Reasonably Foreseeable Development Scenario

for

Oil and Gas Activities

on the

White River National Forest
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1.0 Summary

What is a Reasonably Foreseeable Development Scenario?

A Reasonably Foreseeable Development Scenario (RFDS) is a long-term projection (scenario) of oil and gas exploration, development, production and reclamation activity for a defined area and defined period of time. An RFDS is not a prediction of activity; rather it is a possible reasonable scenario of activity under a specified set of assumptions. The RFDS is a technical report presenting a baseline scenario of unconstrained activity based on geology; resource occurrence potential; past and current leasing, exploration, and development activity; and engineering technology, with consideration of economics and physical limitations on access to resources. It is also based on the assumption that all potentially productive areas can be open under standard lease terms and conditions, except those areas designated as closed to leasing by law, regulation or executive order. An RFDS is not a decision, and it does not establish or imply a ‘cap’ on development.

A RFDS is typically developed using the following methods, and considering the following intended uses:

Methods Used in Developing an RFDS

- Utilize a reasonable, technical and scientific estimate of possible oil and gas activity based on the best available information and data at the time of the study.
- Utilize a sound set of reasonable geologic, engineering and economic assumptions about resource occurrence and development.
- Evaluate complementary activity resulting from oil and gas exploration and development efforts regardless of land ownership or jurisdiction.
- Prepare using specialists with technical and scientific oil and gas experience and qualifications, petroleum geologists and petroleum engineers, with assistance from experienced mineral and natural resource specialists as needed.
- Document in a report subject to peer review by experts with relevant qualifications, such as petroleum geologists and/or petroleum engineers.
- Present scenario in terms of the nature, size, and duration of disturbances, not just in terms of the number of wells.

Intended Uses

- Provides an effective tool for evaluating existing land management plans and/or leasing decisions in order to make informed determinations about any need (or not) for updating and/or revising a management plan and/or leasing decision.
- Facilitates determination and analysis of potential effects that discretionary management decisions may have on the development of oil and gas resources.
- Provides technical information necessary for identifying and analyzing potential direct, indirect, and cumulative effects of a proposed leasing action (leasing availability determination).
- Provides information necessary for identification and analysis of alternatives to a proposed leasing action (leasing availability determination).
- Facilitates informed decisions on the management of oil and gas resources balanced with management of other resources.
- Provides documentation of technical information in the administrative record of any analysis for which it is used.

1 The term unconstrained in an RFDS means that there are no restrictions on surface use assumed in the baseline scenario.
What is the purpose of the White River National Forest RFDS and why is it needed?

Forest Service oil and gas regulations require a “projection of the type/amount of post-leasing activity that is reasonably foreseeable as a consequence of conducting a leasing program consistent with that described in the [oil and gas leasing] proposal and for each alternative.” [36 CFR 228.102(c)(3)]. Further, under a Memorandum of Understanding between the Bureau of Land Management (BLM) and the Forest Service (FS) on the national level, the BLM is responsible for providing the RFDS for oil and gas leasing on national forest system lands if requested.

The purpose of this RFDS is to provide an estimated projection of oil and gas occurrence and unconstrained, baseline development potential on National Forest System (NFS) lands administered by the White River National Forest (WRNF). The purpose of the RFDS is not to predict activity, but to provide a possible scenario of exploration and development activity based on a defined set of assumptions in order to evaluate potential effects that might reasonably occur as a result of leasing under unconstrained conditions. The RFDS provides the “starting point” for the WRNF to propose a leasing availability action and alternatives to a proposed leasing availability action. The timeframe of the projections in the WRNF RFDS is 20 years.

The WRNF RFDS is needed to review a variety of factors that have changed since the WRNF issued its Oil and Gas Leasing EIS Record of Decision in 1993, including the following:

- Data and information to support an update and revision of the existing oil and gas leasing analysis and decision,
- New and improved drilling, completion and production technology,
- Dynamic oil and gas economic environment,
- Expanding oil and gas infrastructure and transportation systems, and
- Increased rate of development on the WRNF.

The WRNF intends to analyze effects of future leasing based on information in this RFDS, and will document those effects in an EIS that will be subject to public comment. Ultimately, the WRNF expects to issue an updated and revised leasing decision based on that analysis.

How was this RFDS document completed?

The WRNF overlaps with the administrative boundaries of the following seven BLM field offices (FO) in Colorado:

- Glenwood Springs FO
- Kremmling FO
- Uncompahgre FO (Montrose)
- Little Snake FO (Craig)
- Grand Junction FO
- Gunnison FO
- White River FO (Meeker)

Portions of the WRNF with potential for occurrence of oil and gas resources overlap with portions of five of these field offices: Glenwood Springs FO, Kremmling FO, Little Snake FO (very little overlap), Grand Junction FO, and White River FO. This RFDS is a compilation of applicable and relevant data and information from the RFDSs for these five field offices, with information for the Little Snake FO included with the White River FO. Information from these documents is collectively referred to as the “existing RFDSs” and all such information is incorporated by reference and cited in the text. A very small portion of the WRNF also overlaps with the Uncompahgre FO and Gunnison FO; however data relevant to this RFDS are not presently available. All referenced documents are listed in Section 9, References.
The existing RFDSs prepared by the BLM field offices identify oil and gas occurrence potential and development potential across all lands (including NFS lands) encompassed by the respective field office boundary. Field office staffs compiled this information as a result of interviewing operators, compiling data from various relevant sources, and developing underlying assumptions regarding future oil and gas development.

Discussion in this RFDS on geologic provinces, oil and gas exploration and development history, occurrence potential, development potential, reserves, and surface disturbance were brought forward from the existing RFDSs. The existing RFDSs referenced in this RFDS were developed by the BLM using the same methods and with the same intended uses in mind as described above.

Additional data sources used in preparation of the existing RFDSs and this RFDS include:

- United States Geological Survey (USGS) - geology, oil and gas plays, total petroleum systems, oil and gas assessments
- Department of Energy (DOE) – technology
- Energy Information Agency (EIA) - supply and demand, activity, and price trends
- Colorado Geological Survey (CGS) - geology, activity and price trends
- Colorado Oil and Gas Conservation Commission (COGCC) - spatial well data and field data
- Bureau of Land Management (BLM) – Automated Fluid Minerals Support System (AFMSS) database
- Academic institutions
- Professional associations
- Oil and gas industry

The following policies and guidance were used in preparing this RFDS:

- BLM Instructional Memorandum (IM) No. 2004-089, “Policy for RFDS.” (The format for the report is consistent with the suggested guideline for content and organization found in this IM.)

**What is the geologic setting on the WRNF?**

The general geologic setting on the WRNF includes areas of mountain ranges formed by uplifts that exposed igneous and metamorphic rocks, which are bordered by basins of sedimentary rocks. These sedimentary basins create a favorable geologic setting for the occurrence of hydrocarbons such as oil and gas. Most notably, the western portion of the WRNF lies within the Piceance Basin.

**What is the oil and gas occurrence potential on the WRNF?**

Recently, the USGS and BLM evaluated geologic provinces called oil and gas assessment provinces. The WRNF falls into three of these assessment provinces: the Uinta-Piceance Province, the Southwestern Wyoming Province and the Park Basins Province. The WRNF lies within the Piceance Basin portion of the Uinta-Piceance Province, the Greater Green River Basin portion of the Southwestern Wyoming Province, and the Middle Park Basin portions of the Park Basins Province (Figure 6).

High oil and gas occurrence potential lies in the western portion of the WRNF in the southern Piceance Basin, overlapping with the Glenwood Springs and a small portion of the Grand Junction FOs. Additional high oil and gas occurrence potential areas are found on the extreme north end of the WRNF in the
Greater Green River Basin, overlapping with the White River and Little Snake FOs. The portion of the WRNF in the Kremmling FO area has low or no known oil and gas occurrence potential (Figure 7).

Portions of the WRNF also lie in areas where geologic conditions are not favorable for oil and gas to occur. Notably the White River Uplift, Eagle Basin and high mountain ranges of the Sawatch and Park Ranges have little to no recognized potential for oil and gas to occur.

**What is the estimated development potential on the WRNF?**

Over the next 20 years, between 903 and 1,014 wells from up to 179 well pads are projected for the WRNF based on resource occurrence potential and assuming minimal constraints on drilling. Projected unconstrained (baseline) oil and gas development activity on the WRNF is summarized in Table 1 below. Discussion on how the number of wells, along with how well sites and road disturbance were projected is addressed in Section 6.0 and Section 8.0 respectively in this document. NFS lands on the Rifle Ranger District and a portion of Sopris Ranger District and within the BLM Glenwood Springs FO and Grand Junction FO areas are anticipated to experience the majority of projected oil and gas development on the WRNF over the next 20 years.

**Table 1. Summary of Well Projections, Well Pads and Associated Surface Disturbance by BLM Field Office Area and Geologic Province on the WRNF.** WRNF lands on the Rifle and Sopris Ranger Districts and within the BLM Glenwood Springs FO have the most activity projected over the next 20 years.

<table>
<thead>
<tr>
<th>BLM Field Office Area / Geologic Province</th>
<th>Projected Wells</th>
<th>Projected Well Pads</th>
<th>Long Term Well Pad Surface Disturbance (acres)$^4$</th>
<th>Surface Disturbance – Roads, Pipelines, and Other Facilities (acres)$^5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glenwood Springs FO / Uinta-Piceance</td>
<td>872$^1$</td>
<td>132$^2$</td>
<td>441</td>
<td>404</td>
</tr>
<tr>
<td>Grand Junction FO / Uinta-Piceance</td>
<td>31 to 132$^3$</td>
<td>Up to 37</td>
<td>Up to 116</td>
<td>52</td>
</tr>
<tr>
<td>White River (WRFO) and Little Snake (LSFO) / Uinta-Piceance and Southwestern Wyoming</td>
<td>Up to 10</td>
<td>Up to 10</td>
<td>Up to 15</td>
<td>Up to 30</td>
</tr>
<tr>
<td>Kremmling (KFO) / Park Basins</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>903 – 1,014</strong></td>
<td><strong>Up to 179</strong></td>
<td><strong>Up to 572</strong></td>
<td><strong>486</strong></td>
</tr>
</tbody>
</table>

$^1$ Per the Glenwood Springs FO RFDS, includes 694 Mesaverde, 28 Niobrara and 150 wells in undeveloped reservoirs on unleased lands.

$^2$ Includes 123 multi-well pads, 9 single well pads. See also Table 5a.

$^3$ Grand Junction FO RFDS projection is presented in ranges, thus reflected here. Includes conventional and coalbed natural gas wells in the Mesaverde TPS. See also Table 5b.

$^4$ Acreage reflects surface disturbance after interim reclamation. See tables 5a, 5b and 5c.

$^5$ Areas in Glenwood Springs FO RFDS assumed 9 acres of road disturbance per pad. Areas in Grand Junction FO assumed road disturbance at 6.5 acres per section.
2.0 Introduction

The White River National Forest (WRNF), located in north-central Colorado, is one of the nation’s largest and oldest national forests. The forest contains about 2.3 million acres of national forest system (NFS) lands in the following 9 counties: Eagle; Garfield; Gunnison; Mesa; Moffat; Pitkin; Rio Blanco; Routt; and Summit. Best known for its world-famous ski areas such as Aspen, Vail, and Breckenridge, the forest also features the 750,000 acres of wilderness, outstanding scenic vistas such as the Maroon Bells, Hanging Lake and the Colorado River. The Forest also boasts the nation’s largest herd of elk.

The WRNF also is rich in geologic-based resources, including natural gas and oil. Natural gas development on the WRNF has occurred since the 1930s. The majority of oil and gas activity on the WRNF has occurred on the western side of the forest within the Piceance Basin portion of the Uinta-Piceance Province. In 1993, the WRNF identified about 950,000 acres of NFS lands (see Figure 1) as available for oil and gas leasing (USDA-FS, 1993). About 133,000 of those acres are currently under lease (Figures 2 and 4).

The purpose of this Reasonable Foreseeable Development Scenario (RFDS) is to describe the potential for oil and gas resource occurrence on the forest, and to provide an unconstrained, baseline projection of potential oil and gas development on NFS lands administered by the WRNF. The RFDS does not predict activity; rather it provides a possible scenario of activity based on a defined set of assumptions in order to evaluate potential effects that might occur as a result of leasing under unconstrained conditions. The RFDS provides the “starting point” for the WRNF to consider a leasing availability action and alternatives to a proposed leasing availability action. The WRNF RFDS provides projections of oil and gas development activities over the next 20 years, until about 2029.

The WRNF RFDS is needed to respond to a variety of factors that have changed since the 1993 Oil and Gas Leasing EIS and Record of Decision, including the following:

- Data and information to support revision to the 1993 WRNF oil and gas leasing analysis and decision,
- New and improved drilling, completion and production technology,
- Dynamic oil and gas economic environment,
- Expanding oil and gas infrastructure and transportation systems, and
- Increased rate of development on the WRNF.

The WRNF will use the information in this RFDS as a basis for a leasing analysis and subsequent analysis of cumulative effects, and will document those effects in an EIS that will be subject to public comment. Ultimately, the WRNF expects to issue an updated and revised leasing decision based on that analysis.

Information in this RFDS is compiled from existing RFDSs prepared by various BLM field offices in conjunction with revisions of resource management plans for those offices. The BLM is charged with administering all federal mineral estate, including federal minerals underlying NFS lands. The following BLM field offices (FO) cover various portions of the WRNF. Figure 1 shows the overlap of each of these field offices with WRNF lands.
The RFDSs for the offices with jurisdiction over minerals underlying the WRNF include information about past, present, and future exploration and development activity on NFS lands encompassed by each of the offices. Likewise, information on development potential for the WRNF, including estimated projections of wells and production, is extracted from relevant BLM field office RFDSs and is so presented in this RFDS.

Footnote:
2 As of 2009, the BLM Glenwood Springs Field Office is known as the Colorado River Valley Field Office, located in Silt, Colorado. For the purposes of the RFDS, it will be referred to under its previous name.
3.0 Description of Geology

3.1 Geologic Setting
The discussion on geologic setting for the WRNF brings forward the general geologic setting, and then provides more specific information on areas where the geology is favorable for oil and gas to occur, such as in the Piceance Basin.

General Geologic Setting
The general geologic setting for the WRNF is condensed from Toth et al. (1993). The geologic history extends over nearly 2 billion years. Sedimentary and volcanic rocks accumulated on the southern margin of the Wyoming craton and were metamorphosed by granitic intrusions 1.7 billion years ago. Almost a billion years later, a thick sequence of sediments deposited in shallow seaways during the Paleozoic Era (570 to 225 million years ago (mya)) buried these basement rocks. Erosion of lower and middle Paleozoic-aged rocks and mountain building during the Late Paleozoic created two highland areas and an intervening basin, the Eagle Basin, which accumulated sediments and evaporites.

Erosion and sedimentation continued through the Mesozoic Era (225 to 65 mya), with inland seas advancing and retreating across the area and depositing marine and nonmarine sediments. The Laramide Orogeny during the Late Cretaceous and early Tertiary periods (about 65-50 mya) resulted in mountain building and the retreat of the seas. Erosion and sedimentation eventually smoothed the mountainous terrain, creating an extensive, relatively flat erosion surface. Granitic intrusions during the Laramide Orogeny, and related volcanic activity were sporadic until as recently as 8 million years ago.

Mountain-building activity in the Tertiary resulted in the formation of several highlands, and several basins, which contain the Paleozoic and Mesozoic hydrocarbon (i.e. oil and gas) source and reservoir rocks of interest today. A portion of the WRNF lies on the White River Uplift, a geologic and topographic high. The basins include the Piceance Basin, in the western portion of the WRNF, and the Middle Park Basin on the eastern edge of the WRNF. Almost all past and current oil and gas activity on the WRNF has occurred in the Piceance basin.

A period of climatic cooling resulted in glaciation that began about 500,000 years ago in the Pleistocene and continued into the Holocene. The flat erosion surface was gouged and worn away by glacial erosion, forming the present day rugged alpine topography with deep U-shaped valleys.

Piceance Basin
The following is an excerpt from the Grand Junction FO RFDS (Hartman and Elser, etal., 2010). Any references cited are included in the text of that document.

The Piceance Basin of Colorado is oriented northwest-southeast and is about 100 miles long and 50 to 90 miles wide, and is bounded on the northeast by the Axial Basin Arch, on the east by the White River Uplift and Grand Hogback, on the southeast by the Elk Mountains, and on the south by the Uncompahgre Uplift. The Douglas Creek Arch separates the Piceance Basin from the Uinta Basin to the west. The Eagle Basin is a structural feature located east of the Piceance Basin and Grand Hogback (the Eagle Basin has low potential for oil and gas to occur).

Exposed bedrock in the Piceance Basin consists of sedimentary units ranging from Upper Cretaceous (late Mesozoic, about 100 mya) to Middle Eocene (early Cenozoic, about 45 mya) in age. Bedrock is exposed on dissected uplands, cliffs, and hogbacks. Outcrops include (in ascending order of age) the Mancos Shale, the Mesaverde Group, Wasatch Formation, Green River Formation, and Uinta Formation. The
Mesaverde Group is divided into the Iles Formation (including Rollins, Corcoran, and Cozzette sandstone members) and the overlying, massively stacked, lenticular non-marine Williams Fork Formation (including the Cameo Coal Zone). Historically, most of the natural gas produced on the WRNF is from the Mesaverde Group, primarily from the Cozzette and Corcoran sandstones. More recently, the Williams Fork and Cameo Formations have also contributed production.

The Wasatch Formation and Mesaverde crop out along valley slopes, and the Mancos Shale is exposed in the valleys below the Mesaverde outcrop (generally outside the Forest boundary). The sequence of buried sedimentary rocks (which overlie Precambrian igneous and metamorphic rocks in the subsurface) include (in ascending order) the Chinle Formation, Wingate Sandstone, Kayenta Formation, Entrada Sandstone, Wanakah Formation, Morrison Formation, Burro Canyon Formation, Dakota Sandstone, Mancos Shale (which in this area includes the Niobrara Formation), the Mesaverde Group, Wasatch Formation, and Green River Formation.

The sedimentary rocks in the Piceance Basin generally dip to the north-northeast at about 200 to 300 feet per mile. The basin is asymmetrical and deepest along its east side near the White River Uplift, where more than 20,000 feet of sedimentary rocks are present. Within the basin are numerous high-angle, small displacement faults, and elongated anticlines and synclines. Structural dips are very steep to overturned along the eastern part of the basin (Grand Hogback); elsewhere in the basin, dips range between 1 and 20 degrees. Outcrops of Eocene and Paleocene age strata (Uinta, Green River, and Wasatch formations) dominate the surface exposures within the basin, with rocks of the Mesaverde Group and Mancos Shale occurring around the edges. In the structurally deepest parts of the basin, rocks of the Mesaverde Group are buried up to 4,000 ft below sea level (Johnson and Roberts, 2003).

Hydrocarbon (i.e. oil and natural gas) source rocks in the basin include coal beds and associated organic-rich carbonaceous shale rocks of the Upper Cretaceous Mesaverde Group. These rocks were deposited along the margins of the Western Interior Cretaceous Seaway in swamps and marshes associated with a deltaic and coastal plain environment. The thickest coals are found in the Cameo coal zone, which overlies the marine and marginal-marine sandstone successions in the lower part of the Mesaverde Group. Net coal thickness ranges from 20 to 80 feet. Gas expelled from coals and carbonaceous shales is interpreted as having migrated into nearby low-permeability sandstone beds of the Mesaverde Group, initiating basin-centered gas accumulations (Johnson and Roberts, 2002). The vertical migration of gas also expanded into the producing reservoir rocks of the overlying Tertiary Wasatch Formation. Peak gas generation from coals and carbonaceous rocks occurred about 47 million years ago (Johnson and Roberts, 2002). Other source rocks include the Mancos Shale, the source for gas migration into the reservoirs which occur in the lower part of the Mesaverde Group (Iles Formation). Gas migrated from the Mancos into the nearby fluvial, tidal, shoreface, and off-shore sandstone reservoirs of the Dakota Sandstone, Corcoran, Cozzette, and Rollins Sandstone Members of the Iles Formation.

The two main types of hydrocarbon traps within the sandstones of the Iles Formation are closed anticlinal structures and basin-centered accumulations (Brown and others, 1986). The anticlinal structures include Divide Creek, Coal Basin, and Wolf Creek. Hydrocarbon seals are the overlying unfractured marine shale tongues of the Mancos Shale. The Rollins is water wet with minimal production, and the lack of a good seal (overlying coals) allowed hydrocarbons to escape (Kirschbaum, 2002). The marine regressive limits (strandlines) of the Corcoran and Cozzette blanket reservoirs are oriented along a northeast-southwest trend in the southeast portion of the basin, which defines the stratigraphic pinchout of these units. Because the Dakota Sandstone is classified as tight, it is generally considered a continuous gas accumulation, sealed by the overlying Mancos Shale.

**Figure 3** is a stratigraphic column that shows the relationships among the rock units in the Piceance Basin portion of the WRNF where oil and gas activity is currently occurring, and projected to occur. The
column identifies organically rich (i.e. hydrocarbon bearing) rocks that are the primary sources of natural gas and oil, along with the units that constitute the primary reservoirs for natural gas and oil in the subsurface of the WRNF.

3.2 Oil and Gas Assessment Provinces
Since 2002, the USGS has been reassessing domestic oil and natural gas resources in a series of priority basins to meet the requirements of the Energy Policy and Conservation Act (EPCA) of 2000. These assessments of undiscovered oil and gas resources use a Total Petroleum System (TPS) approach. In this approach, the assessment unit (AU) is the basic appraisal unit (rather than the oil and gas play used in previous studies). A TPS is a mappable entity that encompasses genetically related accumulations of petroleum. An AU is a mappable volume of rock that contains hydrocarbon accumulations with shared geologic traits. Several AUs may be mapped within a single TPS. A play is a set of known or postulated oil and gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration pathway, timing, trapping mechanism, and hydrocarbon type. A play may differ from an assessment unit; an assessment unit can include one or more plays. The results of the National Assessment of Oil and Gas are available online (NOGA Online) at: http://energy.cr.usgs.gov/oilgas/noga/.

The NFS lands administered by the WRNF are included in portions of three USGS oil and gas assessment provinces. The Geologic Provinces, Total Petroleum Systems, Assessment Units and Plays occurring on the WRNF are shown on Figures 5 and 6, and discussed further below.

3.2.1 Uinta-Piceance Province (Province 20)
This province trends west-east, extending from the thrust belt in north-central Utah, on the west, to the southern Park Range and Sawatch Uplift in central Colorado on the east. This Province encompasses the Uinta and Piceance Basins in Utah and Colorado. The WRNF contains lands in both the southern and northern Piceance Basin.

Numerous oil and gas plays have been discovered in the Uinta and Piceance Basins. According to the USGS, about 99% of the undiscovered gas resource within the Uinta-Piceance Province is continuous, meaning an accumulation consisting of areally extensive reservoirs of petroleum not necessarily related to conventional, structural or stratigraphic traps, is distributed in the Mesaverde TPS and Mancos/Mowry TPS (Figure 5). Other hydrocarbon resources are found in the Phosphoria TPS and Green River TPS.

WRNF lands in the southern Piceance Basin (in the BLM Glenwood Springs and Grand Junction FO areas) fall principally in the Mesaverde TPS, including the Mesaverde Continuous Gas AU and Mesaverde Transitional Gas AU; and the Mancos/Mowry TPS Transitional and Migrated Gas AUs, all of which have tight gas plays. The WRNF also contains lands in the Mesaverde Coalbed Natural Gas AU, Phosphoria-Paleozoic/Mesozoic Conventional AU, and the Phosphoria-Hanging Wall Conventional AU.

Specific gas plays of interest on WRNF lands in the southern Piceance Basin include the Mesaverde Play which includes production from lenticular fluvial channel sandstones of the Williams Fork Formation and the marine shoreface sandstones of the Iles Formation in the Mesaverde Continuous Gas and Transitional Gas AUs, and the Niobrara Play in the Mancos/Mowry Transitional and Migrated Gas AUs, and the Mesaverde Coalbed Natural Gas Play. Developed structures that produce from the Mesaverde TPS on the WRNF are the Divide Creek and Wolf Creek anticlines. The Colorado Oil and Gas Conservation Commission (COGCC) recognize three fields on the WRNF: the Divide Creek, Wolf Creek, and Hells Gulch fields (see Figure 6). No productive wells have been drilled in the WRNF outside of the southern Piceance Basin.
Potential for coalbed natural gas (CBNG) in the Mesaverde Coalbed Natural Gas Play is expected to occur on WRNF lands that overlap both the Glenwood Springs and Grand Junction FO areas on the Rifle and Sopris Ranger Districts. The primary source of CBNG is the Cameo Coal Zone in the Williams Fork Formation, where coal seams occur at depths in less than about 5,500 feet. This area was assessed to have potential by the USGS where coalbeds lie within 7,000 feet of the surface. Some of the previous attempts to produce coal bed gas in the southern part of the Piceance Basin were abandoned because of high water and low gas production. Other CBNG wells contained little water, but were not very productive with respect to gas. There has been an overall lack of progress in resolving problems related to commercial production of CBNG. However, this play has the potential for new discoveries of CNBG. Future production may result largely from recompleting existing gas wells after depletion of the gas resource in associated sandstone reservoirs (Conrath and O’Mara, 2008).

The WRNF lands lying in the northern Piceance Basin (within the BLM Little Snake FO and White River FO areas) are in the Mesaverde TPS, however they lie outside the Mesaverde Play in that area. No productive wells have been drilled in the WRNF in the northern Piceance Basin. Additionally there is no exploration or development activity currently occurring in the northern Piceance portion of the WRNF.

Detailed information on the geology, geologic provinces, assessments units and gas plays in the Piceance Basin portions of the WRNF can be found in the Glenwood Springs FO RFDS (Conrath and O’Mara, 2008), pages 3 to 17, and Maps 2 to 15; the White River FO RFDS (Hendricks and Leschack, 2007) pages 9 to 19; and the Grand Junction FO RFDS (Hartman and Elser, etal, 2010) pages 8 to 17.

3.2.2 Southwestern Wyoming Province (Province 37)
The Southwestern Wyoming Province, also referred to as the Southwestern Basins of Wyoming, Colorado, and Utah is located in the Rocky Mountain Foreland. It is an irregularly shaped area that is a composite of several basins and adjacent uplifts in Wyoming, Colorado, and Utah. The Southwestern Wyoming Province approximates the outline of the Greater Green River Basin in southwestern Wyoming, northwestern Colorado, and northeastern Utah. The southeastern extent of the Greater Green River Basin in Colorado encompasses substantial portions of Moffat and Routt Counties and small portions of Rio Blanco, Garfield, and Eagle Counties and is bounded by the Axial Basin Uplift on the west and the Park Range on the east.

The White River FO RFDS references this area as the Greater Green River Basin. A small portion of the WRNF also lies within this basin. This small portion of the Greater Green River Basin is characterized by relatively low hydrocarbon potential, extremely sparse well control, very few existing oil and gas leases, and has had an absence of drilling activity in the last 50 years. Therefore, the resource potential was not considered in the White River FO RFDS, and thus it is not considered in the WRNF RFDS.

More information on the geology, geologic provinces, and assessments units and gas plays in the Greater Green River Basin portion of the WRNF can be found in the White River FO RFDS (Hendricks and Leschack, 2007) pages 9 to 19.

3.2.3 Park Basins Province (Province 38)
This province includes all Jackson, Grand, Summit, Eagle, Gilpin, Clear Creek, and Park counties in Colorado. The BLM Kremmling FO falls within the portions of this province in Jackson, Grand, Summit, and the northeastern corner of Eagle County. Much of the province consists of Precambrian granitic and igneous intrusive rocks unlikely to contain significant quantities of hydrocarbons. Areas prospective for hydrocarbons are the north-south-trending Laramide-age structural basins of North, Middle, and South Park, as well as the Blue River Valley. All of the Park Basins Province’s current commercial production of oil, gas, and carbon dioxide (CO2) comes from structural and combination traps in the faulted basin-margin anticlines of North Park Basin in Jackson County. The WRNF lands within the Park Basins
Province lie in portions of Middle Park Basin, and the southeastern portion of the ancient Eagle Basin cored with crystalline rocks, where little exploration for oil and gas has occurred and no production has been established (Holm 1992). According to the USGS online national oil and gas assessment, the Park Basins Province can be described as a mature petroleum province. It is reasonable to expect further discoveries in small traps that are difficult to evaluate without drilling due to the complex structures of the province. Additional detailed information on the Park Basins Province can be found in the Kremmling FO Draft RFDS, pages 9 to 14.

### 3.2.4 Other Lands

Portions of the WRNF lie on the White River Uplift and in the Eagle Basin. The White River uplift is a geologic and topographic high which lies mostly outside the provinces evaluated by the USGS. This area was part of the ancient Eagle depositional basin. The Grand Hogback separates the White River Uplift from the Piceance Basin to the southwest (Holm 1992), and the Eagle Basin from the Piceance Basin. There are no oil and gas plays identified east of the Grand Hogback.

The White River Uplift has relatively low potential for the occurrence of economic accumulations of oil or gas. Similarly, the area east of the Grand Hogback, which includes the Eagle Basin, has medium to no known potential for oil and gas, and has no present oil and gas drilling or production. The basin has low potential for the discovery of economic oil accumulations due to very high thermal maturity of most Paleozoic rocks, and the presence of only small areas containing younger rocks with oil source beds.

The Kremmling FO Draft RFDS indicates that the Middle Park basin has not been included in a USGS Assessment of Undiscovered Oil and Gas Potential, nor was it included in the EPCA Phase 1 or 2 studies. No oil and gas production has occurred in Middle Park Basin in the past 20 years. The portion of the Middle park basin WRNF NFS lands falls in areas of low or no known potential for oil and gas occurrence. More information on the geology, geologic provinces, and assessments units and gas plays in the Middle Park Basin portion of the WRNF can be found in the Draft Kremmling FO RFDS (June 2008), pages 9 to 20.
4.0 Past and Present Oil and Gas Activity

4.1 Geophysical and Geochemical Surveys
Limited geophysical and geochemical exploration survey information involving Federal surface in the WRNF over the last 20 plus years is available. The following information is based on the records available at the Glenwood Springs Energy Office. File records indicate the permitting for two surface shot and port-a-drill seismic projects on the Sopris Ranger District were permitted in November of 1987 with one of them being extended into 1988. Three separate port-a-drill seismic projects were also permitted on the Rifle Ranger District in June through November of 1990 and implemented during those same months by ORYX Energy Company. An additional port-a-drill seismic project was permitted and implemented on the Rifle Ranger District in May and June of 1991 by Mobil Oil Company. As far as the records indicate, there has been no geochemical survey work done on the WRNF. There currently is no geophysical or geochemical survey work permitted or proposed on the WRNF.

4.2 Leasing Activity
Prior to the 1987 Federal Onshore Oil and Gas Leasing Reform Act (Leasing Reform Act), the USGS Conservation Division, and subsequently, the BLM was responsible for oil and gas leasing on the WRNF. The Leasing Reform Act provided the Forest Service certain responsibility and authority for leasing, and subsequent to that Act and implementing regulations in 1990 (36 CFR 228 Subpart E), the WRNF analyzed lands for leasing and made approximately 950,000 acres available for oil and gas leasing in the 1993 Oil and Gas Leasing Record of Decision (Figure 1). In 2002, the WRNF published its 2002 Land and Resource Management Plan (LRMP) – 2002 Revision and accompanying FEIS analysis. The 2002 LRMP adopted the 1993 oil and gas leasing decision without changes, except that certain areas were made unavailable for leasing because of wild and scenic river designations, or were recommended for wilderness. The majority of WRNF lands with high oil and gas occurrence potential and historical development are on the Rifle and Sopris Ranger Districts, in the BLM Glenwood Springs FO area.

As of December 2009, there were 143 oil and gas leases on WRNF lands on the encompassing about 132,738 acres (see Figures 2 and 4), the majority of these leases are in the southern Piceance Basin, located south of Interstate 70. The 143 leases represent 14 percent of the land available for leasing forest-wide.

Fifty-three (53) leases (about 38,552 acres) are held by production (HBP), meaning they have at least one well with producing quantities on lease or within a group of unitized leases. The leases held by production are also located in the southern Piceance Basin, and all are within a Federal oil and gas unit (See section 4.3).

Expressions of interest for 42 potential oil and gas lease parcels on the WRNF have been submitted by industry to the BLM for consideration. The majority of the lands nominated for lease lie on the Rifle Ranger District within the southern Piceance Basin. A few nominations are on the Blanco Ranger District in the northern Piceance Basin and the Greater Green River Basin. No leases or pending lease requests are present in other areas of the forest.
4.3 Oil and Gas Units and Storage Areas
Unitized areas (units) and areas used for gas storage on the WRNF are shown on Figure 4 and are described below. All the units and agreement areas are within the boundaries of the Glenwood Springs FO. There are no units or storage areas on the WRNF within the boundaries of other BLM field offices. Table 2 summarizes the number, type and production history of wells on NFS surface within each of the units discussed here. Additional discussion on wells is given in Section 4.4.

4.3.1 Divide Creek Unit
The Divide Creek Unit is on the Rifle Ranger District in Garfield and Mesa counties. Development in the Divide Creek Unit began 1955. It contains 36 leases, upon which 22 wells were drilled on NFS surface. The existing development contains facilities, a water disposal well, and gas production wells.

4.3.2 Wolf Creek Storage Area
The Wolf Creek Storage Area lies southwest of Carbondale, Colorado on the Sopris Ranger District in Mesa and Pitkin Counties. The original producing gas field was converted to a storage area in June 1972, and supplies natural gas to Glenwood Springs and other communities in the Roaring Fork Valley. Gas from local production wells is injected and stored in the Mesaverde Group sandstones during low-demand months (typically May through October), and extracted for distribution to local communities during peak demand months (typically November through April).

The Wolf Creek Storage Area consists of 11 leases, with 7 gas injection wells (both active and inactive), 3 monitoring wells, gas gathering pipelines, and ancillary surface equipment. The wells associated with the storage area have been active since 1966 when the wells were originally drilled for production of natural gas. As the wells were becoming depleted, the storage potential of the field was identified, and the field was put to use for gas storage.

Injection and extraction of the natural gas associated with the storage unit averages between 1 to 1.5 BCFG (billion cubic feet of gas) per year. The working storage capacity of the storage area is 3.0 BCFG with a reserve capacity of 7.4 BCFG. The storage area is critical for the reliable distribution of natural gas to retail customers primarily within Pitkin and Garfield counties. Only natural gas that has been processed, and meets appropriate gas specifications for retail delivery is stored in the Wolf Creek Storage Area.

4.3.3 Willow Creek Unit
The Willow Creek Unit is located just southeast of the Divide Creek Unit in Mesa and Pitkin Counties on the Rifle Ranger District. The Willow Creek Unit includes 7 leases and has 2 gas production wells, 1 undeveloped pad, and a gathering line installed.

4.3.4 Orchard, Twin Creeks, Hunter Mesa and Middleton Creek Units
The Orchard Unit, located on the Rifle Ranger District in Mesa County includes 7 leases, and currently has no activity occurring on NFS lands.

The Twin Peaks Unit lies coincident with the Wolf Creek storage area on the Sopris Ranger District in Mesa and Pitkin Counties. The unit contains 11 leases, and there is no development associated with this unit.

The Hunter Mesa Unit includes 6 leases and lies on the Rifle Ranger District in Garfield and Mesa Counties. There is currently no surface disturbance associated with this unit on NFS lands.
The Middleton Creek Unit includes 8 leases on the Rifle Ranger District in Mesa and Garfield Counties. There is currently no surface disturbance associated with this unit on NFS lands.

More detailed descriptions the units and storage areas are found in the Glenwood Springs FO RFDS, pages 17-22.

4.4 Past and Present Drilling and Development Activity

Exploration and development activity on the WRNF has occurred intermittently over the past 70 years since the first well was drilled on the south side of the Rifle Ranger District in 1939. The current development is primarily on the Rifle Ranger District with a portion on the Sopris Ranger District, on lands that overlap with the BLM Glenwood Springs FO (Figure 2). There is no current development on the WRNF overlapping lands of other BLM field offices.

Queries of the BLM’s AFMSS database, the official record for federal wells, followed by an on-the-ground verification completed in August 2008 and updated in February 2009 by the Glenwood Springs Energy Office, found that 42 well pads with 82 individual wells exist on the WRNF. The wells and drill pads include facilities that produce gas, are used for gas injection, water injection and monitoring wells (Table 2). Of the 82 total wells, 62 are gas production wells. The following sections provide additional information, geographic location and well status data for the 82 wells.

The cyclical nature of the oil and gas industry best describes the history of oil and gas development on the WRNF. Between 1956 and 1993, 32 wells were drilled from 31 pads in the Wolf Creek Storage Area and Divide Creek Unit (Glenwood Springs Energy Office, 2009). In the 1990s and 2000’s, 49 wells were drilled from 9 drill pads in the Willow Creek Unit, and in the Hell’s Gulch Development area (includes Hell Gulch North (Phases I and II), and Hell’s Gulch South development areas). There is currently no development in the Orchard Twin Peaks, Hunter Mesa or Middleton Creek Units. No exploration or development drilling has occurred on surface managed by the WRNF since 2008.

Exploration and production activity has also occurred in other non-unitized areas in West Mamm Creek, East Divide Creek, Cache Creek and Beaver Creek all on the Rifle Ranger District within the Glenwood Springs FO area. One well pad was constructed in the East Mamm Creek development area; however a well has not yet been drilled.

4.4.1 Drilling and Development on the WRNF in the BLM Glenwood Springs Field Office Area

According to the BLM Glenwood Springs FO RFD, drilling and production activity increased markedly in the BLM Glenwood Springs FO between 2000 and 2008 compared with the decades prior to the year 2000. Specific drilling and production activity on the WRNF occurred in the late 1950s to mid-1960s, again in the late 1980s, and most recently since about 2005. Between 2002 and 2009, 73 wells have been drilled either on or to targets beneath the WRNF. No new activity has occurred on surface managed by the WRNF since 2008. Since the early 1990s, all wells drilled on the WRNF have been exclusively in the southern Piceance Basin area (Rifle Ranger District, BLM Glenwood Springs FO area). No wells have been drilled in other areas of the forest in the past 16 years.

Most wells in the southern Piceance Basin involve the drilling of multiple directional wells from a single well pad. The success rate for wells in the area has been greater than 90 percent, meaning that more than 90 percent of all the wells drilled have been completed for production. More than 90 percent of the wells in the BLM Glenwood Springs FO areas are producing from fluvial channel sandstone reservoirs of the Williams Fork Formation (part of the Mesaverde TPS). Coalbed gas development from the Cameo coal zone is occurring on a limited basis in the Divide Creek Field. Most of the wells are being drilled within
existing fields due to decreased spacing. Multiple wells (as many as 22 or more per pad) are being drilled from new and existing locations. Few wildcat wells are being drilled (Glenwood Springs FO RFD).

Table 2. Summary and Status of Oil and Gas Production and Other Wells by Unit, Storage Area, or Development Area on the WRNF. The majority of activity is occurring in the Divide Creek Unit and the Hells Gulch development area. Production values by unit are shown where applicable.

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>County</th>
<th>Well Status</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ABD</td>
<td>WDW</td>
</tr>
<tr>
<td>Divide Creek Unit</td>
<td>Garfield, Mesa</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>Wolf Creek Storage Area</td>
<td>Mesa, Pitkin</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Willow Creek Unit</td>
<td>Mesa, Pitkin</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Orchard Unit</td>
<td>Mesa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Twin Creeks Unit</td>
<td>Garfield</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hunter Mesa</td>
<td>Garfield, Mesa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Middleton Creek Unit</td>
<td>Garfield, Mesa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hell’s Gulch Development Area³</td>
<td>Mesa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>East Mamm Creek</td>
<td>Mesa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Grand Junction (GJFO)</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>White River (WRFO) and Little Snake (LSFO)</td>
<td>N/A</td>
<td>Moffat, Rio</td>
<td>0</td>
</tr>
<tr>
<td>Kremmling (KFO)</td>
<td>N/A</td>
<td>Eagle, Summit</td>
<td>0</td>
</tr>
<tr>
<td>Total Wells by Status</td>
<td>9</td>
<td>1</td>
<td>6</td>
</tr>
</tbody>
</table>

NA= Not applicable
1Well status abbreviations from AFMSS are as follows: ABD = abandoned, WDW=water disposal well, GIW=Gas injection well, GSI=Gas shut in, MW=monitoring well, PGW=producing gas well, TA=temporarily abandoned.
²Cumulative annual production since 1988, data current as of October 2009.
³Includes Hells Gulch North Phase 1 and Phase 2 (Lease COC-66918) and Hells Gulch South Project Areas (Lease-COC66724)
⁴Cumulative annual production since 2004, data current as of October 2009
Source for well information: BLM Automated Fluid Minerals System.
4.4.2 Drilling and Development on the WRNF in the BLM Grand Junction Field Office Area
There are currently no historical wells, producing wells, or permits on the WRNF within the boundaries of the BLM Grand Junction FO.

4.4.3 Drilling and Development on the WRNF in the BLM White River Field Office (White River FO) and Little Snake Field Office (Little Snake FO)
In the portion of the BLM White River FO overlapped by the WRNF, nine wells have been drilled on the north portion of the WRNF Blanco Ranger District. All of these wells were drilled before 1970, tested for oil, and then plugged and abandoned.

A very small portion of the Greater Green River Basin occurs in the easternmost part of the BLM White River FO area and adjoining Little Snake FO. Two wells were drilled and abandoned in this area within the Little Snake FO.

Discussion of the NFS lands in the BLM White River and Little Snake FO boundaries is in the White River FO RFDS, pages 19-22.

4.4.4 Drilling and Development on the WRNF in the Kremmling Field Office Area
There are currently no historical wells, producing wells, or permits on the WRNF in this area as no drilling activity has occurred in these areas in the past 20 years (Kremmling FO Draft RFDS, page 27).

Discussion of the NFS lands in the BLM Kremmling FO boundary is found in the Kremmling FO Draft RFDS, pages 20-33.

4.5 Oil, Gas and Water Production History
Historically, oil and gas development activity on the WRNF has occurred on the southern part of the Rifle and western portion of the Sopris Ranger Districts in the southern Piceance Basin. Consequently, the oil, gas and water production discussion from the BLM Glenwood Springs FO RFDS (Conrath and O’Mara, 2008) is applicable to this area.

The Glenwood Springs FO RFDS states that gas production from wells in the field office area is principally from the Mesaverde Group and Wasatch Formation (Conrath and O’Mara, 2008, page 25). On the scale of the whole Glenwood Springs FO area, wells producing from the Mesaverde Group had cumulative gas production of 1.37 TCFG (95.4% of the total), while the Wasatch Formation had produced 66.06 BCFG (4.6% of the total). Rate versus time for production of gas, oil, and water from the Mesaverde Group in the Glenwood Springs FO area is illustrated in Figures 7 through 9 (data used to generate the production curves were retrieved from IHS Petroleum Information (PI)/Dwights Plus® Rocky Mountain Release November 27, 2006)3. The slight dip toward the end of each production curve reflects a partial year’s production. The upward trend of these curves reflects a steady increase in production since the late 1980s due to an increase in wells drilled in response to increasing demand, higher prices, and advances in drilling and completion technology.

Specific to production from wells on the WRNF, production is coming principally from fluvial channel sandstones in the Mesaverde Continuous Gas AU. In recent years, the majority of the gas production on the WRNF has been from the Divide Creek and Hells Gulch fields. Prior to the 1970s, production also occurred from the Wolf Creek field, which as previously mentioned is now used as a storage area. Since 1988, approximately 41,756 thousand cubic feet of gas (MCFG), and about 67,675 barrels of oil (bo) produced.

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3 These data are the most recent trend data available.
have been produced from production wells on the WRNF (see Table 2). This represents about 3 percent (3%) of the cumulative gas production from Mesaverde Group wells in the Glenwood Springs FO over a similar timeframe. Oil production from wells on the WRNF represents about 6 percent (6%) of the cumulative production of oil from wells administered by the Glenwood Springs FO. The Wasatch Formation has production from it in parts of the Glenwood Springs FO, however there are no wells producing from the Wasatch Formation on the WRNF.

Gas production wells on the WRNF produced about 8.6 million barrels of water (bw) since 1988. Comparing data from 2005, water production from the WRNF presented about 2 percent (2%) of the total water production from Mesaverde wells administered by the Glenwood Springs FO.

There is currently no production occurring from the Mancos/Mowry Transitional and Migrated Gas AUs, the Mesaverde Coalbed Natural Gas AU, Phosphoria-Paleozoic/Mesozoic Conventional AU, or the Phosphoria-Hanging Wall Conventional AU on the WRNF. No production is occurring from lands within the boundaries of other BLM Field Offices.

Figure 8. BLM Glenwood Springs FO area Mesaverde gas production history. Data is the most recent trend data available.
Figure 9. BLM Glenwood Springs FO area Mesaverde oil production history. Data used is the most recent trend data available.

Figure 10. BLM Glenwood Springs FO area Mesaverde water production history. Data used is the most recent trend data available.
5.0 | Oil and Gas Occurrence Potential

The occurrence potential describes the likelihood of encountering hydrocarbon-bearing rocks. An oil and gas occurrence potential map for the WRNF is based on data and information in the existing RFDSs (Figure 7). High occurrence potential areas are delineated in the western portion of the WRNF (Rifle Ranger District) in the southern Piceance Basin portion of Uinta-Piceance Province. These high potential areas include about 176,230 acres of NFS lands in the Glenwood Springs FO area, and about 4,970 acres of NFS lands in the Grand Junction FO area. A small portion of the WRNF (Blanco Ranger District) in the White River FO area in the northern Piceance Basin portion of Uinta-Piceance Province, and in the Little Snake FO area in the Southwestern Wyoming Province (Greater Green River Basin) also has high oil and gas occurrence potential.

Areas of moderate potential occur in the extreme northern portion of the Blanco Ranger District in the Little Snake and White River FO areas in northern Piceance Basin, on a small portion of the western edge of Parks Basins Province (Middle Park Basin) on the Dillon Ranger District in the Kremmling FO area, and on small portions of the southeastern Rifle and western Sopris Ranger Districts in the Glenwood Springs FO area.

Areas of low potential occur on western and northern edges of the Rifle and Blanco Ranger Districts in the northern Piceance Basin in the White River FO area, over most of the Sopris Ranger District in the southern Piceance Basin in the Glenwood Springs FO area, and on the Dillon Ranger District in the Parks Basin Province in the Kremmling FO area. The remaining areas are delineated as having an occurrence potential of none.

The largest part of the WRNF with high potential for oil and gas occurrence overlaps with the western portion of the Glenwood Springs FO area and the southeastern portion of the Grand Junction FO in the southern Piceance Basin. Recent USGS estimates of gas resources in the Piceance Basin approach 300 TCFG. The Glenwood Springs RFD estimates that the lands in the high potential area of the Glenwood Springs FO (outside the Roan Plateau area) in the southern Piceance Basin contain upwards of 40.3 trillion cubic feet of gas (TCFG). A portion of this gas occurs in the Mesaverde continuous tight gas play that underlies the WRNF, particularly in the stacked, lenticular sands of the Williams Fork and Iles Formations (part of the Mesaverde TPS and tight gas play). This type of gas resource is typical of the resources currently being developed in the active gas fields on the WRNF, and on adjacent BLM and private lands in the Rulison, Parachute, and Grand Valley fields. Additional information can be found on page 34 of the Glenwood Springs FO RFDS (Conrath and O/Mara, 2008). An additional portion of this gas is also projected to occur in the Mesaverde Coalbed Natural Gas AU on WRNF lands overlapping with the Grand Junction FO area.

New geologic information and interpretive methods imparted some changes to the evaluation of occurrence potential since the first RFDS was prepared for the WRNF in 1993. Notable differences are that the area around the Blue River Valley on the Dillon Ranger District on eastern edge of the WRNF in the Kremmling FO area went from high potential to low potential, and some areas of no potential became low. An area in the northeast and eastern portion of the Rifle Ranger District in the Glenwood Springs FO area went from no potential to low, and from medium to low. Other smaller variations also occurred based on specific information considered in the existing RFDSs from the various BLM FOs.

Additional information on oil and gas occurrence potential can be found on pages 30-36 of the Glenwood Springs FO RFDS, pages 22 and 23 of the White River FO RFDS, on pages 46-50 of the Draft Kremmling FO RFDS, and on pages 27-28 of the Grand Junction FO RFDS.
6.0 Oil and Gas Development Potential

Potential for development of oil and gas resources on the WRNF is presented in the following sections, each of which summarizes relevant information from the specified BLM field office RFDS. Development potential is expressed in terms of estimated projections of wells, and production where available. The assumptions made by BLM when making these projections are presented in Section 7.0. Additional information for the WRNF lands in the Rifle and Sopris Ranger Districts is presented on pages 36-40 of the Glenwood Springs FO RFDS. Additional information for WRNF lands on the Rifle Ranger District in the Grand Junction FO area can be found on page 31 of the Grand Junction FO RFDS. Additional information for WRNF lands in the Blanco Ranger District in the White River FO area can be found on pages 23-35 of the White River FO RFDS. Additional information for WRNF lands on the Dillon Ranger District in the Kremmling FO area can be found on page 50 of the Draft Kremmling FO RFDS.

6.1 Oil and Gas Development Potential Summary

The drilling projection for the WRNF for the next 20 years (until about 2029) is projected to be between 903 and 1,014 oil and gas wells. The vast majority of this activity is projected to occur on the high oil and gas potential areas of the Rifle and Sopris Ranger Districts in the southern Piceance Basin in the BLM Glenwood Springs and Grand Junction FO areas. A much lower level of drilling activity is projected for low to medium occurrence potential areas of the Rifle and Sopris Ranger Districts and in the low to high occurrence potential areas of the Blanco Ranger District.

The development projected to occur on the WRNF in the area of the BLM Glenwood Springs FO area accounts for 872 wells. The projection includes 694 new Mesaverde wells in currently leased areas, and 150 new wells in unidentified reservoirs in currently un-leased areas. The projection also includes 28 new wells in the Niobrara play in currently leased areas (Conrath and O’Mara, 2008).

Development projected to occur on the WRNF in the BLM Grand Junction FO area, accounts for between 31 and 132 wells overall. The projection includes between 25 and 110 new wells in the Mesaverde conventional play, and between 6 and 22 coalbed natural gas wells (Hartman and Elser, etal, 2009).

Development projected to occur on the WRNF in the BLM White River FO area accounts for up to 10 new wells. This projection is based on a simple assumption that up to 1% of the total projected number of wells elsewhere on the Forest (Rifle and Sopris Ranger Districts) would be drilled in areas with oil and gas potential on the Blanco Ranger District. Given the entrepreneurial nature of the oil and gas industry, existing leases in the area, and a limited drilling history on this portion of the Forest, this assumption is reasonable. Should drilling occur, it would likely first target those areas identified as medium to high occurrence potential.

No drilling activity is projected for the foreseeable future in any other area of the WRNF.

The WRNF has experienced a low level of geophysical activity over the past 20 years and it is reasonable to assume this low trend to continue into the foreseeable future. Geophysical activities result in low intensity, temporal surface disturbance to about 1% of a given project area. Contractors, where possible, must stay on existing roads and trails, and use helicopters when needed to avoid steep slopes and other sensitive areas. Much of the access for work is done on foot and or by ATV.

More detailed information on projected development by each BLM FO is given below.
6.2 Oil and Gas Development Potential on the WRNF Rifle and Sopris Ranger Districts in the BLM Glenwood Springs FO Area

According to the BLM Glenwood Springs FO RFD, oil and gas development in the field office area, including lands administered by the WRNF, is expected to continue and even increase, in the areas that are currently being developed (i.e. south of Interstate 70 Divide Creek in Hells Gulch, Mamm Creek, etc). Infill and step-out drilling in areas of proven reserves is anticipated to constitute the majority of future activity. Some activity may also occur in these areas in other currently undeveloped plays, such as the Niobrara. The WRNF north of Interstate 70 has low to no known potential for oil and gas occurrence, and consequently there is no activity wells projected for this area in the next 20 years.

BLM estimates that 99 percent (99%) of projected drilling will occur in areas mapped as having high potential for the occurrence of oil and gas resources. Approximately 1 percent (1%) of future drilling activity is projected to occur in areas of medium and low potential, and no drilling activity is projected in areas mapped as having no known potential. This development potential distribution corresponds well with existing oil and gas field locations, identified USGS plays, and plans of operators in the area (pages 36 and 37 of the Glenwood Springs FO RFDS). In addition, areas that are currently leased are believed to have the greatest development potential. The areas mapped as having medium and low occurrence potential have few leases, indicating low industry interest at the present time.

The Glenwood Springs FO RFD projected the amount of development activity based on the number of wells needed to drain known oil and gas reservoirs, and incorporates the assumption that multiple well pads will be used in the FO area. The BLM estimates 40.3 trillion cubic feet of gas (TCFG) exist in high potential areas (excluding the Roan Plateau) in the field office, including the 176,231 acres WRNF lands. These reserves lie principally in the Mesaverde TPS (continuous tight gas play). Assuming ten-acre (10-acre) bottom hole density will be required to drain gas from the Mesaverde because of the relatively continuous nature of gas resources in the area, an estimated 17,623 wells would be needed to deplete the gas resources from this high potential area on the WRNF. However, information obtained by BLM from principal operators and current lessees in the area led BLM to project 872 wells on this part of the WRNF over the next 20 years because of accessibility challenges in the more rugged forest terrain, restrictive stipulations on existing leases, and uncertainty about rules on access in Inventoried Roadless Areas (Conrath and O’Mara, 2008, p. 34-37).

Of the 872 wells projected for WRNF lands in the Glenwood Springs FO, 694 would target the Mesaverde play, 150 would target unspecified reservoirs in currently unleased areas, and 28 would target the currently undeveloped Niobrara play. The 872 projected wells would be drilled from 132 well pads, including 123 multi-well pads and 9 single-well pads. The Glenwood Springs FO RFD did not specify separate numbers of exploration or production wells, therefore all are assumed to be production wells. A typical Mesaverde well has an estimated ultimate recovery (EUR) of 1.15 billion cubic feet of gas (BCFG), thus the EUR for 694 projected Mesaverde wells on the WRNF would be 798 BCFG (Conrath and O’Mara, 2008, pages 39-40).

The wells are projected to be gas wells (both coalbed natural gas and natural gas), and some of the natural gas wells will have associated natural gas fluids (condensate) and, in some cases, the gas wells will produce water. However, over time and with an increase in exploring marginal USGS plays, some primary oil wells may also be developed.

Gas resource estimates for other formations are not available. More precise estimates will be possible after additional drilling and completions take place in these underexplored formations. On WRNF lands, the BLM projection calls for development in the Niobrara Formation, which holds promise for future oil and gas discoveries.
6.3 Oil and Gas Development Potential on the WRNF Rifle Ranger District in the BLM Grand Junction FO Area

The BLM Grand Junction FO Draft RFD projected development activity by township within the FO area, based on location in a USGS delineated TPS and proximity to existing development. The projection is presented in ranges of activity assigned to areas where there is very high, high, moderate or low potential for development to occur (Hartman and Elser, etal, 2009).

About 4,970 acres of the WRNF, Rifle Ranger District lies in the Grand Junction FO area. This area lies in areas projected to have very high and high potential for conventional oil and gas development, and high to moderate potential for CBNG development (Hartman and Elser, etal, 2009, pages 58 and 59).

Using percentages of WRNF acres within a township in a certain potential development area, the number of wells is projected as shown in Table 3.

![Table 3. Projected Wells by Well Type and Development Potential on the WRNF in the Grand Junction Field Office Area. Between 25 and 110 conventional natural gas wells, and between 6 and 22 coalbed natural gas wells are projected in areas of very high, high and moderate development potential.](image)

The BLM Grand Junction FO Draft RFD did not differentiate between exploration and production wells, therefore all wells were assumed to be production wells. No projected production values were included; however for the purposes of this RFDS, it was assumed that conventional natural gas wells would produce similarly to others in the Piceance Basin as reported in the Glenwood Springs FO RFDS with an EUR of 1.15 BCFG. Under this assumption, projected production from the 22 to 110 conventional wells would be between 25.3 to 126.5 BCFG.

Likewise, projected production values for coalbed natural gas wells were not specified, therefore for the purposes of this RFDS, it will be assumed that coalbed natural gas wells would produce about 0.5 BCFG. (Szymanski, Personal Communication 2010) Using these values, projected production from coalbed natural gas wells on the WRNF could range between 3 and 11 BCFG.

6.4 Oil and Gas Development Potential on the WRNF Blanco Ranger District in the BLM White River and Little Snake FO Areas

Based on the BLM’s analysis, “extremely limited” exploration and development activity is projected on the WRNF Blanco Ranger District in the White River and Little Snake FO areas (northern Piceance Basin and White River Uplift) during the next 20 years (Hendricks and Leschak, 2007, pages 27-28). The majority of this part of the forest is on the White River Uplift with low to no known potential for oil and gas occurrence. The northernmost and a sliver of the northeastern parts of the District are on the southwestern edge of the Greater Green River Basin (Southwest Wyoming Province), and the
northeastern periphery of the Piceance Basin. These areas have limited moderate to high potential for oil and gas occurrence, but little to no drilling (none on the forest) has occurred in these areas since 2004, and there currently is little interest expressed in the area. Well control is extremely sparse, and no substantive hydrocarbon production has been established to date. Consequently, up to 10 wells are projected for this part of the WRNF. Given the low number of wells and the speculative nature of drilling in this part of the Forest, no production estimate is included in this report, but for analysis purposes, it should be assumed that some of these wells might be productive.

6.5 Oil and Gas Development Potential on WRNF Dillon Ranger District in the BLM Kremmling FO Area

Lands on the WRNF (Dillon Ranger District) in the BLM Kremmling FO area have low to no recognized potential for oil and gas occurrence, and consequently no wells are projected on this part of the forest in the next 20 years. The northeastern portion of this part of the forest is in the Park Basins Province, with two identified oil and gas plays. Crude oil and natural gas resources have long been known to exist in the geologic North Park and Middle Park Basins, portions of which are on the WRNF. However, past exploration has not been successful in establishing production in this area. No wells are projected on NFS lands in the Kremmling FO area in the next 20 years due to the low potential for oil and gas occurrence, lack of success of past drilling, and low interest in the area.
7.0 RFD Baseline Scenario Assumptions and Discussion

The following are assumptions used by BLM Glenwood Springs FO and Grand Junction FO in preparing development projections for those existing RFDSs. As these are the FOs on which most development activity is projected, only those assumptions are included here. Specific references include pages 40-49 in Conrath and O’Mara, 2008; and page 31 of Hartman and Elser, et al, 2009.

Assumptions Used by Glenwood Springs FO in Development Projections

- Productive areas are open under standard lease terms and conditions.
- Multiple wells from a single pad will continue to be the trend.
- Most wells will be drilled directionally.
- The development tendency will be to drill infill wells and expand on existing fields before moving into lesser known areas.
- Oil and gas prices will increase over the life of management plans. Price range examined for RFDS was from 2002 to 2007 and ranged from $2.00/MMBtu and $14.00/MMBtu. The current price posting at the time the RFDS was prepared was $7.50/MMBtu (Conrath and O’Mara, 2008, pages 27 and 28).
- Assume 98% success rate for new wells.
- The EUR for Mesaverde wells will be 1.15 BCFG, and development will occur on 10-acre bottom hole spacing.

Assumptions Used by Glenwood Springs FO in Surface Disturbance Projections

- Ninety-nine percent (99%) of the projected wells would occur in high potential areas, and are projected to be drilled from multi-well pads on an average of 7 wells per pad. Of the projected 872 wells for the WRNF, an estimated 863 of them would be in high potential areas and would be developed under the assumption that 7 wells would be drilled from each well pad. This translates to 123 projected well pads for the 863 wells. The remaining one percent (1%) or 9 wells are projected in areas of low and moderate potential, and are projected to be drilled from single well pads, equating to 9 pads.
- Average pad size during drilling is 6 acres. The 6 acres per drill pad takes into consideration cut-and-fill slopes and disturbance activity outside the pad boundary needed to maneuver heavy equipment and on lease transmission lines and pipelines. After drilling is completed on a single well pad, interim reclamation would reduce the pad size by 2.5 acres (42% reclamation factor).
- Wells will be drilled from existing locations where possible and existing roads and facilities will be used where possible.
- Average disturbances for the Glenwood Springs FO are 6 acres for a drill pad and 9 acres for the access road to each drill pad.
- Any additional offsite or central facilities required for compressors, dehydrators/separators, liquid storage or injection, and metering facilities would be constructed on private surface. (Note: For
In this report, it is assumed that the aforementioned facilities could be located on the WRNF, but given the relatively small number and small footprint of centralized facilities, it is also assumed that associated surface disturbance is included in the overall disturbance projections for oil and gas activity.

Further discussion on these assumptions is given on pages 46 to 48 of the Glenwood Springs FO RFDS.

**Assumptions Used by Grand Junction FO in Development Projections**

- For conventional development, future activity was categorized into five distinct categories based on the anticipated number of wells (individual wellbores, not well locations) to be drilled per township during the planning period.

  Very High Potential: 500 or more wells per township  
  High: 100 to 499 wells per township  
  Moderate: 40 to 99 wells per township  
  Low: 3 to 39 wells per township  
  Very Low: less than 3 wells per township  
  None: No anticipated drilling activity during the planning period

- With respect to CBNG activity, the following categories were used:

  High: 100 or more wells per township  
  Moderate: 20 to 99 wells per township  
  Low: 2 to 19 wells per township  
  Very Low: less than 2 wells per township  
  None: No anticipated drilling activity during the planning period

- Average density of fields in the five different development potential categories:

  Very high development potential:  
  Developed predominately using multi-well pads  
  4 pads per square mile (144 per township)  
  Downhole spacing between 10 and 40 acres per well

  High development potential:  
  Developed with a mixture of single and multi-well pads  
  Up to 4 pads per square mile (144 per township)  
  Downhole spacing between 40 and 320 acres per well

  Moderate and Low development potentials:  
  Developed principally with single well pads  
  Up to 4 pads per square mile  
  Variable downhole spacing depending on target

  Very low development potential:  
  Developed with single well pads  
  Up to 2 pads per square mile  
  Variable downhole spacing depending on target
• U.S. natural gas prices will average $7.00/mcf for the next five years, and will average between $6.00 and $8.00/ mcf in the long-term (to 2025), and are expected to rise from $5.73 per thousand cubic feet (2007 dollars) in 2009 to $8.39 per thousand cubic feet in 2030 (Hartman and Elser, etal, 2009, page 23).

Assumptions Used by the Grand Junction FO in Surface Disturbance Estimations
• Very High – 500 or more wells per township: These areas would predominately be developed with multi well pads at an average of 4 pads per square mile. Downhole spacing density will range from 10 to 40 acres per well. These areas will be developed using an average of eight wells per pad.

• High – 100 to 499 wells per township: These areas would predominately be developed with a mixture of single and multi well pads. Well pad density would not exceed an average of 4 pads per square mile. Downhole spacing density will range from 40 to 320 acres per well. These areas will be developed using an average of three wells per pad.

• Moderate – 40 to 99 wells per township: These areas would be developed with single well pads with well density not exceeding an average of 4 pads per square mile. Downhole spacing density will range from 40 to 320 acres per well.

• Low – 3- 39 wells per township: These areas would be developed with single well pads with well density not exceeding an average of 4 wells per square mile.

• Very Low – less than or equal to two wells per township: These areas would be developed with single well pads with well density not exceeding two wells per square mile.

<table>
<thead>
<tr>
<th>Development potential</th>
<th>Average initial disturbance (acres/pad)</th>
<th>Long term disturbance (acres/pad)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>5.4</td>
<td>1.5</td>
</tr>
<tr>
<td>High and Moderate</td>
<td>4.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Low and Very low</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

• Typical road widths of a total 24 foot disturbed area with an 18 foot running surface equating to 6.5 acre surface disturbance per section.

• Pipelines would be run parallel to the access roads, 50’ average pipeline ROW widths and full reclamation occurring at time of installation.
8.0 Existing and Future Surface Disturbance from Oil and Gas Activity

Existing surface disturbance related to projected oil and gas activity on the WRNF includes estimations of disturbance associated with past (historic) activity where wells have been drilled and continue to be on the landscape. Interim and final reclamation figures are not available for historic and existing surface disturbance.

Future disturbance is presented in terms of initial acres disturbed, less interim reclamation, giving long-term disturbance. The future disturbance accounts for all wells projected according to assumptions made in the specific BLM RFD.

8.1 Existing Surface Disturbance

The Glenwood Springs Energy Office prepared a summary of existing surface disturbance associated with well pads, wells, and other facilities that are currently active on the WRNF in the BLM Glenwood Springs FO area. This area, on the Rifle and Sopris Ranger Districts, is the only area on the WRNF that has had, and presently has oil and gas development. According to this summary, 82 existing wells located on a total of 42 well pads (including co-located facilities), roads (including co-located pipelines) and pipelines existed on the ground as of December 2009. Seven (7) of the existing well pads are multi-well pads, and all other existing well pads are single well pads. Wells include those completed for gas production, gas injection and monitoring.

Existing disturbance from well pads, roads, pipelines, and other facilities was measured on the ground by GPS and laser range finder methodologies. The existing disturbance is estimated to affect 196 acres on over 176,231 acres with development potential. There is no existing disturbance in any other area of the WRNF. Table 4 presents historic and current surface disturbance from oil and gas activity.

<table>
<thead>
<tr>
<th>Unit or Development Area</th>
<th>Well Pads</th>
<th>Pad Disturbance</th>
<th>Access Road Disturbance</th>
<th>Pipeline Disturbance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glenwood Springs (GSFO)</td>
<td>Number</td>
<td>Acres</td>
<td>Acres</td>
<td>Acres</td>
<td>Acres</td>
</tr>
<tr>
<td>Divide Creek Unit</td>
<td>22</td>
<td>29</td>
<td>13</td>
<td>52</td>
<td>94</td>
</tr>
<tr>
<td>Wolf Creek Storage Area</td>
<td>10</td>
<td>9</td>
<td>8</td>
<td>35</td>
<td>52</td>
</tr>
<tr>
<td>Willow Creek Unit</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Hell’s Gulch Development Area¹</td>
<td>6</td>
<td>23</td>
<td>6</td>
<td>7</td>
<td>36</td>
</tr>
<tr>
<td>East Mamm Creek</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total by Component</strong></td>
<td>42</td>
<td>69</td>
<td>31</td>
<td>96</td>
<td></td>
</tr>
</tbody>
</table>

¹Includes Hell’s Gulch North Phase 1 and 2, and Hell’s Gulch South project areas.

Source: Field data gathered by Glenwood Springs Energy Office in 2008 and 2009 by field GPS and laser range finder techniques.

8.2 Projected Future Surface Disturbance

Projected future disturbance estimates for the Rifle and Sopris Ranger Districts were based on assumptions in the Glenwood Springs and Grand Junction FO RFDSs, since they cover the parts of the WRNF on which the majority of activity is projected (see Sections 7.2 and 7.4). These estimates of future disturbance are associated with the well projections presented in Sec. 6.0 Oil and Gas Development Potential.
For projected development in the Glenwood Springs FO area, estimated disturbance projections include well pads, access roads (including co-located pipelines), production facilities and pipelines. Data presented include gross disturbance (including both temporary and long-term), reclamation (including both interim and final), and net disturbance (gross disturbance minus reclamation). Interim reclamation occurs following construction of a well pad and completion of its use for drilling operations. Interim reclamation reduces the disturbed footprint to the amount needed for ongoing production and periodic work-over operations. Final reclamation occurs after a pad no longer has producing wells and after a road is no longer needed for access to a wells site. Table 5a summarizes the projected future surface disturbance for WRNF lands in the Glenwood Spring FO area. Additional discussion on the assumptions and estimation of surface disturbance are given in the Glenwood Springs FO RFDS, pages 46 to 48.

Table 5a. Estimated Surface Disturbance Projections of Future Oil and Gas Activity (Baseline) on the WRNF in the Glenwood Springs FO Area.

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
<th>Acres per Site</th>
<th>Acres Initial Disturbance</th>
<th>Acres Interim Reclamation</th>
<th>Long Term (Net) Acres Disturbance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Glenwood Springs FO area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well Pads – High Potential Area</td>
<td>123¹</td>
<td>6</td>
<td>738</td>
<td>310⁴</td>
<td>428</td>
</tr>
<tr>
<td>Well Pads – Moderate and Low Potential Area</td>
<td>9²</td>
<td>4</td>
<td>36</td>
<td>23⁵</td>
<td>13</td>
</tr>
<tr>
<td>Access Roads, Facilities, Gathering Lines, Utility Corridors</td>
<td>132³ (miles)</td>
<td>9³</td>
<td>1,188</td>
<td>784⁶</td>
<td>404</td>
</tr>
<tr>
<td>Central Facilities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>1,962</td>
<td>1,117</td>
<td>845</td>
</tr>
</tbody>
</table>

¹ Pad in high potential area assume 7 wells per pad. 863 wells projected in high potential areas. 863 ÷ 7 wells per pad = 123 pads.
² Pad in moderate or low potential area assume 1 well per pad. 9 wells projected in moderate or low areas. 9 ÷ 1 well per pad = 9 pads.
³ Estimates from Glenwood Springs FO RFDS; average of 1 mile of road per pad (Conrath and O'Mara 2008).
⁴ Assumes 2.5 acres of original 6 acres is reclaimed (42% reclamation factor). 762 gross acres x .42 = 320 interim reclamation acres.
⁵ Assumes 2.5 acres of original 4 acres is reclaimed (63% reclamation factor). 36 gross acres x .63 = 23 interim reclamation acres.
⁶ Assumes ROW corridor reduced from 75' to 25'.

Long Term (Net) Acres Disturbance = acres initial (gross) disturbance minus acres interim reclamation.

For projected development in the Grand Junction FO area, estimated disturbance projections include well pads, access roads, production facilities and pipelines located in a right-of-way adjacent to roads. The Grand Junction FO presented the data in terms of initial disturbance, and long-term disturbance, the difference being acreage reclaimed as part of interim reclamation. For purposes of this document, these data are presented as gross and net disturbance acres for consistency with the Glenwood Spring FO approach. Table 5b summarizes the projected future surface disturbance for WRNF lands in the Grand Junction FO area. Additional discussion on the assumptions and estimation of surface disturbance are given in the Grand Junction FO RFDS, pages 33 to 35.
Table 5b. Estimated Surface Disturbance Projections of Future Oil and Gas Activity (Baseline) on the WRNF in the Grand Junction FO Area.

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
<th>Acres per Site or Section</th>
<th>Acres Initial (Gross) Disturbance</th>
<th>Acres Interim Reclamation</th>
<th>Long Term (Net) Acres Disturbance ¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grand Junction FO area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well pads – conventional, very high potential area</td>
<td>1</td>
<td>5.4</td>
<td>5.4</td>
<td>1.5</td>
<td>4</td>
</tr>
<tr>
<td>Well pads – conventional, high potential area</td>
<td>7 - 37</td>
<td>4.5</td>
<td>32 – 167</td>
<td>10.5 – 55.5</td>
<td>22 - 112</td>
</tr>
<tr>
<td>Well pads – CBNG, high potential area ²</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Well pads – CBNG, moderate potential area ³</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Roads</td>
<td>8 sections</td>
<td>6.5</td>
<td>52</td>
<td>0</td>
<td>52</td>
</tr>
<tr>
<td>Pipelines</td>
<td>8 sections</td>
<td>17.5</td>
<td>140</td>
<td>140</td>
<td>0</td>
</tr>
<tr>
<td>Central Facilities</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>GJFO Total</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>230 - 365</td>
<td>152 - 197</td>
<td>78 - 168</td>
</tr>
</tbody>
</table>

Total Projected Disturbance From Tables 5a and 5b (values rounded)

| Table 5a GSFO | N/A | N/A | 1,962 | 1,117 | 845 |
| Table 5b GJFO | N/A | N/A | 230 - 365 | 152 - 197 | 78 - 168 |
| **TOTAL** | N/A | N/A | 2,192 – 2,327 | 1,269 – 1,314 | 923 – 1,013 |

¹ Assumes CBNG wells would be co-located with pads developed for conventional wells.
² Assumes 2.9 linear miles of road per section, at 6.5 acres disturbance per section
³ Assumes pipelines would be run parallel to the access roads, 50’ average pipeline ROW widths, 2.9 linear miles per section, and full reclamation occurring at time of installation.
⁴ Long Term (Net) Acres Disturbance = acres initial (gross) disturbance minus acres interim reclamation.
⁵ Assumes disturbance associated with production facilities is included in overall disturbance estimates for pads, roads, and pipelines.

For projected development in the White River FO area, estimated disturbance projections include well pads, access roads, production facilities and pipelines located in a right-of-way adjacent to roads. The White River FO RFD contained sparse information on surface disturbance, so assumptions of disturbance are made similar to those for the other BLM RFD’s utilized in this report. For purposes of this document, these data are presented as gross and net disturbance acres for consistency with the Glenwood Spring FO approach. Table 5c summarizes the projected future surface disturbance for WRNF lands in the White River FO area. Additional discussion on the assumptions and estimation of surface disturbance are given in the White River FO RFDS, pages 36 to 38.
Table 5c. Estimated Surface Disturbance Projections of Future Oil and Gas Activity (Baseline) on the WRNF in the White River FO Area.

<table>
<thead>
<tr>
<th>Component</th>
<th>Number</th>
<th>Acres per Site</th>
<th>Acres Initial (Gross) Disturbance</th>
<th>Acres Interim Reclamation</th>
<th>Long Term (Net) Acres Disturbance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>White River FO area</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well Pads, Facilities – Moderate and Low Potential Area</td>
<td>0 - 10¹</td>
<td>4</td>
<td>0 - 40</td>
<td>0 - 25³</td>
<td>0 - 15</td>
</tr>
<tr>
<td>Access Roads, Gathering Lines, Utility Corridors</td>
<td>0 - 10² (miles)</td>
<td>0 - 9³</td>
<td>0 - 90</td>
<td>0 - 60⁴</td>
<td>0 - 30</td>
</tr>
<tr>
<td>Total</td>
<td>N/A</td>
<td>N/A</td>
<td>0 - 130</td>
<td>0 - 85</td>
<td>0 - 45</td>
</tr>
<tr>
<td><strong>Total Projected Disturbance From Tables 5a and 5b (values rounded)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 5a GSFO</td>
<td>N/A</td>
<td>N/A</td>
<td>1,962</td>
<td>1,117</td>
<td>845</td>
</tr>
<tr>
<td>Table 5b GJFO</td>
<td>N/A</td>
<td>N/A</td>
<td>230 - 365</td>
<td>152 - 197</td>
<td>78 - 168</td>
</tr>
<tr>
<td>Table 5c WRFO</td>
<td>N/A</td>
<td>N/A</td>
<td>0 - 130</td>
<td>0 - 85</td>
<td>0 - 45</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>N/A</td>
<td>N/A</td>
<td>2,192 – 2,457</td>
<td>1,269 – 1,399</td>
<td>923 – 1,058</td>
</tr>
</tbody>
</table>

¹Assumes each well will be drilled on individual 4 acre pad.
²Assumes one mile of road per pad
³Assumes 75-foot ROW
⁴Assumes 2.5 acres of original 4 acres is reclaimed (63 % reclamation factor). 36 gross acres x .63 = 23 interim reclamation acres.

Table 6 summarizes the existing disturbance and projected future surface disturbance. Table 7 provides a summary of estimated projections of disturbance and wells by geographic area.

Table 6. Existing and Estimated Projected Future Surface Disturbance on the WRNF.

<table>
<thead>
<tr>
<th>Component</th>
<th>Existing Disturbance Acres (from Table 4)</th>
<th>Estimated Future Long term (Net) Disturbance Acres (from Tables 5a, 5b and 5c)</th>
<th>Existing + Estimated Future Disturbance Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Pads</td>
<td>69</td>
<td>467 - 572²</td>
<td>536 - 641</td>
</tr>
<tr>
<td>Road and Pipeline</td>
<td>127¹</td>
<td>486</td>
<td>613</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>196</td>
<td>953 – 1,058</td>
<td>1,149 – 1,254</td>
</tr>
</tbody>
</table>

¹Value equals gross access road+ gross pipeline from Table 4 (31+96=127)
²Value equals net acres all pads.
Table 7. Estimated Future Surface Disturbance Projections by WRNF Ranger District, BLM Field Office, and Geologic Province on the WRNF.

<table>
<thead>
<tr>
<th>FS Ranger District / BLM Field Office / Geologic Province</th>
<th>Projected Wells by Occurrence Potential</th>
<th>Projected Pads by Type</th>
<th>Projected High Potential Net Pad Disturbance (Acres)</th>
<th>Projected Moderate / Low Potential Net Pad Disturbance (Acres)</th>
<th>Projected Road, Gathering Line, Utility Net Disturbance (Acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rifle/Sopris RD – Glenwood Springs FO / Uinta-Piceance</td>
<td>863 (high) 9 (mod/low)</td>
<td>123^2 (multi-well) 9 (single-well)</td>
<td>428^2</td>
<td>13^2</td>
<td>404</td>
</tr>
<tr>
<td>Total</td>
<td>872^2</td>
<td>132</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rifle RD – Grand Junction FO / Uinta-Piceance (conventional)</td>
<td>3 (very high) 22 to 110 (high)</td>
<td>8 – 37 (multi-well)</td>
<td>26 -116</td>
<td>0</td>
<td>52</td>
</tr>
<tr>
<td>Rifle RD – Grand Junction FO / Uinta-Piceance (CBNG)</td>
<td>1 (high) 5 – 22 (mod)</td>
<td>0^4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>31 - 132^2</td>
<td>8 - 37</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blanco RD – White River FO and Little Snake FO / Uinta-Piceance and Southwestern Wyoming</td>
<td>0 – 10 (mod/low) 0 - 10 (single well)</td>
<td>0</td>
<td>0 - 15</td>
<td>0 - 30</td>
<td>0</td>
</tr>
<tr>
<td>Dillon RD – Kremmling FO / Park Basins</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>903 – 1,014</td>
<td>140 - 179</td>
<td>454 - 544</td>
<td>13 - 28</td>
<td>456 - 486</td>
</tr>
<tr>
<td>Total Estimated Net Surface Disturbance (acres)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>923 – 1,058</td>
</tr>
</tbody>
</table>

^1Includes 694 Mesaverde, 28 Niobrara and 150 wells in undeveloped reservoirs.

^2Value from Table 5a.

^3All wells projected in Mesaverde TPS

^4Assumes that CBNG wells would be drilled from same pads as conventional wells, therefore no additional pads.
9.0 References


10.0 | Statement of Qualifications

This report was prepared by Kathy Wilkerson, a former Forest Service minerals specialist who worked 19 years for the agency in the Rocky Mountains. She holds a B.S. in Geology from Stanford University and also successfully completed extensive mineral examiner training at the BLM National Minerals Training Center. She has previous experience preparing RFDS analyses for the Forest Service and performing NEPA analyses for oil and gas leasing, exploration, and development. She has been a consultant for more than 10 years, providing NEPA and upstream oil and gas services to a wide range of federal and non-federal clients.


The existing RFDS were prepared by BLM personnel in various field offices in Colorado. Their qualifications are included in the applicable RFDSs listed in Section 9.0, References.

Finally, the report was reviewed and accepted by the Bureau of Land Management, Colorado State Office as noted on page 2.
11.0 | Figure Appendix

Figure 1 Lands Available for Oil and Gas Leasing on the WRNF .............................................A-1

Figure 2 Existing Oil and Gas Wells and Leases on the WRNF ....................................................A-2

Figure 3 Stratigraphic Column of the Piceance Basin...................................................................A-3

Figure 4 Existing Oil and Gas Leases and Units on the WRNF ....................................................A-4

Figure 5 TPS/ Play Boundaries......................................................................................................A-5

Figure 6 Geologic Provinces and Oil and Gas Fields on the WRNF .............................................A-6

Figure 7 Oil and Gas Occurrence Potential....................................................................................A-7
12.0 | Glossary of Selected Terms

Definitions of some terms used in this document are included here. Other terms used are defined in the glossaries for the existing RDFSs, references for which are listed in Section 9, References, of those documents and are not repeated here.

**Assessment Unit (AU).** A mappable volume of rock within a total petroleum system that encompasses accumulations (discovered and undiscovered) that share similar geologic traits and socio-economic factors. Accumulations within an assessment unit should constitute a sufficiently homogeneous population such that the chosen methodology of resource assessment is applicable. A total petroleum system might equate to a single assessment unit. If necessary, a total petroleum system can be subdivided into two or more assessment units in order that each unit is sufficiently homogeneous to assess individually. An assessment unit may be identified as conventional, if it contains conventional accumulations, or as continuous, if it contains continuous accumulations.

**Field.** The general area which is underlaid or appears to be underlaid by at least one pool; and “field” shall include the underground reservoir or reservoirs containing oil or gas or both. The words “field” and “pool” mean the same thing when only one underground reservoir is involved; however, “field”, unlike “pool”, may relate to two or more pools. (Source: Colorado Oil and Gas Conservation Commission, Definitions for Series 100 Rules and Regulations).

**Play.** The phase in the development of a petroleum system during which hydrocarbons migrate into and remain trapped in a reservoir. A set of known or postulated oil and gas accumulations sharing similar geologic, geographic, and temporal properties, such as source rock, migration pathway, timing, trapping mechanism, and hydrocarbon type. A play may differ from an assessment unit; an assessment unit can include one or more plays.

**Reservoir Rock.** A connected layer of porous rock, such as sandstone or carbonates, containing varying amounts of oil, gas, and/or water, based on variations in permeability, porosity, and water saturation.

**Tight Gas Play.** A form of unconventional natural gas in which the gas that is stuck in a very tight formation underground, trapped in unusually impermeable, hard rock, or in a sandstone or limestone formation that is unusually impermeable and non-porous (tight sand).

**Total Petroleum System (TPS).** A mappable entity encompassing genetically related petroleum that occurs in seeps, shows, and accumulations (discovered or undiscovered) which have been generated by a pod or by closely related pods of mature source rock, together with the essential mappable geologic elements (source, reservoir, seal, and over-burden rocks) that controlled fundamental processes of generation, migration, entrapment, and preservation of petroleum.

**Source Rock.** Rocks, such as coal, carbonaceous shale, or shale which provide the source for gas generation and subsequent migration into reservoir rocks.
Figure 1: Lands Available for Oil and Gas Leasing
Figure 2: Existing Oil and Gas Wells and Leases
Figure 3: Stratigraphic Column

Figure 3. Stratigraphic Column. Depositional and stratigraphic framework of the Piceance Basin. Source: Author Unknown.
Figure 4: Existing Oil and Gas Units, Areas, and Leases
Figure 6: Geologic Provinces and Oil and Gas Fields
Figure 7: Oil and Gas Occurrence Potential