Appendix 12

Reasonably Foreseeable Development Scenario

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TABLES

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ACRONYMS AND ABBREVIATIONS

	Full Phrase
°F	degrees Fahrenheit
2015 CO Plan	2015 Northwest Colorado Greater Sage-Grouse Proposed LUPA/Final EIS
2015 ID Plan	2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS
2015 SD Plan	2015 South Dakota Proposed LUPA/Final EIS
2015 WY Plan	2015 Wyoming Greater Sage-Grouse Land Use Plan Amendment
ACEC	Area of Critical Environmental Concern
BCF	billion cubic feet
BLM	Bureau of Land Management
CBNG	Coal Bed Natural Gas
CHMA	connectivity habitat management area
CSU	controlled surface use
DOE	United States Department of Energy
DOI	United States Department of Interior
DRECP	Desert Renewable Energy Conservation Plan
EGS	enhanced geothermal systems
EIS	Environmental Impact Statement
EPCA	Energy Policy and Conservation Act
FLPMA	Federal Land Policy and Management Act of 1976
FO	Field Office
GHMA	general habitat management area
GIS	geographic information system
GRSG	Greater Sage Grouse
HMA	habitat management area
IHMA	important habitat management area
Kwh	kilowatt hours
LCHMA	Linkage/Connectivity Habitat Management Area
LUPA	Land Use Plan Amendment
MCF	thousands of cubic feet
MMBO	million barrels of oil
MMBTU	millions of British thermal units
MW	megawatt
NDOM	Nevada Division of Minerals
NEPA	National Environmental Policy Act
NSO	No Surface Occupancy
OHMA	other habit management area
ONNR	Office of Natural Resource Revenue
P&A	plugged and abandoned
PEIS	Programmatic Environmental Impact Statement
PHMA	priority habitat management area
RFD	reasonably foreseeable development
RHMA	restoration habitat management area
RMP	resource management plan
RMPA	resource management plan amendment
ROW	right-of-way
US	United States
WEMs	waivers, exemptions, and modifications

Appendix 12. Reasonably Foreseeable Development Scenario

This document was developed to support the Greater Sage Grouse planning effort. It is intended to provide a reasonable projection of future activity associated with mineral exploration and development in the planning area under each of the proposed alternatives, in order to assist in the analysis of impacts resulting from proposed actions. It is intended to provide an update to information in previous Greater Sage Grouse planning efforts. Information from these previous efforts was gathered, examined against development trends, advances in technologies, and economic conditions since the time of publication. This was examined in consultation with various Bureau of Land Management (BLM) resource specialists to determine the need for changes or updates to the assumptions and information used to develop expectations regarding mineral exploration and development in the planning area. Once any revisions were completed the information was used to analyze the impact of the proposed alternatives during the 20-year planning period.

12.1 Fluid Minerals – Colorado

12.1.1 Methodology

BLM mineral resource experts examined the reasonably foreseeable development (RFD) document produced for the 2015 Northwest Colorado Greater Sage Grouse (GRSG) Land Use Plan Amendment (LUPA) and Environmental Impact Statement (EIS) as well as development trends and data from development since that time and determined that the methodology and trends that were used to produce the projections did not need modifications given the lack of significant changes in trends surrounding fluid mineral development. Assumptions and methodology used to develop the updated projections below are the same assumptions and methodology described in Appendix N of the 2015 Northwest Colorado Greater Sage-Grouse Proposed LUPA/Final EIS (2015 CO Plan). These were used along with new information to revise the projections provided to the current date and to analyze the proposed Alternatives. Limited data on how the 2015 projections were created is available, but because the trend of the projections is consistent with conditions since that time, they were able to be extended into the future. The projections by alternative taken from Table N.17 were compared to the current Alternatives, to determine the closest matches of alternatives from the two plans using management direction. Alternative 1 would continue management from the 2015 CO Plan. Alternative 2 would continue management from the 2018 Northwest Colorado GRSG Proposed Resource Management Plan Amendment/Final Environmental Impact Statement which would open to leasing approximately 224,200 acres closed under Alternative 1 and add an allowance for exceptions to NSO stipulations; the 2018 Plan did not provide projections of future development, but this management is very similar to what was proposed under Alternative D in the 2015 Plan. Alternative 3 would close all GRSG habitat to leasing, which is similar management to Alternative C in the 2015 CO Plan which proposed closing occupied habitat areas to fluid mineral leasing and applied NSO to the majority of the remaining area; so Alternative C projections were used for Alternative 3. Alternatives 4 and 5 would make approximately 751,000 acres of PHMA open to leasing with NSO stipulations and apply NSO buffers around Leks in the 786,000 acres of GHMA, NSO stipulations would allow for waivers, exemptions, and modifications (WEMs) under this Alternative. When comparing against the 2015 CO Plan Alternatives, this proposed management falls between Alternative D which proposed NSO stipulations on 1,347,400 acres, and Alternative A which proposed NSO stipulations on 350,300 acres (2015 CO Plan Table 2.6). The average of the projections

for Alternatives A and D was calculated for use as the projections for Alternative 4 and 5. Alternative 6 would apply the same management as Alternative 5 except that it would consider the designation of certain areas as areas of critical environmental concern (ACECs), however much of the designated ACEC acreage is already closed to leasing from management of other resources so the ACEC designations were determined to be unlikely to cause major changes to projections.

Projections created for the 2015 CO Plan included wells and production from Federal Minerals under Forest Service surface, however Federal Minerals under Forest Service surface are not part of the decision area in the current planning effort, so these areas were removed from the projections by calculating the proportion of the 2015 decision area that was Federal Minerals under Forest Service surface and then reducing the projections by that proportion.

The 2015 projections of production of oil and gas by Alternative in Table N.18 in the 2015 CO Plan were used for current plan projections using the same match-up between the 2015 and current Alternatives as described for the well projections above. These production amounts were also reduced by the proportion of Federal Minerals under Forest Service surface in the GRSG habitat areas, the Forest Service was not involved in the current planning effort so federal mineral estate located under Forest Service surface estate, which require consent of the Forest Service before BLM can lease, were not included in the decision area and their impact was removed from the projection results.

It was noted that the projected 20-year oil production projections in the 2015 CO Plan were significantly higher than the peak production from the entire state of Colorado despite the analysis area not containing the highest producing fields in the state. According to Energy Information Administration[1] Colorado had a peak production of 192,238 thousand barrels in 2019 (192,238,000 * 20 years = 3,844,760,000 barrels), under the Proposed plan in Table N.18 the 20-year production from Federal, State, and Fee Minerals, All Surface is listed as 44,879 million (44,879,000,000) barrels under the low case scenario and 72,617 million (72,879,000,000) barrels under the high case scenario. Because of this and based on production history from the counties containing the GRSG habitat, it was determined that the projections had been incorrectly converted and were off by a factor of 100, so projected barrels of production were converted by this amount (i.e., 35,903,966,373 barrels became 359,039,664 barrels).

Surface disturbance was calculated by the number of new wells under the high development scenario for each Alternative. Short-term disturbance calculations used the number of wells drilled, and long-term disturbance calculations used the number of wells completed for each Alternative. The disturbance acreage per well was derived from Tables 1 and 2 in the Reasonably Foreseeable Development (RFD) Scenario for Oil and Gas for Grand Junction Field Office,[2] which was chosen because it was the most recent RFD completed in the Planning area. Short term disturbance per well, which is the disturbance that occurs during drilling, was multiplied by the number of wells drilled for each Alternative. The long-term disturbance per well, which is the remaining disturbance necessary for the production of oil and gas after areas of disturbance only needed for drilling and completion of well have been reclaimed, was multiplied by the number of completed wells under each Alternative. Wells that are drilled but not completed would be plugged and abandoned, and the disturbance would be fully reclaimed.

[1] Energy Information Administration. 2023. Petroleum & Other Liquids- Colorado Field Production of Crude Oil. https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=mcrfpco1&f=a

[2] Reasonably Foreseeable Development Scenario for Oil and Gas, Grand Junction Field Office, Colorado. United States Department of the Interior, Bureau of Land Management. June 18, 2012.

Both a high and a low scenario are presented. The high scenario is based on RFDs from each field office in the decision area and is designed as a high case scenario, by assuming that both the number of wells drilled and production per well would be on the high side of what is likely to occur, in order to analyze the impacts of an increase in the rate of drilling and production. The low scenario adjusts projections based on actual spud information from the Automated Fluid Minerals Support System and production levels and is considered a more realistic scenario.

12.1.2 Oil and Gas

The oil and gas potential rankings created in response to the Energy Policy and Conservation Act (EPCA) were overlaid with GRSG habitat management areas (HMAs) using a geographic information system (GIS) to analyze the likelihood of development in priority habitat management area (PHMA) and general habitat management area (GHMA). While more recent assessments of oil and gas development potential are available for many states, the EPCA potential rankings were chosen for use because they are the most recent assessment that covers the entire GRSG planning area, this is desirable because it allows for comparison of development potential across different states. High potential areas are most likely to be developed, medium potential areas are the second most likely to be developed, and low potential areas are the least likely to be developed. The boundaries of HMAs vary slightly by alternative so the Alternative 4 boundaries were used for the purposes of calculation but the distribution of potential by HMA area does not vary significantly across the proposed Alternatives.

Table 1: EPCA Potential for Oil within Colorado GRSG HMAs

Alternative 4	Acres
GHMA	*786,000*
LOW	361,000
MEDIUM	149,000
HIGH	277,000
PHMA	*751,000*
LOW	326,000
MEDIUM	104,000
HIGH	321,000
Grand Total	**1,538,000**

Source: EPCA 2018, BLM GIS 2023

Table 2: EPCA Potential for Gas within Colorado GRSG HMAs

Alternative 4	Acres
GHMA	*786,000*
LOW	317,000
MEDIUM	211,000
HIGH	258,000
PHMA	*751,000*
LOW	344,000
MEDIUM	128,000
HIGH	280,000
Grand Total	**1,538,000**

Source: EPCA 2018, BLM GIS 2023

Existing Oil and Gas Leasing Activity

Existing leases, which could still be developed under the management associated with the resource management plan (RMP) which the lease was issued under, even in areas which would be closed or have

more restrictive stipulations applied under the proposed plan, were overlaid with potential and HMA type in GIS to show how much of the oil and gas in the planning area might not be impacted by the proposed new management.

Table 3: Colorado EPCA Potential for Gas within GRSG HMAs with Existing Oil and Gas Lease Status

Alternative 4	Acres
GHMA	*101,000*
LOW	21,000
Authorized	17,000
Interim	0
Pending	3,000
MEDIUM	48,000
Authorized	44,000
Interim	0
Pending	3,000
HIGH	33,000
Authorized	32,000
Interim	0
Pending	0
PHMA	*135,000*
LOW	63,000
Authorized	55,000
Interim	1,000
Pending	7,000
MEDIUM	26,000
Authorized	26,000
Pending	0
HIGH	46,000
Authorized	38,000
Pending	8,000
Grand Total	**236,000**

Source: EPCA 2018, BLM GIS 2023

Projected Drilling Activity by Alternative

Projections of future oil and gas development contained in Appendix N of the 2015 Colorado GRSG Final EIS were used with details about the new proposed alternatives to create the following updated projections for the development of oil and gas in the planning area under the new proposed alternatives.

Table 4: Number of Oil and Gas Well Projected to be Drilled and Completed on BLM-managed Federal Minerals in the Planning Area During the 20-year Forecast Period

Alternative	Low Scenario	High Scenario
Alternative 1-wells drilled	8,635	16,963
Alternative 1-wells completed	8,204	15,910
Alternative 2- wells drilled	8,760	17,088
Alternative 2-wells completed	8,322	16,026
Alternative 3- wells drilled	8,687	12,716
Alternative 3-wells completed	8,253	11,997
Alternative 4- wells drilled	9,018	17,533
Alternative 4-wells completed	8,567	16,422

Alternative	Low Scenario	High Scenario
Alternative 5- wells drilled	9,018	17,533
Alternative 5-wells completed	8,567	16,422
Alternative 6-wells drilled	9,018	17,533
Alternative 6-wells completed	8,567	16,422

Source: Derived from 2015 Colorado GRSG Final EIS Table N.17

Projected Surface Disturbance Due to Oil and Gas Activity by Alternative

Table 5: High Scenario Projected 20-year Surface Disturbance from Well Pads, Roads, and Pipelines

Alternative	Short term disturbance* (acres)	Long term disturbance* (acres)
Alternative 1-wells drilled	61,729	-
Alternative 1-wells completed	-	19,895
Alternative 2- wells drilled	62,181	-
Alternative 2-wells completed	-	20,040
Alternative 3- wells drilled	46,272	-
Alternative 3-wells completed	-	15,001
Alternative 4- wells drilled	63,804	-
Alternative 4-wells completed	-	20,535
Alternative 5- wells drilled	63,804	-
Alternative 5-wells completed	-	20,535
Alternative 6-wells drilled	63,804	-
Alternative 6-wells completed	-	20,535

Source: Derived using data from Table 1 and Table 2 in the Grand Junction Field Office RFD (2012) and high scenario oil and gas well projections above.
*Short term disturbance is generated by pads for all wells drilled, and construction of roads and pipelines. Long term disturbance is generated by pads for completed wells, and road and pipeline disturbance remaining after reclamation of areas disturbed by construction, well pads for wells that are not completed are reclaimed.

Projected Production by Alternative

Table 6: Projected 20-Year Oil and Gas Production by Alternative

Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5		Alternative 6	
Gas (BCF)	**Oil (MMBO)**	**Gas (BCF)**	**Oil (MMBO)**	**Gas (BCF)**	**Oil (MMBO)**	**Gas (BCF)**	**Oil (MMBO)**	**Gas (BCF)**	**Oil (MMBO)**	**Gas (BCF)**	**Oil (MMBO)**
Low Scenario											
Federal Minerals Below All Surface except Forest Service											
13,100	183.79	13,288	186.44	12,962	138.61	13,715	203.50	13,715	203.50	13,715	203.50
High Scenario											
Federal Minerals Below All Surface except Forest Service											
25,406	356.44	25,591	359.04	18,842	201.49	26,288	389.95	26,288	389.95	26,288	389.95

Sources: Derived from the 2015 Colorado GRSG Final EIS table N.18.
BCF = billion cubic feet; MMBO = million barrels of oil

12.1.3 Geothermal

Although the potential for geothermal development is high in some areas, there currently is no ongoing geothermal power generation on BLM lands in Colorado. Recent increased interest and technological advancements increase the likelihood of its development in the future.

The 2015 and 2018 Sage Grouse Plans did not project the occurrence of geothermal development. Because there is no existing development and no previous estimates to use, the following assumptions are made to analyze the impacts of geothermal development and associated surface disturbance. For the purposes of analysis, it is assumed that under all Alternatives except Alternative 3 up to one 20 megawatt (MW) geothermal power generation facility would be developed on BLM-managed lands in GRSG habitat over the next 20 years. This facility would disturb up to 6 acres for the drilling of up to 6 thermal gradient wells and would disturb up to 24 acres for the drilling of up to 8 production and injection wells. Construction of pipelines would disturb up to 14 acres, and an additional 10 acres could be disturbed for the construction of the generating plant. An assumed 10 miles of road would disturb approximately 50 acres, and 8 miles of power line would disturb approximately 40 acres. Under Alternative 3, it is assumed that no geothermal power development would occur on BLM-managed lands in GRSG habitat because under this alternative all GRSG habitat would be closed to fluid mineral leasing.

12.2 FLUID MINERALS – IDAHO

12.2.1 Methodology

Assumptions and methodology used to develop the updated projections below are the same assumptions and methodology described in Appendix O of the 2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS.[3] These were used along with new information to revise the projections provided to the current date and to analyze the proposed Alternatives.

Tables O-1 and O-2 from Appendix O of the 2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS (2015 ID Plan) were used as the basis for updating projections. Dillion Field Office is located in Montana and was removed from the data for Idaho and moved to the Montana projections for the current planning effort. The proposed management in the current Alternatives was compared to the management in the proposed 2015 ID Plan Alternatives. Alternative 1 would continue the Proposed Plan management from the 2015 ID Plan. Based on the information in the 2015 ID Plan, it is reasonably foreseeable that under this Alternative 15 new oil and gas exploratory wells would be developed on federal fluid mineral estate in the decision area in the next 20 years. Under Alternative 2, areas within PHMA and important habitat management area (IHMA) will be open to mineral leasing, development, and geophysical exploration, subject to NSO stipulations with limited exception, GHMA will be open to mineral leasing and development and geophysical exploration subject to controlled surface use stipulations. Compared to Alternative 1, Alternative 2 would allow for exceptions to NSO stipulations in certain situations if approved by the BLM Authorized Officer but would otherwise apply the same management. It is reasonably foreseeable for planning purposes that 20 new oil and gas exploratory wells would be developed on federal fluid mineral estate in the decision area within the next 20 years under Alternative 2. Alternative 3 is similar to the 2015 Plan Alternative C and would close GRSG to habitat to fluid mineral leasing. Under this Alternative, 13 new oil and gas exploratory wells are projected to be developed on federal fluid mineral estate in the decision area within the next 20 years. Alternative 4 would apply NSO in PHMA and IHMA with WEMs available, and an NSO buffer around Leks in GHMA with WEMs available. Compared to Alternative A from the 2015 Plan this would have fewer acres closed to leasing, but more acres managed

[3] https://eplanning.blm.gov/eplanning-ui/project/103344/510

with NSO stipulations and would allow waivers, exceptions, and modifications (WEMs) to NSO stipulations if approved by the BLM Authorized Officer. It is reasonably foreseeable for planning purposes that 25 new oil and gas exploratory wells would be developed on federal fluid mineral estate in the decision area within the next 20 years. Compared to Alternative 4, Alternative 5 would decrease the number of acres open with standard stipulations by approximately 1.65 million acres and increase the number of acres open with moderate stipulations by approximately 1.28 million. Acres managed as closed to leasing would have a small decrease and acres managed as open with major stipulations would increase slightly. Moderate stipulations typically have a minimal impact, especially in exploratory drilling, where minor changes in drill location have little consequence (versus established fields where drill locations established in layouts located to maximize resource recovery). It is reasonably foreseeable for planning purposes that 24 new oil and gas exploratory wells would be developed on federal fluid mineral estate in the decision area within the next 20 years under Alternative 5. Alternative 6 would apply Alternative 5 management and in addition designate certain areas as ACECs, which would be closed to leasing. However, most of the area that would be designated as ACECs are already closed or under NSO stipulations under the Alternative 5 management, so changes in development due to the ACEC designation would be minimal. Disturbance estimates were based on the projected number of wells under each alternative using the estimated disturbance associated with each well provided in Table O-2 in Appendix O of the 2015 ID Plan.

Geothermal projections were based on information provided in Appendix O of the 2015 ID Plan and on Table O-3 in the plan, as well as information about geothermal development provided in the more recent Four Rivers Resource Management Plan (2020). It was assumed that up to 70MW of geothermal generations could be developed during the 20-year planning period, surface disturbance associated with that level of development was calculated based on information provided in Table O-3 of the 2015 ID Plan and information from the Four Rivers Resource Management Plan (2020).

12.2.2 Oil and Gas

Over 180 oil and gas wells have been drilled in Idaho of which 19 were drilled between 2015 and 2022. Currently there is only one region with active Federal oil and gas leases in the state, the Southwest Idaho oil and gas play near Payette, Idaho. Until 2008, no commercially viable oil or gas resources had been found in Idaho, despite the drilling of around 150 wells throughout the state by that time. In 2008, a natural gas field named Willow Field was discovered in the Southwest Idaho oil and gas play and then in 2015, commercial production began from six wells on private lands. The resource is a relatively small, conventional deposit. The reservoir includes porous sand, is accessed via vertical and directional drilling, and does not require hydraulic fracturing (also referred to as fracking). The field was discovered largely due to recent advances in three-dimensional seismic technology.[4]

All 8,858,000 acres of Sage Grouse HMA in Idaho designated under Alternatives 4 and 5 are ranked as having a low development potential for both oil and gas by the EPCA. There are no existing or pending leases anywhere within the Sage Grouse HMA boundaries proposed under Alternatives 4 and 5.

Projected Drilling Activity by Alternative

The total estimated future surface disturbance for wells, roads, and well pads by Alternative is shown in the table below. These estimates were derived based on information from Table O-1 in Appendix O of the 2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS. The proposed alternatives were compared to the proposed management in that document. Alternative 1 proposed approximately the

[4] https://www.blm.gov/programs/energy-and-minerals/oil-and-gas/about/idaho

same management as the Proposed Plan from the 2015 document. Alternative 2 was based on the Proposed Plan from the changes made to GRSG management in Idaho in 2019 and 2020, the management allows for more mineral leasing and development, and geophysical exploration than Alternative 1. Alternative 3 is substantially similar to Alternative C from the 2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS. Alternative 4 would have fewer closed acres than Alternative 1, would manage PHMA and IHMA as open to leasing with No Surface Occupancy (NSO) stipulations that allow exceptions, and apply a NSO lek buffer around leks in GHMA. Alternatives 5 and 6 would apply similar management as Alternative 4 but would decrease the number of acres open with standard stipulations and increase the number of acres open with moderate stipulations. The application of moderate stipulations (CSU and/or timing limitations) typically have a minimal impact, especially in exploratory drilling where minor changes in drill location have little consequence (versus established fields where drill patterns are often carefully designed to maximize resource recovery). Alternative 6 will also designate some areas as ACECs which would be managed as closed to leasing.

Table 7: Reasonably Foreseeable Development Scenario for the Idaho in the next 20 years.

Alternative	Total Wells	Acres of Drill Pads[1]	Miles of Road[2]	Acres of Roads[3]
Alternative 1	15	45	30	150
Alternative 2	20	60	40	200
Alternative 3	13	39	26	130
Alternative 4	25	75	50	250
Alternative 5	24	72	48	240
Alternative 6	24	72	48	240

Source: updates to data from Table O-1 in Appendix O of the 2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS based on changes to management under the proposed Alternatives.
[1] Assumes 3 acres each.
[2] Miles of road per exploration well varies by RFDS. Miles of road for step-out wells equals one mile per well (in accordance with Idaho well spacing rule).
[3] Assumes 5 acres per mile.

12.2.3 Geothermal Summary

The only utility scale geothermal power development in the state of Idaho is the Raft River geothermal project located in Cassia County Idaho, at a former United States Department of Energy (DOE) geothermal site.

The project was acquired by US Geothermal in 2002 and construction began in June 2006. The plant began commercial operation in January 2008 and utilizes a binary-cycle water cooled system. The Raft River Plant was acquired by Ormat in 2018 and provides about 11MW of net capacity.[5]

The Raft River Geothermal Power plant in the Raft River Valley in Idaho expanded onto public land in GHMA between the 2015 Sage Grouse Plan and the 2018 Sage Grouse Plan Amendment.

[5] https://oemr.idaho.gov/sources/re/geothermal/

According to the Proposed Four Rivers RMP and Final EIS[6] based on the geothermal potential for the planning area, it is reasonable to assume that a 50 MW plant might be developed in those areas determined to have high potential for indirect use. It is reasonable to assume that a 20-MW geothermal power plant might be developed anywhere along a fault zone that trends northwest from east of Mountain Home, Idaho to the Oregon Border, particularly on the southwest (valley) side of the fault zone, over the 20-year life of the plan. This northwest trending fault zone has a medium to high geothermal potential. According to the Proposed Four Rivers RMP and Final EIS, cumulative disturbance associated with development of a 50 MW plant is anticipated to be between 147 and 181 acres, while disturbance associated with developing a 20 MW plant is anticipated to be between 60 and 75 acres. This development includes the construction of drill pads to support the drilling of 20 temperature-gradient wells and 25 production and injection wells, road construction, power plant development, and pipeline and transmission line construction. Much of this disturbance would be reclaimed after each phase of development, such that once the power plant is operational, the actual disturbance would be considerably less than the cumulative total. Development is likely to occur in stages, however this is not always the case. Surface disturbances associated with direct use activities are expected to be much less than those anticipated for indirect use.

Projected Activity by Alternative

Geothermal projections and surface disturbance were developed based on the geothermal section of the RFD in the 2015 ID Plan[7] and additional information contained in the 2020 Four Rivers RMP Geothermal RFD,[8] as well as existing conditions and recent development as described in the summary above.

Table 8: Reasonably Foreseeable New Generating Capacity and Total Disturbance Acreage by Alternative for Geothermal Resources over the next 20-years

Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
MW Predicted	70	70	35	70	70
Acres Disturbed by Thermal Gradient Drilling (1 acre per well)	20	20	10	20	20
# of Prod/ Inj. Wells Predicted	25	25	13	25	25
Acres of Drill Pads (3 acres each)	75	75	39	75	75
Total Miles of Road	19	19	9.5	19	19
Acres of Roads (5 acres Per mile)	95	95	47.5	95	95

[6] Bureau of Land Management. 2020. Four Rivers Field Office, Proposed Resource Management Plan and Final Environmental Impact Statement, Four Rivers Field Office, Boise District, Idaho (Volume 2), Appendix T – Fluid Minerals Reasonably Foreseeable Development Scenario. https://eplanning.blm.gov/public_projects/lup/1250/20012897/250017691/Four_Rivers_Field_Office_Proposed_Resource_Management_Plan_and_Final_Environmental_Impact_Statement_Volume_2.pdf

[7] Bureau of Land Management. 2015. Idaho State Office, Idaho and Southwestern Montana Greater Sage-Grouse Approved Resource Management Plan Amendment. https://eplanning.blm.gov/public_projects/lup/103344/143603/176718/2015_IDMT_ARMPA.pdf

[8] Bureau of Land Management. 2020. Four Rivers Field Office, Proposed Resource Management Plan and Final Environmental Impact Statement, Four Rivers Field Office, Boise District, Idaho (Volume 2), Appendix T – Fluid Minerals Reasonably Foreseeable Development Scenario. https://eplanning.blm.gov/public_projects/lup/1250/20012897/250017691/Four_Rivers_Field_Office_Proposed_Resource_Management_Plan_and_Final_Environmental_Impact_Statement_Volume_2.pdf

Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Acres of Powerplant Construction (1/2 acre per MW)	35	35	17.5	35	35
Pipeline Construction disturbance (acres)	48	48	24	48	48
Transmission Line Construction (5 acres per mile)	16 miles = 80 acres	16 miles = 80 acres	8 miles = 40 acres	16 miles = 80 acres	16 miles = 80 acres
Total Permanent Disturbance (acres)	353	353	178	353	353

Source: updates to data from Table O-3 in Appendix O of the 2015 Idaho and Southwestern Montana Greater Sage-Grouse Proposed LUPA/Final EIS, based on changes to management under the proposed Alternatives.

12.3 FLUID MINERALS – MONTANA

12.3.1 Methodology

BLM mineral resource experts examined the RFD projections in plans produced for the 2015 GRSG planning effort, including the Miles City, HiLine, Billings, Lewistown, and Southwest Montana Plans. They also looked at updates such as the 2021 Lewistown RMP Revision, as well as development trends and data from development since that time and determined that the methodology and trends that were used to produce projections did not need significant modifications given the minimal changes in trends surrounding fluid mineral development in the state.

Assumptions and methodology used to develop the updated projections below are the same assumptions and methodology described in the RFDs developed for the Billings, Hi-Line, Lewistown, Miles City, Dillon, and Butte Field Offices. The Upper Missouri River Breaks National Monument is also part of the planning area but is withdrawn from all forms of entry, location, selection, sale, or leasing or other disposition under the public land laws, however it does have some legacy leases which predate the monument designation that could be developed. All of the above information was used, along with new information, to revise the projections provided to the current date and to analyze the proposed Alternatives.

To develop updated projections for Montana for the current planning effort the projections from all the field office plans that were created in 2015 were collected. These projections were then examined and updated to remove developments that did not occur and modify information on developments that have not met the level of development previously expected. This included removing all project coalbed natural gas wells, because development of that type in the planning area ended with limited success and resulted in poor returns, so planned projects were abandoned, and no coalbed natural gas development has occurred recently. The Bowdoin Natural Gas Project Area in the HiLine District was also removed because specialists reported that it had been developed and was played out with no further wells expected.

The Alternatives from the current planning effort were then compared to earlier Alternatives to determine how the projections would vary by Alternative. Based on the proposed management of PHMA and GHMA including the acres of closed to leasing, open to leasing with additional NSO stipulations, open to leasing with additional minor stipulation or open with standard stipulations. It was determined that the Alternatives 1, 2, 4, 5, and 6 are substantially similar to each other, and to the proposed plan or preferred alternatives from the various 2015 plans in their management of fluid mineral resources (HiLine Alternative E, Billings Pompey Alternative D, Lewistown Alternative C2, Miles City Alternative E, [Dillon did not project any oil and gas production under any Alternative]). Alternative 3 from the current plan is similar to the various

lowest development alternatives from the 2015 plans (Alternative B for all plans). The Billings Pompey, and Dillon RMPs did not differentiate the projected number of wells by alternatives, due to low levels of development expected, the projections from these plans were carried forward into the update without differentiation by alternative. The projections for the total number of wells, surface disturbance, and production of oil and gas projected to occur under the Alternatives in each of the field offices that were most similar in management to the current alternatives being considered were added together to get totals for each of the current Alternatives.

Because there is no geothermal development ongoing or planned within the planning area and no earlier projections of geothermal development are available, no projections were developed for this planning effort.

12.3.2 Oil and Gas

Oil and Gas Development Potential

The tables below show the development potential ranking for oil and gas resources in the planning area by proposed GRSG habitat areas under Alternative 4. The decision area is slightly different under the different Alternatives, so the Alternative 4 decision area was used for the following calculations, but the results are generally applicable across all the Alternatives. Lease status is not considered in development potential rank, both leased and unleased areas are included.

From 2013 to 2023 a total of 755 wells were completed in the state across all mineral types.[9]

Table 9: Montana Oil Development Potential Ranking in Alternative 4 GRSG Habitat Boundaries*

HMA and Potential	Acres
GHMA	1,844,000
Low Potential	1,658,000
Medium Potential	120,000
High Potential	66,000
PHMA	3,307,000
Low Potential	3,048,000
Medium Potential	164,000
High Potential	95,000
RHMA	94,000
Low Potential	72,000
Medium Potential	1,000
High Potential	22,000
Grand Total	**5,246,000**

Source: EPCA 2018, BLM GIS 2023
RHMA = restoration habitat management area
*The decision area is slightly different under the different Alternatives, so the Alternative 4 decision area was used to calculate tables.

[9] Montana Board of Oil & Gas Conservation. 2024. Well Activity. https://bogapps.dnrc.mt.gov/dataminer/Statistics/StatsHorzCompletionCount.aspx

Table 10: Montana Gas Development Potential Ranking in Alternative 4 GRSG Habitat Boundaries

HMA and Potential	Acres
GHMA	1,844,000
Low Potential	1,190,000
Medium Potential	655,000
High Potential	0
PHMA	3,307,000
Low Potential	1,908,000
Medium Potential	1,399,000
High Potential	0
RHMA	94,000
Low Potential	68,000
Medium Potential	27,000
High Potential	0
Grand Total	**5,246,000**

Source: EPCA 2018, BLM GIS 2023

RFD Scenario

The Montana study area for the projections below includes Billings, Butte, Dillon, Hi-Line, Lewistown, and Miles City Field Offices, and the Upper Missouri River Breaks National Monument. A number of the Field Office RFDs prior to the 2015 Greater Sage Grouse planning effort projected large amounts of development of coal-bed natural gas, however BLM specialists reported that since that time coal-bed natural gas development in the state has been much less than was projected and that coal-bed natural gas was no longer considered economically viable in the area. As a result, projections of coal-bed natural gas wells or development were not included in this analysis. The projected number of wells developed on Federal mineral estate in Montana under the proposed Alternatives, and resulting surface disturbance, and oil and gas production is shown in the tables below.

Table 11: Oil and Gas Well 20-year Projections Federal Minerals in Montana

Alternative	Oil and Gas Wells
Alternative 1	2,180
Alternative 2	2,180
Alternative 3	1,272
Alternative 4	2,180
Alternative 5	2,180
Alternative 6	2,180

Source: Derived from tables and information in the GRSG RMP/EISs and Appendix documents for Billings, Butte, Dillon, Hi-Line, Lewistown, and Miles City Field Offices, adjusted for the proposed alternatives.

Table 12: Potential Surface Disturbance from Oil and Gas Drilling on BLM Minerals 2023-2043 in Montana

Alternative	Short term Disturbance (Acres)	Long Term Disturbance (Acres)
Alternative 1	9,118	2,427
Alternative 2	9,118	2,427

Alternative	Short term Disturbance (Acres)	Long Term Disturbance (Acres)
Alternative 3	6,020	1,960
Alternative 4	9,118	2,427
Alternative 5	9,118	2,427
Alternative 6	9,118	2,427

Source: Source: Derived from tables and information in the GRSG RMP/EISs and Appendix documents for Billings, Butte, Dillon, Hi-Line, Lewistown, and Miles City Field Offices, adjusted for the proposed alternatives.

Table 13: Forecast of the Montana Study Area Federal Oil and Gas Production 2023-2043.

Alternative	Oil (barrels)	Gas (MCF)
Alternative 1	130,104,338	565,943,852
Alternative 2	130,104,338	565,943,852
Alternative 3	125,743,303	301,863,108
Alternative 4	130,104,338	565,943,852
Alternative 5	130,104,338	565,943,852
Alternative 6	130,104,338	565,943,852

Sources: Source: Source: Derived from tables and information in the GRSG RMP/EISs and Appendix documents for Billings, Butte, Dillon, Hi-Line, Lewistown, and Miles City Field Offices, adjusted for the proposed alternatives.
MCF= thousands of cubic feet

12.3.3 Geothermal

Geothermal energy is heat energy contained in the rocks of the earth's crust. Certain geologic conditions and processes resulted in shallow geothermal resources that underlie substantial portions of many western states, including land administered by the BLM in Montana.

These shallow resources can be classified as low temperature (less than 194 degrees Fahrenheit [° F]), moderate temperature (194° F to 302° F), and high temperature (greater than 302° F). Low and moderate temperature resources are generally used for heating, rather than power generation. Binary steam plants can generate power with fluid temperatures between 225° and 360° F.

Montana's geothermal systems reflect local and regional geology. The Basin and Range, Yellowstone Hotspot, Northern Great Plains, and intrusive rocks provide favorable conditions for geothermal waters. Montana hosts approximately 150 low- to moderate-temperature springs and wells; most are in the southwestern part of the State. Co-produced water from petroleum wells in eastern Montana reaches temperatures of over 300°F. Naturally occurring hot water and steam, including hot water coproduced or produced from re-purposed petroleum wells, can be used in heat exchangers or steam turbines to generate electrical power. However, direct-use applications in the state are currently limited to local use for heating structures and for recreation and resorts.[10] There is currently a low level of interest in developing federally owned geothermal resources in Montana, so no development is expected in GRSG habitat, and no projections were deemed necessary.

[10] https://www.mbmg.mtech.edu/MontanaGeology/EnergyResources/geothermal.asp#

12.4 FLUID MINERALS – NEVADA AND NORTHEASTERN CALIFORNIA

12.4.1 Methodology

This report is an update to Appendix P- Fluid Minerals Reasonably Foreseeable Development Scenario of the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS with the most current publicly available information. Trends from the 2015 RFD are assumed to continue and it is assumed that the demand for renewable energy, including geothermal will continue to increase and may be influenced by such factors as advances in enhanced geothermal systems (EGS). Technological advances could increase the size and scope of the impacts. These impacts should be considered as potential developments that could lead to further increase in exploration and development of geothermal resources in Nevada in typical geothermal systems and in areas not generally recognized as having high geothermal potential.

This document is limited to publicly available information and does not include confidential drilling data. It does not attempt to quantify the potential impacts of advances in EGS or other technology that is currently being tested for viability and has not been commercially proven. If future developments exceed predictions the BLM will assess these impacts at that time.

Updated projections were developed based on consultation with BLM specialists and the data available from the Nevada Division of Minerals (NDOM). Projections are based on the assumptions and methodology used in the 2015 RFD which were examined in connection to ongoing trends and determined to still be valid.

Projections for oil and gas development were based on Table P-5 from Appendix P of the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS. In this plan a large proportion of the wells projected in Table P-5 were attributed to a development being planned for the Elko-Noble area. BLM specialists confirmed that this planned development was no longer ongoing, and no further wells were expected. As a result, the Elko-Noble area projections were removed from the updated table. The current Alternatives were matched up to the Alternatives from 2015 based on the proposed management. Current Alternative 3 proposes similar fluid mineral management as was proposed under Alternative C in the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS, and all other current Alternatives propose the same or very similar management as under the Proposed Plan Alternative in the same Plan.

Surface disturbance projections were derived from the same Alternative matches described in the previous paragraph. These were based on Table P-9 in the Appendix P of the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS. The production of oil was based on information in Appendix P that based on production data, production wells within the planning area produce on average 14 barrels per day per well. The planning area does not produce significant quantities of natural gas so no projections for natural gas were created.

Geothermal projections from the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS were identified as being potentially too low given the level of ongoing and planned development. There are 732 megawatts (MW) of geothermal power generation operational on federal lands in Nevada as of 2023.[11] Additionally, there is approximately 180MW of generation which has been authorized but not yet constructed, and there is an additional approximately 300 MW of generation in the permitting stage, for a total of 1,042MW likely to be online in the near future. Based on this trend it was assumed that up to 1150MW of generating capacity could be operational by 2035. In 2015 480MW of generating capacity was operational. A linear regression was created using these data three points (480MW in 2015, 732MW in

[11] Alex Jensen, BLM Nevada State Office Geothermal Program Lead 9/28/2023.

2023, and 1150MW in 2035) to extend the projections out to 2043, the end of the 20-year planning period. Table P-1 from Appendix P of the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS was used to estimate surface disturbance but the disturbance from power plant and substation facilities was increased from 10 acres of temporary and permanent disturbance per facility to 20 acres of temporary and 15 acres of permanent disturbance per facility because BLM specialists reported that operators were trending towards larger facilities and producing more MW per facility.

12.4.2 Oil and Gas

Oil production has decreased from 281,382 barrels in 2015 to 223,493 barrels in 2021.[12] This decline is assumed to continue unless new reserves or fields are discovered. Most of the production and exploration activities since 2015 were concentrated in Railroad Valley, Nye County and Pine Valley in Eureka County. There is very little natural gas production in Nevada. The California portion of the decision area has minimal oil and gas development.

Since 2013 a total of 19 oil and gas wells were drilled in Nevada, a number of the wells did not successfully produce. The results of these wells where information is available are described as follows. In December of 2017 True Oil drilled a well in Railroad Valley in Nye County, the well was plugged and abandoned (P&A) in January of 2018. Major Oil drilled a well in Hot Creek Valley, Nye County, in May 2018, the well was P&A in May 2019. Major Oil also drilled another well in Hot Creek Valley in November 2020, the well was P&A in April of 2021. Grant Canyon Oil and Gas drilled two conventional horizontal wells in the 3 Bar Field in Pine Valley, Eureka County, since 2015. One well was drilled in May of 2019 and completed in May of 2019, the well is averaging approximately 994 barrels of oil and 807 barrels of water per month. Another well was drilled in the 3 Bar Field and had reported production of 111 barrels oil and 907 barrels water in May of 2023. Sam Oil drilled a well in White River Valley, Nye County, the well is shut in and has no reported production. Other exploration wildcat wells have been drilled in Newark Valley (all reported as shut in) in Nye County. A well was drilled by Great Basin Operating in 2022 in southwest Elko County, the well is reported as being shut in.[13] The Elko-Noble Project which was a large contributor to the projected number of wells in the 2015 Nevada RFD was less successful than anticipated and is no longer active. Wells that may be drilled in the area are no longer called out as a separate item in projections below.

Oil and Gas Well Projections

Oil and gas well projections by Alternative are shown below in the table.

Table 14: Oil and Gas Well Projections for the Nevada-California GRSG Decision Area for the 20-year Planning Period

Alternative	Oil Wells Expected to be Drilled			Oil Wells Expected to be Producing		
	On Existing Leases	On New Leases	Total	On Existing Leases	On New Leases	Total
1	14	19	33	3	4	7
2	14	19	33	3	4	7
3	10	0	10	2	0	2
4	14	19	33	3	4	7

[12] https://data-ndom.opendata.arcgis.com/pages/oilgasandgeothermalproduction
[13] Nevada Division of Minerals, Well Database, 2022.

Alternative	Oil Wells Expected to be Drilled			Oil Wells Expected to be Producing		
	On Existing Leases	On New Leases	Total	On Existing Leases	On New Leases	Total
5	14	19	33	3	4	7
6	14	19	33	3	4	7

Source: Derived from Table P-5 from the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final and Proposed Alternative information.

Based on production data within the planning area, production wells produce on average 14 barrels per day per well. Gas production in expected to be negligible. Estimated production by alternative is shown below.

Table 15: Decision Area New Well Production by Alternative

Alternative	New Annual Production (barrels)	Total 20-year Production from New Oil Wells (barrels)
1	35,770	715,400
2	35,770	715,400
3	10,220	204,400
4	35,770	715,400
5	35,770	715,400
6	35,770	715,400

Source: Derived from Appendix P Fluid Minerals Reasonably Foreseeable Development Scenario the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final and Proposed Alternative information.

12.4.3 Geothermal

Nevada has eighteen operating geothermal power plants with federal interest, for a total generating capability of over 600 MW, and nearly 400 MW of additional geothermal projects in the permitting, exploration, development, and construction phases are expected to increase that capacity in the near future.[14]

Geothermal leases are for an initial 10-year period with 50 percent of the funds disbursed to the state, 25 percent is disbursed to the respective county, and 25 percent remaining in the Department of the Treasury.

The average kilowatt hours (Kwh) produced using geothermal energy in Nevada shows an increasing trend.[15] The trend for generation from Federal leases is also increasing as shown in the table below.

Table 16: Reported Electrical generation, Federal Geothermal leases.

Nevada Geothermal - Electrical Generation, Federal Leases	Kilowatt Hours (kwh)
2003	658,510,043
2004	674,485,049
2005	681,692,924
2006	637,744,978
2007	586,048,771
2008	569,422,744

[14] https://www.blm.gov/programs/energy-and-minerals/renewable-energy/geothermal-energy/regional-information/nevada

[15] https://minerals.nv.gov/uploadedFiles/mineralsnvgov/content/Programs/Geo/Geo-NVGeoPowerProdAndPrice2021(1).pdf

Nevada Geothermal - Electrical Generation, Federal Leases	Kilowatt Hours (kwh)
2009	726,844,239
2010	1,011,707,412
2011	1,023,720,775
2012	1,213,710,003
2013	1,440,832,542
2014	1,551,677,028
2015	1,871,102,791
2016	2,129,884,592
2017	2,117,036,922
2018	2,327,248,799
2019	2,420,865,506
2020	2,666,774,942
2021	2,683,281,628
2022	2,731,770,420

Source: Office of Natural Resources Revenue 2023

There is also reported geothermal electrical generation from federal leases in Lassen County California which is in the Nevada-California decision area. That production which was reported in millions of British thermal units (MMBTU) and is shown in the table below was last reported in 2018. It is not clear if the usage stopped after 2018 or if the reporting type changed. Geothermal direct utilization, which is also reported in MMBTU, was reported in Lassen County California from 2003 through 2023 and reported amounts jumped in starting in 2018 so it's possible that the type of use reported was changed. This is shown in **Table 17** below. The data obtained from the Office of Natural Resources Revenue does not contain the name of the reporting facilities, but a search suggests that the user is likely the Honey Lake plant operated by Greenleaf Power, which is a biomass electrical generation facility which uses geothermal resources to preheat boiler feed water to increase plant efficiency.[16]

Table 17: Federal Geothermal Leases Reported Use, Lassen County, California

Geothermal - Electrical Generation Lassen County, California	Kilowatt Hours (kwh)
2014	734,855
2015	666,434
2016	533,990
2017	468,609
2018	167,947
Geothermal - Direct Utilization	**Millions of British Thermal Units (MMBTU)**
2003	288,029
2004	165,885
2005	260,242
2006	238,147
2007	217,500
2008	219,089
2009	179,171

[16] https://greenleaf-power.com/honey-lake/

Geothermal - Direct Utilization	Millions of British Thermal Units (MMBTU)
2010	224,486
2011	228,011
2012	271,470
2013	276,337
2014	200,405
2015	170,924
2016	136,144
2017	122,616
2018	272,031
2019	242,702
2020	286,226
2021	255,801
2022	252,412

Source: Office of Natural Resources Revenue 2023

Geothermal Production Projections

The table below shows the projected geothermal generation capacity on federal leases in the Nevada-California GRSG planning area over the next 20 years. Approximately 815 MW of geothermal generation capacity would be added over the next 20 years. The addition of 815 MW may translate into 20 new power plants (589 MW ÷ 30 MW average per power plant = 27 power plants) supported by 138 wells (589 MW ÷ 5.9 MW per well = 138 new wells).

Table 18: Projected Geothermal Generation Capacity on Federal Leases in Nevada 2023-2043

Year	Geothermal Generation Capacity in Megawatts (MW)
2023	743
2024	776
2025	810
2026	843
2027	877
2028	911
2029	944
2030	978
2031	1,011
2032	1,045
2033	1,079
2034	1,112
2035	1,146
2036	1,179
2037	1,213
2038	1,247
2039	1,280
2040	1,314
2041	1,347

Year	Geothermal Generation Capacity in Megawatts (MW)
2042	1,381
2043	1,415

Source: Derived from information contained in Appendix P of the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final EIS and information from the BLM Nevada Geothermal webpage.[17]

As of 2022 there were approximately 160,000 acres of existing nonproducing federal geothermal leases in GRSG habitat, and a total of approximately 476,000 acres of non-producing federal geothermal leases in Nevada. There are approximately 14,000 acres of producing federal geothermal leases in GRSG habitat and approximately 56,000 acres total of producing federal geothermal leases in Nevada. Based on the production capacity of existing producing leases, the amount of acreage under existing nonproducing leases within Greater Sage Grouse habitat is sufficient to meet the projected growth in geothermal generation capacity during the 20-year planning period several times over, so assuming development is pursued on these leases and exploration determines that most have suitable geothermal resources, Increases in the amount of geothermal generation are expected to be the same under all the proposed Alternatives. Alternative 3 would close Greater Sage Grouse habitat to new geothermal leasing, which could prevent some future development in Alternative 3 PHMA, but it is likely that the development that would have occurred in these areas would relocated to other geothermal leases in Nevada.

Geothermal Activity Surface Disturbance Projections

Most geothermal development in the planning area has been of air-cooled binary systems which have the largest acreage disturbance for geothermal development, however that disturbance has been trending down, averaging less than 2 acres per MW of capacity for recent developments. Advances in drilling technology such as directional drilling have allowed for smaller surface disturbance. EGS technology has the potential to use far less groundwater to create binary geothermal production, however it has not yet been proven at the commercial scale, so estimates are based on traditional geothermal developments.

Table 19: Estimated Total New Decision Area Disturbance from Geothermal Development During the Planning Period

Disturbance Type	Temporary Disturbance per Facility (acres)	Permanent Disturbance per Facility (acres)	Number of New Facilities	Total New Temporary Disturbance (acres)	Total New Permanent Disturbance (acres)
Production & Injection Wells (Disturbance from all facility wells)	36	23	27	972	621
Power Plant & Substation	20	15	27	540	405
Switching Station	7	7	27	189	189

[17] https://www.blm.gov/programs/energy-and-minerals/renewable-energy/geothermal-energy/regional-information/nevada "Nevada BLM has eighteen operating geothermal power plants with federal interest, for a total generating capability of over 600 MW and nearly 400 MW of additional geothermal projects in the permitting, exploration, development and construction phases."

Disturbance Type	Temporary Disturbance per Facility (acres)	Permanent Disturbance per Facility (acres)	Number of New Facilities	Total New Temporary Disturbance (acres)	Total New Permanent Disturbance (acres)
Access Roads & Pipelines	18	18	27	486	486
TOTAL:	**81**	**63**	-	**2,187**	**1,701**

Source: Derived from Table P-1 from the 2015 Nevada and Northeastern California Greater Sage-Grouse Proposed LUPA/Final and updated geothermal production capacity estimates.

12.5 FLUID MINERALS – NORTH DAKOTA

12.5.1 Methodology

Since the publication of the 2015 Greater Sage Grouse plan for North Dakota an updated Reasonably Foreseeable Development Scenario for Oil and Gas Development in North Dakota[18] was published in 2022 as part of the revision of the North Dakota Resource Management Plan. Assumptions and methodology used to develop the updated projections below are the same assumptions and methodology described in the RFD for the North Dakota RMP revision. These were used along with new information where available to revise the projections provided to the current date, focus the analysis on the portions of the state with GRSG, and to analyze the proposed Alternatives. GRSG habitat management area in North Dakota is in the south-west corner of the state and limited to a small amount of the total area of the state. Much of the BLM fluid mineral decision area is already under an existing lease with approximately 15 percent unleased. To develop the below projections, the parcels of BLM-administered federal mineral estate that are within the GRSG planning area and the North Dakota boundaries were examined by township and information on the acres of BLM-administered federal mineral and amount leased vs available to lease in each township was recorded. The 20-year projections wells producing federal minerals for townships containing GRSG habitat were counted, and it was determined that under the existing rate of development a total of 222 production wells and 29 support (non-producing) wells are projected to be drilled on BLM-administered federal mineral estate over the next 20 years. To figure out projections by year the total projected federal North Dakota wells projected in a particular year were divided by the total 20-year projected federal wells and then multiplied by the total GRSG area wells to get the proportion of the total wells that occurred in that year. A similar method was used to get the projected production in GRSG habitat, the total production from new federal wells for a specific year was divided by the total number of new federal wells to get per well production for that year which was then multiplied by the number of new GRSG area federal production wells for that year. The reduction under Alternative 3, which would manage all GRSG habitat as closed to leasing, was calculated by determining the proportion of unleased federal mineral estate in the North Dakota GRSG planning area. Approximately 15.38 percent of the area is unleased and thus would not be leasable or able to be developed under Alternative 3, so the projection totals from the other Alternatives were reduced by 15.38 percent for this Alternative.

Surface disturbance projections were based on information from the Reasonably Foreseeable Development Scenario for Oil and Gas Development in North Dakota which assumed that 1.3 acres of surface disturbance per well would occur for new wells on BLM minerals. However, the GRSG area is outside the Bakken/Three Forks Formation where locating many horizontal wells on a single pad, which results in smaller per well disturbance, is the typical method of development. As a result, it was assumed 3 acres of surface disturbance

[18] https://eplanning.blm.gov/public_projects/1505069/200366341/20072477/250078659/NDRMP_Oil%20and%20Gas%20RFD_Oct2022_508.pdf

per well would occur to be more in line with the type of development seen in the GRSG area of North Dakota.

12.5.2 Oil and Gas

Since the publication of the 2015 Greater Sage Grouse plan for North Dakota an updated Foreseeable Development Scenario[19] oil and gas development in North Dakota was published in 2023 as part of the revision of the North Dakota Resource Management Plan. Assumptions and methodology used to develop the updated projections below are the same assumptions and methodology described in the RFD for the ongoing North Dakota RMP revision. These were used along with new information where available to revise the projections provided to the current date, focus the analysis on the portions of the state with GRSG, and to analyze the proposed Alternatives. GRSG habitat management area in North Dakota is in the south-west corner of the state and limited to a small amount of the total area of the state. Much of the BLM fluid mineral decision area is already under an existing lease with approximately 15 percent unleased.

Oil and Gas Development Potential

The North Dakota decision area is located on areas given a development potential rank of medium to high in the North Dakota Field Office RFD prepared for 2020-2040, updated in 2022, and released in 2023 with the Draft RMP/EIS as part of the North Dakota Resource Plan Revision and EIS.[20]

Since 2015 there have been six wells drilled on BLM administered lands in the Greater Sage Grouse decision area in North Dakota, all the drilled wells were located in PHMA,[21] however it is likely that there are other wells that are located outside of the decision area but are producing from federal minerals within the decision area by horizontal or directional drilling.

RFD Scenario

Projected Drilling Activity by Alternative

The 2020-2040 North Dakota RFD predicted that up to 222 wells would be drilled on federal minerals in the North Dakota GRSG decision area. In North Dakota, the vast majority of wells are horizontal wells.

Under the proposed Alternatives almost all of the North Dakota decision area would be PHMA so only PHMA management is presented in the following summary. Under Alternative 1 (existing management) PHMA would be managed as open to fluid mineral leasing subject to NSO stipulation, without waiver or modification, and with limited exception. Because much of the are decision area is already under existing leases which would not be impacted by the application of NSO stipulations to new leases, the potential area impacted by the proposed Alternatives is small. Also, because the vast majority of wells in North Dakota are horizontal, the impacts of NSO stipulations is not expected to have a major impact on the rate of development in most cases. Operators wanting to develop NSO area would be able to locate wellheads outside of NSO and horizontally drill into the minerals without much change to their standard development process. Alternative 2 would apply the same management as Alternative 1. Alternative 3 would manage all GRSG habitat as PHMA, under this Alternative all PHMA would be closed to leasing which would prevent any currently unleased BLM-administered federal mineral estate from being leased and developed. This would reduce the number of wells and total production compared to Alternative 1, but development and production would still occur on existing federal leases in the area, and private minerals would still be available

[19] https://eplanning.blm.gov/public_projects/1505069/200366341/20072477/250078659/NDRMP_Oil%20and%20Gas%20RFD_Oct2022_508.pdf
[20] https://eplanning.blm.gov/eplanning-ui/project/1505069/510
[21] IHS Enerdeq 2023

for leasing. Under Alternatives 4, 5 and 6, PHMA would be managed as open to fluid mineral leasing subject to NSO stipulation with waivers, modifications, and exceptions available at the discretion of the authorized officer. The allowance for waivers, modifications, and exceptions might result in increased development and production compared to Alternative 1, but because waivers, modifications, and exceptions are discretionary it is impossible to quantify any potential increase.

Table 20: Oil and Gas Well and Production Projections on BLM Administered Federal Minerals in the North Dakota GRSG Decision Area Over the 20-year Forecast Period

Year	Alternatives 1, 2, 4, 5 & 6				Alternative 3			
	GRSG Area BLM Mineral Producing Well Spuds	GRSG Area BLM Support Wells	GRSG Area BLM Mineral New Well Oil Production (Barrels)	GRSG Area BLM Mineral New Well Gas Production (MCF)	GRSG Area BLM Producing Well Spuds	GRSG Area BLM Support Wells	GRSG Area BLM Mineral New Well Oil Production (Barrels)	GRSG Area BLM Mineral New Well Gas Production (MCF)
2023	4.47	0.58	524,702	1,079,562	3.79	0.49	443,993	913,505
2024	5.81	0.76	918,328	1,889,438	4.92	0.64	777,072	1,598,807
2025	9.14	1.19	1,533,654	3,155,454	7.74	1.01	1,297,749	2,670,086
2026	9.32	1.21	1,893,439	3,895,704	7.89	1.03	1,602,193	3,296,472
2027	9.68	1.26	2,193,417	4,512,901	8.19	1.06	1,856,029	3,818,732
2028	9.98	1.30	2,463,888	5,069,388	8.45	1.10	2,084,896	4,289,622
2029	10.22	1.33	2,711,891	5,579,648	8.65	1.12	2,294,752	4,721,394
2030	10.48	1.36	2,953,200	6,076,135	8.87	1.15	2,498,943	5,141,513
2031	10.68	1.39	3,180,324	6,543,436	9.04	1.17	2,691,131	5,536,934
2032	10.89	1.42	3,403,177	7,001,951	9.22	1.20	2,879,705	5,924,920
2033	11.06	1.44	3,547,674	7,299,251	9.36	1.22	3,001,976	6,176,490
2034	11.28	1.47	3,677,824	7,567,030	9.55	1.24	3,112,106	6,403,080
2035	11.41	1.48	3,743,933	7,703,049	9.66	1.25	3,168,046	6,518,176
2036	11.72	1.52	3,827,079	7,874,120	9.91	1.29	3,238,403	6,662,933
2037	11.79	1.53	3,887,687	7,998,820	9.98	1.30	3,289,689	6,768,452
2038	11.65	1.51	3,847,130	7,915,373	9.86	1.28	3,255,370	6,697,841
2039	11.70	1.52	3,856,162	7,933,957	9.90	1.29	3,263,012	6,713,566
2040	11.90	1.55	3,972,327	8,172,963	10.07	1.31	3,361,309	6,915,809
2041	12.53	1.63	4,184,601	8,609,712	10.60	1.38	3,540,931	7,285,377
2042	12.98	1.69	4,348,299	8,946,515	10.98	1.43	3,679,449	7,570,375
2043	13.29	1.73	4,445,723	9,146,964	11.25	1.46	3,761,888	7,739,990
Total	**222**	**28.85**	**65,114,459**	**133,971,369**	**188**	**24**	**55,098,642**	**113,364,076**

Source: Derived from the RFD for the 2022 North Dakota RMP revision, updated for the GRSG forecast period. Federal mineral estate located under US Forest Service administered federal surface estate is not included.

Projected Surface Disturbance Due to Oil and Gas Activity by Alternative

Much of the BLM-administered federal mineral estate in the planning area is split estate (meaning the surface is not federal land). Additionally, there is US Forest Service administered federal surface overlying federal mineral estate in some areas, which is not included in the decision area for this Greater Sage Grouse planning effort. The following disturbance calculations project disturbance resulting from development of BLM-administered federal minerals but much of the surface disturbance would occur on non-federal surface, both because only there are 55,000 acres of BLM-administered federal mineral estate but only approximately 33,000 acres of BLM-administered federal surface estate in the decision area, and because operators generally prefer to locate wells on non-federal surface where possible because permitting and documentation required in order to operate on BLM-managed surface adds cost to the project.

The RFD for the 2022 North Dakota RMP/EIS assumed an average of 1.3 acres per well and associated infrastructure for new wells on BLM minerals. However, the GRSG decision area is outside the Bakken/Three Forks Formation where locating many horizontal wells on a single pad is the preferred method of development, so disturbance is likely to be greater; it was assumed that 3 acres of surface disturbance per well would occur in the GRSG area in order to be avoid the chance of underestimating surface disturbance. Using this methodology, it is assumed that approximately 666 acres of total surface disturbance from well pads, roads and tank batteries associated with oil and gas development on BLM-administered federal mineral estate could occur over the 20-year forecast period.

12.5.3 Geothermal

Currently, little geothermal development exists in North Dakota and the state has lower potential than many other western states.[22] However, the extensive deep drilling for oil and gas that has occurred in the state provides an extensive record of subsurface conditions.[23] Research into using co-produced fluids (petroleum and hot water) from deep oil wells is ongoing, and researchers at the University of North Dakota completed a test of the technology that successfully generated geothermal power from hot water that flows naturally from petroleum wells in the Williston Sedimentary Basin in western North Dakota.[24] Research into redeveloping end of life oil wells into geothermal generation wells is also ongoing. Development of electrical generation using geothermal resources could occur anywhere in the state where existing oil wells coproduce sufficient amounts of water at high temperatures, but the scalability and commercial viability of the technology has yet to be proven.

No development of geothermal resources on BLM-administered federal mineral estate in the GRSG planning area is reasonably foreseeable during the 20-year plan life. This is due to a number of factors including the likely need to obtain a federal geothermal lease for use of existing oil wells for development, and heat at depth being higher in parts of the state outside the planning area.[25]

12.6 Fluid Minerals – Oregon

12.6.1 Methodology

There is no ongoing development of oil and gas or geothermal resources on BLM administered surface or mineral estate within the planning area. No projections of development of these types could be developed based on available information. Given the possibility of future geothermal development an assumption was made regarding the possible size and disturbance associated with a theoretical geothermal development for the purpose of being able to analyze impacts associated with any future geothermal development that might occur.

12.6.2 Oil and Gas

Oil and Gas Development Potential

Assessment of oil and gas potential conducted as part of Section 604 of the EPCA ranks all Greater sage grouse HMAs in Oregon as having low potential for both oil and gas. None of the producing oil and gas fields in Oregon are located in GRSG habitat. There are approximately 78,652 acres of oil and gas leases on BLM-

[22] https://www.osti.gov/servlets/purl/1209221
[23] https://www.ndstudies.gov/energy/level2/module-5-biofuels-geothermal-recovered/geothermal-energy-north-dakota
[24] https://www.energy.gov/eere/success-stories/articles/eere-success-story-doe-funded-project-first-permanent-facility-co
[25] https://www.osti.gov/servlets/purl/1209221

managed federal fluid mineral estate within GRSG historical range as of 3/3/2023, none of the leases are producing.

Projected Activity by Alternative

Sage Grouse habitat in the Oregon planning area is presumed to have low oil and gas development potential, however there are current leases. It is expected that minimal if any, leasing, production, or surface disturbance associated with oil and gas exploration and development would occur in the planning area in Oregon over the next 20-years. Because there is no history of development no trend is available to estimate any future production.

12.6.3 Geothermal

There is no ongoing geothermal power generation on BLM-managed fluid mineral estate in Oregon. There are approximately 22,057 acres of authorized or pending federal geothermal leases within the Oregon Sage Grouse historical range as of 3/3/2023.

The state of Oregon has some of the nation's best geothermal resources.[26] Oregon's first geothermal power plant began operating in 2010 at the Oregon Institute of Technology in Klamath Falls. The initial electricity-generating capacity was 0.28 MW. A second plant at Oregon Institute of Technology generates 1.75 MW of power. The only commercial producing geothermal power plant is the Neal Springs plant in Malheur County. It is not within the GRSG planning area. The facility has five permitted production wells and six permitted injection wells, and the plant has an average net production of 22 MW. The city of Klamath Falls uses geothermal energy to heat buildings, homes, pools, and melt snow and ice from sidewalks and roads. In the town of Lakeview, a geothermal well system is used to heat school properties and hospital buildings.[27]

AltaRock Energy developed an EGS demonstration project[28] and Newberry geothermal research project at Newberry, which lies within the Deschutes National Forest and is near but not within the GRSG planning area. Alta Rock announced that results from the site could support construction of a 35 MW binary geothermal power plant utilizing a dry cooling system[29] but no development has been proposed at the site. Funding from the US Department of Energy expired in 2015[30] so future use of the site appears to be uncertain, however the operator is applying for additional Department of Energy grants and is planning to restart stimulation and exploration. EGS technology has the potential to be developed in the planning area, but because EGS technology has not been proven to be commercially viable at this time the scope of such projects is unknown.

Projected Activity by Alternative

The 2015 and 2018 Sage Grouse Plans did not project the occurrence of geothermal development in Oregon. Because there was no existing development and no previous estimates to use, the following assumption is made to analyze the impacts of potential geothermal development and associated surface disturbance. For the purposes of analysis, it is assumed that under all Alternatives except Alternative 3 up to one 20MW geothermal power generation facility would be developed on BLM-managed lands in GRSG habitat over the next 20 years. This facility would disturb up to 6 acres for the drilling of up to 6 thermal

[26] https://www.eia.gov/state/analysis.php?sid=OR
[27] https://www.oregon.gov/energy/energy-oregon/Pages/Geothermal.aspx
[28] https://energyinfo.oregon.gov/blog/2016/06/21/oregon-geothermal-on-the-rise
[29] https://altarockenergy.com/projects/newberry-egs-demonstration/
[30] Cladouhos, T. T., S. Petty, M. W. Swyer, M. E. Uddenberg, K. Grasso, Y. Nordin. Results from Newberry Volcano EGS Demonstration, 2010–2014. Geothermics, Volume 63, 2016. https://doi.org/10.1016/j.geothermics.2015.08.009

gradient wells and would disturb up to 24 acres for the drilling of up to 8 production and injection wells. Construction of pipelines would disturb up to 14 acres, and an additional 10 acres could be disturbed for the construction of the generating plant. An assumed 10 miles of road would disturb /approximately 50 acres, and 8 miles of power line would disturb approximately 40 acres. The total estimated disturbance acres for this scenario equals 144 acres. Under Alternative 3, all BLM-managed minerals in GRSG habitat would be closed to fluid mineral leasing so it is assumed that geothermal power development might be reduced under this alternative, but existing leases could still be used for development.

12.7 FLUID MINERALS – SOUTH DAKOTA

12.7.1 Methodology

BLM mineral resource experts examined the RFD projections produced for the 2015 South Dakota GRSG RMP/EIS as well as development trends and development data available since that time and determined that the methodology and trends that were used to produce the projections for that document did not need modifications given the lack of significant changes in trends surrounding fluid mineral development in the state.

Assumptions and methodology used to develop the updated projections below are the same assumptions and methodology described in the RFD for the of the 2015 South Dakota Proposed LUPA/Final EIS (2015 SD Plan). These were used, along with development data since 2015, to revise the projections in that document to fit the current planning timeline, and to analyze the new proposed Alternatives.

The original RFD for South Dakota was produced in 2009, however as part of the 2015 GRSG planning effort the BLM produced an updated analysis for the planning area titled "Oil and Gas Reasonably Foreseeable Development by Alternative for the SD RMP April 2014", this document contains a summary table for the RFD projections adjusted for the management of the 2015 proposed alternatives. This table was used to analyze the proposed alternatives from the current planning effort. Alternative 1 would continue the management in the preferred Alternative (Alternative D) analyzed in the 2015 SD Plan. Alternative 2 would apply similar management to Alternative 1, as would Alternatives 4 and 5 except that they would allow for more WEMs. Alternative 6 would apply the same management as Alternative 5 except that it would designate ACECs which would be closed to leasing, however no ACEC areas would be designated in South Dakota, so impacts would not differ from Alternative 5. Alternative 3 in the current planning effort proposes approximately the same management as was proposed under Alternative C in the 2015 SD Plan. The projected number of new wells spud (drilled), producing from the Alternatives C and D were carried forward to the updated summary table below. Projections of surface disturbance were similarly taken from the Alternatives C and D projections shown in Table 4-5 in the 2015 SD Plan.

Production projections were created using Table 6 in the 2009 South Dakota Reasonably Foreseeable Development Scenario. The proportion of BLM-administered federal minerals within the GRSG planning area out of the total RFD study area was used to scale the annual production projections for oil and gas provided in the RFD to only the GRSG decision area. The projections provided in the RFD were for the years 2010 through 2029 so the regression equations for the projections of annual production of oil and of gas were calculated and used to extend the projections through 2043, the end of the 20-year planning period of the current effort. Information in the "Oil and Gas Reasonably Foreseeable Development by Alternative for the SD RMP April 2014" Table 6 presented a baseline of expected production. Based on the number of wells projected under the action alternatives compared to the baseline it was determined that Alternatives 1, 2, 4, 5 and 6 represented an approximately 8 percent reduction in production compared to the baseline and that Alternative 3 represented an approximately 9 percent reduction in production compared to the

baseline. The projections of oil and gas production within the South Dakota GRSG mineral decision area were reduced by these percentages to calculate the projected production under each of the current Alternatives during the planning period.

There is no ongoing development of geothermal resources on BLM administered surface or mineral estate within the planning area. No geothermal development is expected, and no projections of geothermal development were created.

12.7.2 Oil and Gas

Oil and Gas Development Potential

The table below shows the potential ranking of the RFD scenario area, however GRSG are only found in the portion of the RFD scenario area considered in the 2015 South Dakota RMP Revision.

Table 21: South Dakota Oil and Gas Development Potential in the RFD Scenario

Development Potential	Total Acres in RFD Study Area (All Ownerships)	Acres of BLM Administered Federal Minerals	Number of Townships	Percent of RFD Study Area (All Ownerships)
High	318,000	113,473	13.81	1.24
Moderate	476,000	80,459	20.65	1.86
Low	1,082,000	284,555	46.95	4.23
Very Low	22,068,000	1,138,091	957.82	86.33
None	1,617,000	54,162	70.20	6.33

Source: 2015 South Dakota Proposed RMP/Final EIS, Table 4-2.

Projected Drilling Activity by Alternative

The projections for the number of wells drilled on Federal minerals in the decision area are shown in the table below. It is estimated that during the 20-year forecast period approximately 355 conventional wells and up to 71 coalbed methane wells would be drilled on non-BLM administered minerals in the state.

Table 22: Oil and Gas Well Projections for Federal Minerals (except federal minerals under US Forest Service surface) Over the 20-year Forecast Period

Well Type	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6
Number of oil and gas wells drilled	59.9	59.9	55.5	59.9	59.9	59.9
Producing oil and gas wells	53.6	53.6	50	53.6	53.6	53.6
Number of CBNG gas wells drilled	2.3	2.3	1.4	2.3	2.3	2.3
Producing CBNG gas wells	2	2	1.3	2	2	2

Source: Derived from the RFD Summary Table in the 2015 the South Dakota RMP RFD updated and adjusted to remove Forest Service decision area from the projections.
CBNG = Coal bed natural gas

Projected Surface Disturbance Due to Oil and Gas Activity by Alternative

Because of split estate (non-federal surface over federal minerals) and use of horizontal and directional drilling in the planning area most development of federal minerals will occur using wells that are not located

on BLM-managed surface. The project disturbance from development of federal minerals regardless of surface ownership, and projected disturbance on BLM-administered surface are both shown in the table below.

Table 23: Potential Surface Disturbance from Oil and Gas and Coalbed Gas Drilling on BLM Land 2023-2043

Alternative	Total Wells Projected on BLM-Managed Federal Minerals	Short-Term Surface Disturbance on Federal Minerals (5.3 acres per well)	Long-Term Surface Disturbance on Federal Minerals (3.2 acres per well)	Percent of Federal Minerals Overlain by BLM Surface	Total Wells Projected for BLM-Managed Surface	Short-Term Surface Disturbance on BLM Surface (5.3 acres per well)	Long-Term Surface Disturbance on BLM Surface (3.2 acres per well)
Potential Surface Disturbance from Oil and Gas Drilling							
Alternative 3	55.5	294	178	16	9	48	29
Alternatives 1,2,4,5,6	60	318	192	16	10	53	32
Potential Surface Disturbance from Coalbed Gas Drilling							
Alternative 3	1.5	8	4.8	16	0.2	1	0.6
Alternatives 1,2,4,5,6	2.5	13.2	8	16	0.4	2	1.3

Source: Derived from Table 4-5 in the 2015 South Dakota Proposed RMP/Final EIS, adjusted to reflect changes in well projections.

Projected Production by Alternative

Table 24: Projected South Dakota Study Area Annual and Cumulative Oil and Gas Production for 2023 Through 2043

Year	Annual Oil (Barrels) All Mineral Estate	Annual Gas (Thousand Cubic Feet) All Mineral Estate	Alternatives 1/2/4/5/6 BLM Administered Annual Oil (Barrels)	Alternatives 1/2/4/5/6 BLM Administered Gas (Thousand Cubic Feet)	Alternative 3 BLM Administered Oil (Barrels)	Alternative 3 BLM Administered Gas (Thousand Cubic Feet)
2023	1,875,085	20,109,885	98,210	1,053,279	97,142	1,041,831
2024	1,920,304	19,715,937	100,578	1,032,646	99,485	1,021,422
2025	1,913,306	19,842,636	100,212	1,039,282	99,122	1,027,985
2026	1,943,632	20,196,635	101,800	1,057,823	100,694	1,046,325
2027	1,882,287	21,069,274	98,587	1,103,529	97,515	1,091,534
2028	1,863,648	20,408,592	97,611	1,068,925	96,550	1,057,306
2029	1,929,270	21,204,288	101,048	1,110,600	99,949	1,098,528
2030	1,929,627	22,147,590	101,067	1,160,007	99,968	1,147,398
2031	1,938,634	22,610,546	101,538	1,184,255	100,435	1,171,382

Year	Annual Oil (Barrels) All Mineral Estate	Annual Gas (Thousand Cubic Feet) All Mineral Estate	Alternatives 1/2/4/5/6 BLM Administered Annual Oil (Barrels)	Alternatives 1/2/4/5/6 BLM Administered Gas (Thousand Cubic Feet)	Alternative 3 BLM Administered Oil (Barrels)	Alternative 3 BLM Administered Gas (Thousand Cubic Feet)
2032	1,947,641	23,073,502	102,010	1,208,502	100,901	1,195,367
2033	1,956,648	23,536,458	102,482	1,232,750	101,368	1,219,351
2034	1,965,655	23,999,414	102,954	1,256,998	101,834	1,243,335
2035	1,974,662	24,462,370	103,425	1,281,246	102,301	1,267,320
2036	1,983,669	24,925,326	103,897	1,305,494	102,768	1,291,304
2037	1,992,676	25,388,282	104,369	1,329,742	103,234	1,315,288
2038	2,001,683	25,851,239	104,841	1,353,990	103,701	1,339,272
2039	2,010,690	26,314,195	105,312	1,378,238	104,168	1,363,257
2040	2,019,697	26,777,151	105,784	1,402,486	104,634	1,387,241
2041	2,028,704	27,240,107	106,256	1,426,733	105,101	1,411,225
2042	2,037,711	27,703,063	106,728	1,450,981	105,567	1,435,210
2043	2,046,718	28,166,019	107,199	1,475,229	106,034	1,459,194
Total	**41,161,946**	**494,742,509**	**2,155,907**	**25,912,735**	**2,132,473**	**25,631,075**

Sources: Derived from Table 6 *Forecast of South Dakota Study Area annual and cumulative oil and gas production for 2010 through 2029* in the South Dakota RMP RFD (2009) updated and adjusted to remove Forest Service decision area from the projections.

12.7.1 Geothermal

Currently, little geothermal development exists in South Dakota and no high temperature geothermal resources (greater than 302°F). have been identified in the state. The development that does exist is comprised of hot springs developed for recreational use (located in the town of Hot Springs) and a few local heating ventures in the western part of the state, none of which are on public land. The few hot springs are connected by faults to deeply buried reservoirs that contain geothermal water that moves upward along the fault zones to discharge at the land surface. See Chapter 3 of the 2015 South Dakota Proposed RMP/Final EIS for more information.

No development of geothermal resources is reasonably foreseeable or likely to occur on federal minerals in the planning area during the 20-year plan life.

12.8 Fluid Minerals – Utah

12.8.1 Methodology

BLM mineral resource experts examined the RFD projections produced for the 2015 Utah Greater Sage-Grouse LUPA and EIS, the 2019 Utah Greater Sage-Grouse Resource Management Plan Amendment (RMPA) and EIS, and the 2020 Utah Greater Sage-Grouse Supplemental EIS.[31] They also looked at development trends and production data available since that time. It was determined that because of the lack of significant changes in trends associated with fluid mineral development in the state, the methodology and trends that were used to produce projections of well development and production in the 2015 Utah Greater Sage-Grouse LUPA and EIS did not need modifications. The assumptions and methodology

[31] Call 1/26/2023 with Quincy Bahr, Mary Higgins, Kevin Kelley, Laura Opal, Teresa Snyder, Duane Spencer, and David Chase (BLM), and Francis Craig and Kate Krebs (EMPSi), and a call 2/15/2023 with Quincy Bahr and Angela Wadman (BLM) and Francis Craig and Kate Krebs (EMPSi).

described in the Oil and Gas Reasonably Foreseeable Development Scenario for Greater Sage-Grouse Occupied Habitat in Utah Sub-Region which was included as Appendix R as part of the 2015 Utah Greater Sage-Grouse Proposed LUPA/Final EIS,[32] were used to develop the updated projections below. These assumptions and methodology were used to incorporate new development data and other relevant information regarding oil and gas development since 2015 to revise the projections provided to the current planning period and to analyze the current proposed Alternatives. Data incorporated included the number, trend and location of wells drilled since 2013, production from federal mineral estate in the state, and information on federal leases in the decision area.

Well projections from the 2015 Utah Proposed Land Use Plan Amendment/Final Environmental Impact Statement Appendix R[33] Table R.1. The projections of new oil and gas wells in the 2015 plan were for a 15-year planning period and included federal minerals estate under Forest Service surface estate in GRSG habitat in the decision area. Because the current planning process is considering a 20-year timeline and federal minerals under Forest Service surface are not included in the current decision area the projections required adjustment. The total number of wells was from Table R.1 was reduced using a factor of approximately 0.786, the ratio of the change in the decision area total acreage of approximately 3,151,000 acres in 2023 from the approximately 4,008,600 acre total in the 2015 plan, to calculate the number of new wells projected in the new decision area (assuming equal distribution of the wells across the landscape). The resulting total number of projected new wells was divided by 15 to calculate the annual average number of new wells and then multiplied by 20 to calculate the total for the 20-year planning period of the current effort.

The Proposed Plan Alternative and Alternative C from the 2015 RFD were brought forward for use in projections for the current planning effort. These Alternatives were selected because they applied similar management to the current alternatives being considered. Alternative 3 would designate all GRSG habitat in the decision area as PHMA and close all PHMA to fluid mineral leasing, Alternative C from 2015 closed all GRSG habitat to fluid mineral leasing and used a similar decision area, so the rate of development from this alternative was extended forward. Alternative 1 would continue management from the 2015 Proposed Plan, PHMA would be open to leasing with NSO stipulations applied subject to WEMs and GHMA would be NSO around Leks. Alternative 2 would apply essentially the same management for fluid minerals as Alternative 1, and Alternatives 4 and 5 would also apply the same management but with minor changes to PHMA boundaries and the addition of WEMs. Alternative 6 would apply the same management as Alternative 5 but with the addition of NSO stipulations applied in ACECs, however most of the acreage that would be designated as ACECs under Alternative 6 is already are closed to leasing or has existing NSO stipulations applied to protect resources other than GRSG, so this alternative would be minimally different from Alternative 5 in impacts on oil and gas development. For all Alternatives other than Alternative 3 the management of fluid minerals would be sufficiently similar, and differences between them due to the allowances for WEMs under some alternatives are not quantifiable because WEM decisions are made by the BLM Authorized Officer on a case-by-case basis and cannot be predicted in advance. As a result it is assumed that impacts on fluid mineral development would be approximately the same under Alternatives 1, 2, 4, 5, and 6, and the projections of oil and gas development from the Proposed Plan management from the 2015 Plan was extended forward for use in the analysis of impacts on oil and gas development under these alternatives for the current planning effort.

[32] https://eplanning.blm.gov/public_projects/lup/103346/143763/177169/AppendixR_OilGasForeseeableDevelopment.pdf
[33] https://eplanning.blm.gov/public_projects/lup/103346/143763/177169/AppendixR_OilGasForeseeableDevelopment.pdf

Production was determined using information from the 2015 Utah Proposed Land Use Plan Amendment/Final Environmental Impact Statement Appendix W[34] which details the expected average production of oil and gas from new oil and gas wells as 200 thousand barrels of oil per oil well and 1,471 million cubic feet per gas well, over a 20 year well life. These production amounts were multiplied by the number of new oil and gas wells, respectively, over the 20-year planning period that were derived using the process described above. Surface disturbance was determined based on the total number of new wells in the 20-year planning period multiplied by the average disturbance per each feature type from Tables R.3 through R.7 in the 2015 Utah GRSG RMP/EIS Appendix R.

12.8.2 Oil and Gas

In order to show the oil and gas potential of the Utah GRSG planning area, and allow for comparison of the development potential across the entire GRSG planning area, the assessment of oil and gas potential conducted under part of the Section 604 of the EPCA was intersected with GRSG HMAs in the current BLM decision area. The boundaries of GRSG habitat vary slightly between some of the alternatives so the Alternative 4 and 5 boundaries were used in the calculations shown in the table below. Very little of the planning area has a high development potential for either oil or gas.

Table 25: Oil and Gas Potential Ranking in the Decision Area

Utah Oil Potential by GRSG Habitat Type	Acres
PHMA	3,388,000
Low Potential	2,193,000
Moderate Potential	2,120,000
High Potential	0
GHMA	1,195,000
Low Potential	950,000
Moderate Potential	234,000
High Potential	11,000
Utah Gas Potential by GRSG Habitat type	
PHMA	2,193,000
Low Potential	2,031,000
Moderate Potential	162,000
High Potential	0
GHMA	1,195,000
Low Potential	848,000
Moderate Potential	347,000
High Potential	0

Source: EPCA 2018, BLM GIS 2018

Historical Drilling Trends

In Utah there are 94,000 acres of federal oil and gas leases in PHMA and 276,000 acres of federal leases in GHMA. Of these 89,000 acres in PHMA and 211,000 acres in GHMA are authorized, no matter which Alternative is chosen, these leases would be available for development in the future unless they expire, are relinquished, or are surrendered due to lack of diligent development. The remaining lease acres are listed under pending or interim status.

[34] https://eplanning.blm.gov/public_projects/lup/103346/143763/177174/AppendixW_EconomicImpactAnalysisMethodology.pdf

Since 2013 there have been 4,883 new wells spud (meaning drilling of the well was started) within Utah on both federal and non-federal lands, out of these approximately 90 percent were intended to be producing wells. Approximately 42% of the wells were directional wells, 14% were horizontal wells, and 44 percent were vertical wells.[35] The trend in the number of well spuds per year is highly variable as shown in **Table 26**, below.

Table 26: Well Spuds by Year

Year	Well Spuds
2013	685
2014	1434
2015	402
2016	246
2017	501
2018	474
2019	303
2020	69
2021	292
2022	350
2023*	127

Source: IHS Enerdeq 2023, query date 7/24/2023
*2023 data complete through approximately mid-July 2023.

A total of 60 wells have been recorded as being drilled at a surface location in GRSG PHMA or GHMA federal surface in the decision area, but more wells producing federal minerals by horizontal or directional drilling from a non-federal surface location likely exist.

Projections produced as part of RFD scenarios typically aim to estimate levels of development that would be nearer the upper bound of expected development in order to allow for an analysis of impacts associated with fluid mineral development that avoids understating possible impacts. If actual levels of development have exceeded the projections it is an indicator that an update to the projections is needed, however if actual levels of development have not reached the level projected that is acceptable.

The projections below were based on the development scenarios created in the 2015 Utah GRSG RFD which were based on criteria including past and present oil and gas exploration, development and production activity within and near Greater Sage-Grouse occupied habitat, existing oil and gas leases, expressions of interest submitted by industry, exploration and development trends, locations of seismic surveys, existing infrastructure, and commodity prices.

The Carbon, Uintah, and Rich population areas (Carbon, Duchesne, Daggett, Rich, Summit and Uintah Counties) are the areas expected to have the majority of the oil and gas development that would potentially be impacted under the proposed Alternatives. The rest of the planning area is expected to have minimal to no future oil and gas development.

Because the planning effort for which this document has been developed is being conducted on a range-wide scale, projections were extended at the state-level scale rather than the population area scale that was used in previous planning.

[35] IHS Enerdeq 2023, query date 7/24/2023.

Projections by Proposed Alternative

Proposed Alternatives 1 and 2 continue the management from the 2015 and 2018 GRSG planning efforts, respectively, in order to form the dual No Action Alternatives. Proposed Alternative 1 is the same as the Proposed Plan from the 2015 Utah GRSG LUPA and EIS, the projections assumptions which were defined in the 2015 Utah GRSG RFD continue to be used for Alternative 1. Proposed Alternative 2 is the same management proposed plan from the 2018 Utah GRSG RMPA and Final EIS. The analysis of the proposed plan in the 2018 Utah GRSG RMPA and Final EIS concluded that the projected number of wells under the 2018 proposed plan would be approximately the same as the number of wells that was projected under the 2015 proposed plan. Thus Alternatives 1 and 2 continue to result in the same proposed levels of oil and gas development. Proposed Alternative 3 would manage all GRSG habitat as PHMA and close all PHMA to fluid mineral leasing. This same management was proposed and analyzed as Alternative C in the 2015 Utah GRSG LUPA and EIS, and the 2015 Utah GRSG RFD. The analysis and assumptions from those documents are carried forward and used in the Analysis of Alternative 3 below. Proposed Alternatives 4 and 5 would manage PHMA as open to leasing with NSO stipulations, subject to waivers, exemptions, and modifications; and manage GHMA as open to leasing with NSO applied around leks only. This would result in effectively the same management of fluid minerals as under Alternative 1. As a result, the projections of future oil and gas development are the same across Alternatives 1, 2, 4, 5, and 6. Alternative 3 would result in reduced oil and gas development and production compared to the other Alternatives, due to the decision to close all PHMA to leasing, but because preexisting lease that are in the new PHMA boundary could still be developed, some new well drilling and production would continue under Alternative 3. The results are shown in the tables below.

Table 27: Projected Wells Drilled in GRSG Habitat 2023-2043

Alternative	Total Wells	Total Gas Wells	Total Oil Wells
1	3,111	2,436	676
2	3,111	2,436	676
3	2,775	2,159	616
4	3,111	2,436	676
5	3,111	2,436	676
6	3,111	2,436	676

Source: Derived using information from Table R.1 in Appendix R of the 2015 Utah Greater Sage-Grouse Proposed LUPA/Final EIS, and Proposed alternatives.

Table 28: 20-year Projected Oil and Gas Production from Federal Mineral Estate in the Decision Area by Alternative

Alternative	20-year Gas Production (Millions of Cubic Feet)	20-year Oil Production (Barrels)
1	3,582,970	135,202,315
2	3,582,970	135,202,315
3	3,175,530	123,187,946
4	3,582,970	135,202,315
5	3,582,970	135,202,315
6	3,582,970	135,202,315

Source: Derived using information from Appendix W, and Tables R.1 and R.2 in Appendix R of the 2015 Utah Greater Sage-Grouse Proposed LUPA/Final EIS, and Proposed alternatives.

Table 29: Estimated 20-Yr Surface Disturbance from Oil and Gas Development of BLM-Administered Federal Mineral Estate

Type of Development	Alternative	1	2	3	4	5	6
Well pads	Total Wells	3,111	3,111	2,775	3,111	3,111	3,111
	Total Well Pads	831	831	741	831	831	831
	Average Disturbance per Pad	5.4	5.4	5.4	5.4	5.4	5.4
	Total Pad Disturbance Acres	4,487.74	4,487.74	4,002.99	4,487.74	4,487.74	4,487.74
Roads	Road Miles	536.51	536.51	478.56	536.51	536.51	536.51
	Average Disturbance per Road Mile	4.8	4.8	4.8	4.8	4.8	4.8
	Road Disturbance Acres	2,576.30	2,576.30	2,298.01	2,576.30	2,576.30	2,576.30
Pipelines	Pipeline Miles	545.98	545.98	487	545.98	545.98	545.98
	Average Disturbance per Mile	1.2	1.2	1.2	1.2	1.2	1.2
	Pipeline Disturbance Acres	655.38	655.38	584.59	655.38	655.38	655.38
Total Ancillary Features Acres		480	480	480	480	480	480
TOTAL Disturbance Acres		**8,199.42**	**8,199.42**	**7,365.60**	**8,199.42**	**8,199.42**	**8,199.42**

Source: Derived using information from Appendix R of the 2015 Utah Greater Sage-Grouse Proposed LUPA/Final EIS, and Proposed alternatives.

Total Estimated Future Surface Disturbance for Geophysical Exploration

Estimated surface disturbance associated with seismic exploration is shown in the table below.

Table 30: Estimated 20-Yr Seismic Exploration Surface Disturbance

Alternative	Miles of Seismic Lines	Average Disturbance per Mile	Disturbance Acres
1	1,248.70	1.2	1,498.02
2	1,248.70	1.2	1,498.02
3	1,113.82	1.2	1,336.21
4	1,248.70	1.2	1,498.02
5	1,248.70	1.2	1,498.02
6	1,248.70	1.2	1,498.02

Source: Derived using information from Appendix R of the 2015 Utah Greater Sage-Grouse Proposed LUPA/Final EIS, and Proposed alternatives.

12.8.3 Geothermal

Utah currently has three operational utility scale geothermal energy facilities with an installed capacity of 72.5MW. The Blundell Plant operated by PacifiCorp Energy consists of a 23MW flash steam plant and 10MW secondary recovery binary plant.[36] The Cove Fort Hybrid Plant operated by Enel Green Power is a

[36] https://geology.utah.gov/docs/emp/geothermal/ugwg/pdf/larsen0408.pdf

geothermal-hydro hybrid power plant with a 25MW installed capacity.[37] The Thermo Geothermal Power Plant operated by Cyrq Energy consists of a 14.5MW binary process plant.[38] Both Blundell and Cove Fort plants have federal geothermal leases, but neither are located in GRSG HMAs. The Utah BLM has conducted geothermal lease sales during three of the past 4 years; 3045.19 acres were leased in 2023, 21,685.35 acres were leased in 2022, and 26,200.62 acres were leased in 2020.[39]

The table below shows geothermal electrical generation from federal geothermal leases in Utah from 2013 to 2023. This shows the trend over time which is tied to the amount of geothermal development.

Table 31: Utah Geothermal Electrical Generation from Federal Geothermal Leases in Kilowatt Hours

Year	Kilowatt Hours (kwh)*
2013	12,986,766
2014	132,080,000
2015	130,138,400
2016	150,003,437
2017	144,419,064
2018	132,624,724
2019	143,793,551
2020	112,090,593
2021	129,606,607
2022	128,459,411
Total	**1,216,202,553**

Source Office of Natural Resources Revenue 2023
*Some geothermal electrical generation in Utah is reported by ONNR in thousands of pounds (presumed to be of steam for a flash steam plant) which are not able to be converted to kilowatt hours generated without additional information, as a result that data is not included in these totals.

The 2015 Utah Greater Sage-Grouse LUPA and EIS contained the following as an RFD scenario for Geothermal:

> *It is possible that the existing Thermo Geothermal Field (currently, Cyrq-owned wells and generation plant) could expand in the future to include an adjacent 980-acre geothermal lease (UTU-087662) that is located within the Bald Hills Populated Area. Development of this lease is expected to comprise of drilling five geothermal energy production or produced fluid injection wells. With an estimated surface disturbance of 7 acres per well, including respective access roads and pipelines, a total of 35 acres of long-term surface disturbance would result.*

It also noted that geothermal resources are plentiful in the middle and northwest portions of the state, although a lack of transmission capacity may hinder electricity development in the northwest corner.

[37] https://www.enelgreenpower.com/our-projects/operating/cove-fort-hybrid-plant
[38] https://cyrqenergy.com/energy-plant-locations/#minersville-ut
[39] https://www.blm.gov/programs/energy-and-minerals/renewable-energy/geothermal-energy/regional-information/utah

The 2019 Utah Greater Sage-Grouse RMPA and EIS did not provide an updated RFD scenario for geothermal development, but did provide the following updates to geothermal information:

> *Between 2015 and 2017, the BLM has offered for lease 24,468 acres within HMAs. Lease stipulations apply as described in the leases as analyzed in the 2015 Final EIS.*
>
> *Six geothermal development permits have been approved and drilled on existing pads on existing leases. McGinness Hills Phase 3 Environmental Assessment authorized up to 42 acres of disturbance on existing leases, which will be offset according to the mitigation hierarchy.*

Since 2019 the BLM in Utah has conducted annual geothermal lease sales which can be viewed on the Utah Geothermal Energy webpage.[40]

Geothermal RFD scenario

Over the next 20 years both exploration and development activities could occur on existing and future geothermal leases. Test and thermal gradient wells typically disturb approximately 1 acre per well and production and injection wells for power generation typically disturb up to 7 acres. For the purposes of analysis, it is assumed that one 30MW geothermal power generation facility would be developed on BLM-managed lands in GRSG habitat over the next 20 years. This facility could disturb up to 6 acres for the drilling of up to 6 thermal gradient wells and would disturb up to 56 acres for the drilling of up to 8 production and injection wells. Construction of pipelines would disturb up to 14 acres, and an additional 10 acres could be disturbed for the construction of the generating plant. An assumed 10 miles of road would disturb approximately 50 acres, and 8 miles of power line would disturb approximately 40 acres. Because the existing issued geothermal leases are likely sufficient develop a facility of this size this could occur under any of the proposed Alternatives, but it would be less likely under Alternative 3 because the closure of all GRSG PHMA to new fluid mineral leasing would not allow new geothermal leases to be issued within GRSG HMAs under Alternative 3. The potential surface disturbance from the development of a new geothermal facility by Alternative are shown in the table below.

Table 32: Surface Disturbance Associated with the Development of a Geothermal Generating Facility

Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Thermal Gradient Well Disturbance (acres)	6	6	6	6	6
Production and Injection Well Disturbance (acres)	56	56	56	56	56
Pipeline Construction Disturbance (acres)	14	14	14	14	14
Generating Plant Disturbance (acres)	10	10	10	10	10

[40] https://www.blm.gov/programs/energy-and-minerals/renewable-energy/geothermal-energy/regional-information/utah

Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Road Disturbance (acres)	50	50	50	50	50
Powerline Disturbance (acres)	40	40	40	40	40
Total (acres)	**176**	**176**	**176**	**176**	**176**

Source: 2015 Utah Greater Sage-Grouse LUPA and EIS modified based on current alternatives

12.9 FLUID MINERALS – WYOMING

12.9.1 Methodology

Production projections from the 2015 document were not well documented in how they were derived or what was included. As a result, new projections were created using available data. Data on the production of oil and gas from federal mineral estate in Wyoming was pulled from the US Department of Interior (DOI) Office of Natural Resource Revenue (ONNR).[41] This data was then edited to remove the production that did not occur in the decision area, this included removing the proportion of federal minerals under Forest Service surface, and the proportion of federal minerals in areas of the state without GRSG habitat. For the purposes of this it was assumed that there is an equal distribution of federal fluid mineral production across the state. The acreage of the current mineral decision area which does not include federal minerals under Forest Service surface) was divided by the total area of federal mineral estate in Wyoming to get the proportion of total federal mineral estate that is part of the decision area. The production data from ONNR was reduced using this proportion to get amount of oil and gas production that is from the GRSG mineral decision area. It was then assumed that Alternatives 1 and 2 which would both approximately continue existing management so the existing annual production (for 2022, the year-over-year trend is relatively steady) was multiplied by the 20-year project timeline, to project production for those Alternatives. For the other Alternatives, the proportion of the projected total number of wells under Alternatives 1 and 2 was taken as the ratio of the number of wells under other Alternatives to reduce or increase the projected 20-year production from Alternatives 1 and 2 to derive the projected 20-year production for the other Alternatives.

While Coal Bed Natural Gas (CBNG) wells were seeing considerable interest in the period leading up to the development of the 2015 Greater Sage Grouse planning, since that time the economics have been unfavorable and developments have underperformed, in Wyoming no CBNG wells have been drilled in the planning area in the past 10 years and none are likely in the future. As a result, CBNG wells were removed from all projections and not projected forward into the future.

The 2015 plan did not include all of BLM-managed lands in Wyoming because there were ongoing resource management plan (RMPs) efforts for the Buffalo Field Office (FO), Lander FO, and Bighorn Basin (combined plan for Cody FO and Worland FO), and Sage Grouse Planning was completed as part of the RMP process for these FOs. For the current proposed plan amendment all of Wyoming is being included in the planning area so the oil and gas development projections from the Buffalo, Lander and Bighorn Basin RMPs were collected, CBNG wells were removed from the projections and the remaining wells projected were added to the well projections associated with the most similar fluid mineral management alternative in the GRSG plan. So that projections being created would cover BLM-managed federal minerals across the entire state.

[41] https://revenuedata.doi.gov/query-data?dataType=Production

For updating well projections, Table 4-43[42] from the 2015 Wyoming Greater Sage-Grouse Land Use Plan (LUP) Amendment (2015 WY Plan), was used as a starting point. Alternatives 1 and 2 would continue existing management from 2015 LUPA so the Proposed LUP Amendments column is carried forward for those Alternatives. Alternative 3 would close almost all GRSG habitat in the decision area to fluid mineral leasing. While this is approximately the same management as Alternative C in the 2015 WY Plan, concerns were raised with how the Alternative C projections appeared not to fully account for the impacts associated with closing lands around existing undeveloped leases, the extent of possible development in areas with NSO stipulations, and ROW exclusions preventing the construction of new off-lease roads and pipelines required for development of existing undeveloped leases. Similar concerns were raised that Alternatives 4, 5, and 6 would need to account for areas where existing undeveloped leases surrounded by NSO would be stranded due to lack of access, and areas where NSO would be too far from locations where surface facilities could be placed to be developed by horizontal or directional drilling. To account for these concerns the following process was developed. All proposed NSO areas were reverse buffered to calculate the area within the average reach of directional or horizontal drilling technology, a 0.5 mile inward buffer distance from all edges of NSO areas was used for all areas of Wyoming except for the Power River Basin (as delineated by the Wyoming State Geologic Survey[43]) which used a 2-mile inward buffer distance because the producing formations in the Powder River basin are horizontal and continuous making them straightforward to develop using long reach horizontally drilling. In the remaining NSO area, and areas that would be closed to new leasing, existing leases that were not recorded as held by production (existing leases held by production are assumed to already have needed off-lease infrastructure in place) were overlaid with layers of existing roads and pipelines to determine how many of these leases would be able to be accessed using existing roads and production pipelines, and how many could be cut off from being able to access the lease to develop wells and transport produced oil and gas to market. It was assumed that the existing leases not held by production that intersected roads or pipelines would be able to use these corridors to construct additional off lease road or pipeline infrastructure if needed. The acreage of developable NSO (NSO within the reach of horizontal or directional drilling, on an existing lease that is held by production, or on an existing lease not held by production but with road or pipeline access) was calculated and used for NSO in projection comparisons, and the remaining non-accessible NSO acreage which would not be able to be developed was treated as effectively closed to leasing when comparing against the 2015 WY Plan projections. The acreage of existing leases by lease status and production status was calculated because it was reported in the US Government Accountability Office Report 21-138[44] that approximately 25 percent of existing leases get developed in their first term, leases in areas that would be closed to leasing would not be considered for extension, and many leases in areas with new NSO stipulations applied would be likely to have reduced leasing interest making them less likely to be renewed. The total acreage of existing leases not held by production in NSO and closed areas was reduced by 75 percent to reflect that only 25 percent of leases in these areas are likely to be developed. The acreage of 'developable NSO' (NSO within the reach of horizontal or directional drilling, on an existing lease that is held by production, or on an existing lease not held by production but with road or pipeline access[reduced by 75% of total acreage]) was calculated and used for NSO in projection comparisons, and the remaining non-accessible NSO acreage which would not be able to be developed was treated as effectively closed to leasing when comparing against the 2015 WY Plan projections. The output map was examined for 'islands' of leasable minerals fully surrounded by NSO

[42] https://eplanning.blm.gov/public_projects/lup/103347/143798/177223/11_Chapter-4_Environmental-Consequences_FEIS_052115.pdf

[43] https://www.wsgs.wyo.gov/pubs-maps/gis.aspx see the "Wyoming Basins" dataset under the Geology tab.

[44] Oil and Gas: Onshore Competitive and Noncompetitive Lease Revenues. US Government Accountability Office. GAO-21-138. Published: November 19, 2020. https://www.gao.gov/products/gao-21-138

or closed (with ROW exclusion and no existing roads/pipeline corridors) and any areas are added to the projection as a further percent reduction of the existing lease acres total. The results of this process were used to adjust projections of wells for Alternatives 3, 4, 5 and 6.

There is no ongoing development of geothermal resources on BLM administered surface or mineral estate within the planning area. No projections of geothermal development could be developed based on available information. However, given that the possibility of future geothermal development exists, an assumption was made regarding the possible size and disturbance associated with a theoretical geothermal development for the purpose of being able to analyze impacts associated with future geothermal development that might occur.

12.9.2 Oil and Gas

Oil and Gas Development Potential

Assumptions and methodology used to develop the updated projections below follow the assumptions and methodology used in the 2015 Wyoming Greater Sage-Grouse Land Use Plan Amendment. These were used along with new information to revise the projections provided to the current date and to analyze the proposed Alternatives. The trends described in the 2015 Wyoming Greater Sage-Grouse Land Use Plan Amendment and the RFDs for the Wyoming BLM field offices within the GRSG planning area generally remain in line with the levels of development occurring, however some documents did not fully anticipate the level of changes associated with technological improvements in horizontal and directional drilling. Improvements in horizontal drilling and geosteering technology have allowed for a reduction in surface impacts associated with developing of oil and gas. Multiple horizontal wells can be located on a single well pad and extend well bores horizontally for two or more miles out in the productive formations under ideal conditions. This allows a reduction in surface infrastructure as a single well pad can produce from the same area that would previously have required numerous conventional or less advanced wells in the past. This allows for a reduction in disturbance associated with development infrastructure such as roads and pipelines which now only route to a small number of multi-well pads rather than numerous pads across the landscape. Improvements in this technology also allow for greater development of resources in areas where NSO stipulations are applied. In basins where the characteristics of the productive formations are well suited to this type of development, including the Powder River Basin in the Buffalo Field Office and Casper Field Office, this has become the dominate form of development resulting in a reduction of surface impacts per unit of production.

Since 2013 approximately 9,127 wells associated with oil and gas development have been drilled in all of Wyoming. Since 2015 approximately 2,700 wells have been drilled in GRSG habitat.[45] This total includes production wells, service wells, injection wells, workovers of existing wells, and may include some wells that were plugged and abandoned or never completed. The Wyoming Oil and Gas Conservation Commission database repots a total of 6,455 unique well spuds of oil, gas, and coalbed methane wells in the state from 2013 through 2023.[46]

The tables below show the EPCA development potential ranking for oil and gas in the proposed GRSG management areas from Alternative 4. The decision area is slightly different under the different Alternatives, so the Alternative 4 decision area was used for the following calculations, but the results are generally

[45] IHS Enerdeq 2023.

[46] Wyoming Oil and Gas Conservation Commission. 2024. Count of Spuds by Type and Year(s). Internet website: http://pipeline.wyo.gov/online_stats_bk/spud_stats.cfm

applicable across all the Alternatives. Not all areas were given a developmental potential rank, so the totals below do not add up to the entire decision area.

Table 33: EPCA Oil Development Potential within Alternative 4 Greater Sage-grouse HMAs in Wyoming

Wyoming	Acres
PHMA	13,370,000
Low	5,949,000
Medium	2,188,000
High	5,233,000
GHMA	13,095,000
Low	5,606,000
Medium	2,399,000
High	5,090,000
Grand Total	**26,465,000**

Source: EPCA 2018, BLM GIS 2023

Table 34: EPCA Gas Development Potential within Alternative 4 Greater Sage-grouse HMAs in Wyoming

Wyoming	Acres
PHMA	10,917,000
Low	6,452,000
Medium	3,556,000
High	909,000
GHMA	13,184,000
Low	7,229,000
Medium	4,805,000
High	1,150,000
Grand Total	**24,101,000**

Source: EPCA 2018, BLM GIS 2023

The table below shows the acres of existing leases by status in the proposed GRSG management areas under Alternative 4. Approximately 24% of the HMAs are under an existing authorized lease.

Table 35: BLM Fluid Mineral Lease Status within Alternative 4 Greater Sage-grouse HMAs in Wyoming

Alternative 4	Acres
GHMA	4,481,000
Authorized	4,231,000
Pending	124,000
Interim	126,000
PHMA	3,206,000
Authorized	3,023,000
Pending	61,000
Interim	122,000
Grand Total	**7,957,000**

Source: BLM GIS 2023

Projected Oil and Gas Activity by Alternative

The estimated number of wells and future surface disturbance associated with wells, roads, and pads is shown in the table below.

Table 36: Reasonably Foreseeable Development Scenario for Oil and Gas Development and Surface Disturbance in Wyoming GRSG Habitat in the next 20 years.

Alternative	1	2	3	4	5	6
Projected number of oil and gas wells	14,450	14,450	4,284	9,148	13,565	13,387
Projected number of CBNG wells*	0	0	0	0	0	0
Total Projected Short-term Surface Disturbance from new well pads, roads, and pipelines (acres)	111,988	111,988	33,198	70,900	105,126	103,753
Total Projected Long-term Surface Disturbance from new well pads, roads, and pipelines (acres)	61,413	61,413	18,205	38,880	57,650	56,897

Source: updates to data from Table 4-43 in the 2015 Wyoming Greater Sage-Grouse Land Use Plan Amendment based on changes to management under the proposed Alternatives and changes to the decision area.
*Coal Bed Natural Gas (CBNG) wells were seeing considerable interest in the period leading up to the development of the 2015 Greater Sage Grouse planning, however since that time the economics have been unfavorable and developments have underperformed, in Wyoming no CBNG wells have been drilled in the planning area in the past 10 years and none are likely in the future, CBNG wells were removed from the projections.

Projected Production by Alternative in the Decision Area

Under Alternatives 1 and 2 approximately 791,060,387 barrels of oil and 16,289,517,518 mcf of natural gas are projected to be produced over the 20-year planning period of 2023-2043.

Under Alternative 3, approximately 567,523,820 barrels of oil and 11,686,451,964 mcf of natural gas are projected to be produced over the 20-year planning period of 2023-2043.

Under Alternative 4, approximately 674,488,974 barrels of oil and 13,889,078,683 mcf of natural gas are projected to be produced over the 20-year planning period of 2023-2043.

Under Alternative 5 approximately 771,593,305 barrels of oil and 15,888,651,312 mcf of natural gas are projected to be produced over the 20-year planning period of 2023-2043.

Under Alternative 6 approximately 767,697,101 barrels of oil and 15,808,420,677 mcf of natural gas are projected to be produced over the 20-year planning period of 2023-2043.

12.9.3 Geothermal

Geothermal Summary

There is no existing use of geothermal resources in Wyoming for power generation.[47] A study conducted for the Wyoming Energy Authority found that:[48]

> *Detailed literature review and analysis suggests Wyoming's geothermal resources are moderate to low temperatures, approximately 300 °F or less… and situated in localized regions throughout the state. Most*

[47] https://www.wsgs.wyo.gov/energy/geothermal.aspx
[48] Batir, J., E. Gentry, K. Kitz, M. Richards, J. Boak, H. Soroush, Petrolern LLC. 2022. Final Report of Geothermal Resource and Applicable Technology for Wyoming, Final Report for Wyoming Energy Authority. July 2022. Ref. No. WYO0722RE01. Internet website: https://wyoenergy.org/wp-content/uploads/2022/11/Petrolern_FinalReportWYGeothermalPotentialAndApplicableTechnology_FINAL1Aug2022.pdf

of the geothermal resources are below 200 °F, below ideal electrical generation potential temperatures. There are no indications for a widespread high temperature geothermal resource that would provide significant geothermal value to Wyoming and the costs and risks of exploration for high-temperature resources are high; however, technologies to utilize lower temperature resources are likely to have the greatest economic impact and benefit for Wyoming, given the widespread indication of potential low temperature geothermal resources.

There has been discussion of the possibility of converting oil and gas wells with favorable temperature characteristics that are no longer productive for oil and gas into use as geothermal wells, but this has not been commercially proven at this time.

Projected Geothermal Activity by Alternative

It is unlikely that any geothermal energy development would occur in GRSG habitat during the 20-year planning period. However, for the purposes of analysis it is assumed that under all Alternatives except Alternative 3 up to one 20MW geothermal power generation facility would be developed on BLM-managed lands in GRSG habitat over the next 20 years. A facility of this size could disturb up to 6 acres for the drilling of up to 6 thermal gradient wells and disturb up to 24 acres for the drilling of up to 8 production and injection wells. Construction of pipelines would disturb up to 14 acres, and an additional 10 acres could be disturbed for the construction of the generating plant. An assumed 10 miles of road would disturb approximately 50 acres, and 8 miles of power line would disturb approximately 40 acres. Under Alternative 3 it is assumed that no geothermal power development would occur on BLM-managed lands in GRSG habitat because under this alternative all GRSG habitat would be closed to fluid mineral leasing and there are no existing geothermal leases that could be developed.

12.10 WIND ENERGY

The following criteria and assumptions were used in the development of the RFD table (**Table 37**).

General Assumptions

- The planning area is only within HMAs.
- Alternative 1 - See **Table 38** of this document.
- Alternative 2 - No changes from Alternative 1. Nevada exceptions do not apply to the RFD Table. Utah avoidance criteria are not incorporated due to the fact that exact lek locations are not known.
- Alternative 3 - All habitat is managed as exclusion.
- Alternative 4 - PHMA is managed as right-of-way (ROW) exclusion areas. IHMA is managed as ROW avoidance areas. Areas (regardless of PHMA, GHMA, IHMA or non-HMA status) within 0.5 miles are managed as ROW avoidance areas. GHMA is not included in the 0.5-mile buffer managed as ROW avoidance areas for utility scale wind projects.
- Alternative 5 - PHMA and IHMA would be avoidance areas for utility scale wind and solar energy development. GHMA is open with minimization measures.
- Existing Avoidance and Exclusions include protections for other resources, Wind Mapper exclusion and avoidance datasets combined to create this data.

Data Gaps

- Colorado - No Linkage Management Area (LMA) in calculations, No GHMA Avoidance or Exclusion ROW data available
- Nevada and California - No other habit management area (OHMA) in calculations

- Montana - No restoration habitat management area (RHMA) or connectivity habitat management area (CHMA) in calculations
- North and South Dakota - There is no existing ROW avoidance or exclusion data.
- Utah - No GHMA Acres under Alternative 2

GIS Workflow

Wind energy development constraints (ROW avoidance, RMP wind energy avoidance, low wind energy potential, etc.) are all combined together to create a total constraints layer. The wind potential layer then has this master constraints layer erased from it to identify areas where there are no constraints to wind energy development (labeled as "potential developable wind resources"); this layer is combined with the master constraints layer to create a comprehensive wind development layer indicating constraints or lack of constraints and annual wind speeds for these areas. The comprehensive wind development layer is then clipped to BLM-managed surface across the 10 states included in the RFD. This layer is then combined with the GRSG Habitat Management Area layer(s) for each alternative (these have also been clipped to BLM surface). The output of this workflow is a layer that contains wind speed data for each GRSG HMA by alternative, and information on constraints to wind energy development that might impact the ability to develop wind energy in these areas.

Data Sources

BLM GIS (U.S. Bureau of Land Management Geographic Information Systems) data used in the Greater Sage Grouse Planning alternatives, affected environment, and impact analysis (BLM GIS 2023).

Wind Potential Source: National Renewable Energy Laboratory United States Wind Speed at 80-Meter above Surface Level (National Renewable Energy Laboratory 2017).

Wind Constraints source: Wind Energy Development Exclusions and Resource Sensitivities for the BLM West-wide Wind Mapping Project (Argonne National Laboratory 2016).

Table 37: RFD Acres by Alternative

Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternatives 5 and 6	
Status	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**
Idaho	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	9,656,000	Total Acres of BLM Surface within HMAs	9,642,000	Total Acres of BLM Surface within HMAs	9,644,000	Total Acres of BLM Surface within HMAs	9,644,000	Total Acres of BLM Surface within HMAs	9,644,000
Land Unsuitable for Wind Resources	1,333,000	Land Unsuitable for Wind Resources	1,329,000	Land Unsuitable for Wind Resources	1,311,000	Land Unsuitable for Wind Resources	1,311,000	Land Unsuitable for Wind Resources	1,311,000
Existing Open to Development	5,913,000	Existing Open to Development	5,912,000	ROW Avoidance Acres	0	Existing Open to Development	5,915,000	ROW Avoidance Acres	632,000
Existing Avoidance Area	771,000	Existing Avoidance Area	771,000	ROW Exclusion Acres	8,333,000	Existing Avoidance Area	764,000	Land Open for Development	7,701,000
Existing Exclusion Area	1,640,000	Existing Exclusion Area	1,629,000	—	—	Existing Exclusion Area	1,654,000	—	—
Proposed Open to Development	1,288,000	Proposed Open to Development	1,288,000	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	5,254,000	—	—
Proposed Avoidance Area	771,000	Proposed Avoidance Area	771,000	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	8,422,000	—	—
Proposed Exclusion Area	4,855,000	Proposed Exclusion Area	4,818,000	—	—	Proposed Exclusion Acres (PHMA)	5,164,000	—	—
Montana	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	5,776,000	Total Acres of BLM Surface within HMAs	5,776,000	Total Acres of BLM Surface within HMAs	5,173,000	Total Acres of BLM Surface within HMAs	5,465,000	Total Acres of BLM Surface within HMAs	5,465,000
Land Unsuitable for Wind Resources	143,000	Land Unsuitable for Wind Resources	143,000	Land Unsuitable for Wind Resources	104,000	Land Unsuitable for Wind Resources	105,000	Land Unsuitable for Wind Resources	105,000
Existing Open to Development	5,087,000	Existing Open to Development	5,087,000	ROW Avoidance Acres	0	Existing Open to Development	4,665,000	ROW Avoidance Acres	151,000
Existing Avoidance Area	222,000	Existing Avoidance Area	222,000	ROW Exclusion Acres	5,068,000	Existing Avoidance Area	182,000	Land Open for Development	5,209,000
Existing Exclusion Area	158,000	Existing Exclusion Area	158,000	—	—	Existing Exclusion Area	118,000	—	—
Proposed Open to Development	0	Proposed Open to Development	0	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	3,391,000	—	—
Proposed Avoidance Area	2,292,000	Proposed Avoidance Area	2,292,000	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	5,174,000	—	—
Proposed Exclusion Area	3,175,000	Proposed Exclusion Area	3,175,000	—	—	Proposed Exclusion Acres (PHMA)	3,183,000	—	—
South Dakota	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	151,000	Total Acres of BLM Surface within HMAs	151,000	Total Acres of BLM Surface within HMAs	151,000	Total Acres of BLM Surface within HMAs	151,000	Total Acres of BLM Surface within HMAs	151,000
Land Unsuitable for Wind Resources	6,000	Land Unsuitable for Wind Resources	6,000	Land Unsuitable for Wind Resources	6,000	Land Unsuitable for Wind Resources	6,000	Land Unsuitable for Wind Resources	6,000
Existing Open to Development	145,000	Existing Open to Development	145,000	ROW Avoidance Acres	0	Existing Open to Development	145,000	ROW Avoidance Acres	ND
Existing Avoidance Area	ND	Existing Avoidance Area	ND	ROW Exclusion Acres	145,000	Existing Avoidance Area	ND	Land Open for Development	ND
Existing Exclusion Area	ND	Existing Exclusion Area	ND	—	—	Existing Exclusion Area	ND	—	—
Proposed Open to Development	23,000	Proposed Open to Development	23,000	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	131,000	—	—
Proposed Avoidance Area	ND	Proposed Avoidance Area	ND	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	154,000	—	—
Proposed Exclusion Area	122,000	Proposed Exclusion Area	122,000	—	—	Proposed Exclusion Acres (PHMA)	122,000	—	—

Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternatives 5 and 6	
Status	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**
North Dakota	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	33,000	Total Acres of BLM Surface within HMAs	33,000	Total Acres of BLM Surface within HMAs	33,000	Total Acres of BLM Surface within HMAs	33,000	Total Acres of BLM Surface within HMAs	33,000
Land Unsuitable for Wind Resources	22,000	Land Unsuitable for Wind Resources	22,000	Land Unsuitable for Wind Resources	22,000	Land Unsuitable for Wind Resources	22,000	Land Unsuitable for Wind Resources	22,000
Existing Open to Development	11,000	Existing Open to Development	11,000	ROW Avoidance Acres	0	Existing Open to Development	11,000	ROW Avoidance Acres	ND
Existing Avoidance Area	ND	Existing Avoidance Area	ND	ROW Exclusion Acres	11,000	Existing Avoidance Area	ND	Land Open for Development	ND
Existing Exclusion Area	ND	Existing Exclusion Area	ND	—	—	Existing Exclusion Area	ND	—	—
Proposed Open to Development	0	Proposed Open to Development	0	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	33,000	—	—
Proposed Avoidance Area	0	Proposed Avoidance Area	ND	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	33,000	—	—
Proposed Exclusion Area	11,000	Proposed Exclusion Area	11,000	—	—	Proposed Exclusion Acres (PHMA)	11,000	—	—
Colorado	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	1,680,000	Total Acres of BLM Surface within HMAs	1,777,000	Total Acres of BLM Surface within HMAs	1,584,000	Total Acres of BLM Surface within HMAs	1,681,000	Total Acres of BLM Surface within HMAs	1,681,000
Land Unsuitable for Wind Resources	318,000	Land Unsuitable for Wind Resources	310,000	Land Unsuitable for Wind Resources	292,000	Land Unsuitable for Wind Resources	318,000	Land Unsuitable for Wind Resources	318,000
Existing Open to Development	1,291,000	Existing Open to Development	1,398,000	ROW Avoidance Acres	0	Existing Open to Development	1,292,000	ROW Avoidance Acres	0
Existing Avoidance Area	0	Existing Avoidance Area	0	ROW Exclusion Acres	1,292,000	Existing Avoidance Area	0	Land Open for Development	1,363,000
Existing Exclusion Area	0	Existing Exclusion Area	0	—	—	Existing Exclusion Area	ND	—	—
Proposed Open to Development	0	Proposed Open to Development	0	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	1,102,000	—	—
Proposed Avoidance Area	621,000	Proposed Avoidance Area	559,000	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	1,721,000	—	—
Proposed Exclusion Area	670,000	Proposed Exclusion Area	839,000	—	—	Proposed Exclusion Acres (PHMA)	673,000	—	—
Nevada	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	21,176,000	Total Acres of BLM Surface within HMAs	21,168,000	Total Acres of BLM Surface within HMAs	22,651,000	Total Acres of BLM Surface within HMAs	22,629,000	Total Acres of BLM Surface within HMAs	22,629,000
Land Unsuitable for Wind Resources	333,000	Land Unsuitable for Wind Resources	315,000	Land Unsuitable for Wind Resources	4,568,000	Land Unsuitable for Wind Resources	4,561,000	Land Unsuitable for Wind Resources	4,561,000
Existing Open to Development	2,126,000	Existing Open to Development	3,151,000	ROW Avoidance Acres	0	Existing Open to Development	2,734,000	ROW Avoidance Acres	746,000
Existing Avoidance Area	1,103,000	Existing Avoidance Area	1,393,000	ROW Exclusion Acres	18,083,000	Existing Avoidance Area	1,494,000	Land Open for Development	17,322,000
Existing Exclusion Area	10,279,000	Existing Exclusion Area	3,711,000	—	—	Existing Exclusion Area	1,681,000	—	—
Proposed Open to Development	1,553,000	Proposed Open to Development	1,549,000	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	13,630,000	—	—
Proposed Avoidance Area	336,000	Proposed Avoidance Area	1,393,000	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	16,284,000	—	—
Proposed Exclusion Area	11,619,000	Proposed Exclusion Area	5,313,000	—	—	Proposed Exclusion Acres (PHMA)	9,195,000	—	—

Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternatives 5 and 6	
Status	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**
California	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	1,360,000	Total Acres of BLM Surface within HMAs	1,330,000	Total Acres of BLM Surface within HMAs	1,376,000	Total Acres of BLM Surface within HMAs	1,376,000	Total Acres of BLM Surface within HMAs	1,376,000
Land Unsuitable for Wind Resources	333,000	Land Unsuitable for Wind Resources	315,000	Land Unsuitable for Wind Resources	335,000	Land Unsuitable for Wind Resources	335,000	Land Unsuitable for Wind Resources	335,000
Existing Open to Development	831,000	Existing Open to Development	829,000	ROW Avoidance Acres	0	Existing Open to Development	986,000	ROW Avoidance Acres	0
Existing Avoidance Area	0	Existing Avoidance Area	0	ROW Exclusion Acres	1,040,000	Existing Avoidance Area	0	Land Open for Development	1,041,000
Existing Exclusion Area	0	Existing Exclusion Area	0	—	—	Existing Exclusion Area	0	—	—
Proposed Open to Development	441,000	Proposed Open to Development	438,000	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	692,000	—	—
Proposed Avoidance Area	0	Proposed Avoidance Area	0	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	1,344,000	—	—
Proposed Exclusion Area	390,000	Proposed Exclusion Area	391,000	—	—	Proposed Exclusion Acres (PHMA)	692,000	—	—
Oregon	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	10,386,000	Total Acres of BLM Surface within HMAs	10,383,000	Total Acres of BLM Surface within HMAs	11,225,000	Total Acres of BLM Surface within HMAs	11,225,000	Total Acres of BLM Surface within HMAs	11,225,000
Land Unsuitable for Wind Resources	966,000	Land Unsuitable for Wind Resources	966,000	Land Unsuitable for Wind Resources	1,131,000	Land Unsuitable for Wind Resources	1,131,000	Land Unsuitable for Wind Resources	1,131,000
Existing Open to Development	7,299,000	Existing Open to Development	7,297,000	ROW Avoidance Acres	0	Existing Open to Development	7,674,000	ROW Avoidance Acres	537,000
Existing Avoidance Area	1,604,000	Existing Avoidance Area	517,000	ROW Exclusion Acres	10,093,000	Existing Avoidance Area	1,753,000	Land Open for Development	9,557,000
Existing Exclusion Area	517,000	Existing Exclusion Area	0	—	—	Existing Exclusion Area	666,000	—	—
Proposed Open to Development	0	Proposed Open to Development	0	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	6,867,000	—	—
Proposed Avoidance Area	4,899,000	Proposed Avoidance Area	4,003,000	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	10,996,000	—	—
Proposed Exclusion Area	4,521,000	Proposed Exclusion Area	2,391,000	—	—	Proposed Exclusion Acres (PHMA)	5,964,000	—	—
Utah	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	2,564,000	Total Acres of BLM Surface within HMAs	2,123,000	Total Acres of BLM Surface within HMAs	3,642,000	Total Acres of BLM Surface within HMAs	3,459,000	Total Acres of BLM Surface within HMAs	3,459,000
Land Unsuitable for Wind Resources	806,000	Land Unsuitable for Wind Resources	612,000	Land Unsuitable for Wind Resources	1,114,000	Land Unsuitable for Wind Resources	1,054,000	Land Unsuitable for Wind Resources	1,054,000
Existing Open to Development	1,503,000	Existing Open to Development	1,287,000	ROW Avoidance Acres	0	Existing Open to Development	2,091,000	ROW Avoidance Acres	51,000
Existing Avoidance Area	227,000	Existing Avoidance Area	214,000	ROW Exclusion Acres	2,528,000	Existing Avoidance Area	265,000	Land Open for Development	2,354,000
Existing Exclusion Area	28,000	Existing Exclusion Area	10,000	—	—	Existing Exclusion Area	50,000	—	—
Proposed Open to Development	216,000	Proposed Open to Development	0	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	2,503,000	—	—
Proposed Avoidance Area	227,000	Proposed Avoidance Area	0	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	16,948,000	—	—
Proposed Exclusion Area	1,529,000	Proposed Exclusion Area	1,511,000	—	—	Proposed Exclusion Acres (PHMA)	1,624,000	—	—

Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternatives 5 and 6	
Status	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**	**Status**	**Acres**
Wyoming	—	—	—	—	—	—	—	—	—
Total Acres of BLM Surface within HMAs	17,200,000	Total Acres of BLM Surface within HMAs	17,200,000	Total Acres of BLM Surface within HMAs	17,016,000	Total Acres of BLM Surface within HMAs	17,025,000	Total Acres of BLM Surface within HMAs	17,025,000
Land Unsuitable for Wind Resources	1,172,000	Land Unsuitable for Wind Resources	1,172,000	Land Unsuitable for Wind Resources	1,171,000	Land Unsuitable for Wind Resources	1,172,000	Land Unsuitable for Wind Resources	1,172,000
Existing Open to Development	15,387,000	Existing Open to Development	15,387,000	ROW Avoidance Acres	0	Existing Open to Development	15,223,000	ROW Avoidance Acres	0
Existing Avoidance Area	0	Existing Avoidance Area	0	ROW Exclusion Acres	15,845,000	Existing Avoidance Area	0	Land Open for Development	15,853,000
Existing Exclusion Area	641,000	Existing Exclusion Area	0	—	—	Existing Exclusion Area	631,000	—	—
Proposed Open to Development	8,315,000	Proposed Open to Development	8,315,000	—	—	Proposed Avoidance Acres [within 0.5 miles of PHMA]	10,398,000	—	—
Proposed Avoidance Area	7,072,000	Proposed Avoidance Area	7,072,000	—	—	Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	16,948,000	—	—
Proposed Exclusion Area	641,000	Proposed Exclusion Area	641,000	—	—	Proposed Exclusion Acres (PHMA)	9,304,000	—	—

ND = No Data Available

^The colors used in Alternative 1 in Table 36 correspond to the proposed ROW management in Table 37.

Table 38: Alternative 1 ROW Management

Region	PHMA or IHMA	GHMA
North Dakota	Exclusion	Avoidance
Idaho	Exclusion	Open
Southwest Montana	Exclusion	Avoidance
Nevada/Northeastern California	Exclusion	Yes
Colorado	Exclusion	Avoidance
Oregon	Exclusion	Avoidance
South Dakota	Exclusion	ND
Utah	Exclusion	Open
Wyoming	Avoidance	Open

Table 39: Calculation Theory

Alternative 1	Data Inputs
Total Acres of BLM Surface within HMAs	State Total
Land Unsuitable for Wind Resources	"Low Wind Resources"
Existing Open to Development	Potentially developable wind resources - All HMAs
Existing Avoidance Area	ROW avoidance - All HMAs
Existing Exclusion Area	ROW exclusion - All HMAs
Proposed Open to Development	Potentially developable wind resources - GHMA
Proposed Avoidance Area	Potentially developable wind resources - IHMA, ROW avoidance - GHMA and IHMA
Proposed Exclusion Area	Potentially developable wind resources - PHMA, Row Avoidance - PHMA, Row Exclusion - GHMA, IHMA, and PHMA
Alternative 2	**Data Inputs**
Total Acres of BLM Surface within HMAs	State Total
Land Unsuitable for Wind Resources	"Low Wind Resources"
Existing Open to Development	Potentially developable wind resources - All HMAs
Existing Avoidance Area	ROW avoidance - All HMAs
Existing Exclusion Area	ROW exclusion - All HMAs
Proposed Open to Development	Potentially developable wind resources - GHMA
Proposed Avoidance Area	Potentially developable wind resources - IHMA, ROW avoidance - GHMA and IHMA
Proposed Exclusion Area	Potentially developable wind resources - PHMA, Row Avoidance - PHMA, Row Exclusion - GHMA, IHMA, and PHMA
Alternative 3	**Data Inputs**
Total Acres of BLM Surface within HMAs	State Total
Land Unsuitable for Wind Resources	"Low Wind Resources"
ROW Avoidance Acres	N/A - All HMAs are Exclusion
ROW Exclusion Acres	Potentially developable wind resources, ROW avoidance, ROW exclusion
Alternative 4	**Data Inputs**
Total Acres of BLM Surface within HMAs	State Total
Land Unsuitable for Wind Resources	"Low Wind Resources"
Existing Open to Development	Potentially developable wind resources - All HMAs

Alternative 4	Data Inputs
Existing Avoidance Area	ROW avoidance - All HMAs
Existing Exclusion Area	ROW exclusion - All HMAs
Proposed Avoidance Acres [within 0.5 miles of PHMA]	0.5mi buffer of PHMA
Proposed Avoidance Acres [GHMA and IHMA and areas within of 0.5 miles of PHMA]	Proposed Avoidance Acres [within 0.5 miles of PHMA], POTENTIALLY DEVELOPABLE WIND RESOURCES - GHMA and IHMA, ROW Avoidance - GHMA and IHMA
Proposed Exclusion Acres (PHMA)	PWDR - PHMA, ROW Avoidance - PHMA, ROW Exclusion - All HMAs
Alternative 5	**Data Inputs**
Total Acres of BLM Surface within HMAs	State Total
Land Unsuitable for Wind Resources	"Low Wind Resources"
ROW Avoidance Acres	ROW avoidance - PHMA
Land Open for Development	State Total-Land Unsuitable-ROW Avoidance

12.11 SOLAR ENERGY

The RFD for solar development is needed to guide analyses on the effect of alternatives being considered to solar power generation. The solar development RFD for this GRSG EIS incorporates and builds on the RFD from the 2023 Solar Programmatic EIS (PEIS), under concurrent development.

In order to evaluate the adequacy of lands available for application in meeting the nation's renewable energy goals, the Solar PEIS developed a projection of the land area and electricity-generating capacity (power) requirements for future solar energy development. For the 2023 Solar PEIS (BLM 2024) (*Note: this is the 2024 Solar PEIS*), the amount of land area and power projected for utility-scale solar energy development in the 11-state Solar PEIS planning area through the year 2045 is used as the RFD. The year 2045 was used because it allows for approximately 20 years of development, which is the typical time period the BLM uses for programmatic planning. The amount of land area and power projected for utility-scale solar energy development in the Solar PEIS 11-state planning area is shown in **Table 41**.

The 2023 GRSG EIS and 2023 Solar PEIS each have five different alternatives and differing planning areas, and it is not known which alternative (or combination of alternatives) either process will ultimately select. Because of this, the GRSG EIS solar RFD is a qualitative analysis that builds off the RFD from the Solar PEIS RFD. The allocations associated with solar energy ROW development in the GRSG EIS are shown in **Table 40** below, organized by each state within the GRSG planning area and by GRSG habitat management area.

The acres associated with these habitat management areas are shown in **Table 2-1** in **Chapter 2** of the GRSG EIS. Additional information on ROW management and criteria that define these management actions are in **Section 4.8**, Lands and Realty, of the EIS.

Table 40: Solar ROW Management based on Greater Sage-Grouse Habitat Management Area

State	GRSG Alternative 1		GRSG Alternative 2		GRSG Alternative 3		GRSG Alternative 4		GRSG Alternative 5	
	PHMA[1]	GHMA	PHMA[1]	GHMA	PHMA[1]	PHMA[1]	PHMA[1]	GHMA	PHMA[1]	GHMA
North Dakota	Exclusion	Avoidance	Exclusion	Avoidance	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Idaho	Exclusion[2]	Open	Exclusion[2]	Open	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Montana	Avoidance[3]	Avoidance[3]	Avoidance[3]	Avoidance[3]	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Nevada / Northeastern California	Exclusion[2]	Exclusion[4]	Exclusion[2]	Exclusion[4]	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Colorado	Exclusion[3]	Avoidance	Exclusion[3]	Avoidance	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Oregon	Exclusion	LSP	Exclusion	LSP	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
South Dakota	Avoidance[3]	Avoidance[3]	Avoidance[3]	Avoidance[3]	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Utah	Exclusion[4]	Exclusion[4]	Exclusion[4]	Open	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open
Wyoming	Open[3]	Open	Open[3]	Open	Exclusion	Exclusion	Exclusion	Avoidance	Avoidance	Open

[1] – IHMA in Idaho, [2] – Greater than 20 Megawatt facilities, [3] – Based on Major ROW for Utility Corridors, [4] – Based on 2012 Solar EIS.

Table 41: Solar PEIS - Reasonably Foreseeable Development Scenarios

State	Estimated BLM-Administered Acres Developed by 2045 under RFDs	Estimated Non-BLM-Administered Acres Developed by 2045 under RFDs
Arizona	198,210	66,070
California*	109,972	413,706
Colorado	45,207	15,069
Idaho	89,574	29,858
Montana	5,387	1,796
Nevada	48,119	16,040
New Mexico	11,123	3,708
Oregon	51,387	17,129
Utah	39,793	13,264
Washington	71,781	23,927
Wyoming	27,255	9,085
TOTAL	**697,809**	**326,865**

Source: BLM 2024 (Note: this is the 2024 Solar PEIS)

* To account for exclusion of the Desert Renewable Energy Conservation Plan (DRECP) area in California, the proportion of BLM-administered lands outside of the DRECP area (28%) was applied to the estimated RFDs development acres. It is estimated that 282,787 acres of BLM-administered land within the DRECP planning area would be developed by 2045 under the RFDs.

The basis for the Solar PEIS' state-level projections of solar energy development by 2045 in **Table 41** above was the DOE's Solar Futures study (2021) and its companion report on environmental implications (Heath et al. 2022). The Solar PEIS concluded that in general, the lands available for solar energy development in each state, usually outside of GRSG PHMA, would be adequate to meet the RFD under each of the Solar PEIS alternatives. However, due to the uncertainties in estimating RFD values by state, both the Solar PEIS and GRSG EIS recommended that the total RFDs for BLM-administered lands across the planning area be considered the most likely development level across all alternatives and that the state-level breakdown of the RFDs be recognized as forecasted estimates that may shift among states. None of the management actions in the GRSG EIS alternatives would preclude achieving the RFD projections of acres needed to achieve the nation's renewable energy goals. The nature and type of effects of the GRSG RFDs are discussed in Section 4.8 of the GRSG EIS.

12.12 REFERENCES

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