United States
Department of the Interior
Bureau of Land Management

REASONABLY FORESEEABLE DEVELOPMENT SCENARIO (RFD) FOR OIL AND GAS

RFD for
The Monticello Planning Area

Monticello Field Office

Encompassing Approximately 4.58 million acres
San Juan County, Utah

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I. Summary

A Reasonably Foreseeable Development Scenario (RFD) for oil and gas is a long-term (15 years) projection of oil and gas exploration, development, production, and reclamation activity.

There are approximately 1,135 active wells within the Monticello Planning Area (MtPA). These wells include producing oil wells, shut-in oil wells, producing gas wells, shut-in gas wells, water injection wells, water disposal wells, water source wells, and temporarily abandoned wells. In addition, there are 480 abandoned wells. Abandoned wells are wells that have had reclamation initiated but final release by the surface management agency is pending. The estimated surface disturbance for all active wells, abandoned wells, and associated roads and pipelines is 15,504 acres. This amounts to about 9.6 acres of surface disturbance per well.

Future oil and gas drilling is projected at about 5 to 21 wells per year. It is recognized that there would be some years with less than 5 wells and some years with more than 21 wells. For the purpose of analyzing the impacts of oil and gas leasing, an average of 13 wells per year was utilized, which amounts to a total of about 195 wells over the next 15 years. The surface disturbance for construction of a well pad, road, and associated pipelines is estimated at 9.6 acres. Therefore, the total projected surface disturbance for oil and gas drilling over the next 15 years is about 1,872 acres.

It was assumed that 59% of the wells drilled would be productive; and that the remaining 41% would be abandoned and reclaimed; and that revegetation would be successful within a scope of 10 years. Therefore, over the next 15 years, about 27 wells would be successfully reclaimed for a totaled of 259 reclaimed acres. It is also reasonable to assume that the number of wells to be abandoned over the next 15 years will equal approximately one-half the number of wells going into production. This equates to about 4 abandoned wells per year and only wells abandoned in the first 5 years will be successfully reclaimed over the next 15 years, totaling 20 wells and 192 acres of reclaimed land. Finally, it is assumed that all 480 currently abandoned wells will be reclaimed in the next 15 years, totaling 4,608 acres of reclaimed land. The current surface disturbance, plus the predicted future surface disturbance, minus all land that will be reclaimed, equals a net surface disturbance of 12,317 acres.

For geophysical exploration, 1,230 linear miles of source lines are projected over the next 15 years. Assuming vibroseis buggies or buggies transporting drills drove over every mile of source line and the path of the buggies was 15 feet wide, the total surface disturbance is estimated at 2,236 acres. It was assumed that reclamation of disturbance would be successful within a scope of 10 years depending on reclamation times related to soils, vegetation, and rainfall.

The baseline RFD scenario for the MtPA is summarized as follows:

- Existing surface disturbance for 1,135 active wells, 480 abandoned wells, and associated infrastructure is about 15,504 acres. This amounts to about 9.6 acres of surface disturbance per well.
- Future surface disturbance over the next 15 years for a projected 195 wells and infrastructure amounts to about 1,872 acres.
- During this period, 27 dry wells, 20 abandoned wells, and all 480 currently abandoned wells should be successfully reclaimed, making the total reclaimed surface area equal 5,059 acres.
- The total net surface disturbance for wells drilled in the MtPA over the next 15 years will equal roughly 12,317 acres.
- Future surface disturbance over the next 15 years for geophysical exploration (1,230 linear miles) amounts to about 2,236 acres. Reclamation of all these disturbed lands would be successful over the scope of 10 years.

II. Introduction

The following Reasonably Foreseeable Development Scenario (RFD) projects the level of oil and gas activity that can reasonably be expected to occur during the next 15 years in the Monticello Planning Area (MtPA). An RFD for oil and gas is a long-term projection of oil and gas exploration, development, production, and reclamation activity. The RFD is a technical report typically referenced in the National Environmental Policy Act (NEPA) document. The RFD is neither a planning decision nor the "No Action Alternative" in the NEPA document. All lands (Federal, State of Utah, Indian and Private) are included in the projection following guidance in Bureau of Land Management (BLM) Handbook H-1624-1 and Instruction Memorandum No. 2004-089. The baseline projection will assume that all potentially productive areas are open for leasing under standard lease terms and conditions except those areas designated as closed to leasing by law, regulation or executive order.

The largest blocks of excluded lands are National Parks and Monuments, encompassing 266,321 acres, the bulk of which is within Canyonlands National Park; the majority of the Glen Canyon National Recreation Area, totaling 228,881 acres; the BLM's Wilderness Study Areas (WSAs), totaling 386,852 acres; and designated wilderness within the Manti-LaSal Nation Forest (USFS) totaling approximately 46,011 acres (Map 1). The following RFD will include the remaining lands in the USFS and the Glen Canyon National Recreation Area, the Navajo Indian Reservation, and private lands within the MtPA. Table 1 shows a breakdown of the land status within the MtPA and the lands included and excluded in the RFD. Land status within the MtPA is detailed on maps included with the Mineral Potential Report.

Energy analysts agree that worldwide demand for oil and gas will continue to increase in the near future. At the same time many experts are predicting that world production will soon peak and begin to decline (Deffeyes, 2002; Campbell 2003). These dynamics point to continuing price increases for oil and natural gas and ready markets. Against this backdrop of increasing demand, activity levels in the MtPA will be determined largely by the local geology. Past and present activity levels will provide a starting point for projecting future activities.

Table 1 Land status and lands included and excluded in the RFD for the MtPA

Land status	**Lands included in the RFD**	**Lands excluded from the RFD**
	acres	acres
BLM	1,398,271	
BLM - Wilderness Study Areas		386,852
State	202,318	
Indian Reservation	1,278,473	
Private	353,515	
US Forest Service	319,932	
USFS - Wilderness Areas		46,011
Glen Canyon Nat. Rec. Area	101,720	228,881
National Park Service		266,321
Total	**3,654,229**	**928,065**

Source: BLM Monticello Field Office

III. Description of Geology

The geology of the MtPA is described in detail in the Mineral Potential Report for the Monticello Resource Management Plan. The major oil and gas resources in the MtPA are all located in the Paradox Basin. The northern section of the MtPA includes the southern portion of the Paradox Fold and Fault Belt, while the southeastern portion is referred to as the Blanding sub-basin. The southwestern area of the MtPA is characterized by the Monument Upwarp and contains one small producing oil and gas field. The oil and gas plays defined by the U.S. Geological Survey (USGS) in the 1995 National Assessment of United States Oil and Gas Resources (Gautier and others, 1996) are of special interest relative to future exploration and development activity. The plays are described and shown on maps in the Mineral Potential Report.

The following plays are located in the MtPA:

Play 2101 Buried Fault Block Play
Play 2102 Porous Carbonate Buildup Play
Play 2103 Fractured Interbed Play
Play 2105 Salt Anticline Flank Play
Play 2106 Permo-Triassic Unconformity Play
Play 2403 Precambrian Chuar Group Play.

Play 2101, the Buried Fault Block play, is located in the northern portion of the MtPA in the Paradox Fold and Fault Belt and includes oil and gas trapped in porous dolomite or dolomitic limestone beds of the Upper Devonian McCracken Sandstone Member of the Elbert Formation and the Mississippian Leadville Limestone (Huffman, 1996). Probable source rocks are the organic-rich black dolomitic shales of the Pennsylvanian Paradox Formation. Play 2102, the Porous Carbonate Buildup play, contains the highest concentration of oil and gas fields in the MtPA, most of which are located in the Blanding sub-basin. This play is characterized by oil and gas accumulations in mounds of algal limestone and dolomitic reservoirs in five informal zones of the Pennsylvanian Hermosa Group within the Paradox Formation. Probable source rocks are the interbedded organic-rich black dolomitic shale and mudstone and laterally equivalent carbonate rocks within the Paradox Formation (Huffman, 1996). Play 2103, the Fractured Interbed play, is an unconventional continuous-type play that depends on extensive fracturing in the organic-rich dolomitic shale and mudstone in the interbeds between evaporites of the Paradox Formation or carbonate and clastic rocks of the related cycles on the shelf of the Paradox evaporite basin. This play is located throughout the northern and eastern portions of the MtPA and is thought to be sourced from the same organic-rich black dolomitic shales and mudstones of the Paradox Formation (Huffman, 1996). Play 2105, the Salt Anticline play, is located in the northern part of the MtPA and is characterized by oil and gas productive Permian and Pennsylvanian reservoirs along the flanks of northwest-trending salt anticlines in the axial part of the Paradox Basin. Source rocks are thought to be organic-rich black dolomitic shales of the Hermosa Group, as well as coaly carbonaceous shale locally present at the Cutler-Hermosa contact (Huffman, 1996). Play 2106, the Permo-Triassic Unconformity Play, is located in the southern part of the MtPA and is a down-dip extension of the tar sand deposits of south-central Utah. Reservoirs are located in the Hoskinnini Tongue of the Triassic Moenkopi Formation (the lateral equivalent of the Timpoweap Member) and from the Permian DeChelly Sandstone. The specific source rocks are unknown but are likely the Mississippian Chainman Shale, the Pennsylvanian Paradox Formation, the Permian Kaibab Limestone and Phosphoria Formation, the Triassic Moenkopi Formation, and/or the Precambrian Chuar Group (Huffman, 1996). Play 2403, the Late Proterozoic (Chuar-sourced) and Lower Paleozoic play, located in the southwestern corner of the MtPA, is hypothetical and highly speculative, being defined on the inference that the Late Proterozoic Chuar Group

sourced reservoir units within itself and in superadjacent Paleozoic reservoirs, primarily the Tapeats Sandstone (Butler, 1996).

IV. Past and Present Oil and Gas Exploration

Geophysical Exploration

Geophysical exploration has almost exclusively occurred in the eastern portion of the MtPA, mostly within the Blanding sub-basin, Lisbon Valley, and areas in between. Several surveys were conducted during the 1980's and during the late 1990's, including large 3-dimensional (3-D) surveys in 1999 and 2001 in the western portion of the Blanding sub-basin. The Utah Division of Oil, Gas and Mining keeps a database of seismic surveys conducted within the state of Utah (DOGM, 2005a). Map 2 shows the locations of several surveys within the MtPA; however, this is not an exhaustive list.

V. Past and Present Oil and Gas Development Activity

Oil and Gas Leasing Activity

Existing and pending oil and gas leases in the MtPA are shown on maps included with the Mineral Potential Report. They are concentrated near the Lisbon Valley, which is on the eastern side of the Paradox Fold and Fault Belt, and in the Blanding sub-basin. A few pending leases are located within the Manti-La Sal National Forest.

Historical Drilling Activity

The MtPA has been the site of active oil and gas drilling for the past 100 years. The wells listed in Table 2 were compiled from the Utah Division of Oil, Gas and Mining (DOGM) data and are current as of March 24, 2005 (DOGM, 2005b). There have been 3,267 wells drilled in the MtPA, of which 2,132 wells have been plugged and abandoned. Of the remaining 1,135 active wells, 508 are currently producing oil and gas.

Drilling activity in San Juan County was significantly higher between 1989 and 1998, when the average number of wells drilled annually was 36, than between 1999 and 2004, when the average dropped to just 3 wells per year (Table 3). DOGM indicates that roughly 41% of the wells drilled in San Juan County during the period 1991-2004 were dry.

Table 2 Wells located within the MtPA

Well status	Number of wells
Producing oil wells	493
Producing gas wells	15
Shut-in oil wells	198
Shut-in gas wells	14
Temporarily abandoned oil wells	29
Temporarily abandoned gas wells	1
Plugged and abandoned oil wells*	415
Plugged and abandoned gas wells*	8
Plugged and abandoned water injection wells*	30
Plugged and abandoned water disposal wells*	11
Plugged and abandoned water source wells*	20
Dry holes	1,034
Abandoned oil locations**	475
Abandoned gas locations**	5
Approved oil permits	3
Approved gas permits	0
Active water injection well	371
Active water disposal well	11
Active water source well	3
Inactive water injection well	35
Well type unknown	96
Total	**3,267**

*Released – well plugged and reclamation satisfactorily completed
**Release pending completion of surface reclamation
Source: DOGM, 2005b

Table 3 Well statistics for San Juan County during the past 15 years

Year	Permits approved (APDs)	Wells spudded	Oil well completions	Gas well completions	Dry holes	Service wells	Total wells drilled
1989	20	36	na	na	na	na	36
1990	125	38	na	na	na	na	30
1991	68	57	42	1	22	0	65
1992	48	45	16	0	23	1	40
1993	23	21	10	0	15	0	25
1994	30	23	12	0	8	1	21
1995	40	38	27	0	8	3	38
1996	36	31	16	1	3	10	30
1997	53	41	22	2	3	14	41
1998	33	33	18	1	3	15	37
1999	4	1	1	0	0	1	2
2000	5	1	0	0	1	0	1
2001	12	5	0	0	6	0	6
2002	6	6	2	0	4	0	6
2003	5	1	0	0	0	0	0
2004	5	3	1	1	1	0	3

Source: DOGM, 2005b

Historical Oil and Gas Production

Both oil and gas production from the MtPA have in general been declining since 1984, but production has decreased more rapidly in the last six years. Figure 1 shows the total production of oil and gas from all wells within the MtPA, while Figures 2 to 4 show production trends for the largest three fields in the area (note, the Lisbon field is half in the MtPA and half in the Moab Planning Area to the north, production in Figure 3 is for the entire field) (DOGM, 2005b).

Figure 1 Production of oil and gas from all wells within the MtPA

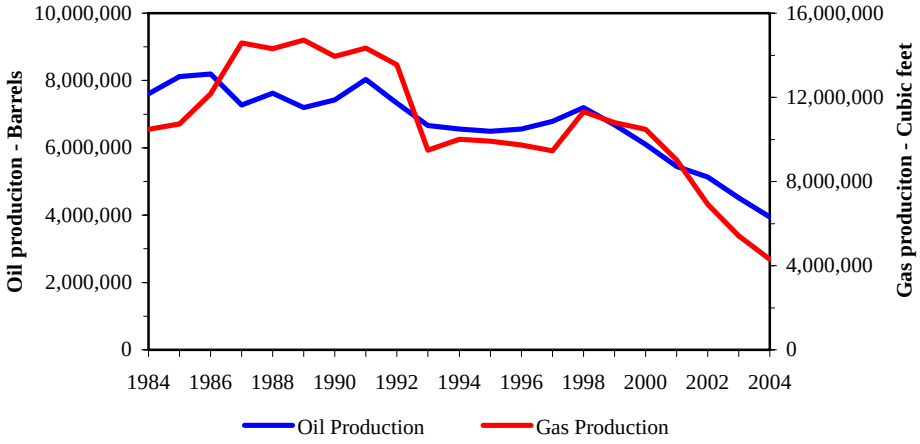


Figure 2 Production of oil and gas from the Greater Aneth Field

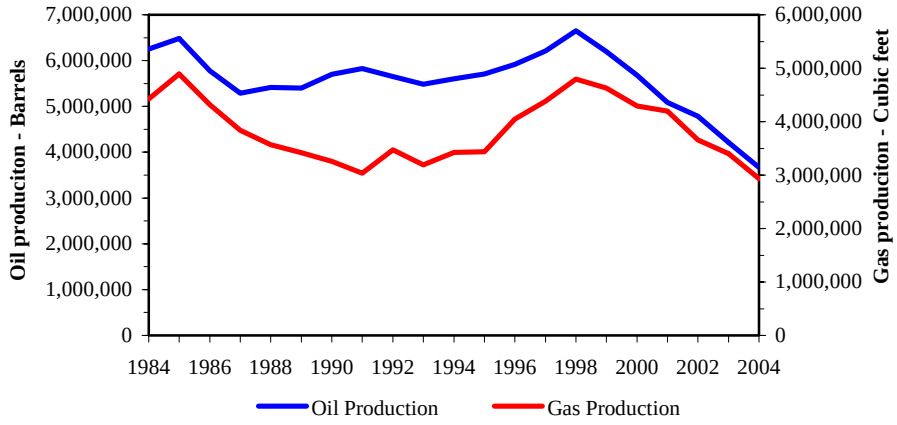


Figure 3 Production of oil and gas from the Lisbon field

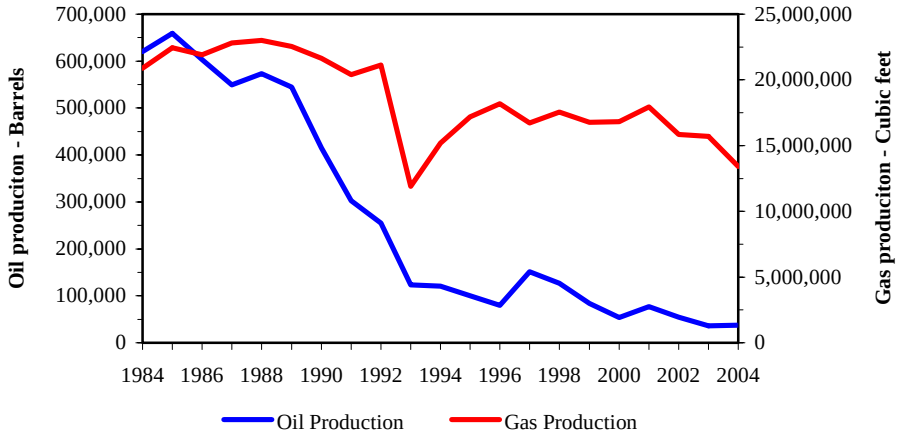
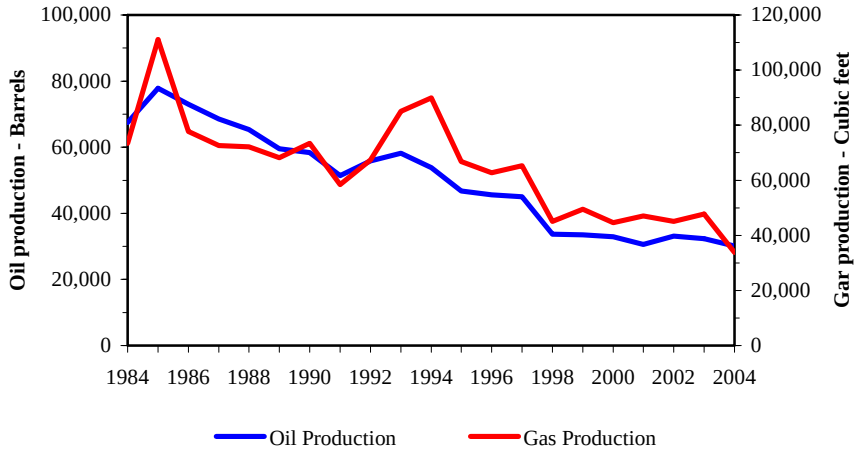


Figure 4 Production of oil and gas from the Ismay field



Well Spacing

Typical oil and gas well spacing in Utah is one well per 160 or 320 acres, depending on location. Within the MtPA, the Lisbon field has a well spacing of one well per 360 acres, while the Bug field has a spacing of one well per 160 acres (DOGM, 2005b). After fields begin to mature, exceptions can be made for wells to be placed closer together in order to extract more oil and gas. For example, the Greater Aneth field has a permitted well spacing of one well per 80 acres, and the Boundary Butte field has a spacing of one well per 20 acres (DOGM, 2005b).

Infrastructure

Road Systems

The primary roads providing access to oil and gas fields in the MtPA are part of the San Juan County Class B road system and are maintained by the county on a regular basis. Numerous secondary roads connecting to the B road system provide access to individual wells and facilities.

Interstate Pipeline Systems and Gas Plants

There are two interstate gas pipeline systems running through the MtPA. A 26-inch pipeline operated by Williams Pipeline (formally Northwest Pipeline), runs from the Greater Cisco area in the Moab Planning Area, through the northeastern part of the MtPA, just south of the Lisbon field, and on to Colorado (Chidsey and other, 2004). A 16-inch gas pipeline operated by Western Gas Resources, Inc., runs from the Greater Aneth field south into Arizona. There are also three interstate crude oil pipeline systems running through the MtPA. A 10-inch oil pipeline operated by Tom Brown, Inc., carries oil from near the Lisbon field south to the Greater Aneth area. A 12-inch oil pipeline operated by Four Corners Pipeline Co., runs south from the Greater Aneth field to Arizona and a 16-inch pipeline operated by Texas New Mexico Pipeline Co., carries oil southeast from the Greater Aneth field into Colorado and on into New Mexico. Oil and gas pipelines are shown on maps included with the Mineral Potential Report.

Three gas processing plants are located in the MtPA: the Lisbon, Aneth, and Four Corners plants. The Lisbon Gas Plant is operated by Tom Brown, Inc. and has a capacity of 60 million cubic feet of gas per day (UGS, 2005). The plant currently produces natural gas, condensate, natural gas liquids, and liquid helium. In addition to the natural gas produced in the Lisbon Valley area, pipelines currently gather natural gas production from wells in San Miguel County, Colorado. There is also a pipeline running south from the plant that could have the capability to gather natural gas from other fields in San Juan County. The facilities at the Lisbon Gas Plant are adequate to process future gas production, and in the event that additional facilities are needed, there is room for expansion at the existing location.

The Aneth Gas Plant is operated by Elkhorn Operating Co. and has a capacity of 12 million cubic feet of gas per day. The Four Corners Gas Plant is operated by Western Gas Resources, Inc. and has a capacity of 15 million cubic feet of gas per day. Both of these plants service the Blanding sub-basin area and produce a mix of natural gas liquids. These two plants are currently running below capacity, suggesting that additional capacity will not be needed in the near future, especially since the fields in the area mostly produce crude oil.

Produced Water and Disposal Facilities

There are currently 371 active water injection wells within the MtPA, which are most likely used for secondary oil recovery efforts (DOGM, 2005b). There are also 11 water disposal wells and 3 water source wells.

Hydrogen Sulfide Gas (H_2S)

Hydrogen Sulfide (H_2S) is a poisonous gas that can occur in association with oil and gas operations. Wells in the Lisbon Valley area typically produce from the Mississippian age Leadville Limestone and the Devonian age McCracken Sandstone, both of which naturally contain H_2S in high concentration. The Lisbon Gas Plant is equipped to safely extract H_2S from the gas stream. In association with the plant, there are two wells that are used to inject the produced H_2S back into the Leadville Limestone.

Public access is restricted at the gas plant, and warning signs for H_2S have been installed at well sites where H_2S has been identified. In some cases, gates have been installed at the edge of the well pads or along the roads to the wells to further warn the public of the H_2S safety concerns.

Conflicts with other Mineral Development

No conflicts with other mineral development have been identified. Due to the low potential for commercial development of coal, it is not likely that there would be any conflicts between coal and the development of oil and gas resources.

There is potential for oil and gas drilling in areas with uranium, especially in the Lisbon Valley area. Historically, uranium mining operations have been small enough that oil and gas exploration and development could occur adjacent to the mining operations. In the past, there were no unresolved conflicts between oil and gas and uranium operations.

Currently, potash development potential is considered low, but could be more attractive in the future in the Lisbon Valley area and might overlap with oil and gas drilling activities. However, it is likely that any future development of potash would be through solution mining operations. In most cases, there would be adequate latitude in selecting well sites for either solution mining or oil and gas drilling to avoid direct impacts to either resource.

VI. Oil and Gas Occurrence Potential

The oil and gas occurrence potential within the MtPA is described in detail, including several maps, in the Mineral Potential Report for the Monticello Field Office Resource Management Plan. The Buried Fault Block play (2101) contains one of Utah's large producing fields, the Lisbon field, and is rated as having H occurrence potential with a D level of certainty. The Porous Carbonate Buildup play (2102) contains the most oil and gas fields, including the largest producing field in Utah, the Greater Aneth field. The southeastern portion of this play, where all current oil and gas fields are located, is rated as H occurrence potential with a D level of certainty. The northwestern portion of this play, on the Monument Upwarp, is rated as H occurrence potential with a C level of certainty. No fields are located in this section of the play, but potential is there for future discovery. The area of this play around the Abajo Mountains is rated as L occurrence potential with a C level of certainty. This area has been intruded with Tertiary volcanics, making oil and gas accumulations unlikely. Only one oil or gas field is located in the Fractured Interbed Play (2103), the now abandoned Kane Creek field. The northern part of this play is rated as H occurrence potential with a D level of certainty, since fractured units are known to exist in this area. The western and southern portions of this play are rated as H occurrence potential with a C level of certainty, except around the Abajo Mountains, which is rated as L occurrence potential with C certainty. The Salt Anticline Flank play (2105) is rated as H occurrence potential with a D level of certainty since it contains a few small fields with the potential for the discovery of others. The Permo-Triassic Unconformity play (2106) is rated as H occurrence potential with a C certainty. No oil or gas fields have been discovered in this play. The Late Proterozoic (Chuar-sourced) and Lower Paleozoic play (2403) is rated as H occurrence potential with only a B level of certainty, since this play is only speculative.

VII. Oil and Gas Development Potential

The oil and gas development potential within the MtPA is described in detail, including several maps, in the Mineral Potential Report for the Monticello Field Office Resource Management Plan. The potential for development of hydrocarbon resources in the MtPA is based on the geology of the area and historic exploration and production activities. Map 1 shows the locations of the three development areas located within the MtPA. The area along the broad linear trend that encompasses the Lisbon Valley area, the

Paradox Fold and Fault Belt, and the area of concentrated oil and gas fields in the southeastern portion of the MtPA, within the Blanding sub-basin region of the Paradox Basin, both have a high development potential. The remaining areas found within a specified USGS play and located on the Monument Upwarp to the west, have a moderate development potential. Finally, the areas not encompassed by a specific play, the area around the Abajo Mountains, and areas within a national park or monument, wilderness study area, or other areas restricted by law or regulation, all have a low development potential.

Paradox Fold and Fault Belt

Oil and gas fields in the Paradox Fold and Fault Belt, in the northern portion of the MtPA, produce from the Buried Fault Block, Fractured Interbed, and Salt Anticline Flank play reservoirs. As discussed in the Mineral Potential Report, the complexity in reservoir development may explain the scarce number of reservoirs in the Buried Fault Block play. Therefore, little development is anticipated for reservoirs that are moderate in size with more than minimal oil columns. However, one of the largest oil and gas fields in the MtPA, the Lisbon field, is located in this play. Some development is anticipated in the Salt Anticline Flank play as seismic technology continues to improve, allowing better definition of the location and nature of the structural traps in the play and promoting increased drilling and recompletion opportunities along the flanks of the salt anticlines. More development of the Fractured Interbed play is anticipated given that it already contains producing fields. Also, the recent successes and continued technological advances being made in the areas of underbalanced drilling, horizontal drilling, fracture identification tools, and completions in fractured shales will all help in the discovery of new fields. Additionally, there are other organic shales, notably the Chimney Rock, Gothic, and Hovenweep Shales that may provide new drilling targets for hydrocarbon accumulations in this play. Based on available information and the current oil and gas production in the area, development potential for the Paradox Fold and Fault Belt portion of the MtPA is considered high.

Blanding Sub-basin

The Porous Carbonate Buildup, Fractured Interbed, and Permo-Triassic Unconformity plays all occur within the Blanding sub-basin area. The lack of any fields completed in the Fractured Interbed play reservoirs in this area and the scarcity of productive wells makes it difficult to determine future development within this play. As previously discussed, only tar sands deposits have been identified in the Permo-Triassic Unconformity play in the MtPA and, hence, development of oil and gas reservoirs in this play in the Blanding sub-basin area is not anticipated. Conversely, prolific oil production occurs in the Blanding sub-basin area from the biohermal buildups of the Porous Carbonate Buildup play, which is the primary reservoir type of the Paradox Basin and specifically the Blanding sub-basin. In fact, the largest oil-producing field in Utah, the Greater Aneth field, is located within reservoirs of this play. Based on the significant occurrence of oil fields in this area, and the fact that several seismic surveys have been run, development potential in the Blanding sub-basin area is considered high.

Monument Upwarp

The Porous Carbonate Buildup, Fractured Interbed, Permo-Triassic Unconformity, and Late Proterozoic (Chuar-sourced) Lower Paleozoic plays all occur within the Monument Upwarp area. Only two fields are developed in this area, the Mexican Hat field, which consists of marginal wells and is nearly depleted, and the Lime Ridge field, which currently has no producing wells. Little, if any, development is anticipated

in these plays for this area. Based on this information, and the lack of other producing wells, development potential for the Monument Upwarp is considered moderate to low.

VIII. RFD Baseline Scenario Assumptions

Assumptions for Coalbed Methane Development

Currently, there are no coalbed methane wells in the MtPA, and coalbed methane development potential is very low or nonexistent. There are four coal horizons in the Dakota Sandstone, each separated vertically by 12 to 15 feet of shale and sandstone strata. Each coal horizon generally contains multiple lens-shaped beds of coal ranging from 2- to 15-feet-thick (Gloyn and others, 1995). Thus, the coal in the Dakota is generally thin and discontiuous and not usually thick enough to be an attractive reservoir. The coal is also of low rank, generally subbitumious C, and as such will not have generated any thermogenic gas. Any gas present will likely be late-stage biogenic gas. The coal is commonly impure or boney, with thinly interlaminated shale, and nearly everywhere contains 30% or more ash. Higher ash content reduces the gas carrying capacity of the coal. Furthermore, the coal horizons of the Dakota Sandstone are exposed around the margins of the Sage Plain plateau. Due to the flat topography of the plateau, the coal horizons are only covered by 35 feet or less of upper Dakota Sandstone and 100 feet or less of Mancos Shale strata (Doelling and Graham, 1972). Such shallow and dissected deposits of coal are likely to have lost any contained gas to the atmosphere.

Assumptions for Drilling Deep Wells

A few deep wells (10,000 feet or deeper) have been drilled in the MtPA in the past, and it is likely that some deep wells will be drilled in the next 15 years (DOGM, 2005b). The drilling of a deep well requires a larger drill rig and a larger drill pad (approximately 400 feet by 450 feet) than used for drilling conventional vertical wells. While the size of a well pad for drilling a deep well would be larger than other well pads, there would not be many deep wells, and the addition of a few deep wells would not substantially affect any long-term projections based on the sizes of smaller well pads. In addition, deep drilling in the Blanding sub-basin is less likely since most tests of deeper Paleozoic targets have only had shows of carbon dioxide.

Assumptions for Horizontal Drilling

Horizontal drilling technology has been used mainly in the Greater Aneth field (DOGM, 2005b). The drilling of multiple horizontal laterals from a single location has occurred in the MtPA, but again, mainly in the Greater Aneth field. Increased use of horizontal drilling technology in the MtPA would not result in any new types of impacts not already being analyzed.

Projected Level of Oil and Gas Activity

Historical Drilling Trends

Historical drilling activity can be used as an indicator for estimating future drilling activity (DOGM, 2005b). The information below includes private, state, and federal mineral actions.

Since 1989, the numbers of Applications for Permit to Drill (APDs) approved and wells drilled in San Juan County show two distinct periods (Table 3). Between 1989 and 1998, the annual average for approved APDs equaled 48 and varied from a high of 125 to a low of 20. Between 1999 and 2004, the average dropped sharply to only 6, and varied from 12 to 4 permits approved per year. A similar trend is seen in the number of wells drilled per year. Between 1989 and 1998, the number of wells drilled varied from 21 to 65, and averaged 36 wells per year (Table 3). Between 1999 and 2004, the number of wells drilled varied from 0 to 6, and averaged just 3 per year. Although the previous activity can be an indicator of future activity, the reliability of these forecasts is limited by unforeseen factors, such as changes in economic conditions and technology.

In order to utilize the historical information to project future drilling activity, the following assumptions were made:

1. Drilling activity could continue at the same rates seen currently, between 1999-2004; and
2. There could be a small boom in oil and gas drilling, similar to the early 1990s.

Based on these assumptions, during the next 15 years, it is predicted that 3 wells will be drilled each year except for a possible boom period of 3 years, where drilling would increase to 36 wells per year. Therefore, it is feasible for about 144 wells to be drilled on federal, state, and private lands within the MtPA during the next 15 years. This amounts to an average of about 10 wells per year. This projection takes into account the fact that the oil and gas fields in the MtPA are mature and the area is well explored. However, it also projects that there might be an increase in drilling related to higher prices, increasing demand, and improved technology.

Projected Drilling Activity

The number of wells projected for the three development areas is based on previous drilling, knowledge and experience of BLM staff, abundant informal discussions with oil industry personnel (geologists, engineers, managers), and consideration of current market conditions (Table 4).

Table 4 Predicted drilling and associated surface disturbance for each development area within the MtPA

Development Area	Number of wells projected to be drilled	Estimated future surface disturbance from drilling wells (acres)
Paradox Fold and Fault Belt (per year)	1 - 6	9.6 - 57.6
Blanding Sub-basin (per year)	3 - 13	28.8 - 124.8
Monument Upwarp (per year)	1 - 2	9.6 - 19.2
Totals per year for next 15 years	**5 - 21**	**48.0 - 201.6**
Average per year for next 15 years	**13**	**124.8**
Total for next 15 years	**195**	**1,872.0**

Source: Utah Geological Survey

Future drilling is affected by economic situations that cannot be accurately forecasted; therefore, a range was utilized to reflect the potential numbers of future wells. It is recognized that future drilling activity and future wells will not be evenly distributed throughout the geologic areas. When new wells are drilled, and especially if new fields are discovered, there could be additional drilling activity concentrated around the new wells.

The yearly projections in Table 4 provide a range of potential drilling activity and are not thresholds for limiting drilling activity to 21 wells per year. It is recognized that there would be some years with less than 5 wells and some years with more than 21 wells. In the event that more than 21 wells were drilled in one or more years, the years with increased drilling would average out with the years when fewer wells were drilled.

The range of wells projected for the development areas averages about 13 wells per year, which is slightly higher than the projection of 10 wells per year based on historical drilling information. Recent technology and market developments in the oil and gas industry favor an increase in drilling activity over historical trends. Prices of both oil and gas have increased substantially, and market analysts project the high commodity prices to continue. Local and regional gas pipeline expansion is continually increasing access to markets, thus enhancing the economic incentive to drill. Although these developments have only had a brief term of influence on the industry, they are already being expressed locally in terms of increased interest in oil and gas leasing and an increase in drilling applications. Therefore, an average of about 13 wells per year is projected for a total of about 195 wells over the next 15 years (Table 4).

IX. Surface Disturbance Due to Oil and Gas Activity on All Lands

A wide range of variables will affect the surface disturbances from drilling and producing a well in the MtPA. The estimates for surface disturbances would be affected by size of the well pad, topography, and length of new road construction. The primary factor affecting the size of the well pad would be the size of the drill rig needed to reach the total depth of the well. Some of the shallow wells drilled within the MtPA could be drilled with minimal equipment, and in some cases, the well pad could be less than 1 acre in size. A well pad constructed for drilling a deep well (over 10,000 feet deep) would probably have to be at least 4 acres to provide enough room for the drilling equipment and service trucks. Typically, the well pad for gas production facilities would be smaller than a well pad for a producing oil well where several oil storage tanks would be required. Based on this information on the range of pad sizes, it is assumed that an average well pad disturbs 2 acres.

The large majority of future wells will probably be drilled within the Blanding sub-basin or near Lisbon Valley, where new road construction may be minimal; however, there are also areas throughout the MtPA where 2 miles of new road construction would be expected and the surface disturbance for the road would be between 8 and 12 acres (depending on the road width and terrain). Some areas within the Monument Upwarp could require over 5 miles, or 25 acres, of new road construction and/or road upgrading, but development potential in these areas is low to moderate. Where tanker trucks are used to haul oil from a producing well, the road would have to be constructed wider than a road for a shallow gas well. Construction in steep terrain would result in higher volumes of cut and fill, and the surface disturbances in the steep terrain would be wider than in flat terrain. Based on this information, it is estimated that the length of roads will mostly range between 0.2 to 2 miles, and the average disturbance per well would be 5.5 acres.

Most of the fields in the MtPA produce oil instead of gas, meaning that additional gas pipelines and processing facilities will probably not be needed in the next 15 years. Also, the majority of new wells

will probably be drilled near areas that currently have significant pipeline coverage. It is estimated that there will be 0.5 acres of surface disturbance per well for gathering/injection pipelines and 1.6 acres per well for transportation pipelines.

Based on the ranges of variables described above, the total surface disturbance for construction of a well pad, road, and associated pipelines is estimated at 9.6 acres per well. This estimate is higher than the actual surface disturbance for most oil and gas wells drilled in producing fields with existing road systems, and may be low for exploratory wells in areas where more than 2 miles of new road construction will be required. This estimate is for the average surface disturbance during future drilling, but it is not a threshold for limiting future exploratory drilling programs.

Estimated Existing Surface Disturbance

As of March 24, 2005, there are approximately 1,135 wells in the MtPA (Table 2) (DOGM, 2005b). The 1,135 wells include producing oil wells, shut-in oil wells, producing gas wells, shut-in gas wells, water injection wells, water disposal wells, water source wells, and temporarily abandoned wells. In addition, there are 480 abandoned wells that have had reclamation initiated but final release by the surface management agency is pending. Using the data and assumptions above, the estimated surface disturbance for the existing wells, roads, and pipelines in the MtPA is 15,504 acres (1,135 active wells x 9.6 acres of disturbance per well + 480 abandoned wells x 9.6 acres of disturbance per well = 15,504 acres of total existing surface disturbance) (Table 5).

Total Estimated Future Surface Disturbance for Wells, Roads, and Pads

It would be reasonable to assume that portions of the producing well pads would be reclaimed after the drilling operations and entire well pads would be reclaimed after wells were plugged. Projecting the acreages or percentages of a producing well pad that would be reclaimed or the percentages of the future wells that would be plugged is difficult due to the cyclic nature of drilling programs, the wide range of drilling success rates between drilling in known fields and exploratory drilling in new areas, the variability in well pad sizes, and the variability of reclamation times related to the soils, vegetation, and rainfall. However, for the purpose of this RFD and based on historical trends (Table 3), it is assumed that 59% of the wells drilled will be productive, the remaining 41% will be abandoned and reclaimed, and that revegetation will be successful within a scope of 10 years. It is also reasonable to assume that the number of wells to be abandoned over the next 15 years will equal approximately one-half the number of wells going into production (195 total wells x 59% will be productive = 115 wells ÷ 2 = 58 abandoned wells or an average of 4 per year).

Table 5 Total existing and predicted surface disturbance from drilling activities, as well as predicted reclamation, for the MtPA

	Number of wells	Total surface disturbance
Existing surface disturbance - Total	**1,615**	**15,504**
Active wells	*1,135*	*10,896*
Abandoned wells	*480*	*4,608*
Future surface disturbance for the next 15 years	**195**	**1,872**
Gross surface disturbance for the next 15 years	**1,810**	**17,376**
Predicted reclamation in the next 15 years - Total	**527**	**5,059**
Reclamation of future dry wells	*27*	*259*
Reclamation of existing abandoned wells	*480*	*4,608*
Reclamation of future abandoned wells	*20*	*192*
Total net surface disturbance for the next 15 years		**12,317**

Source: Utah Geological Survey

The estimated surface disturbance for future wells, roads, and pipelines in the MtPA is 9.6 acres per well or a total of 1,872 acres for the 195 wells projected over the next 15 years (Table 5). Adding in the existing surface disturbance, the gross surface disturbance for the MtPA for the next 15 years is 17,376 acres.

During this period about 27 of the projected wells will probably be dry and successfully reclaimed for a total of 259 reclaimed acres (Table 5). Only the wells drilled during the first 5 years would be successfully reclaimed over the next 15 years (13 wells per year x 5 years x 41% dry = ~27 wells). It is also assumed that all 480 abandoned wells will be reclaimed in the next 15 years, totaling 4,608 acres of reclaimed land. In addition, there will be some reclamation of future abandoned wells. It is assumed that 4 wells will be abandoned per year and only wells abandoned in the first 5 years will be successfully reclaimed over the next 15 years. Reclamation of these 20 abandoned wells will total 192 acres. Altogether, 5,059 acres should be reclaimed in the next 15 years. The existing surface disturbance, plus the predicted disturbance, minus all acres expected to be reclaimed, leaves a total net surface disturbance of 12,317 acres.

Total Estimated Future Surface Disturbance for Geophysical Exploration

Although geophysical data may have been collected from an area in the past, previous geophysical activity does not preclude the gathering of additional data. Old data is continuously being reprocessed, but there are limits to the quality of data that can be interpreted from the older data. It is feasible that new geophysical exploration could occur anywhere within the MtPA in the future. Based on the geophysical activities during the last 15 years, the majority of the future geophysical projects would probably be

within the eastern portion of the Paradox Fold and Fault Belt and within the Blanding sub-basin area (Map 2).

Typically, geophysical operations would utilize either two-dimensional (2-D) or three-dimensional (3-D) data acquisition technology. The activities would require spreading cables and geophones for receiver lines and utilizing vibroseis trucks or shotholes along source lines to supply the source of energy for creating seismic reflections (seismic acoustic waves). There is little doubt that 3-D projects of up to 40 square miles would be proposed within the MtPA in the future.

The distances between the receiver lines and the distances between the source lines would vary depending upon the depth of the target formations. For shallow reservoirs, such as those in the Blanding sub-basin area, the receiver/source lines for a 3-D project would be approximately 660 feet apart, and there would be 8 linear miles of source lines for every 1 square mile of the project. For deeper reservoirs, like those near the Lisbon Valley, the receiver/source lines for a 3-D project would be 1,320 feet apart, and there would be 4 linear miles of source lines for every 1 square mile of the project.

Based on the previous 3-D projects in the MtPA and depths of the oil and gas formations in the area where geophysical projects would be expected, most of the 3-D projects in the MtPA would likely have receiver/source lines at 660-1,320 feet intervals and at least 8 linear miles of source lines per square mile of the project. A 40 square mile 3-D project would then require at least 320 linear miles of source lines where a vibroseis buggy or drill buggy would be driven. Depending on the network of existing roads and trails in the project area, it may be feasible to move some of the source points to the roads and avoid some cross-country travel with the buggy vehicles.

In addition to 3-D projects, 2-D projects will continue to occur. Future 2-D geophysical projects could vary from 1-2 lines of 1-2 miles each, or dozens of lines several miles long. In remote areas with steep slopes and limited access, there would be a potential for a 2-D seismic line to be run down a narrow mesa or canyon.

Vibroseis buggies or buggies transporting drills would typically be used to travel cross-country. Buggies transporting drills would likely follow a single route and make a single pass or round trip along the source lines. Vibroseis buggies would probably be run in single file with each buggy following the previous buggy, or the vibroseis buggies could be spread 3 to 4 abreast and running parallel to each other when recording source lines. The buggy routes would be zig-zagged (weaved) to avoid long, straight visual impacts.

When vehicles travel cross-country, there would be no dozing along vehicle access routes. The surface impacts from the buggies would be the vehicle tracks along the buggy routes and a drill hole if it is a shothole project. Helicopters would be utilized to distribute receiver cables on most big projects and for moving portable drilling equipment in terrain that is too steep for buggies.

Some companies and/or geophysicists prefer vibroseis technology for gathering data, because the frequency of the source can be varied and data can be collected at several different frequencies while the vibroseis buggy is on the line. The depths and types of formations may also affect the preference of one type of source equipment over another.

Geophysical surveys measuring gravity, magnetic, or electrical conductivity, and soil sampling have been completed in the past. It would be likely that these types of geophysical surveys would be utilized during the next 15 years. Typically, the gravity/magnetic/electrical geophysical surveys would be low-impact actions that could be classified as casual use, as long as vehicles stayed on existing roads.

Projections for future geophysical exploration projects in the MtPA are based on the following assumptions:

1. Most areas within the MtPA that have a high development potential for oil and gas already have significant seismic coverage;
2. Geophysical exploration would be cyclic and could increase if there was a boom in oil and gas activity;
3. Data acquisition would involve the use of 2-D, 3-D, or similar technology;
4. The number and size of 3-D projects will probably increase in the future;
5. Measuring the exploration in linear miles of source lines would be more meaningful than the number of geophysical projects;
6. An estimate of 8 linear miles of source lines for every square mile of 3-D project would be representative for the majority of projects in the MtPA;
7. Casual use activities would not be included in the projections.

Using these assumptions, the potential for future geophysical exploration on federal, state, and private lands within the MtPA during the next 15 years could range from 770 to 1,700 linear miles of source lines, or an average of 51 to 113 linear miles of source lines per year. These estimates assume 30 to 50 linear miles run each year with 1 to 3 larger 3-D projects, each totaling roughly 40 square miles. It is predicted that the Paradox Fold and Fault Belt area will see the most geophysical activity, roughly 24 to 53 linear miles per year for the next 15 years (Table 6). This area has a high potential for development and only limited existing surveys (Map 2). The Blanding sub-basin is predicted to have between 18 and 40 linear miles of geophysical surveys performed per year for the next 15 years. This area has been extensively researched, but there is still high potential for discovery. The remaining area, the Monument Upwarp, is predicted to have 9 to 20 linear miles of surveys performed per year for the next 15 years. This area has a moderate to low potential for development, but could yield producing fields if more seismic exploration was performed.

For the purpose of analyzing the impacts of geophysical exploration, a total of 1,230 linear miles of source lines over the next 15 years was utilized (Table 6). Assuming vibroseis buggies or buggies transporting drills drove over every mile of source line and the path of the buggies was 15 feet wide, there would be a surface disturbance of approximately 2,236 acres over the next 15 years, or an average of 149 acres per year. It is assumed that reclamation of disturbance would be successful within a scope of 10 years depending on reclamation times related to soils, vegetation, and rainfall.

Table 6 Predicted amount of geophysical activity and associated surface disturbance for each development area within the MtPA

Development Area	Projected linear miles of geophysical surveys	Estimated future surface disturbance from geophysical surveys (acres)
Paradox Fold and Fault Belt (per year)	24 - 53	43.6 - 96.4
Blanding Sub-basin (per year)	18 - 40	32.7 - 72.7
Monument Upwarp (per year)	9 - 20	16.4 - 36.4
Totals per year for next 15 years	**51 - 113**	**92.7 - 205.5**
Average per year for next 15 years	**82**	**149.1**
Total for next 15 years	**1,230**	**2,236.4**

Source: Utah Geological Survey

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