APPENDIX A
OIL AND GAS DEVELOPMENT POTENTIAL
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SUMMARY

Increased oil and gas activity is expected to occur in the Vernal Planning Area (Planning Area) over the next 15 years. This oil and gas activity is projected to include some coal-bed methane exploration and development as well. Increased seismic activity, both three-dimensional (3D) surveys and 2D surveys expected over the next 15 year planning period, particularly in the East Tavaputs Plateau exploration and development area. Forty five (45) to 75 Notices of Intent to perform surveys are anticipated over the planning period. Approximately 2,055 oil wells, 4,345 gas wells and 130 coal-bed methane wells are projected to be drilled over the planning period. The majority of the oil and gas development activity is anticipated to occur in the Monument Butte-Red Wash exploration and development area. Coal-bed methane activity is anticipated to occur in both the East and West Tavaputs Plateau areas.

INTRODUCTION

The purpose of this report is to assess the mineral resource occurrence and development potential for the oil and gas resources within the Vernal Planning Area. The assessment involved reviewing published data and selected pertinent data for use in the assessment. It did not include field studies. The oil and gas resources are classified according to the system of the U.S. Bureau of Land Management (BLM) found in BLM Manuals 3031 and 3060.

This report has been prepared as an appendix to the Vernal Planning Area Minerals Potential Report (MPR), which provides a preliminary assessment of all mineral resources in the Planning Area. This oil and gas resource assessment includes the estimated number of new oil and gas wells anticipated to be drilled in the Planning Area and related surface disturbance associated with these activities. Although directional drilling has had limited success in the Planning Area, if success rates were to improve, an additional 20 directionally drilled wells per year could be expected over the estimates discussed in this report. Such an increase would not result in an appreciable increase in surface disturbance in the Planning Area.

GEOLOGY

The geology of the Planning Area is briefly summarized in the regional geology section of the Vernal Planning Area MPR. Oil and gas production within the Planning area and adjacent areas occurs primarily from the following formations, which are delineated in Figure 4 of the MPR:

\$\ Tertiary Green River and Wasatch Formations (mapping units T2 and T1, respectively, in Figure 4 of the MPR)

\$\ Cretaceous Mesaverde Group and Dakota Sandstone Formations (mapping units K3 and K1, respectively)
Jurassic Navajo Sandstone Formation (mapping unit Jg)
Pennsylvanian Weber Formation (mapping unit PP).

While not as productive, the Tertiary Uinta Formation is also a source for the gas resource in the Planning Area.

The oil and gas plays described in the following sections are based on the geologic features in the Planning Area. Likewise, the six potential oil and gas development areas, also described below, were delineated, in part, based on the geologic features of the Planning Area.

**Conventional Oil and Gas Plays**

Seven conventional oil and gas plays exist in the Planning Area. These plays have been identified by the U.S. Geological Survey (USGS), based on the geologic features of each play (USGS, 1995). These plays, which are delineated in Figure A-1, are:

- Uinta Tertiary Oil and Gas Play (Play No. 2002)
- Upper Cretaceous Conventional Play (Play No. 2003)
- Cretaceous Dakota to Jurassic Play (Play No. 2004)
- Permian-Pennsylvanian Sandstones and Carbonates Play (Play No. 2005)
- two hypothetical Basin Margin Subthrusts plays (Play Nos. 2014 and 3706)
- Basin Margin Anticline Play (Play No. 3755).

The Uinta Tertiary Play consists of oil and gas accumulations within fluvial reservoirs of the Tertiary Green River and Wasatch Formations. Hydrocarbons in these fluvial reservoirs are sourced from the Cretaceous Mesaverde Group Formation gas-prone coals, shales and mudstones, along with lacustrine shales and marlstones of the Green River Formation. This play produces the oil that is being extracted in the Altamont-Bluebell Field area.

The Upper Cretaceous Conventional Play consists mostly of gas in the sandstones of the Cretaceous Mesaverde Group Formation, the source of these gas deposits being the organic shales and coals in this same formation. Although the discovered fields in this play are located in the adjacent Piceance Basin, which is located east of the planning area in western Colorado, gas deposits are thought to exist in the Uinta Basin as well.
The Cretaceous Dakota to Jurassic Play contains primarily natural gas. Reservoirs are located in the fluvial deposits of the Cretaceous Dakota Sandstone and the aeolian deposits of the Jurassic Navajo Sandstone Formation.

The Permian and Pennsylvanian Sandstones and Carbonates Play contains primarily oil deposits. The primary reservoir unit in this play is the sandstones of the Pennsylvanian Weber Formation, but carbonate units in this play can also be reservoirs. The Ashley Valley field is currently producing oil from this play.

The two hypothetical Basin Margin Subthrusts plays (Play Nos. 2014 and 3706) are believed to exist on the northern and southern margins of the Uinta Mountains. Wells have not been drilled in these plays, but reserves are thought to exist here based on similar producing structures along the margins of other thrust belts in the Rocky Mountains.

The Basin Margin Anticline Play is a narrow tract paralleling the thrust margin of the Greater Green River Basin in Wyoming, Utah and Colorado. The play is only present in the extreme northeast corner of the Planning Area. All current gas extraction in the Clay Basin area is occurring from this play.

Unconventional Continuous Type Oil and Gas Plays

Unconventional continuous-type plays also exist in the Planning Area in the form of tight gas (low permeability reservoir), coal-bed methane plays, and self-sourced fractured shale oil plays. These plays are delineated in Figure A-2.

Tight gas plays within the Planning Area include the Tight Gas Uinta Tertiary East Play (Play No. 2015) and the Tight Gas Uinta Tertiary West Play (Play No. 2016). Additional tight gas hypothetical plays in the area include the Basin Flank Uinta Mesaverde Play (Play No. 2018) and the Deep Synclinal Uinta Mesaverde Play (Play No. 2020). Of the tight gas plays, natural gas production has been greater in the Tight Gas Uinta Tertiary East Play.

Two coal-bed methane plays exist within the Planning Area: (1) the Uinta Basin-Book Cliffs Play (Play No. 2050) and, (2) the hypothetical Uinta Basin-Sego Play (Play No. 2051). Production has occurred from the Cretaceous Mesaverde Group Formation in the Uinta Basin Book Cliffs Play.

One self-sourced fractured play exists in the Planning Area. This hypothetical oil play (Play No. 2009) is thought to exist within the fractured Upper Cretaceous Mancos Shale and equivalents. While this play is classified as continuous by the USGS, success rates would be expected to vary within this play, based on localized structures.
**Oil and Gas Development Areas**

For the purpose of analysis, the Planning Area was divided into the following six potential development areas: (1) Manila - Clay Basin, (2) Tabiona - Ashley Valley, (3) Altamont - Bluebell, (4) Monument Butte - Red Wash, (5) West Tavaputs Plateau, and (6) East Tavaputs Plateau. These areas, which are shown in Figure A-3, were established based on geologic rationale, relative geographic locations, and their potential for on-going and future oil and gas development.

**PAST AND PRESENT OIL AND GAS ACTIVITY**

Oil and gas development is one of the major resource development activities within the Uinta Basin. Development commenced during the early 1900s and is continuing at record or near record levels. Table A-1 summarizes the number of wells and well status by county within the Planning Area. The PI/Dwights well data, State of Utah Division of Oil, Gas, and Mining (UTDOGM), and the BLM Automated Fluid Minerals Support System were reviewed to determine present well status.

Table A-2 presents the related oil and gas surface disturbance associated with present operations. The related surface disturbance estimates presented in Table A-2 were based on the following assumptions, which were based on BLM review of the above databases and upon BLM field experience in the area (Cleavinger, personal communication).

- Seventy-five percent of producing wells will be producing at any given time
- Average well life: 25 years
- Time for successful reclamation of surface disturbance: 5 to 10 years
- The number of shut-in wells returning to producing status will equal the number of producing wells being placed into shut-in status
- 33 existing compressor sites, each with an average surface disturbance of 2 acres per site
- The miles of gas gathering pipeline systems will equal the miles of road for those wells that produce gas. Only 10 percent of the gas gathering pipeline systems will be buried
- Oil secondary recovery project water pipeline systems will equal road disturbance for every other well drilled in a secondary recovery project
- Access road construction equals 0.18 mile per well (1.5 acres surface disturbance per well)
- Well pad construction:
2.0 acres surface disturbance per well

0.8 acre surface disturbance per well will be reclaimed within 1 year after completion of operations

Existing pipeline systems:

Gathering/Injection Lines: 0.47 acre surface disturbance per well (producing, shut-in, temporarily abandoned, and service wells)

Transportation Lines: 0.15 mile per well (producing, shut-in, temporarily abandoned, and service wells). 0.79 acre surface disturbance per well (producing, shut-in, temporarily abandoned, and service wells). Approximately 1/3 of pipeline surface disturbance will be reclaimed in short term.

Existing pipeline systems:

Gathering/Injection Lines: 0.47 acre surface disturbance per well (producing, shut-in, temporarily abandoned, and service wells)

Transportation Lines: 0.15 mile per well (producing, shut-in, temporarily abandoned, and service wells). 0.79 acre surface disturbance per well (producing, shut-in, temporarily abandoned, and service wells). Approximately 1/3 of pipeline surface disturbance will be reclaimed in short term.

Powerlines: Ten (10) percent of wells (producing, shut-in, temporarily abandoned, and service wells) will have electrification. Where powerlines are present, the length will approximate access road length. Existing activity accounts for approximately 73 miles of powerlines. Future development activity will result in approximately 119 additional miles of powerlines. There will be approximately 0.25 acre of surface disturbance per mile of powerline.

Emissions associated with compressor sites located in the Planning Area are presented in Table A-3.

**POTENTIAL FOR OCCURRENCE AND FUTURE OIL AND GAS ACTIVITY**

Oil and gas occurrence potential in the Planning Area was derived from the 1995 National Assessment of United States Oil Reserves (USGS, 1996). This inventory identified the plays and the hypothetical plays that exist within the Planning Area, which have been previously described in the geology section, above. The delineation of oil and gas occurrence potential is shown in Figure A-4.

Using the BLM classification system, which is described in the Vernal Planning Area MPR, identified conventional oil and gas plays have been classified as H occurrence potential and D certainty. Known unconventional plays are classified as H occurrence potential and C certainty. Hypothetical plays (both conventional and unconventional) are classified as M occurrence potential and B certainty. Certain of the areas in the Planning Area encompass multiple plays, which occur at different depths. Therefore, overlapping of occurrence potential and certainty ratings occurs within certain areas of the Planning Area, as shown in Figure A-4.

The foreseeable development for oil and gas (including coal bed methane [CBM]) in each of the six development areas was determined by the Geologic and Engineering Team in the Vernal Field Office (Cleavinger, Forsman, and Mayers, personal
communication). The assumptions used to arrive at the reasonably foreseeable development of the oil and gas resource in each area were based on current development trends, communication with existing operators about future activities, predicted energy needs for the future, and the overall professional opinion of the Geologic and Engineering Team. The number of wells projected to be drilled in each of the development areas discussed below encompass all lands within the areas, not just Federal lands. The number represents all wells drilled (i.e., producing, abandoned and service wells).

**Manila-Clay Basin Exploration and Development Area**

Historical exploration and production in this region has been relatively low, particularly over the last 15 years. All producing wells in the area were drilled prior to 1980. Historical gas well data indicates that only three gas wells have been drilled since 1980, none of which are producing wells (Figure A-5). New geologic data or an increase in the price of natural gas could create increased interest in this area. A maximum of 45 additional gas wells are projected to be drilled in this area over the next 15 years.

**Tabiona-Ashley Valley Exploration and Development Area**

Historical exploration and production of oil and gas resources in this region have been relatively low in the past. Data indicate that one oil well has been drilled in this region since 1980, which is not producing (Figure A-6). Only oil has been extracted from this area in the past. No more than 30 oil wells are projected to be drilled within this area over the next 15 years. Similar to the Manila-Clay Basin development area, new geologic information, or an increase in oil and gas prices, would be required to enhance demand and interest in oil and gas extraction in this area.

**Altamont-Bluebell Exploration and Development Area**

This area has had appreciable oil exploration and production in the past (Figure A-7). The number of oil wells drilled annually has decreased from highs in the mid-1980s and early 1990s that were associated with changes in well spacing orders. No more than 175 oil wells are projected to be drilled within this area over the next 15 years. While historical exploration and production does not indicate a high potential for gas development (Figure A-8), the presence of deep gas reserves in the southern portion of this area could be developed quite extensively over the next 15 years. This would particularly hold true if development of similar deep gas reserves is successful to the west of this area. Therefore, it is projected that 250 gas wells could potentially be drilled in this area over the next 15 years.

**Monument Butte-Redwash Exploration and Development Area**

The Monument Butte-Redwash exploration and development area has been an area of extensive oil and gas development and production in the past (Figures A9 and
A10), which is expected to continue throughout the next 15 years. As many as 1,700 oil wells are projected to be drilled in this area. A projected 3,100 gas wells could also be drilled in this area over the next 15 years.

West Tavaputs Plateau Exploration and Development Area

This area has not been extensively developed for oil and gas resources in the past 15 years (Figures A-11 and A-12). However, based on BLM communications with oil and gas producers, interest exists for future development of both resources in this area, with the eastern portion of this area being particularly active for gas exploration and development. As many as 75 oil wells, 350 gas wells, and 50 coal-bed methane wells could be drilled in this area over the next 15 years.

East Tavaputs Plateau Exploration and Development Area

This area has been slightly more developed for oil and gas than the West Tavaputs Plateau area (Figures A-13 and A-14), and it is believed that increased development, particularly concerning gas deposits, will occur in the area over the next 15 years. Increased seismic study activity is expected in the area, and a potential land exchange with the State of Utah (subject to congressional approval) is expected to lead to increasing additional drilling in the area in the first five years of the 15-year planning period. Seventy-five (75) oil wells are projected to be drilled in this area over the next 15 years. A projected 600 new gas wells and 80 coal-bed methane wells could also be drilled in this area over the next 15 years.

SURFACE DISTURBANCE RELATED TO FUTURE OIL AND GAS ACTIVITY

Estimated surface disturbance related to oil and gas development in each of the designated development areas is presented in Table A-4. Surface disturbance was estimated based on the same assumptions described in the historic and present oil and gas activity section of this report. A total of 84 new compressor sites, each with an average surface disturbance of 2 acres per site, are anticipated to accommodate projected new oil and gas wells in the Planning Area.

REFERENCES

