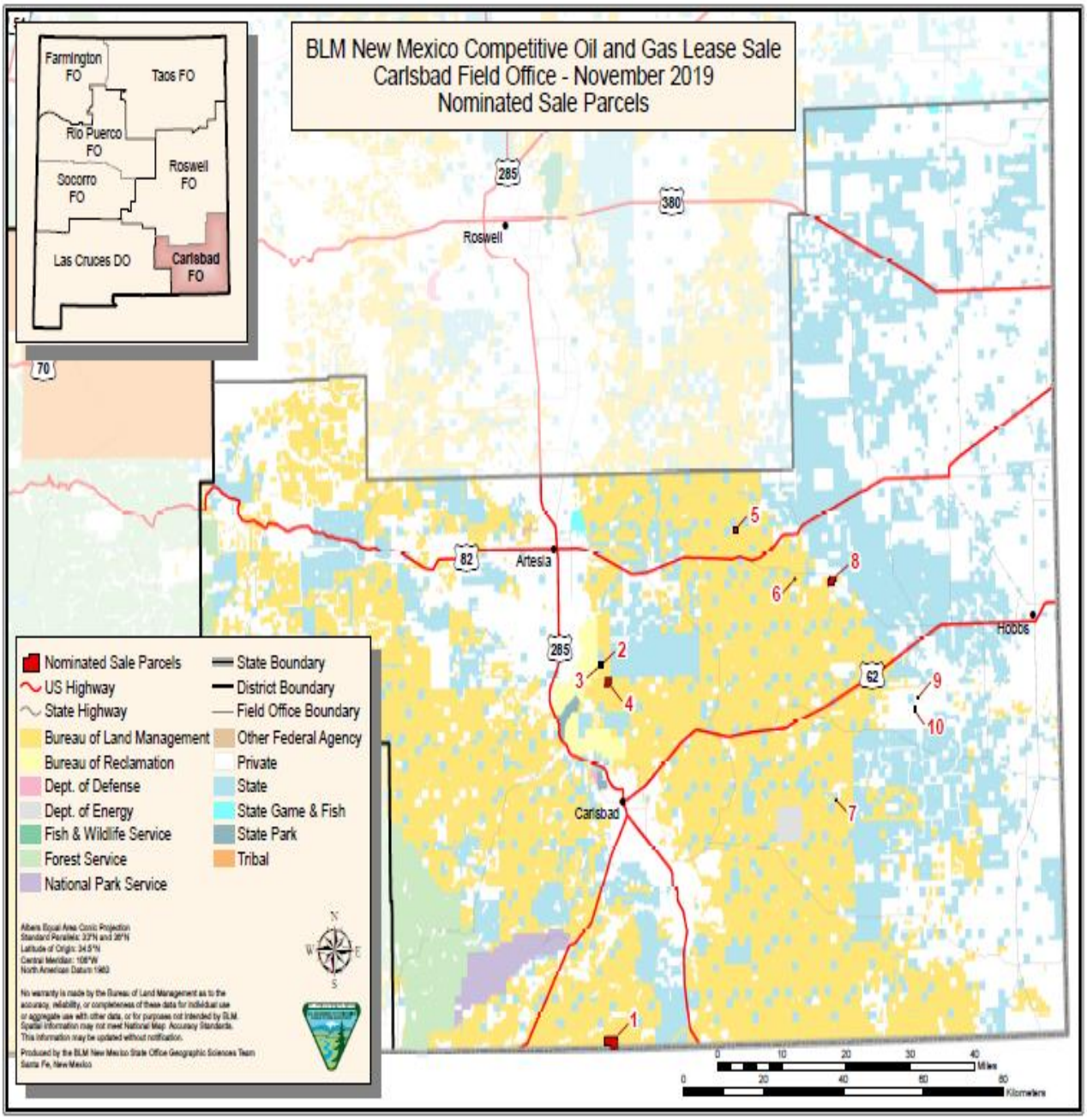

Figure B.1. Location of the Ten (10) Parcels Analyzed within this Environmental Analysis in the BLM Carlsbad Field Office.

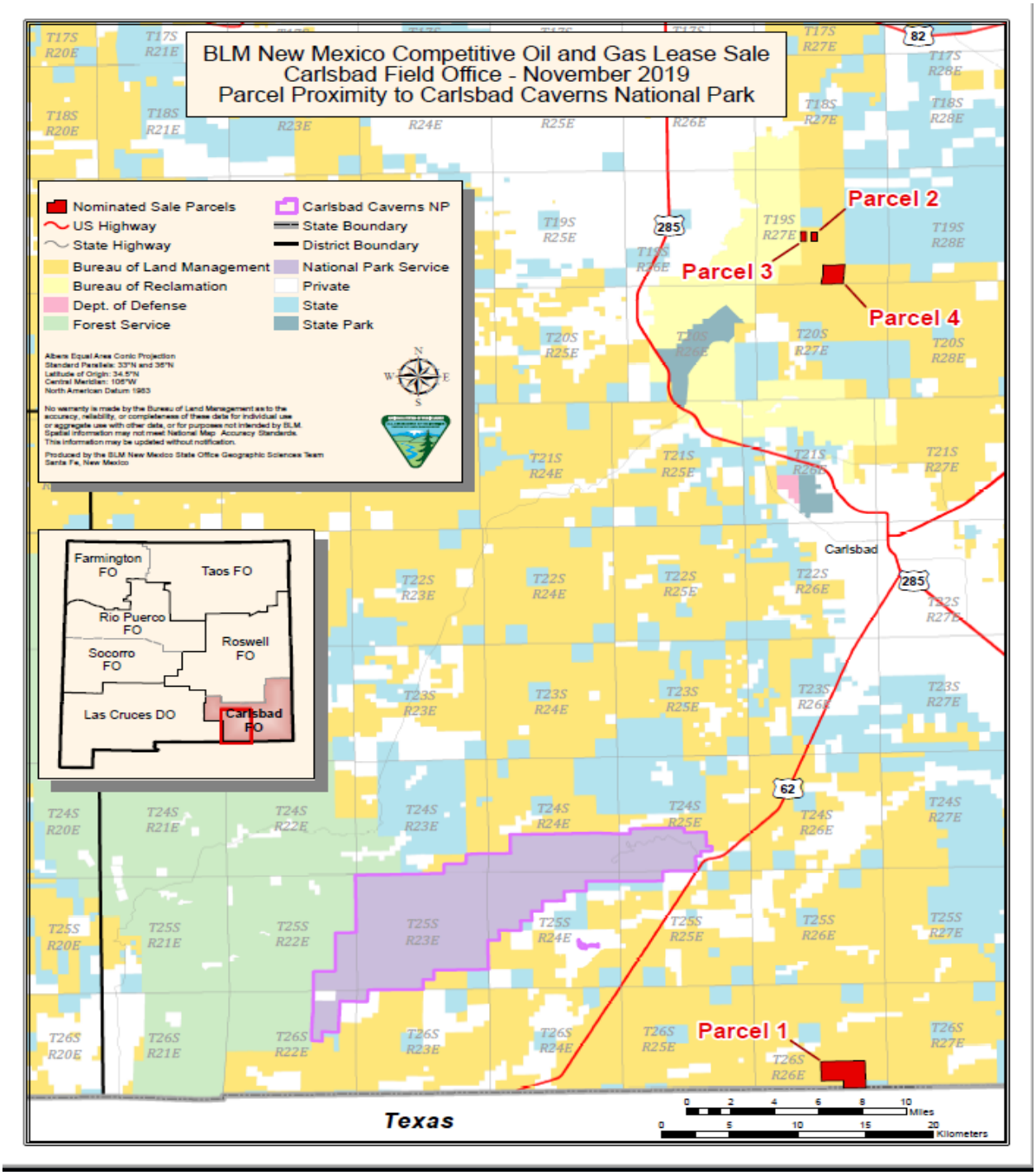

Figure B.2 Map illustrating Nearest Parcel to Carlsbad Caverns National Park (parcel 1). The distance of parcel 1 to park boundary is 11.48 miles.

Appendix C –Carlsbad Field Office Lease Stipulation Summary

Table 7.3 Lease Stipulations

Stipulation	Description/Purpose
SESM-S-15	CONTROLLED SURFACE USE – WILDLIFE HABITAT PROJECTS Surface disturbance will not be allowed within up to 200 meters of existing or planned wildlife habitat improvement projects. Largescale vegetation manipulation projects such as prescribed burns will be excepted. This requirement will be considered for waiver with appropriate off-site mitigation, as determined by the Authorized Officer.
SENM-S-16	CONTROLLED SURFACE USE - RAPTOR NESTS AND HERONRIES Surface disturbance will not be allowed within up to 200 meters of active heronries or by delaying activity for up to 120 days, or a combination of both. Raptor nests on special, natural habitat features, such as trees, large brush, cliff faces and escarpments, will be protected by not allowing surface disturbance within up to 200 meters of nests or by delaying activity for up to 90 days, or a combination of both.
SENM-S-17	CONTROLLED SURFACE USE – SLOPES OR FRAGILE SOILS Surface disturbance will not be allowed on slopes over 30 percent. Occupancy or use of fragile soils will be considered on a case-by-case basis.
SENM-S-18	CONTROLLED SURFACE USE – STREAMS, RIVERS, FLOODPLAINS Surface disturbance will not be allowed within up to 200 meters of the outer edge of 100-year floodplains, to protect the integrity of those floodplains.
SENM-S-19	CONTROLLED SURFACE USE – PLAYAS AND ALKALI LAKES Surface disturbance will not be allowed within up to 200 meters from the edge of playas or alkali lakes.
SENM-S-21	CONTROLLED SURFACE USE – CAVES AND KARST Surface disturbance will not be allowed within up to 200 meters of known cave entrances, passages or aspects of significant caves, or significant karst features.
SENM-S-22	CONTROLLED SURFACE USE – LESSER PRAIRIE-CHICKEN (LPC) Drilling for oil or gas, and 3-D geophysical exploration will not be allowed in LPC (*Tympanuchus pallidicinctus*) habitat from March 1 through June 15. During that period noise producing activities associated with these operations will not be allowed between 3:00 a.m. and 9:00 a.m. In addition, no new drilling will be allowed within up to 200 meters of leks, and exhaust noise from pump jack engines must not exceed 75 db measured at 30 feet from the source of the noise.
SENM-S-23	CONTROLLED SURFACE USE – DUNES SAGEBRUSH LIZARD (DSL) Surface disturbance will not be allowed in documented occupied habitat areas, or within up to 200 meters of suitable habitat associated with occupied habitat areas identified through field review. An exception to this restriction will be considered when an on-site evaluation of habitat extent, available species occurrence data, the proposed surface use, and proposed mitigations indicate the proposal will not adversely affect the local population.
SENM-S-25	VISUAL RESOURCE MANAGEMENT Painting of oil field equipment and structures to minimize visual impacts be conducted according to the requirements of Notice to Lessees (NTL) 87-1, New Mexico. Low profile facilities also may be required, when needed to reduce the contract of a project with the dominant color, line, texture, and form of the surrounding landscape. Other surface facilities or equipment approved by the BLM, such as large-scale range improvements or pipelines, will be painted, when needed, to conform with the requirements of visual resource management to minimize visual impacts.
SENM-S-27	PLAN OF DEVELOPMENT (POD) A “plan of development” (POD) for the entire lease must be submitted for review and approval, including NEPA analysis, by the BLM, with concurrence from BOR, New Mexico Game and Fish Department, FWS, and New Mexico State Parks, as appropriate, PRIOR to approval of development (APD, Sundry Notices) action. The POD must indicate planned access to well facilities (roads, pipelines, power lines), and the approximate location of well sites.

Stipulation	Description/Purpose
SENM-S-34	SHINNERY OAK SAND DUNE HABITAT COMPLEX POD A plan of development (POD) for the entire lease must be submitted for review and approval, including NEPA analysis, by the BLM, prior to approval of development actions (APD, Sundry Notices). 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 approval of subsequent development actions. Deviations from a current POD are not authorized until an amended POD has been approved by BLM.
SENM-S-47	RECLAMATION The subject properties contain facilities (well, pad, road, powerline, pipeline, etc.) that were not plugged, removed and/or reclaimed to current standards. Unless the facilities are not to a beneficial and direct use under the new lease, the lessee shall plug, remediate and reclaim the facilities within two years of lease issuance.
SENM- S-51	FARMLAND All or a portion of this lease contains private surface used for cultivation. Any surface-disturbing activities associated with oil and gas development will be excluded from the surface area used for cultivation. The BLM may consider on an individual application basis, an exception to this stipulation if the surface owner signs an agreement with the lessee or operator allowing the proposed surface-disturbing activity within the cultivated area.
SENM-LN-1	LEASE NOTICE – POTENTIAL CAVE OR KARST OCCURRENCE AREA All or a portion of the lease is located in a potential cave or karst occurrence area. Within this area, caves or karst features such as sinkholes, passages, and large rooms may be encountered from the surface to a depth of as much as 2,000 feet, within surface areas ranging from a few acres to hundreds of acres. Due to the sensitive nature of the cave or karst systems of this area, special protective measures may be developed during environmental analyses and be required as part of approvals for drilling or other operations on this lease. These measures could include: changes in drilling operations; special casing and cementing programs; modifications in surface activities; or other reasonable measures to mitigate impacts to cave or karst values.
SENM-LN-2	LEASE NOTICE- PROTECTION OF DUNES SAGEBRUSH LIZARD This lease may encompass suitable and occupied habitat of the dunes sagebrush lizard (Sceloporus arenicolous). The lessee may be required to conduct an examination of the lands to determine the occurrence of the lizard (peak activity is May – August). Exploration and lease development activities may be limited to areas outside of suitable or occupied habitat within the lease. If it is determined lease development activities may adversely impact suitable or occupied habitat, restrictions to the lessee's proposal may result.
NM-1-LN	LEASE NOTICE - SPECIAL STATUS PLANT SPECIES The lease contains potential, suitable and/or occupied habitat for special status plant species; therefore, special status plant species clearance surveys may be required prior to approving any surface disturbing activities within or adjacent to BLM Special Status Plant Species' potential, suitable and occupied habitats. Based on the results of the survey, conditions of approval may be applied to land use authorizations and permits that fall within the area of direct/indirect impacts or affected habitat, as appropriate. Possible mitigation strategies may include, but are not limited to avoidance, utilizing existing disturbance, twinning wells, limiting the extent of disturbance, dust abatement, signs, fencing, deterrents to reduce human disturbance, construction outside of the blooming season, specialized reclamation procedures, long term monitoring by qualified, independent third-party contractors.
NM-11-LN	LEASE NOTICE - CULTURAL RESOURCES The lease may contain historic properties, traditional cultural properties (TCPs) 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 modification to or disapprove proposed activities that are likely to adversely affect TCPs or sacred sites for which no mitigation measures are possible. This could result in extended time frames for processing authorizations for developments activities, as well as changes in the ways in which developments are implemented.

Stipulation	Description/Purpose
WO-NHPA	CULTURAL RESOURCES AND TRIBAL CONSULTATION the lease area may be found to contain historic properties and/or resources protected under the National Historic Preservation Act (NHPA), American Indian Religious Freedom Act, Native American Graves Protection and Repatriation Act, Executive Order 13007, or other statutes and executive orders. The BLM will not approve any ground-disturbing activities that may affect any such properties or resources until it completes its obligations (e.g., State Historic Preservation Officer (SHPO) and tribal consultation) under applicable requirements of the NHPA and other authorities. The BLM may require modification to exploration or development proposals to protect such properties, or disapprove any activity that is likely to result in adverse effects that cannot be successfully avoided, minimized, or mitigated.
WO-ESA-7	ENDANGERED SPECIES ACT SECTION 7 CONSULTATION the lease area may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or other special status species. 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 USC § 1531 et seq., including completion of any required procedure for conference or consultation.

Appendix D – 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 ROW) are reclaimed by recontouring the surface and establishing vegetation.

If a pipeline is needed, the ROW 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 on site 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 horizontal well to target the desired formation. The depth of the well is entirely dependent on the target formation 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 (Groundwater Protection Council 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% 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.

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 (Groundwater Protection Council 2009).

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 (Groundwater Protection Council 2009).

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

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.

Before operators or service companies perform a hydraulic fracturing treatment, a series of tests are performed. These tests are designed to ensure that the well, casing, well equipment, and fracturing equipment are in proper working order and would 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 groundwater 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 aboveground structures not subject to safety considerations are painted a standard BLM environmental 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.

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. Table 7.1 includes some of the common wastes (hazardous and nonhazardous) that are produced during oil and gas development.

Table 7.4. Common Wastes Produced During Oil and Gas Development

PHASE	WASTE	
Construction	Domestic wastes (i.e. food scraps, paper, etc.)	
	Excess construction materials	Woody debris
	Use lubricating oils	Paints
	Solvents	Sewage
	Drilling muds, including additives (i.e. chromate and barite) and cuttings; Well drilling g, 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	Rigwash
	Production testing wastes	Excess drilling chemicals
	Excess construction materials	Processed water
	Scrap metal	Contaminated soil
	Sewage	Domestic wastes
Hydraulic Fracturing	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	

PHASE	WASTE
	Workover wastes (e.g., brines)
Abandonment /Reclamation	Construction materials
	Decommissioned equipment
	Contaminated soil

Reference

Groundwater Protection Council. 2009. Modern Shale Gas Development in the United States: A Primer. Prepared for the U.S. Department of Energy, Office of Fossil Energy, and National Energy Technology Laboratory (NETL). DE-FG26-04NT15455. Oklahoma City, Oklahoma. Available at: https://energy.gov/fe/downloads/modern-shale-gas-development-united-states-primer.

Appendix E – Social Cost of Carbon

A protocol to estimate what is referenced as the "social cost of carbon" (SCC) associated with greenhouse gas (GHG) emissions was developed by a Federal Interagency Working Group (IWG), to assist agencies in addressing Executive Order (EO) 12866, which requires Federal agencies to assess the cost and the benefits of proposed regulations as part of their regulatory impact analyses. The SCC is an estimate of the economic damages associated with an increase in carbon dioxide emissions and is intended to be used as part of a cost-benefit analysis for proposed rules. As explained in the Executive Summary of the 2010 SCC Technical Support Document "the purpose of the [SCC] estimates…is to allow agencies to incorporate the social benefits of reducing carbon dioxide (CO2) emissions into cost-benefit analyses of regulatory actions that have small, or 'marginal,' impacts on cumulative global emissions." Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 February 2010 (withdrawn by EO 13783). While the SCC protocol was created to meet the requirements for regulatory impact analyses during rulemakings, there have been requests by public commenters or project applicants to expand the use of SCC estimates to project-level National Environmental Policy Act (NEPA) analyses.

The decision was made not to expand the use of the SCC protocol for the lease sale NEPA analysis for a number of reasons. Most notably, this action is not a rulemaking for which the SCC protocol was originally developed. Second, on March 28, 2017, the President issued EO 13783 which, among other actions, withdrew the Technical Support Documents upon which the protocol was based and disbanded the earlier IWG on Social Cost of Greenhouse Gases. The Order further directed agencies to ensure that estimates of the social cost of greenhouse gases used in regulatory analyses "are based on the best available science and economics" and are consistent with the guidance contained in Office of Management and Budget (OMB) Circular A-4, "including with respect to the consideration of domestic versus international impacts and the consideration of appropriate discount rates" (EO 13783, Section 5(c)). In compliance with OMB Circular A-4, interim protocols have been developed for use in the rulemaking context. However, the Circular does not apply to project decisions, so there is no EO requirement to apply the SCC protocol to project decisions.

Further, the NEPA does not require a cost-benefit analysis (40 CFR § 1502.23), although NEPA does require consideration of "effects" that include "economic" and "social" effects (40 CFR 1508.8(b). Without a complete monetary cost-benefit analysis, which would include the social benefits of the Proposed Action to society as a whole and other potential positive benefits, inclusion solely of an SCC cost analysis would be unbalanced, potentially inaccurate, and not useful in facilitating an authorized officer's decision. Any increased economic activity, in terms of revenue, employment, labor income, total value added, and output, that is expected to occur with the Proposed Action is simply an economic impact, rather than an economic benefit, inasmuch as such impacts might be viewed by another person as negative or undesirable impacts due to potential increase in local population, competition for jobs, and concerns that changes in population will change the quality of the local community. Economic impact is distinct from "economic benefit" as defined in economic theory and methodology, and the socioeconomic impact analysis required under NEPA is distinct from cost-benefit analysis, which is not required.

Finally, the SCC, protocol does not measure the actual incremental impacts of a project on the environment and does not include all damages or benefits from carbon emissions. The SCC protocol estimates economic damages associated with an increase in carbon dioxide emissions - typically expressed as a one metric ton increase in a single year - and includes, but is not limited to, potential changes in net agricultural productivity, human health, and property damages from increased flood risk over hundreds of years. The estimate is developed by aggregating results "across models, over time, across regions and impact categories, and across 150,000 scenarios" (Rose et al. 2014). The dollar cost figure arrived at based on the SCC calculation represents the value of damages avoided if, ultimately,

there is no increase in carbon emissions. But the dollar cost figure is generated in a range and provides little benefit in assisting the authorized officer's decision for project level analyses. For example, in a recent environmental impact statement, Office of Surface Mining estimated that the selected alternative had a cumulative SCC ranging from approximately $4.2 billion to $22.1 billion depending on dollar value and the discount rate used. The cumulative SCC for the no action alternative ranged from $2.0 billion to $10.7 billion. Given the uncertainties associated with assigning a specific and accurate SCC resulting from oil and gas production that could occur once the oil and gas lease is issued, and that the SCC protocol and similar models were developed to estimate impacts of regulations over long time frames, this environmental assessment (EA) quantifies direct and indirect GHG emissions and evaluates these emissions in the context of U.S. and State/County GHG emission inventories as discussed in the Affected Environment and Environmental Impacts section of the EA.

To summarize, this EA does not undertake an analysis of SCC because 1) it is not engaged in a rulemaking for which the protocol was originally developed; 2) the IWG, technical supporting documents, and associated guidance have been withdrawn; 3) NEPA does not require cost-benefit analysis; and 4) the full social benefits of oil and gas production have not been monetized, and quantifying only the costs of GHG emissions but not the benefits would yield information that is both potentially inaccurate and not useful.

References

Executive Order 13783. 2017. Presidential Executive Order on Promoting Energy Independence and Economic Growth. March 28, 2017.

Rose, S., Turner D., Blanford G., Bistline J., de la Chesnaye, F., and T. Wilson. 2014. Understanding the Social Cost of Carbon: A Technical Assessment. Electric Power Research Institute. Palo Alto, CA. Technical Update 3002004657.

Appendix F – Induced Seismicity

Disposal of wastewater (fluids that are a byproduct of oil production) is the primary cause of anthropogenic felt earthquakes in New Mexico. Hydraulic fracturing is a very minor for inducing felt earthquakes. Even relatively-extreme seismic incidents associated with hydraulic fracturing are well below the damage threshold for modern building codes (Ellsworth 2013).

The two main areas of concern are the Dagger Draw (approximately 15 miles northwest of Carlsbad) and Raton Basin (near Raton), which may be linked to specific nearby wastewater injection wells (Sanford et al. 2006; Pursley et al. 2013). Between 2010-2017, eight earthquakes with a magnitude of 2.5 or greater were felt around the Permian Basin (Table 1; USGS 2019c). The risks for induced seismicity increases with high-volume injections into deep wells carried out through wastewater injections or saltwater disposal (SWD) (Ellsworth 2013) and enhanced oil recovery (EOR) techniques. A combination of many factors is necessary to induce felt earthquakes; the injection rate and total volume injected, the presence of faults that are large enough to produce felt earthquakes, stresses that are large enough to produce earthquakes, and the presence of pathways for the fluid pressure to travel from the injection point to faults (USGS 2019a; Machette 2000). High injection rates of >300,000 barrels per month are much more likely to be associated with earthquakes and any earthquake within 15 km of an active injection well could be associated with that well (Weingarten 2015).

Injection of produced water into basal sedimentary rock reservoirs represents a key geologic factor related to triggering seismicity within the underlying crystalline basement (Zhang 2016). Fluid injection into a permeable, horizontally extensive reservoir allows for the rapid radial propagation of elevated fluid pressures outward from injection wells. In the absence of a basal confining unit, basal reservoir injection maximizes the amount of crystalline basement surface area exposed to elevated fluid pressures. If elevated fluid pressures within a basal reservoir encounter a relatively high-permeability fault or if the bulk permeability of the crystalline basement is moderately high then fluid pressures can propagate downward over a period of a few years and laterally away from the injection site. If elevated fluid pressures encounter a critically stressed fault, only a small pressure increase is needed to trigger seismicity (Zhang 2016). Beneath the Dagger Draw field, saline water water was injected into the basal Ellenburger carbonate reservoir which rests unconformably on the crystalline basement (Zhang 2016).

Aside from induced earthquakes, New Mexico has naturally occurring earthquakes. These mainly occur near Socorro within the Socorro Seismic Anomaly, a naturally-occurring earthquake cluster predating oil and gas development. The majority of the faulting and folding in New Mexico is distributed within the Rio Grande rift (Machette et al. 2000), which is part of a large region of the western North America affected by Cenozoic extension and includes the Basin and Range Province to the west (Keller 1991). The closest quaternary faults related to the Rio Grande Rift in the CFO/PDO are the Guadalupe faults to the southwest (Fig. 1; USGS 2019b).

The Permian basin formation resulted from the onset of a major continental collision event, the Pennsylvanian Ouachita-Marathon orogeny (Robinson 1988). The region is divided into several distinct structural and tectonic elements: the Central Basin Platform and the Ozona Arch, which separate the Delaware and Val Verde Basins on the west from the Midland Basin on the east; the Marfa Basin, separated from the Delaware Basin by the Diablo Platform; the Northwestern Shelf on the southern extremity of the Pedernal Uplift and Matador Arch; and the Eastern Shelf on the western periphery of the Bend Arch (Robinson 1988). The New Mexico portion of the Permian Basin comprises the Delaware Basin and Northwest Shelf (Snee 2018). A normal faulting stress field is observed throughout the Delaware Basin (Snee 2018). In the Northern Delaware Basin and much of the Central Basin Platform, faults striking east-west are the most likely to slip in response to fluid-pressure increases (Snee 2018). North-south striking faults, which are predominantly located along the Central Basin Platform, the western Delaware Basin, and large parts of the Northwest Shelf have low fault slip potential (Snee 2018).

Earthquakes caused by wastewater injections are declining because of New Mexico's Underground Injection Control (UIC) Program which monitors and regulates the injection of fluids into the subsurface.

The EPA classifies these wells as Class II injection wells; which are wells used for disposal of fluids associated with the production of oil and natural gas (hydrocarbons); to inject fluids for enhanced oil recovery; or for the storage of liquid hydrocarbons. New Mexico regulations set limits on maximum allowable injection pressures and require mechanical integrity testing of the boreholes, pressure monitoring, and reporting.

The initial permitted injection pressure is limited to 0.2 psi/ft. to the uppermost perforation, or to the pressure specified in the Division Order authorizing injection (NMOCD 2004). Wells are required to be equipped with a pressure-limiting device which will ensure that the maximum surface injection pressure is not exceeded (NMOCD 2004). Compliance officers from the district office periodically inspect wells and surface facilities to ensure to wells and related surface equipment are in good repair and meet regulations (NMOCD 1993). The Division may, authorize an increase in injection pressure upon a proper showing by the operator that such higher pressure will not fracture the formation and will not result in migration of injected fluids from the authorized injection zone (NMOCD 2004). An adequate step-rate test will need to be conducted at per Section III.A.3 (NMOCD 2004).

The BLM's regulations state, "for an injection well proposed on Federal or Indian leases, the operator shall obtain an UIC permit pursuant to 40 CFR parts 144 and 146 from the Environmental Protection Agency or the State/Tribe where the State/Tribe has achieved primacy" (BLM 1993). The operator shall also comply with procedural and information requirements for Application for Permit to Drill or Sundry Notice as set forth In Onshore Oil and Gas Order No. 1 (BLM 1993). The injection well shall be designed and drilled or conditioned in accordance with the requirements and standards described in Order No. 2 and pertinent NTLs as well as the UIC permit (BLM 1993).

Currently, within the Permian basin area none of the active injection wells are injecting into the Ellenberger limestone and none exceed an average monthly injection rate of 300,000 barrels. The well with the highest average monthly injection rate (231,480 barrels) is 49.7 km from Dagger Draw. Future oil and gas development of the lease parcels would result in approximately 38,010,000 barrels of produced water for the life of the wells as compared to a total number of 1,049,328,026 barrels of produced water in 2018 from New Mexico (NMOCD 2019). When considering how New Mexico regulates its injection wells, the low amount of produced water resulting from the lease sales, and the current risk of earthquakes in the Permian Basin outside of the Dagger Draw area, development of the leases is not expected to result in induced seismicity.

Appendix G – Well Emission Estimates

Emissions for a one-well horizontal and oil gas well on federal lands are included in Tables G-1 and G-2. Emissions for vertical wells were omitted from this analysis due to current predominant technological drilling methods being horizontal. Additionally, presenting horizontal oil and gas wells emissions estimates represent a more conservative summary of emissions when compared to emissions from a vertical well with the exception SO_2 which could be 4-5x greater in a vertical well scenario however sulfur dioxide emissions are still estimated to be within the same magnitude and less <1 ton per year of SO_2 emissions per well.

Table G-1. Emission Estimates for One Horizontal Oil Well (BLM 2018)

Activity/Phase	Annual Emissions (Tons)*							
	PM_{10}†	$PM_{2.5}$	NO_x	SO_2	CO	VOC**	HAPs	CO_2e
Construction	2.41	0.49	5.21	0.11	1.44	0.42	0.42	578.89
Operations	2.90	0.33	0.80	0.00	1.11	0.75	0.75	126.81
Maintenance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.089
Reclamation	0.00	0.00	0.18	0.00	0.08	0.00	0.00	0.00
Total	5.31	0.81	6.19	0.11	2.63	1.17	1.17	705.79

* Values where a "0.00" appear may be too small and not appear due to rounding.

† Reclamation PM_{10} emissions were estimated to be twice the value of Maintenance PM10 values.

** VOC emissions at the operational phase represent a 95% control efficiency and estimates potential emissions representing the contribution for "one oil well" from the emissions at storage tanks, gathering facilities, etc.

Table G-2. Emission Estimates for One Horizontal Gas Well (BLM 2018)

Activity/Phase	Annual Emissions (Tons)*							
	PM_{10}†	$PM_{2.5}$	NO_x	SO_2	CO	VOC	HAPs	CO_2e
Construction	0.64	0.31	5.18	0.11	1.41	0.61	0.41	1125.79
Operations	0.28	0.18	0.34	0.00	0.46	0.16	0.18	126.81
Maintenance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.089

Reclamation	0.00	0.00	0.18	0.00	0.08	0.00	0.00	0.00
Total	0.92	0.49	5.71	0.11	1.95	0.77	0.59	1252.69

* Values where a "0.00" appear may be too small and not appear due to rounding.

† Reclamation PM_{10} emissions were estimated to be twice the value of Maintenance PM_{10} values.

Emission estimates for a construction, operations, maintenance and reclamation are included. Construction emissions for both an oil and gas well include well pad construction (fugitive dust), heavy equipment combustive emissions, commuting vehicles and wind erosion. Operations emissions for an oil well include well workover operations (exhaust and fugitive dust), well site visits for inspection and repair, recompletion traffic, water and oil tank traffic, venting, compression and well pumps, dehydrators and compression station fugitives. Operations emissions for a gas well include well workover operations (exhaust and fugitive dust), wellhead and compressor station fugitives, well site visits for inspection and repair, recompletions, compression, dehydrators and compression station fugitives. Maintenance emissions for both oil and gas wells are for road travel and reclamation emission activities are for interim and final activities and include truck traffic, a dozer, blade and track hoe equipment.