UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

WYOMING STATE OFFICE

RESERVOIR MANAGEMENT GROUP

FINAL

Reasonable Foreseeable Development Scenario for Oil and Gas, Royal Gorge Field Office, Colorado

March 22, 2012

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REASONABLE FORESEEABLE DEVELOPMENT SCENARIO FOR OIL AND GAS ROYAL GORGE FIELD OFFICE, COLORADO

Dakota sandstone cliffs at brink of canyon and light colored sandstone of Purgatoire formation on middle slopes. Las Animas County, Colorado. 1912(USGS photographic library).

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INTRODUCTION

The Colorado Bureau of Land Management Royal Gorge Field Office has determined the need to update their Resource Management Plan. The Bureau of Land Management, Wyoming State Office, Reservoir Management Group (the authors of this report) was asked to help by preparing a detailed Reasonable Foreseeable Development Scenario for the next twenty years (2011-2030 or the Planning Period. Compiled herein is resource information on the potential magnitude and trend of future oil, gas, and coalbed natural gas activity for the Field Office staff to use in the preparation of their Resource Management Plan update. The location of the Royal Gorge Field Office (hereinafter the Planning Area) is shown on Figure 1. In addition, we were asked to provide oil, gas, and coalbed natural gas projections for those parts of the Planning Area that are within certain air quality non-attainment areas (hereinafter the AQNAAs). The Royal Gorge Planning Area and AQNAAs are shown on Figure 2. The Greater Wattenberg Field area lies within the largest AQNAA and when that area is discussed we will refer to it as the Greater Wattenberg AQNAA. The next largest non-attainment area straddles parts of Canon City, Colorado and will be referred to as the Canon City AQNAA. The smallest non-attainment area straddles parts of Lamar, Colorado and will be referred to as the Lamar AQNAA.

The authors recently completed two Reasonable Foreseeable Development analyses for the U.S. Department of Agriculture, Forest Service in southern parts of the Planning Area (Stilwell, *et al.*, 2011a and 2011b). We are bringing those projections made for oil and gas and coalbed natural gas development forward to include in our overall projection for the Planning Area. The areas studied for the Forest Service did not fall within the AQNAAs.

We would like to thank Ms. Cathy Stilwell of the Bureau of Land Management, Wyoming State Office, Reservoir Management Group staff for the important Geographic Information System contributions that she has made to this reasonable foreseeable development analysis. We would also like to thank Joe Rochelle (of the same office) for his contribution to our oil and gas prices section of the report. In addition we would like to thank Leslie Peterson, formerly of the Bureau of Land Management (Canon City), who provided assistance in preparing the development potential analysis. Tomas Kamienski, also with the Bureau of Land Management (Canon City), assisted in making surface disturbance assumptions.

OPERATOR INPUT

To aid our analysis of the Reasonable Foreseeable Development Scenario, we requested that operators active in the Planning Area (see Figure 1) provide their projections for the location and intensity of future oil, gas, and coalbed natural gas exploration and development activity for the 20-year Planning Period. We provided each operator a map of the Planning Area for their use (Figure 3). Operators were asked to mark townships with their projections of potential for oil and gas drilling activity on the map. Since the Forest Service had recently requested similar information from operators for certain lands

in and around the Pike and San Isabel National Forests and Cimarron and Comanche National Grasslands, those operators were not solicited again. Information previously obtained from those operators was included in this analysis. Operators were asked only for information concerning their own anticipated drilling plans, not for their estimations of future activity of the industry as a whole in the Planning Area.

We received written, e-mail, and/or verbal responses from 19 companies active in the Planning Area. Follow-up calls were made to some companies to further clarify their submittals. These companies account for the bulk of all oil, gas, and coalbed natural gas drilling in the Planning Area in recent history.

The companies responding to our request for information were:

- Anadarko Petroleum Corporation
- Bayhorse Petroleum LLC
- Chesapeake Energy
- Chaparral Energy LLC
- Dyad Petroleum Company
- El Paso E&P Company, L.P.
- Encana Corporation
- EOG Resources, Inc.
- K.P. Kauffman Company, Inc.
- Marathon Oil Company
- Mountain Petroleum Corporation
- Murfin Drilling Company, Inc.
- Noble Petroleum, Inc. (or Noble Energy, Incorporated)
- Omimex Resources, Inc.
- OXY USA Inc.
- Pine Ridge Oil & Gas, LLC/Comet Ridge Resources, LLC
- Pioneer Natural Resources USA, Inc.
- Rosewood Resources, Inc.
- Shell Frontier Oil & Gas, Inc.

As requested, responses appeared to be tied to each company's projections on areas and plays within the Planning Area where they had a specific interest in developing an existing productive area or exploring for new hydrocarbon resources. Based on the numbers provided and recent drilling trends within the Planning Area, most projections seemed to assume high oil prices, ample rig availability, and the ability to obtain necessary drilling budgets. Several operators, in the Greater Wattenberg Field area anticipate future activity will generally follow a pad-drilling program whereby a number of deviated wells are all drilled from the same surface location in areas where the spacing is tight. Pad drilling programs will be predominately tied to the Niobrara Formation play currently being developed in the northern parts of the Planning Area and where it is being explored in other parts of the Planning Area. Additional data on pad-drilling and directional and horizontal wellbores will be presented latter.

PUBLICATIONS

Information from the Colorado Oil and Gas Conservation Commission and IHS Energy PI/Dwight's well databases was used to examine recent patterns in drilling activity in the Planning Area. Electronic files of known oil, gas, and coalbed natural gas field boundaries were acquired from the Colorado Geological Survey and were also used in projecting where future activity would likely be concentrated.

Areas of drilling activity are first and foremost related to geology. Drilling will only occur where operators feel there is a likelihood of encountering hydrocarbons in the subsurface. The U.S. Geological Survey has extensively mapped the surface and subsurface geology of the United States and publishes such data in the form of geologic maps and reports. In addition to these products, the U.S. Geological Survey also publishes reports on their assessment of the oil and gas resource size and occurrence in major sedimentary basins (provinces) in the United States. Parts of seven U.S. Geological Survey provinces are partially within the Planning Area (Figure 4). These provinces are:

- Denver Basin Province (U.S. Geological Survey, 2003 and 2007a and Higley, 1996),
- Raton Basin-Sierra Grande Uplift Province (U.S. Geological Survey, 2005 and 2007b and Keighin, 1996a),
- Anadarko Basin Province (U.S. Geological Survey, 2011 and Henry and Hester, 1996),
- Park Basins Province (Wandrey, 1996),
- Las Animas Arch Province (Keighin, 1996b),
- Uinta-Piceance Basin Province (Spenser, 1996), and
- Albuquerque-Santa Fe Rift Province (Molenaar, 1996).

The Uinta-Piceance Basin and Albuquerque-Santa Fe Rift provinces lie on the western edges of the Planning Area and no potential resources were assessed in the Planning Area for either province.

The U.S. departments of Interior, Agriculture, and Energy (2003, 2006, and 2008) inventoried potential oil and gas resources in the onshore United States. Parts of their inventories cover portions of the Planning Area.

Recently, the exploration industry has begun emphasizing exploration and development of the Niobrara Formation in northern parts of the Planning Area. Most wells being permitted for drilling in these areas are targeting the Niobrara Formation. A new publication from the Rocky Mountain Association of Geologists (2011) surveys the Niobrara Formation. Niobrara biogenic gas in the northeastern part of the Planning Areas is reviewed by Kelso et al., (2006).

The large Wattenberg Field and surrounding fields are known as the Greater Wattenberg Field. This area north of Denver (Figures 6 and 7b) has had some of the greatest recent

drilling activity. Recent publications discussing this field are:

- Higley *et al*., (2003),
- Ladd (2001a and b),
- Hu and Simmons (2001),
- Birmingham *et al*., (2001), and
- Weimer *et al*., (1986).

For coalbed natural gas in the Raton Basin area, the paper by Carlton (2006) provides an updated summary of development that supplements the Raton Basin-Sierra Grande Uplift Province reports mentioned above.

HISTORICAL DRILLING DATA

A total of 55,256 wells have been spudded within the Planning Area (Colorado Oil and Gas Conservation Commission, 2012) as of February 21, 2012 (Figures 5a, 5b, and 5c). Fields established by historical drilling are shown in Figure 6. An additional 3,737 well locations have been permitted and are waiting to be drilled. There have also been 5,808 well locations that were permitted, but were then not drilled and their approval has expired. We consider that 26,259 wells (47.5 percent) are in an abandoned status and all disturbances associated with these wells are assumed to have been reclaimed. Present status categories of all wells that we consider to be abandoned are:

- Dry and Abandoned 17,493 wells,
- Plugged and Abandoned 8,743 wells,
- Abandoned Completion 3 wells, and
- Unknown 20 wells.

A total of 26,864 wells (48.62 percent of all wells) have been spudded within the Greater Wattenberg AQNAA as of February 21, 2012 (Figure 5b). More than 93 percent of these wells are located north of Denver, Colorado. In the Greater Wattenberg AQNAA an additional 2,567 well locations have been permitted and are waiting to be drilled. This is 68.69 percent of total permits for the Planning Area. We consider that 7,435 wells (27.65 percent) in the Greater Wattenberg AQNAA are in an abandoned status and all disturbances associated with these wells are assumed to have been reclaimed. Present status categories of all wells that we consider to be abandoned within the Greater Wattenberg AQNAA are:

- Dry and Abandoned 3,532 wells,
- Plugged and Abandoned 3,893 wells, and
- Unknown 10 wells.

In the Canon City AQNAA (Figure 5c) there are presently 17 wells in an abandoned status (15 wells dry and abandoned and 2 wells plugged and abandoned). There are no wells within the Lamar AQNAA.

Of the wells with available drill depths, 12,986 (38.92 percent) were drilled to a total vertical depth of less than 5,000 feet (HIS Energy Group, 2012). Between 5,000 and

10,000 feet 20,363 wells (61.04 percent) were drilled and only 13 wells (0.04 percent) exceeded 10,000 feet. The deepest well was drilled to 12,768 feet in township 10 south, range 75 east. The deepest vertical completion interval appears to have been from 9,508 to 9,556 feet and produced from the Dakota Formation.

Active Wells

Of the 55,256 wells spudded, there are 28,997 wells (52.5 percent) that we consider to be in an active status. There are active wells in the Greater Wattenberg and Canon City AQNAAs, but not in the Lamar AQNAA.

Some un-reclaimed disturbance is assumed to be associated with each well. Present status categories of all wells we consider to be still active are:

- Producing 27,161 wells,
- Active 208 wells,
- Injecting 245 wells,
- Domestic 23 wells,
- Temporarily Abandoned 273 wells,
- Shut In 871 wells,
- Waiting on Completion 188 wells, and
- Drilling 28 wells.

Fields with 25 or more active wells are shown on Figure 7a. Figure 7b labels the larger fields and Figure 7c shows the Florence-Canon City Field.

Thirty operators manage at least 100 active wells within the Planning Area. Eleven of the 30 operators are responsible for more than 300 wells each (Table 1a). Wells and the fields that each company operates in are also shown on Table 1a. These 11 operators account for 22,832 wells, or 78.74 percent of all active wells.

Noble Energy Incorporated operates the largest number of active wells, with 7,871 wells in 83 named fields. Pioneer Natural Resources USA Incorporated operates almost all their 2,399 wells in the Purgatoire Field (primarily a coalbed natural gas producing field in the Raton Basin, see Figure 7a). All of the 492 wells operated by XTO Energy Incorporated also are within Purgatoire Field. This field is in the southwestern part of the Planning Area (Figure 7a). Purgatoire Field produces gas secondarily from the Pierre Shale.

Nineteen companies operate 100 to 300 active wells each (Table 1b). These 19 operators account for 3,177 wells, or 10.96 percent of all active wells. The remaining 2,988 wells (10.3 percent of all active wells) are managed by 252 operators.

Active wells by county and percent of the total active wells are:

- Weld 17,922 wells (61.81 percent),
- Yuma 3,818 wells (13.17 percent),
- Las Animas 3,043 wells (10.49 percent),
- Adams 996 wells (3.43 percent),
- Washington 511 wells (1.76 percent),
- Cheyenne 415 wells (1.43 percent),
- Morgan 338 wells (1.17 percent),
- Boulder 308 wells (1.06 percent),
- Baca 253 wells (0.87 percent),
- Larimer 232 wells (0.80 percent),
- Logan 211 wells (0.73 percent),
- Arapahoe 179 wells (0.62 percent),
- Kiowa 128 wells (0.44 percent),
- Phillips 123 wells (0.42 percent),
- Broomfield 85 wells (0.29 percent),
- Fremont 84 wells (0.29 percent),
- Elbert 71 wells (0.24 percent),
- Lincoln 56 wells (0.19 percent),
- Denver 54 wells (0.19 percent),
- Huerfano 46 wells (0.16 percent),
- Bent 39 wells (0.13 percent),
- Prowers 32 wells (0.11 percent),
- Kit Carson 29 wells (0.10 percent),
- Sedgwick 12 wells (0.04 percent),
- Jefferson 8 wells (0.03 percent),
- El Paso 3 wells (0.01 percent) and
- Park 1 well (0.003 percent).

Three counties (Weld, Yuma, and Las Animas) account for 85.47 percent of all wells still active. Eleven counties each contain between 100 and 1,000 active wells (12.73 percent of all active wells). The remaining 13 counties each contain fewer than 100 active wells or 1.8 percent of total active wells.

There are 490 active wells located on Bureau managed oil and gas minerals and 53 wells located on Forest Service managed oil and gas minerals within the Planning Area.

Active Wells in Greater Wattenberg AQNAA

Of the 26,864 wells spudded in the Greater Wattenberg AQNAA, the remaining 19,429 wells (72.32 percent) not considered to be abandoned are considered to be in an active status, with some un-reclaimed disturbance associated with each well. The Greater Wattenberg AQNAA contains 67 percent of all the active wells within the Planning Area.

Present status categories of all wells we consider to be active are:

- Producing 18,770 wells,
- Active 59 wells,
- Injecting 65 wells,
- Domestic 4 wells,
- Temporarily Abandoned 38 wells,
- Shut In 407 wells,
- Waiting on Completion 72 wells, and
- Drilling 14 wells.

Fields with 25 or more active wells are shown on Figure 7a.

Twenty-four operators manage at least 50 active wells within the Greater Wattenberg AQNAA. Six of the 24 operators manage more than 250 wells each (Table 2a). Wells and fields that each company operates in are also shown on Table 2a. These six operators account for 15,700 wells, or 80.81 percent of all active wells in the Greater Wattenberg AQNAA.

Noble Energy, Incorporated operates the largest number of active wells, with 7,871 wells in 66 named fields. Kerr-McGee Oil & Gas Onshore LP operates 5,339 wells in 15 fields.

Eighteen companies operate 50 to 250 active wells each (Table 2b). These 18 operators account for 1,959 wells, or 10.08 percent of all active wells. The remaining 1,770 wells (9.11 percent of all active wells) are managed by 111 operators.

Active wells by county and percent of the total active wells are:

- Weld 17,619 wells (90.68 percent),
- Adams 996 wells (5.13 percent),
- Boulder 308 wells (1.59 percent),
- Arapahoe 179 wells (0.92 percent),
- Larimer 179 wells (0.92 percent),
- Broomfield 85 wells (0.44 percent),
- Denver 54 wells (0.28 percent),
- Jefferson 8 wells (0.04 percent), and
- El Paso 1 wells (0.01 percent).

There are 259 active wells located on Bureau managed oil and gas minerals and no wells located on Forest Service managed oil and gas minerals within the AQNAA.

Active Wells in Canon City AQNAA

Of the 21 wells spudded in the Canon City AQNAA, the 4 wells (19.05 percent) not considered to be abandoned are considered to be in an active status, with some un-

reclaimed disturbance associated with each well. Three wells are producing and one is classified as a domestic well. These wells are part of the larger Florence-Canon City Field (Figure 7c). There are no wells located on Bureau or Forest Service managed oil and gas minerals in this AQNAA.

Well Permits

There are presently 3,737 permitted yet undrilled well locations in the Planning Area (Figure 8a). Twenty operators have each filed more than 30 permits to drill new wells (Table 3). Wells permitted by each operator in each field are also shown on the table. These 20 operators have permitted 3,146 well locations in the Planning Area, or 84.19 percent of all permits. The remaining 591 permits are held by 102 additional companies.

Noble Energy, Incorporated has permitted the largest number of wells, with 1,080 permits in 20 named fields (Table 3). One hundred of their permits are for wildcat wells. In the Purgatoire River Field (Figure 7a) Pioneer Natural Gas Resources USA Incorporated has 97 permits, while XTO Energy, Incorporated has 26 permits and two other companies have one permit each.

At least 10 well locations have been permitted for 23 different fields. The Greater Wattenberg Field area (Figure 7b) contains the most permits with 2,119, or 56.7 percent of all permits. In the Purgatoire River Field (Figure 7a) 125 permits have been filed.

The remaining 21 fields with at least 10 permits contain fewer than 100 permits each. There are 451 permits in these 21 fields, or 11.8 percent of the total (Table 4a). See Figures 7a, 7b, and 7c for field locations.

Wildcat well permits (815 permits) account for 21.8 percent of all permits (Figure 8a). These are predominately located in the north part of the Planning Area. Most wells in these two areas are presently targeting the Niobrara Formation.

There are 64 permits (1.7 percent) spread across a number of unnamed fields in the Planning Area. In addition, operators have permitted fewer than 10 permits in 81 fields for a total of 173 permits, or 4.6 percent of total permits.

Active well permits of all types are shown by county in Table 4b. Weld County, where the Wattenberg Field is located, accounts for 74.04 percent of all permits. Table 4b also shows that more than 18 percent of Weld County permits are for wildcat wells, primarily located north and east of Wattenberg Field, where horizontal Niobrara zones are currently being explored. An additional 18.36 percent of permits are located in Yuma, Phillips, Las Animas, Lincoln, and Boulder counties. The remaining 7.6 percent of permits are spread across 21 counties.

Well Permits in AQNAAs

Operators have filed permits for 2,566 well locations in the Greater Wattenberg AQNAA or 68.66 percent of all permits (Figure 8b). Twenty-four operators have each filed more

than 10 permits to drill new wells (Table 5). Wells permitted by each operator in each field are also shown on the table. These 24 operators have permitted 2,455 well locations in the AQNAA, or 95.67 percent of all permits. The remaining 111 permits are held by 39 additional companies.

Noble Energy, Incorporated has permitted the largest number of wells in the Greater Wattenberg AQNAA, with 918 permits in 14 named fields (Table 5). Thirty-two of their permits are for wildcat wells. Two other operators have more than 100 permits and the other 21 operators have between 10 and 100 permits each.

At least 10 well locations have been permitted for nine different fields in the Greater Wattenberg AQNAA. Wattenberg (Figure 7b) contains the most permits with 2,107, or 82.11 percent of all permits. The remaining eight fields contain at least 10 to 51 permits each. See Figure 7b for field locations. There are 181 permits in these eight fields, or 7.05 percent of the total. These fields are:

- Spindle 51 permits,
- Eaton 43 permits,
- Bracewell 28 permits,
- Greeley 18 permits,
- Severeance 11 permits,
- Crow Creek 10 permits,
- Hambert 10 permits, and
- Kersey 10 permits.

Wildcat well permits (214 permits) account for 8.34 percent of all permits (Figure 8b). These are predominately located in the north part of the Greater Wattenberg AQNAA and in the northeast. Most wells in these two areas are presently targeting the Niobrara Formation for horizontal wellbores.

There are four permits (0.16 percent) spread across a number of unnamed fields in the Greater Wattenberg AQNAA. In addition, operators have permitted fewer than 10 wells in 27 fields for a total of 60 permits, or 2.34 percent of total permits.

Greater Wattenberg AQNAA active well permits of all types are shown by county in Table 6. Weld County, where the Wattenberg Field is located, accounts for 93.49 percent of all permits. An additional 4.84 percent of permits are located in Boulder, Adams, Arapahoe, and Broomfield counties. Locations of the remaining 1.64 percent of permits are spread across the remaining four counties.

One permit is active in the Canon City AQNAA (Figure 8c). This permit is for a well in the Florence-Canon City field and is operated by Javernick Oil. No permits were filed in the Lamar AQNAA.

RECENT HISTORICAL DRILLING DATA

A total of 2,056 wells were spudded on new locations in the Planning Area from 2007 through 2011 (IHS Energy Group, 2012). There were 1,470 conventional oil and gas wells spudded (71.5 percent) within the Planning Area (Figure 9a). An additional 586 coalbed natural gas wells (28.5 percent) were spudded in the Purgatoire River Field (Figure 9b). Conventional drilling activity occurred in the Greater Wattenberg AQNAA, but not in the other two AQNAAs. Coalbed natural gas drilling activity did not occur in any of the three AQNAAs.

Conventional Activity

Of the 1,470 conventional wells spud within the Planning Area boundary (Figure 9a) from 2007 through 2011, there have been 1,249 completions (84.97 percent) with the remaining 221 waiting on a final completion (IHS Energy Group, 2012). Completion status of wells was:

- Abandoned or Junked and Abandoned 163 (13.05 percent),
- Gas 735 (58.85 percent),
- Oil 318 (25.46 percent),
- Gas Storage 14 (1.12 percent),
- Observation/Service 10 (0.80 percent),
- Temporarily Abandoned 7 (0.56 percent),
- Pilot 1 (0.08 percent), and
- Water Injection 1 (0.08 percent).

The high overall success rate of 87 percent for wells completed in the Planning Area is mainly due to the fact that most of the completed wells were drilled as field development wells. There were 1,039 wells drilled as development wells and 92.94 percent were successful. Only 179 wildcat wells were completed, with a success rate of only 49.72 percent.

There have been 1,052 wells completed as gas or oil productive. The 13 productive geologic units in the Planning Area are shown in Table 7. The Niobrara Formation produces in the most wells (60.27 percent). The other major producing units have been the Dakota/Muddy formations (17.68 percent) and the Codell Sandstone (11.79 percent). The remaining 10.26 percent of wells are split between the remaining 10 productive units.

Table 7 also shows percentage of completions as gas or oil wells for each type of unit. Overall, 70 percent have been completed as gas wells and 30 percent as oil wells.

Within the Denver Basin part of the Planning Area (Figure 4) 1,292 wells have been spudded but not completed as of this writing. Producing wells were completed as predominately Cretaceous aged producers with a small number of older producers of Permian and Pennsylvanian age. The completion status of these wells was:

- Pierre Shale gas 4 wells at Florence-Canon City field,

- Pierre Shale oil 17 wells at Florence-Canon City field,
- Niobrara Formation gas 482 wells in the north part of the basin,
- Niobrara Formation oil 142 wells predominantly north of Greeley, Colorado,
- Codell Formation gas 77 wells in the Greater Wattenberg area,
- Codell Formation oil 46 wells predominantly north of Greeley, Colorado,
- Greenhorn Limestone gas 2 wells,
- Dakota/Muddy formations gas 124 wells,
- Dakota/Muddy formations oil 60 wells,
- Lyons Sandstone oil 1 well in T. 8 north, R. 68 west,
- Lansing Group oil 1 well in T. 10 south, R. 55 west,
- Marmaton Group oil 5 wells in T. 10 south, R. 55 west,
- Cherokee Group gas 1 well, in T. 14 south, R. 55 west,
- Cherokee Group oil 13 wells in T. 10, 13, & 14 south, R. 55 west,
- Atoka Formation oil 10 wells in southeast part of basin,
- Morrow Formation oil 1 well in T. 10 south, R. 55 west,
- Gas Storage 14 wells at Totem field T. 2 north, R. 62 west,
- Service 5 wells,
- Temporarily Abandoned 5 wells,
- Water Injection 1 well,
- Abandoned 76 wells, and
- Spudded 205 wells.

Within the Raton Basin part of the Planning Area (Figure 4) 35 wells have been spudded. Producing wells have been Cretaceous aged. The completion status of these wells was:

- Pierre Shale gas 18 wells,
- Niobrara Formation gas 3 wells,
- Dakota Formation gas 2 wells,
- Service/Observation 5 wells,
- Abandoned 4 wells, and
- Spudded 3 wells.

Within the Anadarko Basin part of the Planning Area (Figure 4) 18 wells have been spudded. Producing wells have been Pennsylvanian and Mississippian in age, with most wells abandoned. The completion status of these wells was:

- Wabaunsee Group gas 2 wells,
- Mississippian gas 1 well,
- Abandoned 13 wells,
- Temporarily Abandoned 1 well, and
- Spudded 1 well.

Within the Las Animas Arch part of the Planning Area (Figure 4) 104 wells have been spudded. Thirty producing wells have been Pennsylvanian and Mississippian in age, with

eight gas wells of Cretaceous age. More than half have been abandoned. The completion status of these wells was:

- Niobrara Formation gas 7 wells,
- Codell Sandstone gas 1 well,
- Lansing Group oil 1 well,
- Marmaton Group gas 1 well,
- Morrow Group gas 7 wells,
- Morrow Formation oil 7 wells,
- Cherokee Group oil 1 well,
- Mississippian gas 1 well,
- Mississippian oil 12 wells,
- Abandoned 54 wells, and
- Spudded 12 wells.

Most wells spudded (1,029 wells or 70 percent) were vertical and drilled between 995 and 9,550 feet in depth. Only 339 wells were directional (23.06 percent) and 102 (6.94 percent) were horizontal wells (Figure 10). Most directional and horizontal wells have been spudded in areas north of Denver, Colorado (Greater Wattenberg Field area). Most targets in this area have been the Codell Shale, Niobrara Formation, Greenhorn Limestone, Lyons Sandstone, and some Dakota Formation. Additionally, a few have been spudded in the Florence-Canon City field and in the southwest part of the Planning Area (Purgatoire Field). The Pierre Shale has been the target in these two areas. Pine Ridge has operated the new directional wells in Florence-Canon City Field that targeted fracture systems that seismic had helped to delineate. We expect a larger percentage of both directional and horizontal wells to be drilled during the Planning Period, especially in the Greater Wattenberg Field area and northward to the border with Wyoming.

Production in directional wells that have been completed has been entirely from Cretaceous aged units. Those units were:

- Niobrara Formation 228 wells,
- Codell Shale 32 wells,
- Dakota/Muddy Formations 15 wells,
- Pierre Shale 12 wells,
- Greenhorn Limestone 1 well, and
- Lyons Sandstone 1 well.

Production in horizontal wells that have been completed has been predominantly from Cretaceous aged units. Those units that have been productive were:

- Niobrara Formation 61 wells,
- Pierre Shale 11 wells,
- Cherokee Group 3 wells,
- Dakota/Muddy formations 1 well,
- Codell Shale 1 well, and

- Atoka Formation 1 well.

Conventional Activity in AQNAAs

Of the 740 conventional wells spud within the Greater Wattenberg AQNAA (Figure 11a) from 2007 through 2011, there have been 682 completions (92.16 percent) with the remaining 58 waiting on a final completion (IHS Energy Group, 2012). Completion status of wells was:

- Abandoned or Junked and Abandoned 16 (2.35 percent),
- Gas 504 (73.9 percent),
- Oil 146 (21.41 percent),
- Gas Storage 14 (2.05 percent),
- Observation/Service 1 (0.15 percent), and
- Water Injection 1 (0.15 percent).

The high overall success rate of wells completed in the Greater Wattenberg AQMAA is mainly due to the fact that most of the completed wells were drilled as field development wells. There were 676 wells drilled as development wells and 97.93 percent were successful. Only six wildcat wells were completed, with a success rate of only 66.67 percent.

There have been 650 wells completed as gas or oil productive. There are only five productive units in the Greater Wattenberg AQNAA (Table 8). The Niobrara Formation produces in the most wells (70.46 percent). The other major producing units have been the Codell Sandstone (18.46 percent) and the Dakota/Muddy formations (10.62 percent). The Greenhorn Limestone and Lyons Sandstone account for the remaining 0.46 percent of productive units.

Table 7 also shows percentage of completions as gas or oil wells for each type of unit in the Greater Wattenberg AQNAA. Overall, 78 percent have been completed as gas wells and 22 percent as oil wells.

Most wells spudded (401 wells or 54.19 percent) in the Greater Wattenberg AQNAA were vertical and drilled between 3,422 and 9,540 feet in depth. There were 317 wells (42.84 percent) drilled or spudded using directional drilling technology (Figure 10). There are 22 wells (2.97 percent) drilled or spudded using horizontal drilling technology (Figure 10). Directional targets in this area have included all units in Table 8. Fourteen horizontal wells drilled or spudded have targeted the Niobrara Formation. Eight horizontal wells have been spudded in the Totem gas storage field to the Dakota Formation (township 2 south, range 62 west). We expect a larger percentage of both directional and horizontal wells to be drilled during the Planning Period.

Only one well was spudded in the Canon City AQNAA (Figure 11b). This well targeted the Pierre Shale in the Florence-Canon City field, but was abandoned. No wells are located in the Lamar AQNAA.

Coalbed Natural Gas Activity

Of the 586 coalbed natural gas wells spud within the Planning Area boundary (Figure 8b) from 2007 through 2011, there have been 561 completions (95.73 percent) with the remaining 25 waiting on a final completion (IHS Energy Group, 2012). Exploration activity for coalbed natural gas began in 1982 in the Planning Area. The Purgatoire River Field has since been well defined by drilling. All wells spudded from 2007 through 2011 have been within the Purgatoire River Field and all but two of the 561 completions were productive. The very high overall success of these wells is due to the fact that all of the spudded wells were drilled as field development wells.

Two formations have been productive in the Purgatoire River Field. The Upper Cretaceous Vermejo Formation coals were completed in 186 wells, the Lower Tertiary Raton Formation coals were completed in 369 wells, and both coal formations were dually completed in 4 wells. All wells have been drilled vertically. Production has come from depths as shallow as 453 feet and as deep as 3,601 feet.

Directional Drilling

Developments in drilling techniques have allowed for more widespread use of directional and horizontal drilling technology. Directional drilling has many benefits, but also limitations. For instance, directional drilling may be employed to avoid sensitive or inaccessible surface features, increase the area that a well bore contacts a producing formation (allowing for increased production volumes), and, when multiple directionals are drilled from the same vertical well bore or from the same surface location, reduce drilling time, associated waste volumes and emissions, and provide greater protection of sensitive environments (Carr *et al.*, 2003).

In addition to the benefits of directional and horizontal drilling outlined above, such wellbores will often be allowed to “drift” updip along the flanks of geologic structures (e.g., along the axis of a plunging anticline), thereby naturally contacting more of the producing formation. Directional wells also have the benefit of providing the operator with the option of drilling multiple wells from the same location, substantially reducing the surface disturbance and potentially avoiding environmentally sensitive areas. Drilling and completion costs for directional and horizontal wells are typically significantly higher than for conventional vertical boreholes, even when the cost savings associated with reduced need for surface disturbance is taken into account. Eustes (2003) and Fritz and others (1991) identified the following specialized requirements and risk factors unique to horizontal and directional drilling that can affect drilling and completion costs for these types of wells:

- specialized equipment (e.g., mud motors, measurement while drilling tools) and specially trained personnel,
- a larger drilling rig and associated equipment,
- casing and drilling string modifications to address problems associated with ovality and bending stresses,

- increased risk of borehole damage due to unique tectonic stresses,
- slower penetration rates lengthens overall drilling time on location, and/or
- increased torque and drag on borehole equipment.

In addition to increased costs, the risk of losing the well due to geologic and/or mechanical failures is also greater in directional and especially horizontal boreholes than in conventional vertical boreholes. As a result of these increased costs and risk, operators tend to prefer vertical over directional or horizontal boreholes unless special circumstances exist that make such drilling a necessity or economically attractive. As an example, the geology of a reservoir may be such that a vertical borehole may only contact a few feet of the productive horizon, while a horizontal borehole may be able to contact tens to thousands of feet, depending on factors such as how the well is completed and the areal extent of the pool. In these cases, the operator must make the determination that the increased potential for productivity outweighs the inherent risks involved in directional and horizontal drilling.

Exploration and development of the plays in the Planning Area has traditionally used vertical wells. The rate at which directional, horizontal, and vertical wells were spudded for each five-year period from 1997 through 2011 is shown in Table 9. Horizontal wells doubled between the first five-year period and the second and then increased by almost 12 times between the second and third periods. Directional drilling increased more rapidly. Directional wells tripled between the first five-year period and the second and then increased by almost 14 times between the second and third periods.

As discussed earlier, most horizontal and directional wells have been spudded in the Greater Wattenberg AQNAA and immediately to the north. Directional drilling in the Greater Wattenberg AQNAA appears to be at least partly tied to the need to avoid surface features. The increased emphasis on horizontal drilling is tied to the geologic reservoir conditions of the Codell Sandstone and Niobrara Formation targets that may increase production volumes that can be obtained from a single horizontal borehole.

During the 2002-2006 period, horizontal drilling occurred most often for coalbed natural gas tests in the Raton Basin (11 wells) and on the Las Animas Arch (five wells). During the most recent five-year drilling period, no horizontals for coalbed natural gas were drilled and only one occurred on the Las Animas Arch. Production does not appear to have been good enough in these areas to justify continued drilling of these higher cost wells.

In addition to the concentration of horizontal and directional wells in the Greater Wattenberg AQNAA and immediately north, the latest five-year drilling period saw nine horizontal and 17 directional wells at Florence-Canon City field (Figure 10). These appear to have been drilled to try to obtain additional hydrocarbon volumes from the Pierre Shale reservoir.

We expect that continued industry development of reservoirs (such as the Codell

Sandstone, Niobrara Formation, and Pierre Shale) during the Planning Period will likely result in more horizontal and directional well drilling. The IHS Energy Group database (2012) indicates that permits that have been approved in the Planning Area, but not spudded, is about equally split between horizontal, directional, and vertical boreholes. We assume that this proportion will remain about the same for the Planning Period.

Pad Drilling

It has become common in the Planning Area to drill multiple directional wells from a single surface location, a practice known as pad drilling. Pad drilling has many advantages to both the operator and the environment. While directional wells are generally more costly than their vertical counterparts, drilling multiple directional boreholes from a single location eliminates the costly process of moving the drilling rig and operations to a new location between spuds. Instead, many rigs today may simply be shifted on tracks several feet away from the recently drilled well to where the next well is spud.

Pad drilling may also maximize the efficiency of the production from a particular reservoir, depending on the geology. As many directional wells have S-shaped wellbores, their close proximity on the surface has little bearing on their proximity in the producing formation (indeed, some wells may even target entirely different formations in the subsurface). Depending on the anticipated area of drainage or spacing regulations, such well bores at the surface may only be separated by several feet, while in the subsurface may be many acres away from one another, and spaced according to the most efficient means of production for that particular reservoir.

Drilling multiple wells from a single location may also minimize the impact of drilling activities on the local environment. In traditional drilling (i.e., one well per location), each well must have a drilling site cleared and a pad constructed to accommodate the drilling operations. Each location would have a road built for access, and each well may also need a right-of-way cleared for pipeline construction. Each location will usually have its own dedicated production equipment which may cause an impact on the view shed. Pad drilling centralizes the production equipment to one site, eliminates the need for multiple pipelines and roads, and requires only one surface location cleared for operations.

However, not all hydrocarbon reservoirs lend themselves to pad drilling. For example, many stratigraphic and structural traps are too small to be effectively developed using multiple, closely spaced wells. Reservoirs whose properties create wide drainage areas would likewise not benefit for the denser well spacing typical of pad drilling. As the geology of the area must be understood in great detail to design such programs, reservoirs whose lateral extent is unknown, or whose thicknesses are in question would also be poor candidates for these types of drilling programs.

To determine the locations of multi-well pads the databases for active wells and permitted wells were combined. We assumed that all wells that were within 100 feet of

each other could be effectively considered to be on the same well pad. ArcGIS software was used to apply a 100-foot buffer to all active and permitted wells. All active wells and permits with at least two wells within a 100-foot buffer of each other are shown on Figure 12a. Figure 12b shows all Greater Wattenberg wells and permitted wells at a larger scale.

There are 295 two-well pads located in the Purgatoire River Field west of Trinidad, Colorado (Figure 12a). Coalbed natural gas wells in the field can produce from the Vermejo Formation and/or Raton Formation coals. Because of pressure differentials between these two coals, these coals are better produced from separate wellbores (Carlton, 2006). If both coal formations can be productive at a location then a two-well drill and production pad is used. Permit data indicates that about 35 percent of these new wells will be drilled with two-wells per pad. We assume additional future permits for wells in this area will be drilled in the same proportion.

There are 2,077 multi-well pads located in the Greater Wattenberg AQNAA (Figure 12b). The Codell Sandstone and the Niobrara Formation are the dominate geologic targets in the Greater Wattenberg AQNAA. The numbers of well pads, of each multi-pad type, are:

- 2-well pads 1,057 pads,
- 3-well pads 443 pads,
- 4-well pads 217 pads,
- 5-well pads 129 pads,
- 6-well pads 77 pads,
- 7-well pads 68 pads,
- 8-well pads 53 pads,
- 9-well pads 11 pads,
- 10-well pads 5 pads,
- 11-well pads 6 pads.
- 12-well pads 6 pads,
- 13-well pads 2 pads,
- 15-well pads 2 pads, and
- 16-well pads 1 pad.

At present, the average number of wells per pad is 3.2 wells. About 67 percent of new wells permitted will be drilled with two or more wells per pad. With increased drilling interest and increased interest in multi-pad wells, we assume that 70 percent of new wells will be drilled on an average of four wells per pad. The remaining 30 percent will average one well per pad. Increased drilling interest in this area and increased interest in multi-pad wells is expected to raise the average number of wells per pad and increase the percentage of new wells permitted with two or more wells per pad for the Planning Period.

In the area to the north of the Greater Wattenberg AQNAA there are 11 two-well pads and two three-well pads. At present, about six percent of permits in the area are for multi-well pads. Targets will be predominately to the Niobrara Formation in this area.

As with the Greater Wattenberg AQNAA, we expect that after the initial stages of exploration are completed in this area, successful development will proceed with pads averaging at least three wells and multi-well pads accounting for 50 percent of new wells drilled.

In the rest of the Planning Area there are only 15 two-well pads, one three-well pad, and one five-well pad. Permit data indicates that only about one percent of these new well permits will be drilled with two wells per pad. Target formations in this area are not as favorable for the drilling and completion of multi-well pads as other parts of the Planning Area. Higley *et. al.*, (1996) indicate that the ultimate recovery of the fractured Pierre Shale could be increased by the use of horizontal drilling, which is conducive to pad drilling. Some pads have recently been developed in this field as shown on Figure 12a (Township 19 South, Range 69 West). As technology improves, some small increases in multi-well pad drilling in this area are likely to happen.

Well Life

It is currently not possible using the available data to accurately estimate abandonment rates for all types of wells previously drilled in the Planning Area. For the purpose of calculating long-term surface disturbance, it is important to have an understanding how many wells sites are likely to be reclaimed during the Planning Period. Toward this end, an average well life for different well types within the Planning Area will be used. The major operator in the Raton Basin (Pioneer Natural Resources, 2009) indicates that coalbed natural gas wells will have an average life of 35 years and the Pierre Shale gas wells in the area will be economic for up to 40 years. The Niobrara Formation wells in the northeast part of the Planning Area are projected to produce for up to 30 years (Williams, 2007).

Existing vertical Niobrara and Codell wells in the Greater Wattenberg area appear to have an average well life of about 30 years and newer horizontal wells are expected to have an economic life of about 50 years (Jungwirth, 2012). All other types of wells within the Planning Area are assumed to have an average life of 30 years.

OIL AND GAS PRICE ESTIMATES

Anticipated oil and gas prices are an important factor controlling the amount of future drilling and production activity in the Planning Area. Kaiser (2012) reported that "unconventional gas resources are abundant, but their development is particularly sensitive to technologic risk, geologic uncertainty, and gas price". Conventional plays in 2010 reportedly had an operational costs break-even price of $3-4 per thousand cubic feet (Schaefer, 2010). The National Petroleum Council (2011) stated "Significant technology advances have unlocked abundant natural gas and oil resources, but the potential benefits can only be realized if developed prudently."

Gas Prices

In 1996, natural gas prices in Colorado started on a general increase (Figure 13). Several peaks and valleys in the price trend have occurred since that time, but by 2005, prices had increased to an average of $7.43 per thousand cubic feet. Colorado wellhead prices declined sharply from 2005 to 2007 ($4.57 per thousand cubic feet), peaking again in 2008. As world economies struggled in 2009, Colorado wellhead gas prices fell to $3.21 per thousand cubic feet. In recent months gas prices have fallen below $3 per thousand cubic feet. "Natural gas in the New York market slipped further below $2.50/MMBTU, and given the more mild weather forecasts, we don't expect this to improve much anytime soon" (Raymond James, 2012).

Data for Figure 13 (historical and projected future natural gas prices) were obtained from the Energy Information Administration (2011). In the Annual Energy Outlook 2012 (Lower 48), average annual wellhead prices for natural gas remain below $5 per thousand cubic feet (nominal dollars) through 2017. The projected prices reflect continued industry success in tapping the Nation's extensive shale gas resource. Natural gas prices rise as production gradually shifts to resources that are less productive and more expensive. Natural gas wellhead prices (nominal dollars) reach $10.24 per thousand cubic feet in 2035. The forecasted natural gas price using 2009 dollars is $6.42 per thousand cubic feet in 2035.

The natural gas price projections allow for some generalizations concerning future gas drilling and production activity in the Planning Area. For the short term, the interest in natural gas exploration and development will be somewhat limited due to low price projections shown in Figure 13. Gas drilling levels have so far been resilient for Codell Sandstone and Niobrara Formation targets in areas north of Denver, Colorado (Figures 9a and 11a), for the shallow biogenic Niobrara Formation in the northeast part of the Planning Area (Figure 9a), and coals of the Purgatoire Field to the south (Figure 9a) despite low natural gas prices. Well permitting (Figures 8a and 8b) shows that these areas will continue to see activity in the short-term. The level of future drilling activity, beyond the short-term, will likely be driven more by the success of drilling efforts currently underway in these areas.

The future gas drilling target areas discussed will generally also produce condensate in association with the gas production and will be sold as oil (see discussion below). The only exception would be the coalbed natural gas reservoirs in the Raton Basin which only produce gas.

Oil Prices

U.S. energy demand and economic activity in 2012 will gain some momentum from last year's doldrums but growth for each will remain anemic (Radler, 2012). Total energy demand will increase by 1.2 percent in the U. S., according to Oil & Gas Journal's annual Forecast & Review. Early estimates indicate that in 2011 demand climbed by a mere 0.3 percent. But uncertainties abound this year—from the state of the European Union and

its economies weakened by debt defaults to the effect of the West's reactions to Iran's development of nuclear capabilities—and it is those uncertainties that will drive the 2012 oil market.

Data for Figure 14 (historical and projected crude oil prices) were obtained from the Energy Information Administration (2011). The data are projected averages of low sulfur light crude oil prices and are made in nominal dollars. Historical prices represent the actual average price at the wellhead and show the historic volatility that has occurred in per barrel crude oil prices in Colorado. Per barrel prices began declining in the early 1980's from a high of $35.69 in 1981 to a low of $12.56 in 1998. A significant climb is seen in oil prices starting in 1999 up to 2008. The rise from a low of $12.56 per barrel to the most recent average high of nearly $100 per barrel represents a nearly 90 percent increase in prices in just eleven years.

Prices for crude oil in 2011 remained generally in a range between $74 and $100 per barrel. Low sulfur light crude oil prices (nominal dollars) in the Annual Energy Outlook rise to $125 per barrel in 2019 as pipeline capacity from Cushing, Oklahoma, to the Gulf Coast increases, the world economy recovers, and global demand grows more rapidly than the available supplies of liquids from producers outside the Organization of the Petroleum Exporting Countries (OPEC). In 2035, the average real price of crude oil is about $125 per barrel in 2009 dollars, or about $200 per barrel in nominal dollars.

The Annual Energy Outlook assumes that limitations on access to energy resources restrain the growth of non-OPEC conventional liquids production between 2012 and 2035, and that OPEC targets a relatively constant market share of total world liquids production. There is a wide range of price scenarios and a great deal of uncertainty surrounding future world oil prices. In several resource rich regions, high oil prices, oil sands development, expanded infrastructure, further investment in exploration, and all drilling contribute to additional non-OPEC oil production.

Historically, exploration and development of oil resources in the Planning Area has been minor in comparison to gas resources. Oil production historically has occurred at Florence Field (Figure 7c) and at scattered locations in the Denver Basin and northeast part of the Las Animas Arch (Figure 4). The Niobrara Formation has recently been found to be oil productive at locations north of Greeley, Colorado. This has caused an increase in drilling plans and drilling permits for this area. The robust future oil price projections of Figure 14 are expected to encourage continued exploration and development of oil resources in oil prone parts of the Planning Area for the length of the Planning Period.

ASSESSMENT OF OCCURRENCE POTENTIAL

The Bureau has established criteria to use in rating the oil and gas "occurrence potential" of lands studied for planning documents such as the Resource Management Plan to be prepared for the Planning Area. Occurrence potential is the rating of the potential for the presence of hydrocarbon resources to occur within the Planning Area. The rating is based on geological and geophysical indications that hydrocarbons are present. Other

factors, such as, accessibility, exploration cost, risk, oil and gas prices, and Planning Period are not include in an analysis of Occurrence potential.

The occurrence potential rating is based on guidance outlined in Bureau of Land Management Handbook H-1624-1 which states:

"Due to the nearly ubiquitous presence of hydrocarbons in sedimentary rock... the following [is used] for classifying oil and gas [occurrence] potential:

- HIGH: Inclusion in an oil and gas play as defined by the USGS [U.S. Geological Survey] national assessment, or, in the absence of play designation by the USGS, the demonstrated existence of: source rock, thermal maturation, and reservoir strata possessing permeability and/or porosity, and traps. Demonstrated existence is defined by physical evidence or documentation in the literature.
- MEDIUM: Geophysical or geological indications that the following may be present: source rock, thermal maturation, and reservoir strata possessing permeability and/or porosity, and traps. Geologic indication is defined by geological inference based on indirect evidence.
- LOW: Specific indications that one or more of the following may not be present: source rock, thermal maturation, reservoir strata possessing permeability and/or porosity, and traps.
- NONE: Demonstrated absence of (1) source rock, (2) thermal maturation, or (3) reservoir rock that precludes the occurrence of oil and/or gas. Demonstrated absence is defined by physical evidence or documentation in the literature."

Using the above criteria, we consider that the Planning Area lands have high, medium, or low potential for the occurrence of oil and gas (excluding coalbed natural gas) as shown in Figure 15. Parts of the Planning Area within the seven provinces (Figure 4) evaluated by the U.S. Geological Survey (see previous “Publications” section) as containing assessment units or plays with the potential for future discovery of oil and gas resources meet the Bureau criteria for a classification of high occurrence potential. Shows of hydrocarbons have been encountered in exploratory wells in 11 townships or areas within the Planning Area that lay outside the high occurrence potential area. These shows indicate indirect evidence that hydrocarbon reservoirs could be present in these 11 locations, so they have been assigned a medium occurrence potential. The rest of the Planning Area was assigned a low occurrence potential for hydrocarbons since one or more specific indicators of the presence of hydrocarbons (source rock, thermal maturation, reservoir strata possessing permeability and/or porosity, and traps) may not be present.

A separate map (Figure 16) of occurrence potential for coalbed natural gas was prepared for the Planning Area. The lands within coalbed gas assessment units (Raton and Vermejo assessment units) in the Raton Basin Province designated by the U.S. Geological Survey are considered as having high occurrence potential for coalbed natural gas (see “Publications” section for references to the Raton Basin Province assessment). Two coal fields (South Park and Canon City) identified by Tully (1996) but not assessed for coalbed natural gas potential by the U.S. Geological Survey were assigned a medium

occurrence potential. In addition, those portions of the Planning Area designated by the U.S. Geological Survey as being hypothetical coalbed natural gas assessment units (Denver Formation Coals and Laramie Formation Coals assessment units) within the Denver Basin Province (see "Publications" section for references to the Denver Basin Province assessment) are assigned a medium occurrence potential. Coal beds are known to occur in these coal fields and assessment units, but at present there is only an inference that coalbed natural gas could be present in economic quantities. Parts of the Planning Area known to contain Cretaceous aged sediments that could contain coalbeds (Tweto, 1979) were designated as having low occurrence potential. These areas are not known to meet all the criteria needed to define a coalbed natural gas play. All rocks older than the Cretaceous and Tertiary aged intrusive rocks (Tweto, 1979) do not contain potential coalbed natural gas reservoirs and we thus designated them as having an occurrence potential of "none."

PROJECTIONS OF FUTURE DRILLING ACTIVITY

It is difficult to predict what will occur a few years into the future, but it is even more difficult to predict 20 years ahead. In an attempt to gain more insight as to what may occur in the Planning Area, major oil and gas companies operating in the Planning Area were contacted by letter and asked what development activity they anticipated during the next 20 years. The Bureau also contacted many of these companies by telephone in order to clarify information after replies were received. These data were compiled and used to help project locations and amounts of future drilling activity within the Planning Area. As previously stated, we also brought into this analysis the development potential analyses obtained from two reasonable foreseeable development reports prepared by Stilwell, *et al.*, (2011a and 2011b). A review of additional available technical data was also made to help make these projections. Much of the data reviewed has been summarized above.

Two maps were prepared to show our assessment of the potential for conventional oil and gas and coalbed natural gas exploration and development activities for the Planning Period (see Figures 17 and 18). Future activity was categorized into eight distinct categories based on the anticipated number of wells (individual wellbores, not well locations) to be drilled per township during the Planning Period. For conventional drilling potential these categories were:

- Very High (Wattenberg Area): greater than 150 wells per township
- Very High: greater than 50 to 150 wells per township,
- High: greater than 20 to 50 wells per township,
- Moderately High: 10 to 20 wells per township,
- Moderate: 5 to less than 10 wells per township,
- Low: 1 to less than 5 wells per township,
- Very Low: less than 1 well per township, and
- None: no projected drilling activity.

With respect to coalbed natural gas activity in the area during the Planning Period, six categories were used. Those categories were:

- Very High: greater than 30 wells per township,
- High: greater than10 to 30 wells per township,
- Moderate: 5 to 10 wells per township,
- Low: less than 5 to 1 well per township,
- Very Low: less than 1 well per township, and
- None: no projected drilling activity for Planning Period.

Each map also outlines areas of no leasing (Bureau Wilderness Study areas, Forest Service wilderness, and National Park Service lands).

Projected Oil and Gas Drilling Activity

Operator input was first considered and accepted unless it was in conflict with submittals from other operators or other information was available to indicate a certain township should have a different potential designation than that submitted. Locations of established oil and gas fields, historical and recent drilling activity, published data, an internet search, geology and geologic trends, production statistics, and institutional knowledge of the region were all similarly used to determine where future activities would likely occur. These types of data were especially useful for making determinations of potential for future activities in townships that operators did not indicate a potential.

As stated previously, the projections of Stilwell *et al.* (2011a and 2011b) were carried forward into this analysis. The potential categories changed to reflect a broader area of analysis with large increases in well density for some of the new areas. Well density ranges used in the two reports do remain the same in this report for those areas previously studied.

Play and assessment unit boundaries from U.S. Geological Survey reports (see "Publications" discussion) were used on the conventional potential map to separate areas of no potential for development from other areas with at least some potential for development. The U.S. Geological Survey has not delineated potential assessment units or play areas within the areas of no potential outline on Figure 17.

For a base line reasonable foreseeable development projection (Rocky Mountain Federal Leadership Forum, 2002, page 13), we estimate that during the Planning Period as many as 12,355 wells (excluding coalbed natural gas wells) will be drilled in the Planning Area (Table 10). This baseline activity scenario assumes 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. Of these 12,355 wells, most (10,045 wells) are projected to be drilled in and around existing very active fields in the Greater Wattenberg area, in the northeast part of the Planning Area, and to the north of Greater Wattenberg to the state boundary with Wyoming (Figure 17 and Table 10). These areas

are marked as very high (Wattenberg), very high, or high development potential on Figure 17. There are 987 wells projected in areas of moderately high and moderate potential. These areas are located in and around existing fields where the pace of future drilling will not be as high. The remaining 1.323 wells (those drilled in areas of low, or very low potential), are projected to be drilled in areas generally not proven as productive by historical drilling, but which do contain some existing active fields.

Many of the townships marked very high (Wattenberg) and very high already are relatively densely drilled. Much of the development of these townships in the Greater Wattenberg AQNAA is expected to be developed with pad drilling and horizontal wellbores that could extend laterally as much as 10,000 feet. In the area to the north of the Greater Wattenberg AQNAA, exploration and development will also tend to be with horizontal wellbores and multi-well pads, but at a lower percentage than in the Wattenberg AQNAA.

Wells within townships marked with moderately high potential down to low potential will likely be drilled as fringe and infill wells in and around existing fields or as wildcat wells looking to discover entirely new fields. Drilling in these areas will be predominately vertical.

In areas marked as very low development potential, very few new wells will be drilled and well densities will remain similar to what they are at present, with isolated townships having a small potential for an increase in drilling density, most likely around the fringes of townships marked with a higher potential. In these areas, anticipated activity will be tied to exploration for new field discoveries, and most of these townships will not receive any drilling at all. If a new field discovery is made in any of these areas of very low development potential, subsequent drilling density could increase moderately. Based on previous exploration efforts in the Planning Area, the probability of successful discovery of one or more new gas fields in these areas of very low development potential is unlikely (though possible) during the Planning Period. Any wells drilled will be predominately vertical.

We anticipate that drilling depths (true vertical depth) will not change significantly during the Planning Period (see previous discussions under “Conventional Activity” and “Conventional Activity in AQNAAs’). There could be some minor localized increases in depth if deeper reservoirs are locally encountered. Few, if any, wells are expected to be drilled to depths exceeding 10,000 feet, as the productive formations within the Planning Area are generally found at significantly shallower depths. Most wells are expected to be drilled to depths between 5,000 and 10,000 feet. As previously discussed horizontal drilling is expected to become more common in parts of the Planning Area, with laterals that could approach 10,000 feet in length.

Projected Oil and Gas Drilling Activity in AQNAAs and on Bureau and Forest Service Lands

Figure 10 also shows a projection of all wells drilled in AQNAAs, which is a subset of all

projected Planning Areas wells. Of the 12,355 wells projected for the Planning Area we projected 7,234 wells (almost 59 percent) would be located within AQNAAs. All of the very high (Wattenberg) category wells (80 percent of wells in the three AQNAAs) are located within the Greater Wattenberg AQNAA.

In, addition, Table 10 further breaks out how many of the 12,355 wells would be located on all Bureau managed lands (471 wells) and on all Forest Service managed lands (258 wells). Table 10 then breaks out the number of wells that would by in Bureau managed AQNAAs (240 of the 471 wells, or 51 percent) and in Forest Service managed AQNAAs (126 of 258 wells, or 49 percent). Of the 240 wells projected on Bureau managed lands in AQNAAs, 82 percent would be located in the very high (Wattenberg) part of the Greater Wattenberg AQNAA. Of the 125 wells projected on Forest Service managed lands in AQNAAs, 87 percent would be located in the high and moderately high potential parts of the Greater Wattenberg AQNAA.

Projected Coalbed Natural Gas Drilling Activity

The same types of input used to project wells in the previous section were also used to make projections of future coalbed natural gas drilling activity. Again, the projections of Stilwell et al. (2011a) were carried into this analysis. In this case the potential categories and their density ranges remained exactly the same between the two reports.

Areas of with a coalbed natural gas occurrence potential of low or none, as shown on Figure 16 were assigned no development potential for the Planning Period (Figure 18). Only those areas with an assessment unit or coal field (see “Assessment of Occurrence Potential” discussion) were projected to have at least some development potential during the Planning Period. The lands within coalbed gas assessment units (Raton and Vermejo assessment units) in the Raton Basin Province designated by the U.S. Geological Survey are considered as having a moderate to very high development potential, with the unitized area having a very high potential and the least active portions having only a moderate potential. The two coal fields (South Park and Canon City) identified by Tully (1996) but not assessed for coalbed natural gas potential by the U.S. Geological Survey were assigned a low development potential. In addition, those portions of the Planning Area designated by the U.S. Geological Survey as being hypothetical coalbed natural gas assessment units (Denver Formation Coals and Laramie Formation Coals assessment units) within the Denver Basin Province (see “Publications” section for references to the Denver Basin Province assessment) are assigned only a very low development potential.

For a base line reasonable foreseeable development projection (Rocky Mountain Federal Leadership Forum, 2002, page 13), we estimate that during the Planning Period as many as 686 wells will be drilled in the Planning Area (Table 11). This baseline activity scenario assumes 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. Of these 686 anticipated coalbed natural gas wells, most (491 wells or 71.57 percent) are projected to be drilled in and around the Purgatoire Field (areas of high and very high potential). Only 44 of the 686 projected wells will be located on Bureau

managed lands (Figure 11) and one of those wells will be located in the Greater Wattenberg AQNAA. Six of the 686 wells will be located on Forest Service managed lands (Stilwell *et al.* 2011a) in the Raton Basin and one additional well will be located in the Greater Wattenberg AQNAA.

As previously discussed, some two-well pads are projected in this area. Most of the rest of the projected wells (137) will be drilled in those parts of the Raton Basin area with a moderate development potential. The remaining 59 wells (those drilled in areas of low or very low potential), are projected to be drilled in areas not proven as productive for coalbed natural gas by historical drilling. We assume that some exploratory activity could occur in these areas during the Planning Period and if a discovery is made, some limited development would occur. We anticipate that drilling depths (true vertical depth) will not change significantly during the Planning Period (see previous discussions under "Coalbed Natural Gas Activity").

ESTIMATED FUTURE OIL AND GAS PRODUCTION

As indicated above, we projected 12,355 conventional oil and gas wells and 686 coalbed natural gas wells could be drilled within the Planning Period of 2011 through 2030. Calculations of spudded wells and associated production for the Planning Period were generated via analysis through the program scripting language, Octave. The constraints used for the well spuds for both conventional wells and coalbed natural gas wells were cumulative values and historical trend. A historical cumulative of spudded well data generates a smoother curve from which yearly differences can be extracted to produce annual projected well counts. Decline curves were then generated for gas and oil for both the conventional oil and gas and coalbed natural gas analysis. The decline curves were then normalized and convolved with the historical spudded well counts to generate a best fit with the historical production of oil, gas, and coalbed natural gas. The normalized decline curves were then convolved with the projected spudded well counts to produce annual mean projected oil and gas production for both conventional and coalbed natural gas hydrocarbons (Table 12) that are projected to be drilled during the Planning Period. If future drilling activity does not meet our projections then production will not occur at the rate projected. Production from new wells projected on Bureau or Forest Service managed lands was not included. We assume that Bureau production would be equal to about the Bureau percentage of all wells projected (about four percent for conventional wells and six percent for coalbed natural gas wells). We also assume that Forest Service production would be equal to about the Forest Service percentage of all wells projected (about two percent for conventional wells and one percent for coalbed natural gas wells).

The same above procedure was used to calculate conventional oil and gas production for just the AQNAAs in the Planning Area (Figure 13). A projection of production of coalbed natural gas was not made since only a small number of coalbed natural gas wells (30 wells) were projected within the AQNAAs. Again, a projection of production from Bureau and Forest Service managed wells was not made since they are such a small proportion of the total for both conventional (two percent for Bureau wells and one percent for Forest Service wells) and coalbed natural gas.

SURFACE DISTURBANCE

Table 14a projects short-term disturbance associated with existing wells and projected drilling activity for 2011 through 2030 and Table 14b projects long-term disturbance. The method used to determine the number of new wells drilled during this period has been previously discussed. In addition, we assumed for oil and gas wells (excluding coalbed natural gas) that:

- Success rates for all wells will be 87 percent and in AQNAAs it will be 90 percent. At least one well on all multi-well pads will always be productive, so no multi-well pads will be abandoned during the Planning Period.
- All new wells that are not immediately abandoned will remain active for the entire Planning Period.
- With increased drilling interest and increased interest in multi-pad wells in the Greater Wattenberg AQNAA, we assume that 70 percent of new wells will be drilled on an average of four wells per pad. The remaining 30 percent of new wells will average one well per pad.
- We assume that in the area to the north of the Greater Wattenberg AQNAA, successful exploration and development will proceed with pads averaging at least three wells each and these pads will account for 50 percent of new wells drilled in the area. The remaining 50 percent of new wells will average one well per pad.
- In the rest of the Planning Area we assume as many as five percent of new conventional wells will be drilled with an average of two wells per pad and the remaining 95 percent will average one well per pad.
- Pads with one well will have two acres of initial disturbance associated with the pad, 0.91 acres associated with a road, and 1.1 acres associated with a pipeline. If the well is not successful the pipeline disturbance will not occur. For productive wells the pad will be reclaimed to 0.25 acres, the road will be reclaimed to 0.43 acres, and the pipeline will be completely reclaimed.
- Pads with two wells will have four acres of initial disturbance associated with the pad, 0.91 acres associated with a road, and 1.1 acres associated with a pipeline. If the well is not successful the pipeline disturbance will not occur. For productive wells the pad will be reclaimed to 0.5 acres, the road will be reclaimed to 0.43 acres, and the pipeline will be completely reclaimed.
- Pads with three wells will have 10 acres of initial disturbance associated with the pad, 0.91 acres associated with a road, and 1.1 acres associated with a pipeline. If the well is not successful the pipeline disturbance will not occur. For productive wells the pad will be reclaimed to 0.7 acres, the road will be reclaimed to 0.43 acres, and the pipeline will be completely reclaimed.
- Pads with four wells will have 10 acres of initial disturbance associated with the pad, 0.91 acres associated with a road, and 1.1 acres associated with a pipeline. If the well is not successful the pipeline disturbance will not occur. For productive wells the pad will

be reclaimed to 0.9 acres, the road will be reclaimed to 0.43 acres, and the pipeline will be completely reclaimed.

- Of the existing active wells (as of February 2012) 20 percent wells will be abandoned by the end of the Planning Period.

Our assumptions for coalbed natural gas wells were:

- The success rate for new wells will be 98 percent in areas of high and very high development potential, 90 percent in moderate development potential, and 50 percent in areas of low and very low development potential.
- All new wells that are not immediately abandoned will remain active for the entire Planning Period.
- Thirty-five percent of new wells projected in areas of high and very high potential will be drilled with two wells per pad and 65 percent will be drilled with one well per pad. At least one well on the two-well pads will always be productive, so no pads will be abandoned during the Planning Period. Any coalbed natural gas wells drilled in the remainder of the Planning Area will be drilled on single well pads.
- Existing wells are 35 percent on two-well pads and the remaindering 65 percent are on one-well pad.
- Ten percent of existing wells (as of February, 2012) will be abandoned by the end of the Planning Period.
- Disturbance for two-well pads will be 0.5 acres and for one-well pads it will be 0.55 acres for two-well pads. After reclamation, all pads will be 0.5 acres in size for productive wells. Associated road for each pad will be 1.35 acres with initial reclamation leaving only 0.48 acres disturbed. If a well is productive, associated pipeline disturbance will be 0.9 acres and the entire disturbance will be reclaimed.

Table 14a shows our projection of 13,041 new exploratory and development wells that could be drilled in the Planning Area for the Planning Period. Wells were subdivided into eight types (six conventional well types and two coalbed natural gas types) for analysis. We project that 515 total wells of all types will be on lands managed by the Bureau and 265 wells will be on lands managed by the Forest Service. There were 28,997 existing active wells (26,127 associated with conventional oil and gas activity and 2,870 associated with coalbed natural gas activity) as of February 2012. There are 490 active wells on Bureau managed lands and 245 on Forest Service managed lands.

Table 14a estimates total number of disturbed sites for each type of well. The projected 13,041 wells will be located on 8,742 separate disturbed sites. Bureau managed disturbed sites are projected to be 374 and Forest Service managed disturbed sites are projected to be 170.

Table 14a also calculates associated acres of total short-term surface disturbance directly associated with all new wells drilled and the total number of disturbed sites projected during the Planning Period. The number of disturbed sites are multiplied by acres of disturbance (per site) to calculate total acres of surface disturbance and Bureau and Forest

Service managed well disturbance for each well type [E.g., total disturbed sites * (access roads and pipelines + well pad)]. For well sites that are abandoned, pipelines will not be installed so pipeline disturbance is not included in the calculation. Approximately 44,440 acres of new short-term surface disturbance (1,741 acres of disturbance on Bureau managed lands and 935 acres of disturbance on Forest Service managed land) could occur if all projected wells are drilled. Existing disturbance is projected to be 26,822 acres, with 453 acres disturbed on Bureau managed lands and 228 acres disturbed on Forest Service managed lands.

Table 14b shows our projection of new active wells that will remain in an active status after all new exploratory and development wells are drilled, success rates are taken into account, and all dry holes are abandoned and reclaimed. Of the 11,600 total new wells, 634 are projected to be associated with coalbed natural gas. We project that 460 wells will be located on Bureau managed lands and 234 wells will be located on Forest Service managed lands. In addition, this analysis projects that 23,485 of the 28,997 existing active wells will remain in an active status at the end of the Planning Period.

Table 14b also shows well sites that remain active at the end of the Planning Period and I shows unreclaimed associated acres of total surface disturbance (long-term disturbance) directly associated with all remaining active wells. Approximately 6,455 acres of unreclaimed surface disturbance will be associated with new wells site drilled and 18,648 will be associated with existing sites that remain active. Remaining disturbance associated with Bureau and Forest Service managed lands are also presented in Table 14b. Total unreclaimed long-term surface disturbance is projected to be as much as 25,104 acres, with 586 of those acres on Bureau managed lands and 278 acres on Forest Service managed lands.

Both Table 14a and 14b use calculations that contain decimals, but all results are shown in rounded whole numbers. As a result of this rounding, the whole numbers shown may not exactly add up to the totals shown.

SUMMARY

We examined the available information on the Royal Gorge Field Office area (operator input, environmental documents, unit agreement activity, publications, historical drilling data, and professional knowledge of the area) and used that data to prepare two maps that indicate areas of potential conventional oil and gas and coalbed gas development for 2011-2030. We also estimated a range of wells that could be drilled during this period for both categories of wells. We estimated that up to 12,355 conventional wells and 686 coalbed natural gas wells may be reasonably assumed to be drilled in the area during the Planning Period.

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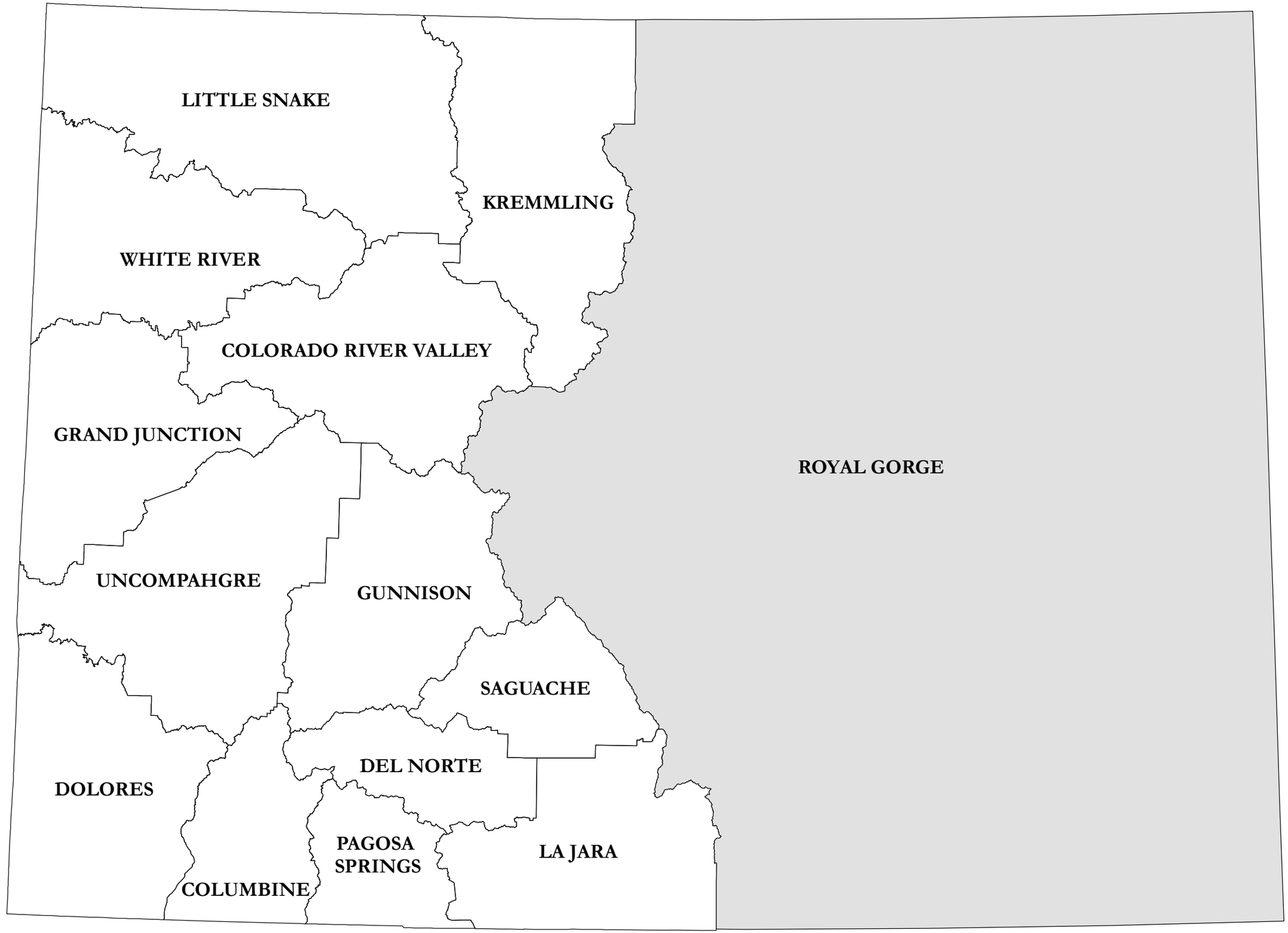
Figure 1.
The Royal Gorge Field Office and its location within Colorado.



0 45 90 Miles

1:2,000,000

February, 2012

Dean Stilwell, Geologist
Al Elser, Geologist
Stan Lawrence, Petroleum Engineer

No warranty is made by the Bureau of Land Management as to the accuracy, reliability, or completeness of these data for individual or aggregate use with other data.
Original data was compiled from various sources. This information was developed through digital means and may be updated without notification.

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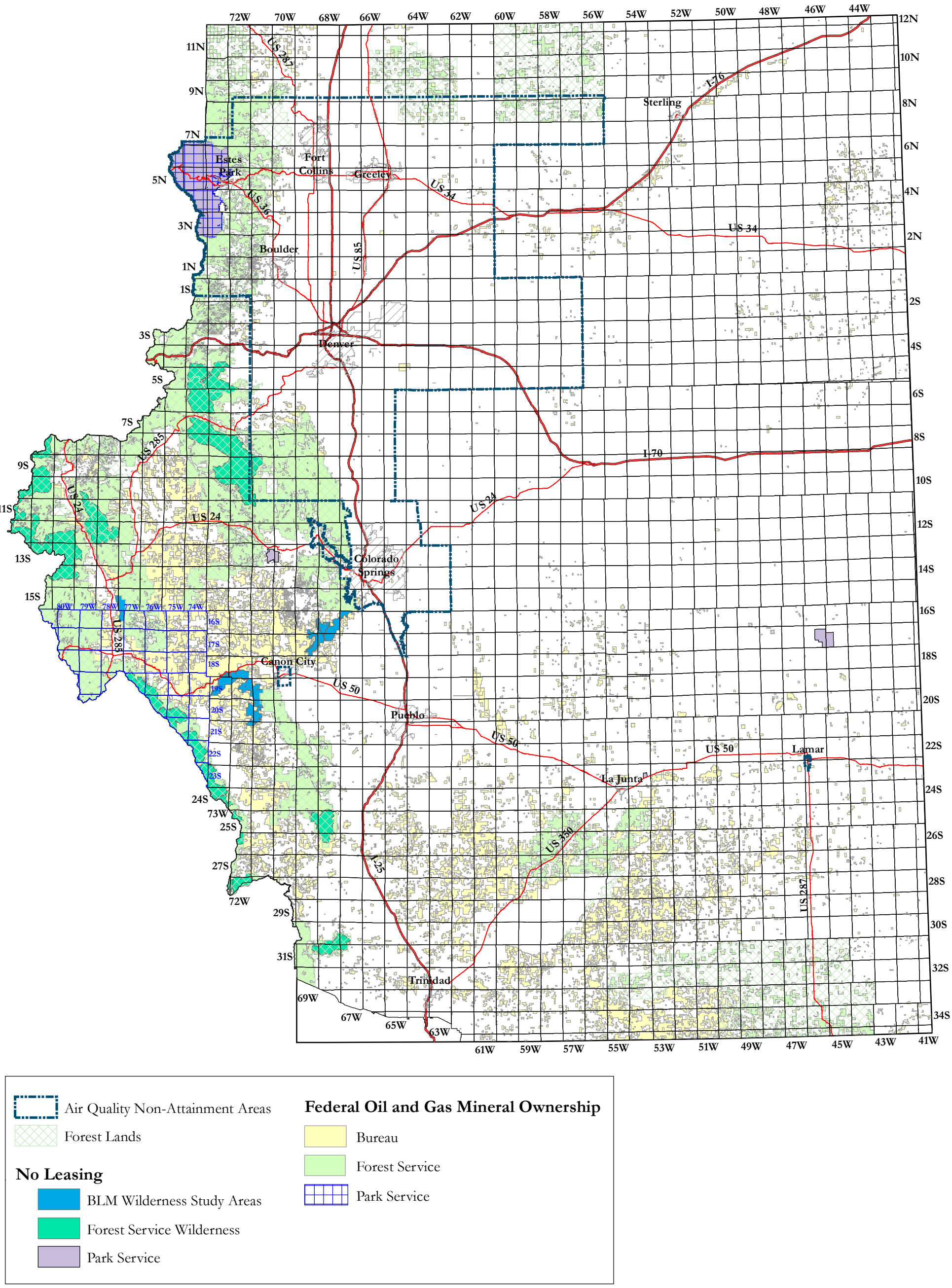
Figure 2.
Locations of Federal oil and gas mineral ownership within the Royal Gorge Planning Area.



February, 2012

Dean Stilwell, Geologist
Al Elser, Geologist
Stan Lawrence, Petroleum Engineer

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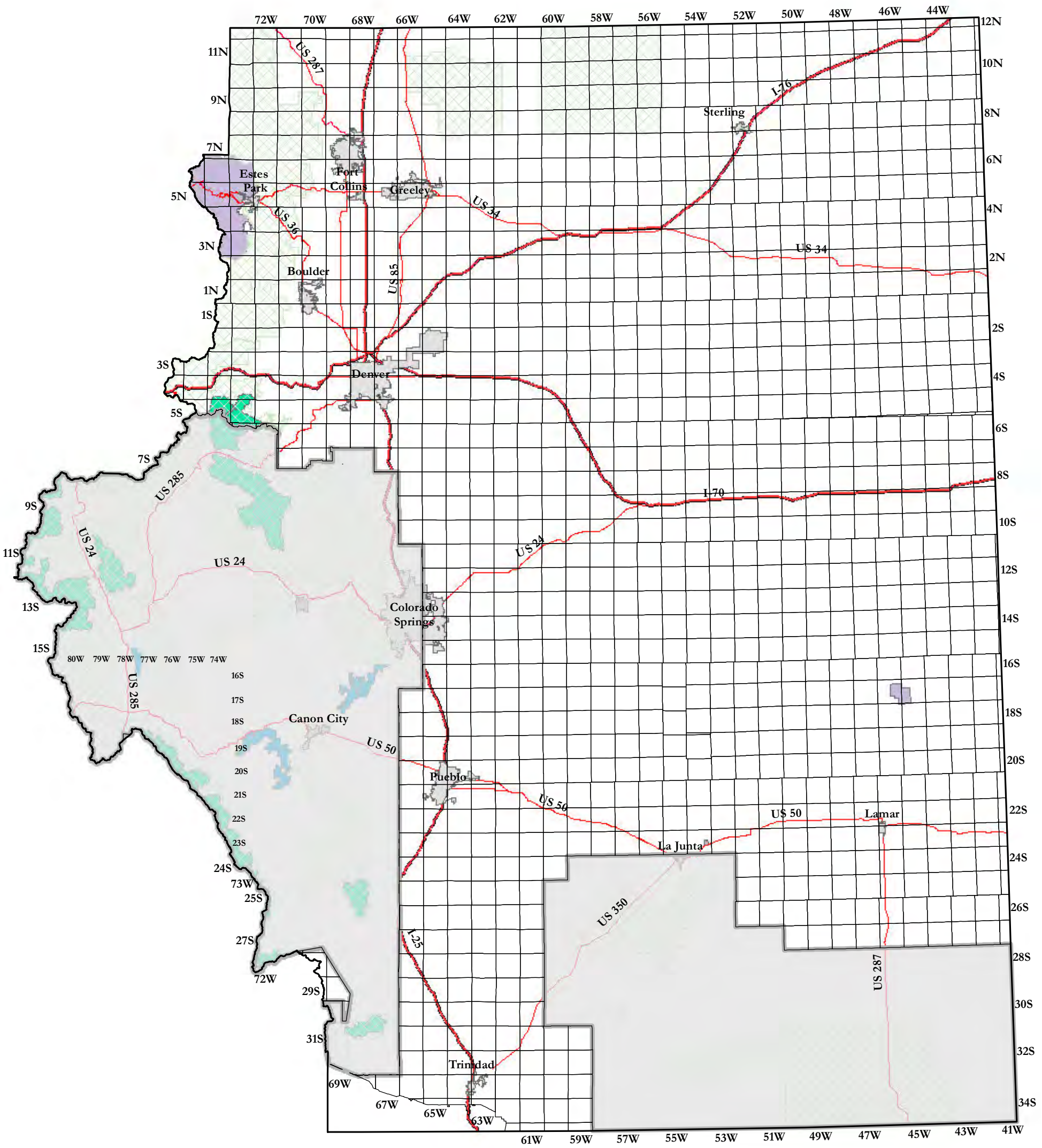
Figure 3.
Map of Royal Gorge Planning Area sent to operators.



Lands Included in Previous USFS Analysis
Forest Lands
Forest Service Wilderness
BLM Wilderness Study Areas
Park Service

0 25 50 100 Miles

1:1,625,000

May, 2011

Dean Stilwell, Geologist
Al Elser, Geologist
Amber Robbins, Geologist

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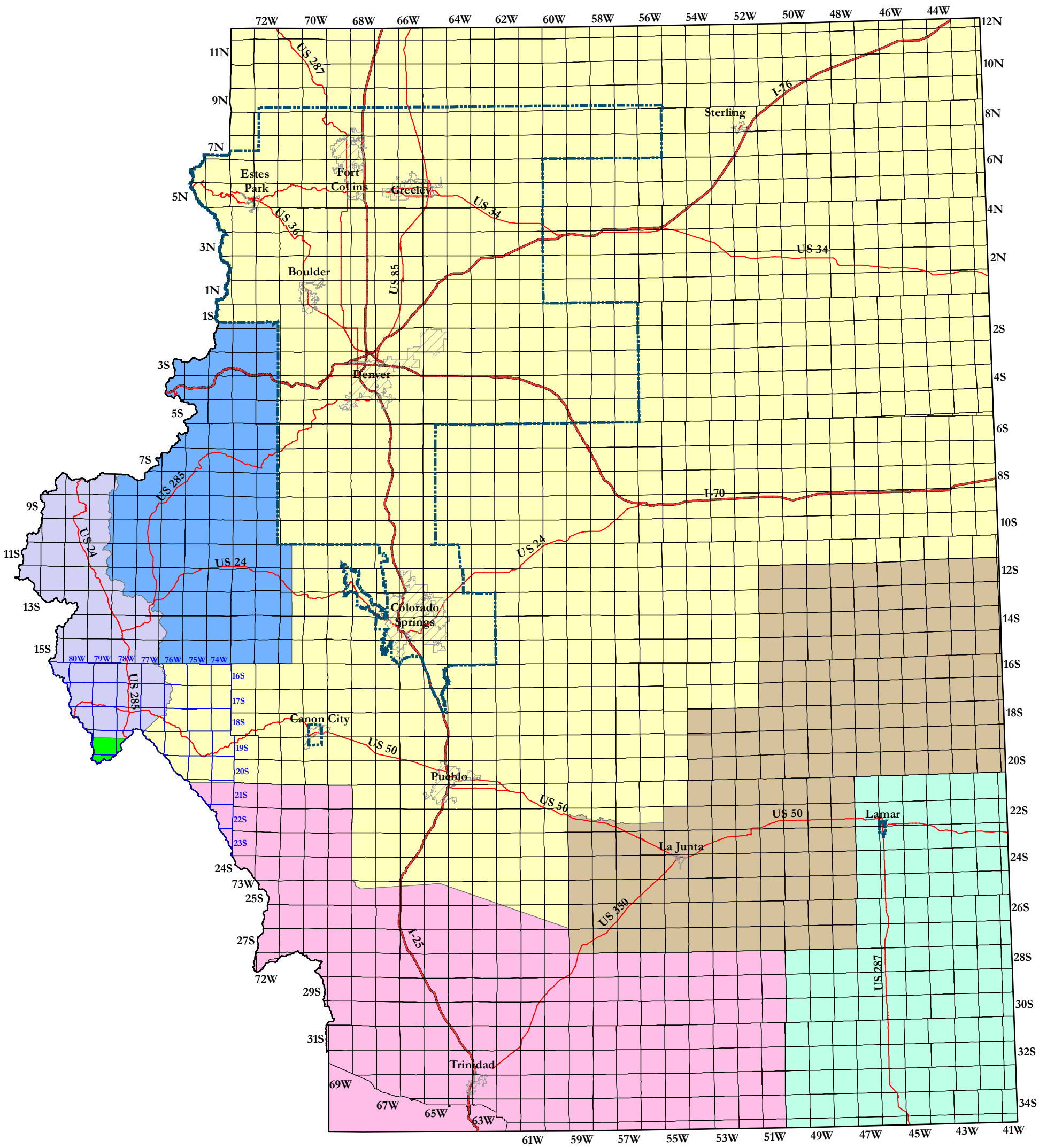
Original data was compiled from various sources. This information was developed through digital means and may be updated without notification.

N

Figure 4.
Location of geologic provinces within the Royal Gorge Planning Area.



Province Boundaries

- Albuquerque Santa Fe Rift
- Anadarko Basin
- Denver Basin
- Las Animas Arch
- Park Basin
- Raton Basin
- Uinta Piceance Basin
- Air Quality Non-Attainment Areas

0 25 50 100 Miles

1:1,625,000

March, 2012

Dean Stilwell, Geologist
Al Elser, Geologist
Stan Lawrence, Petroleum Engineer

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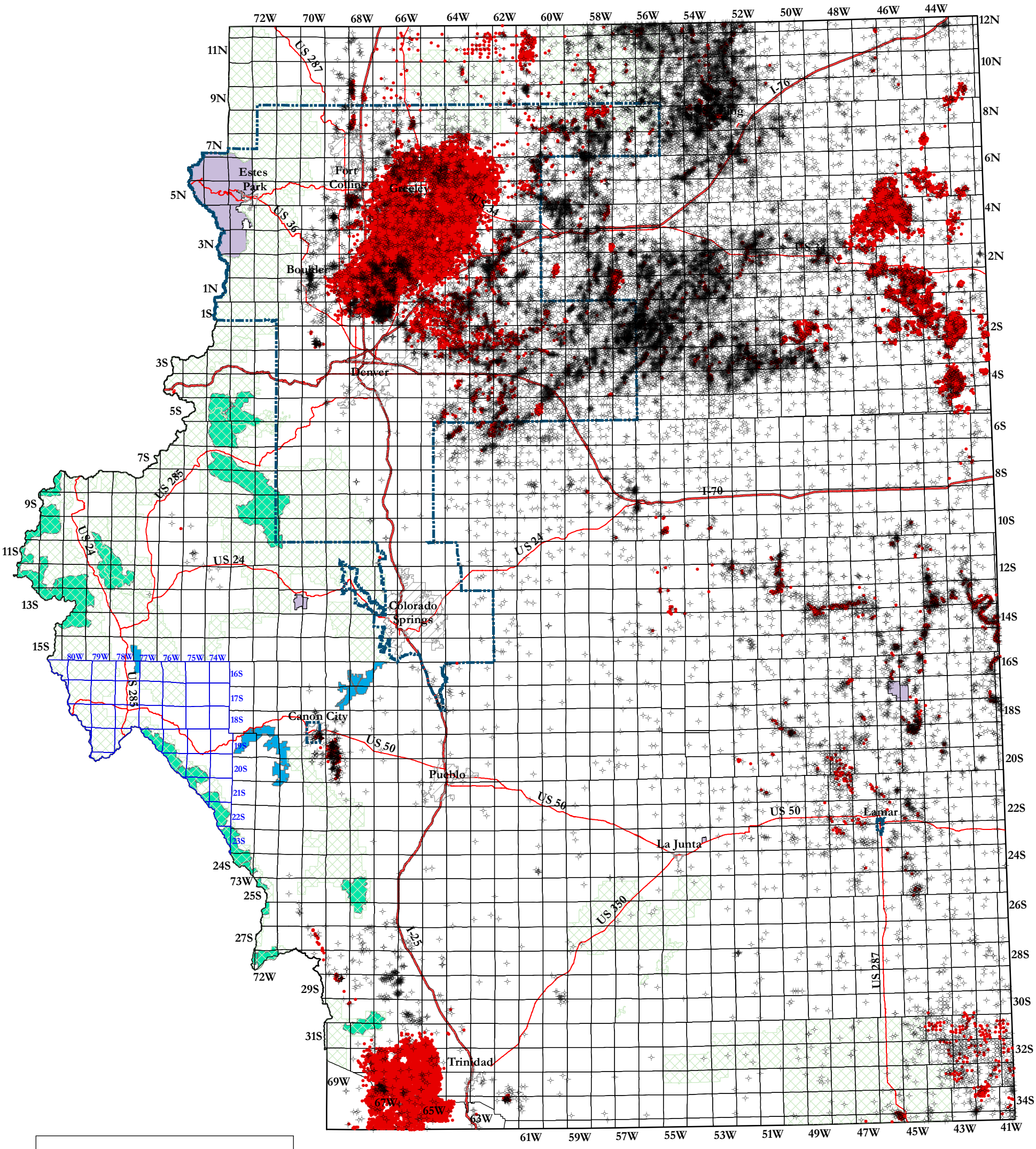
N

Figure 5a.

Locations of all active and abandoned wells within the Royal Gorge Planning Area. Well data from Colorado Oil and Gas Conservation Commission (2012).



Wells

- Active
- Abandoned

Air Quality Non-Attainment Areas

Forest Lands

No Leasing

- BLM Wilderness Study Areas
- Forest Service Wilderness
- Park Service

0 25 50 100 Miles

1:1,625,000

N

February, 2012

Dean Stilwell, Geologist
Al Elser, Geologist
Stan Lawrence, Petroleum Engineer

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Figure 5b.
Locations of all active and abandoned wells within the Greater Wattenberg AQNAA of the Royal Gorge Planning Area. Well data from Colorado Oil and Gas Conservation Commission (2012).

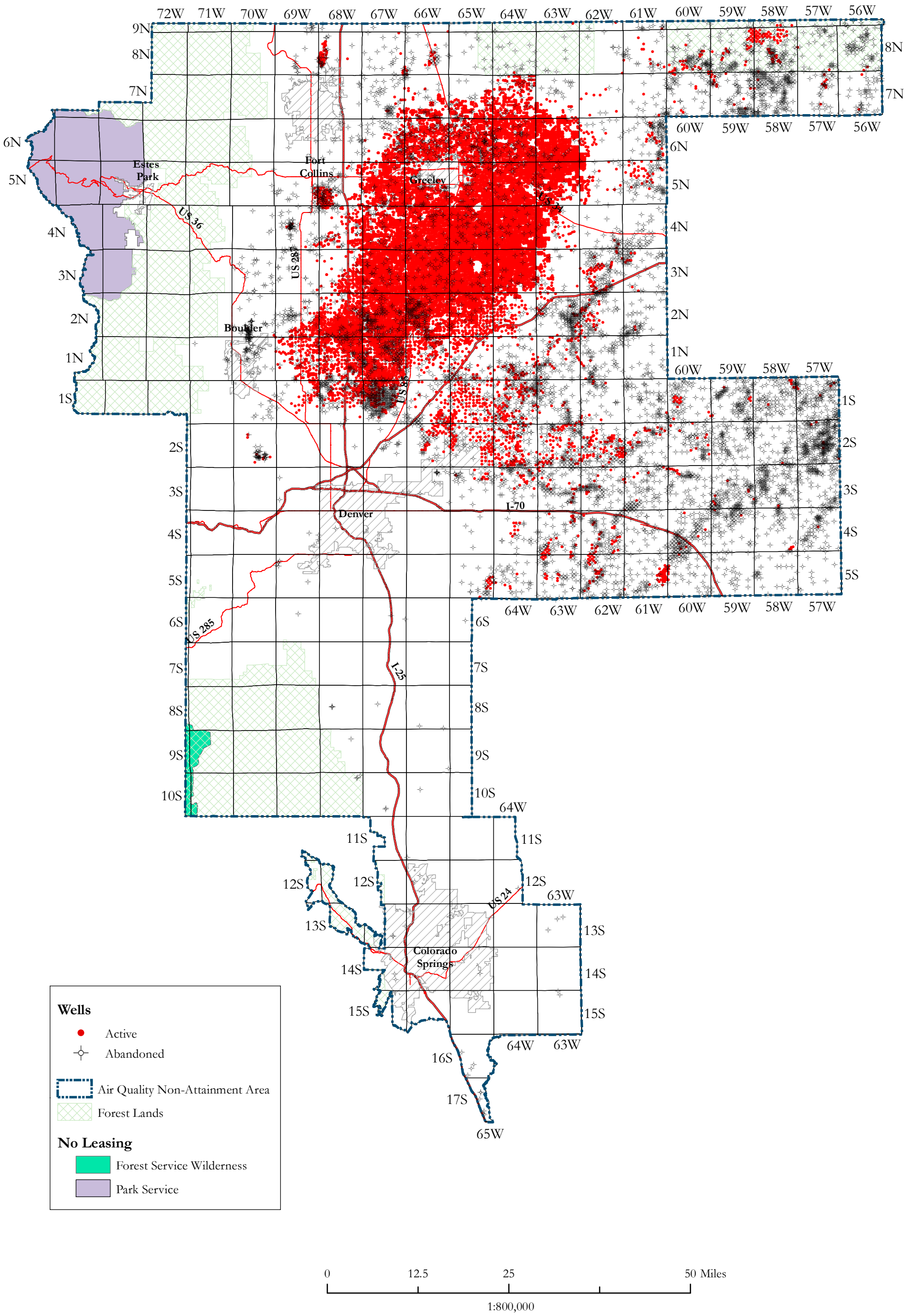

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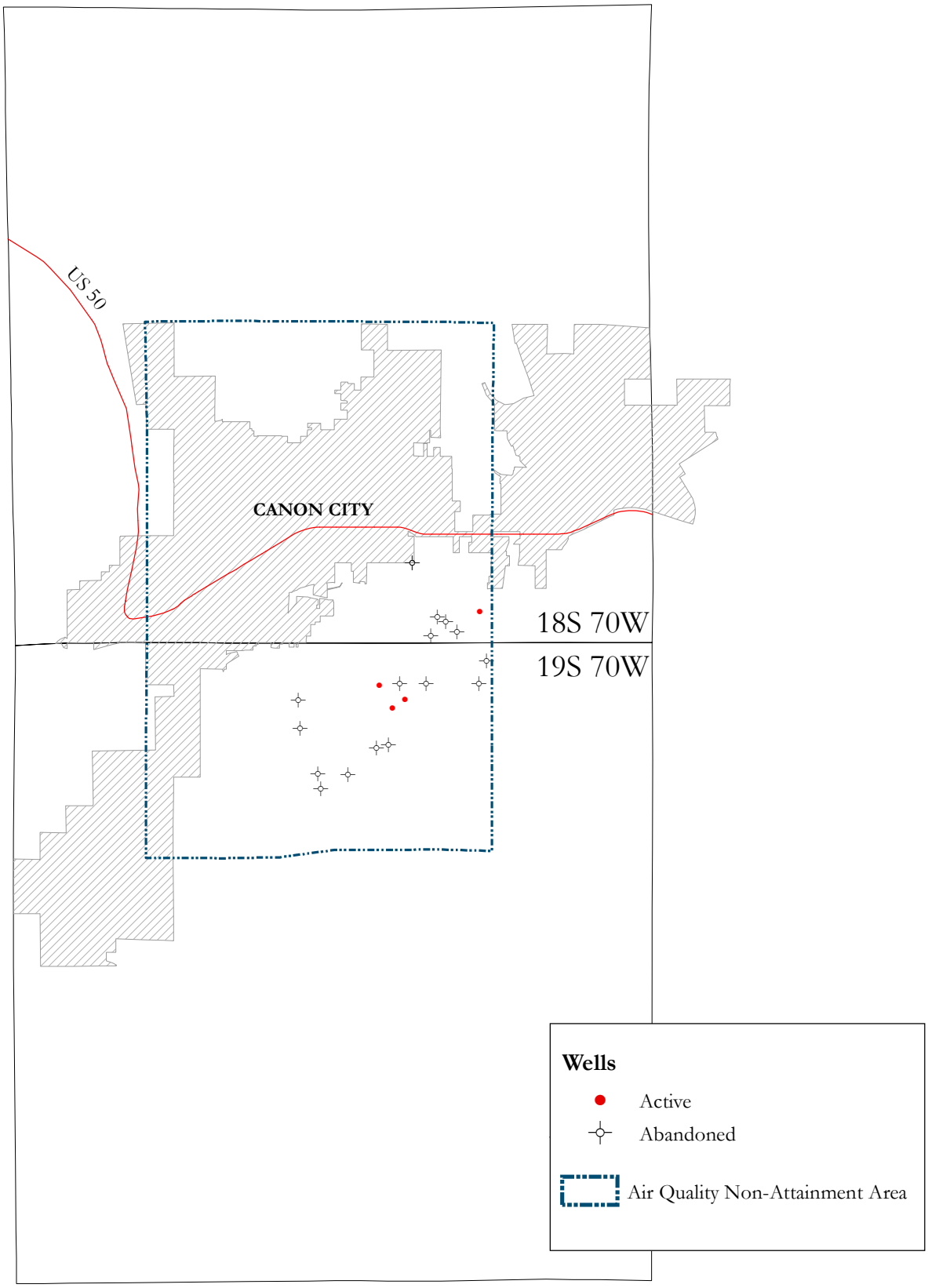
Figure 5c.

Locations of all active and abandoned wells within the Canon City AQNAA of the Royal Gorge Planning Area. Well data from Colorado Oil and Gas Conservation Commission (2012).



0 0.75 1.5 3 Miles

1:90,000

February, 2012

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Al Elser, Geologist
Stan Lawrence, Petroleum Engineer

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N

Figure 6.
All fields within the Royal Gorge Planning Area. Field data from the Colorado Geological Survey.

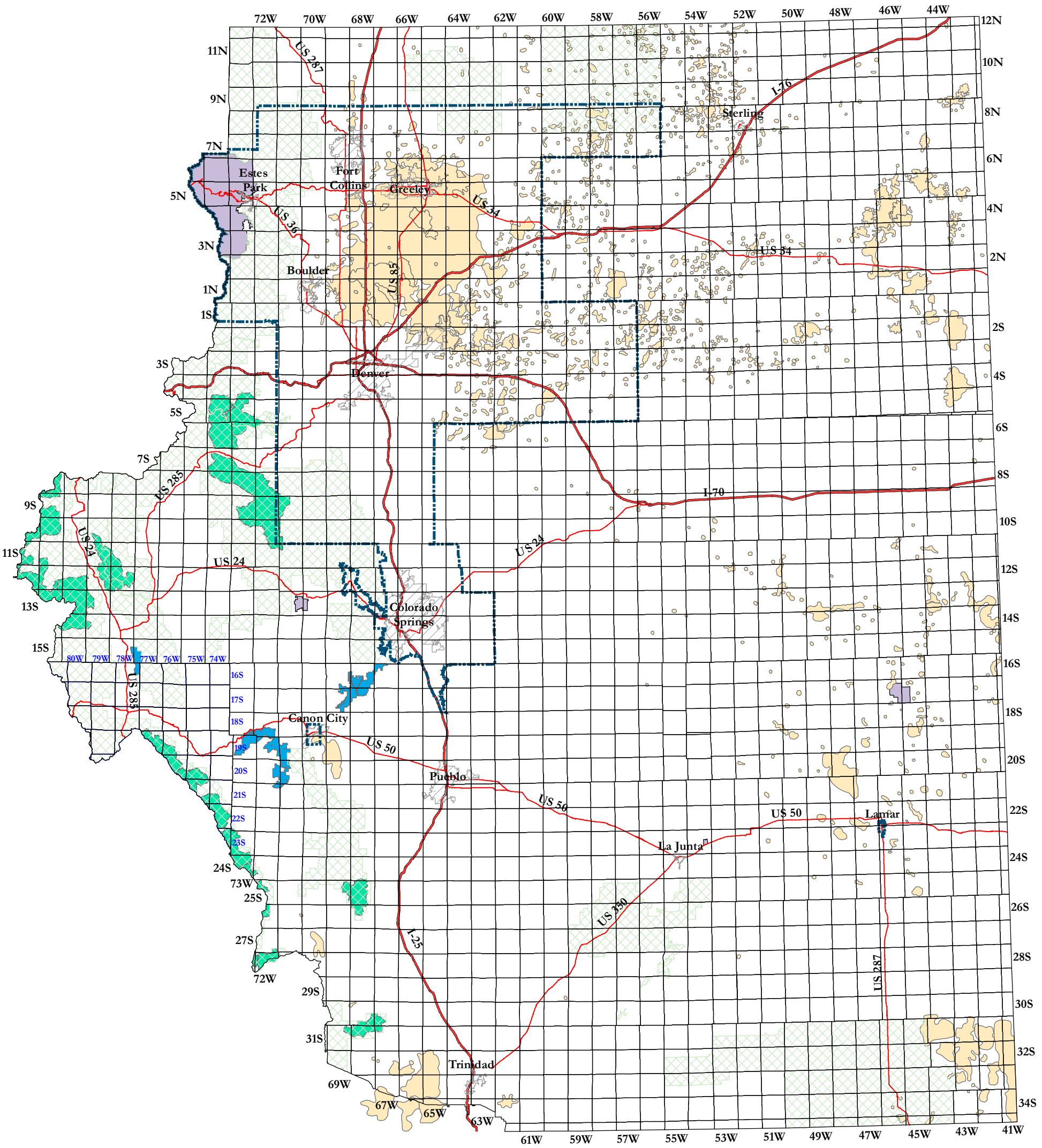

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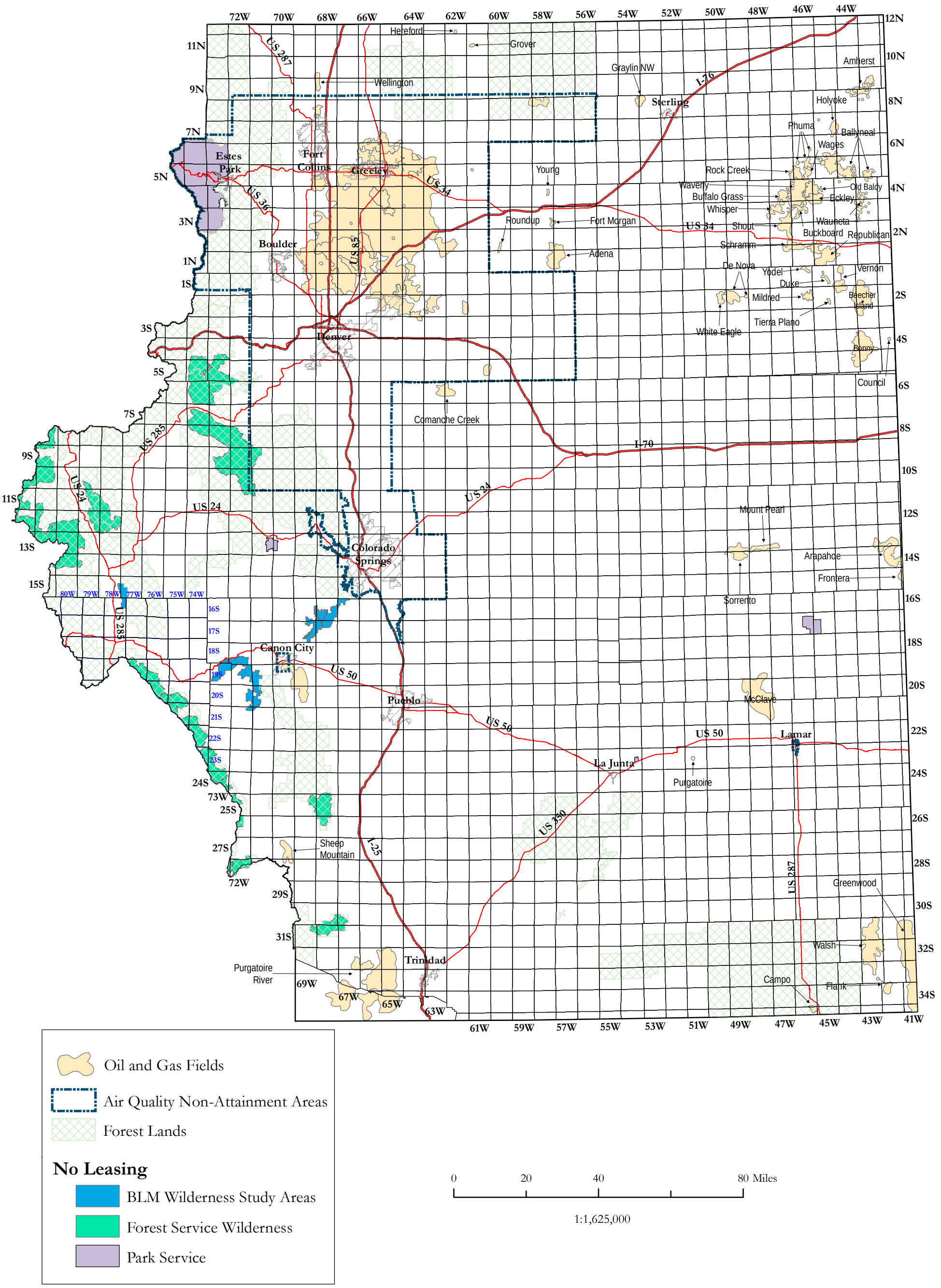
Figure 7a.

Larger oil and gas fields within the Royal Gorge Planning Area. Field data from the Colorado Geological Survey.



Oil and Gas Fields

Air Quality Non-Attainment Areas

Forest Lands

No Leasing

BLM Wilderness Study Areas

Forest Service Wilderness

Park Service

0 20 40 80 Miles

1:1,625,000

February, 2012

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Stan Lawrence, Petroleum Engineer

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N

Figure 7b.

Larger oil and gas fields within the Greater Wattenberg AQNAA of the Royal Gorge Planning Area. Field data from the Colorado Geological Survey.

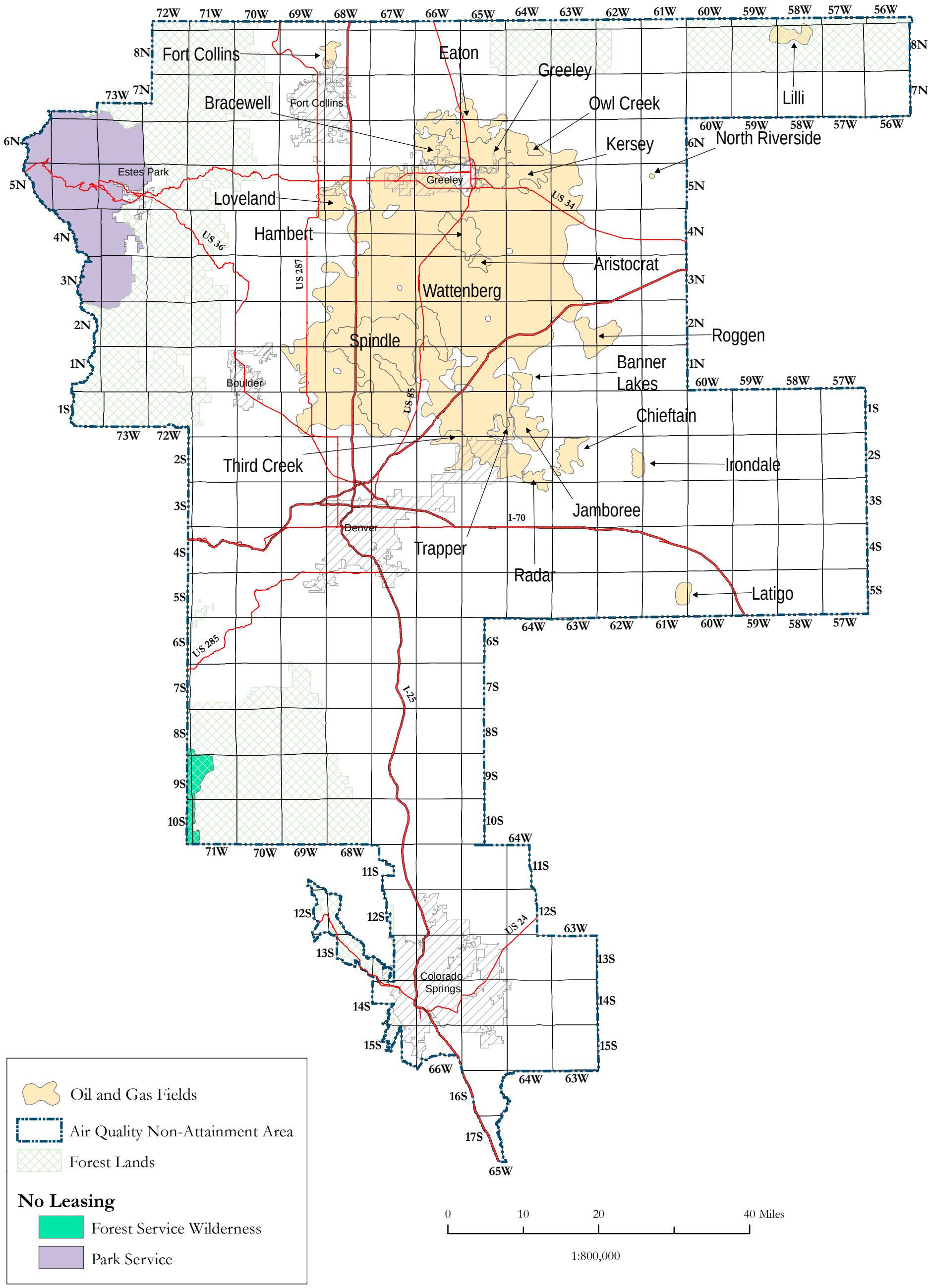

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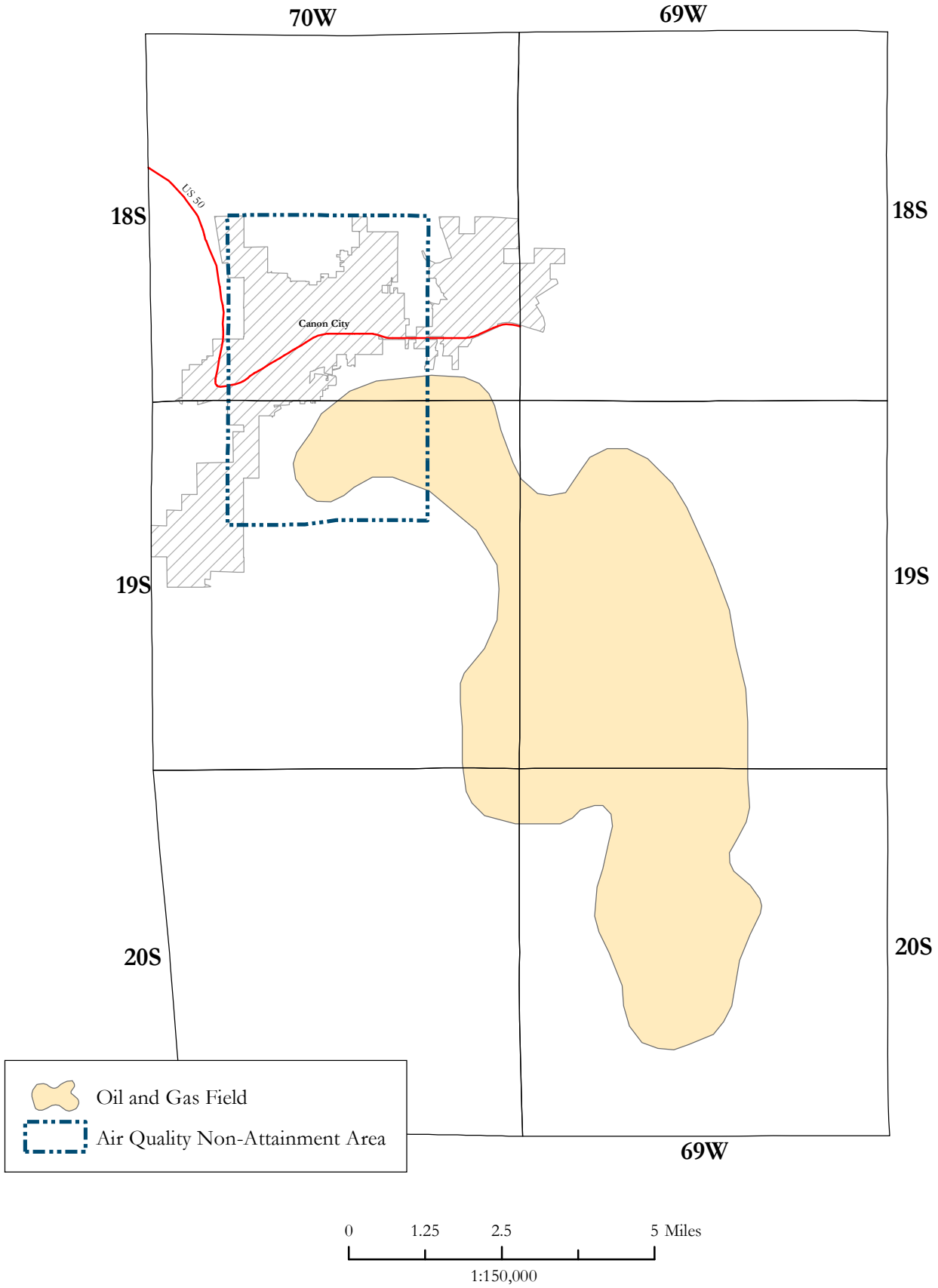
Figure 7c.

Florence-Canon City field within the Canon City AQNAA of the Royal Gorge Planning Area. Field data from the Colorado Geological Survey.



March, 2012

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Figure 8a.

Locations of all active new well permits within the Royal Gorge Planning Area. Data from Colorado Oil and Gas Conservation Commission (2012).

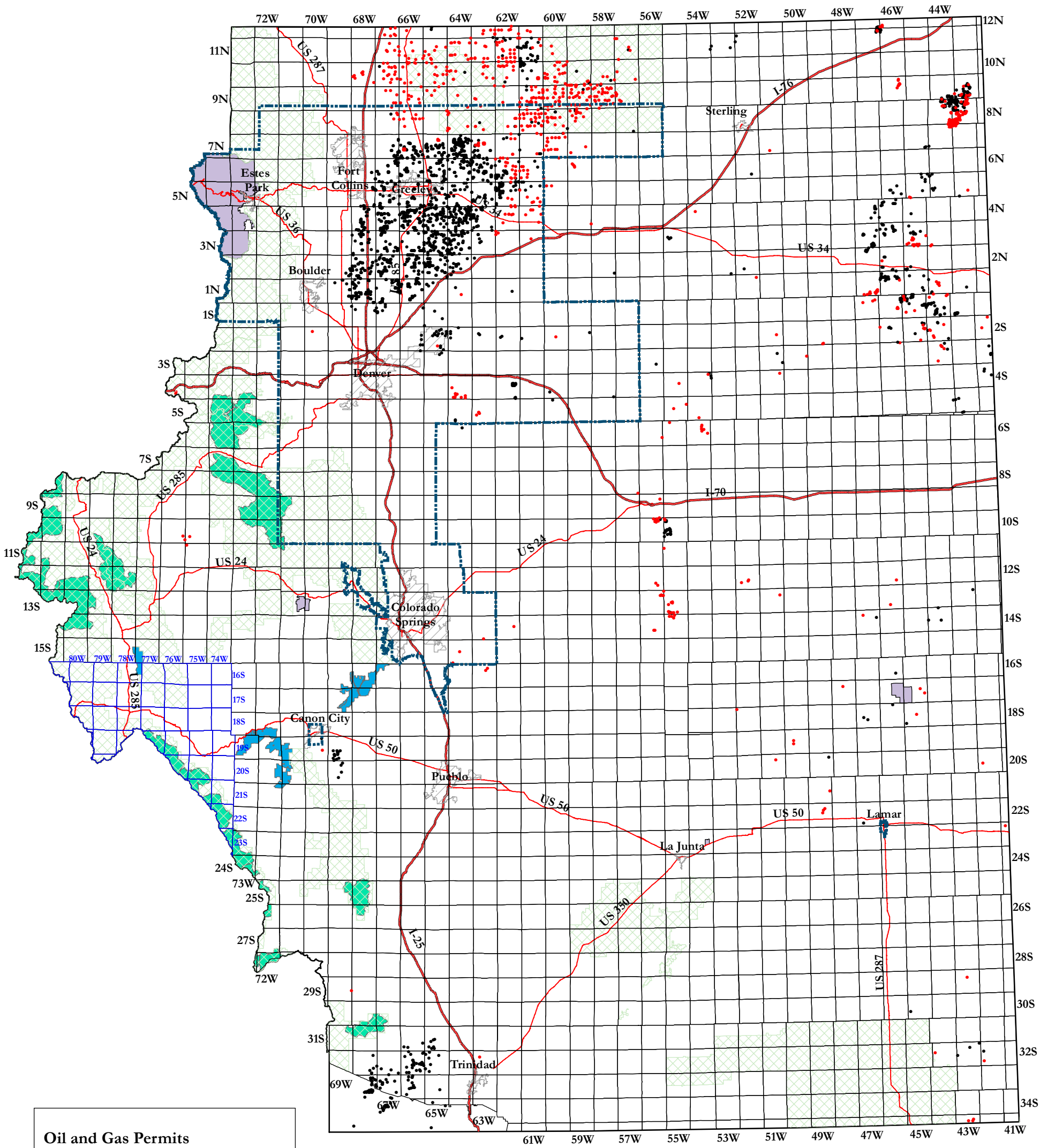

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Figure 8b.

Locations of all active new well permits within the Greater Wattenberg AQNAA of the Royal Gorge Planning Area. Data from the Colorado Oil and Gas Conservation Commission (2012).

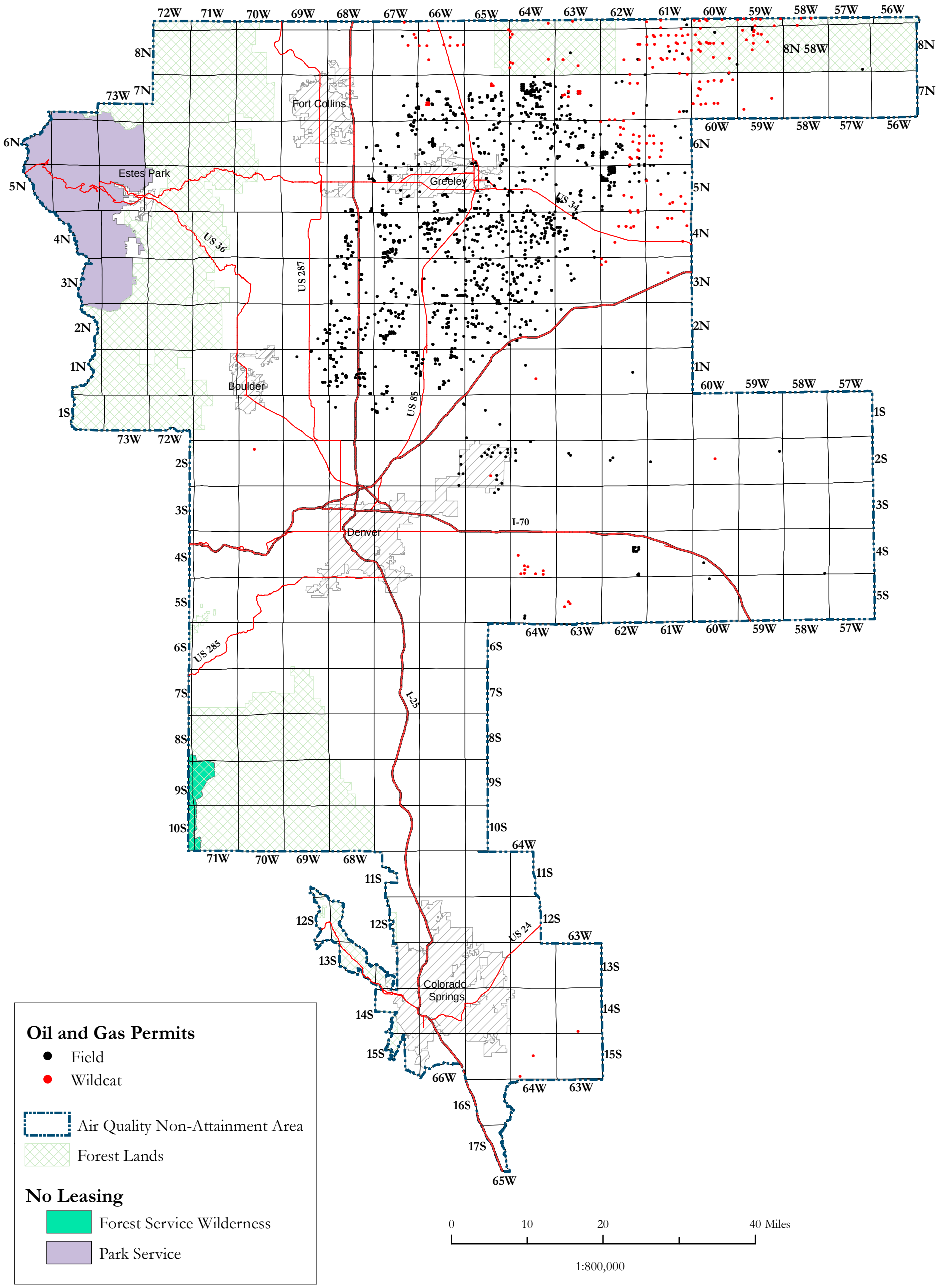

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Figure 8c.

Locations of all active new well permits within the Canon City AQNAA of the Royal Gorge Planning Area. Data from the Colorado Oil and Gas Conservation Commission (2012).

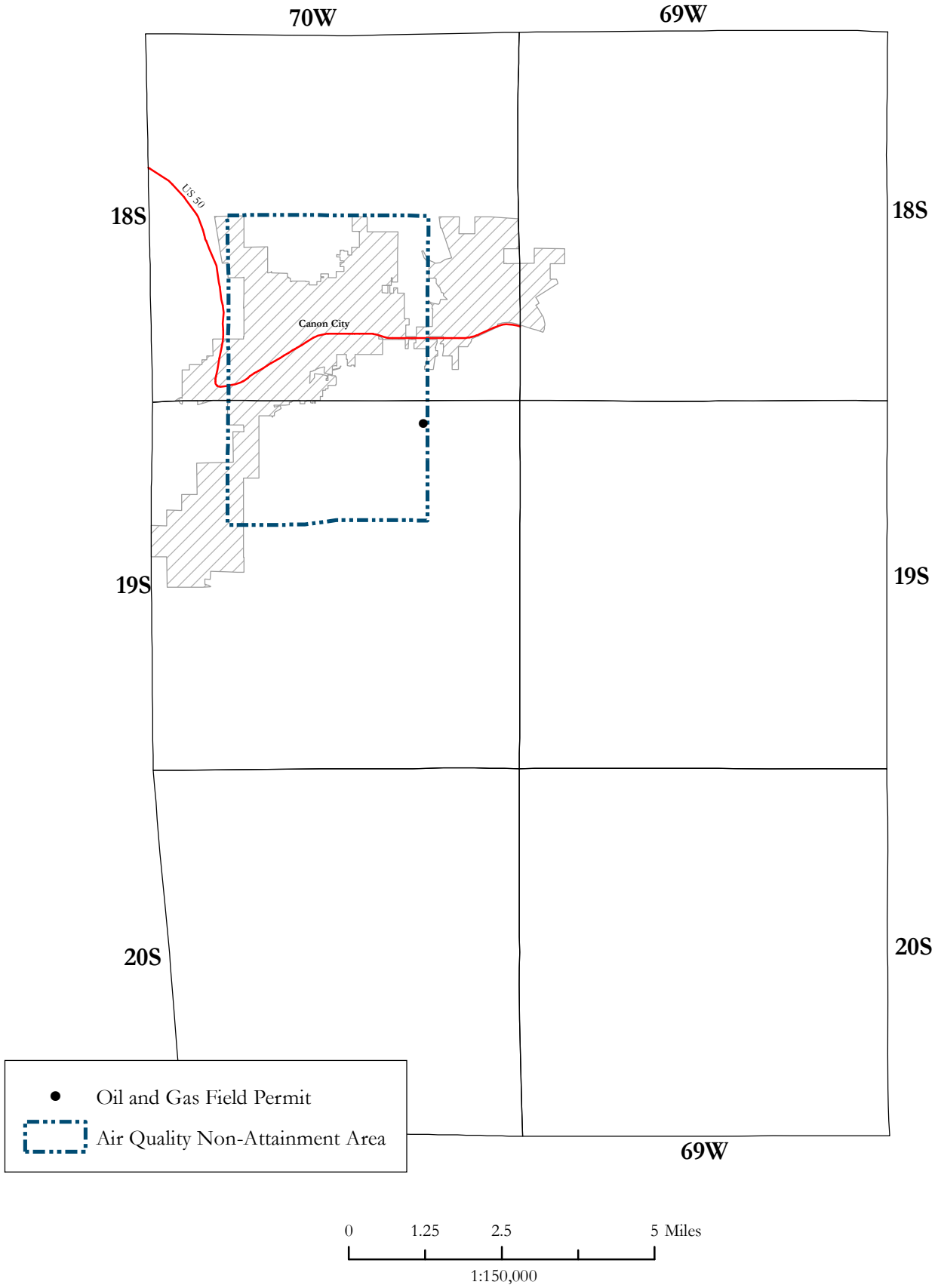

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Figure 9a.
Locations of conventional oil and gas wells spudded between January, 2007 and December, 2011 within the Royal Gorge Planning Area. Data from IHS Energy Group (2012).

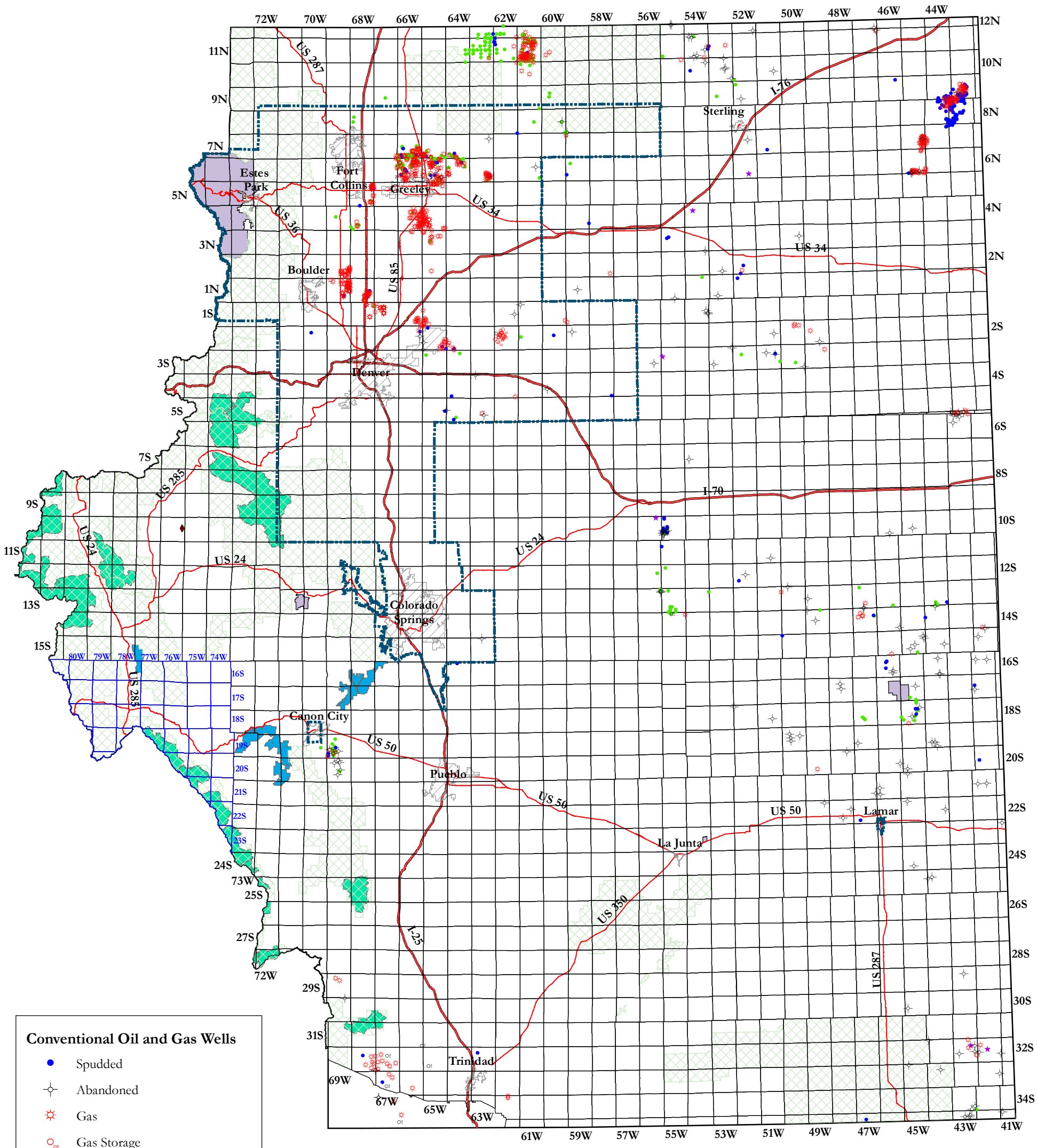

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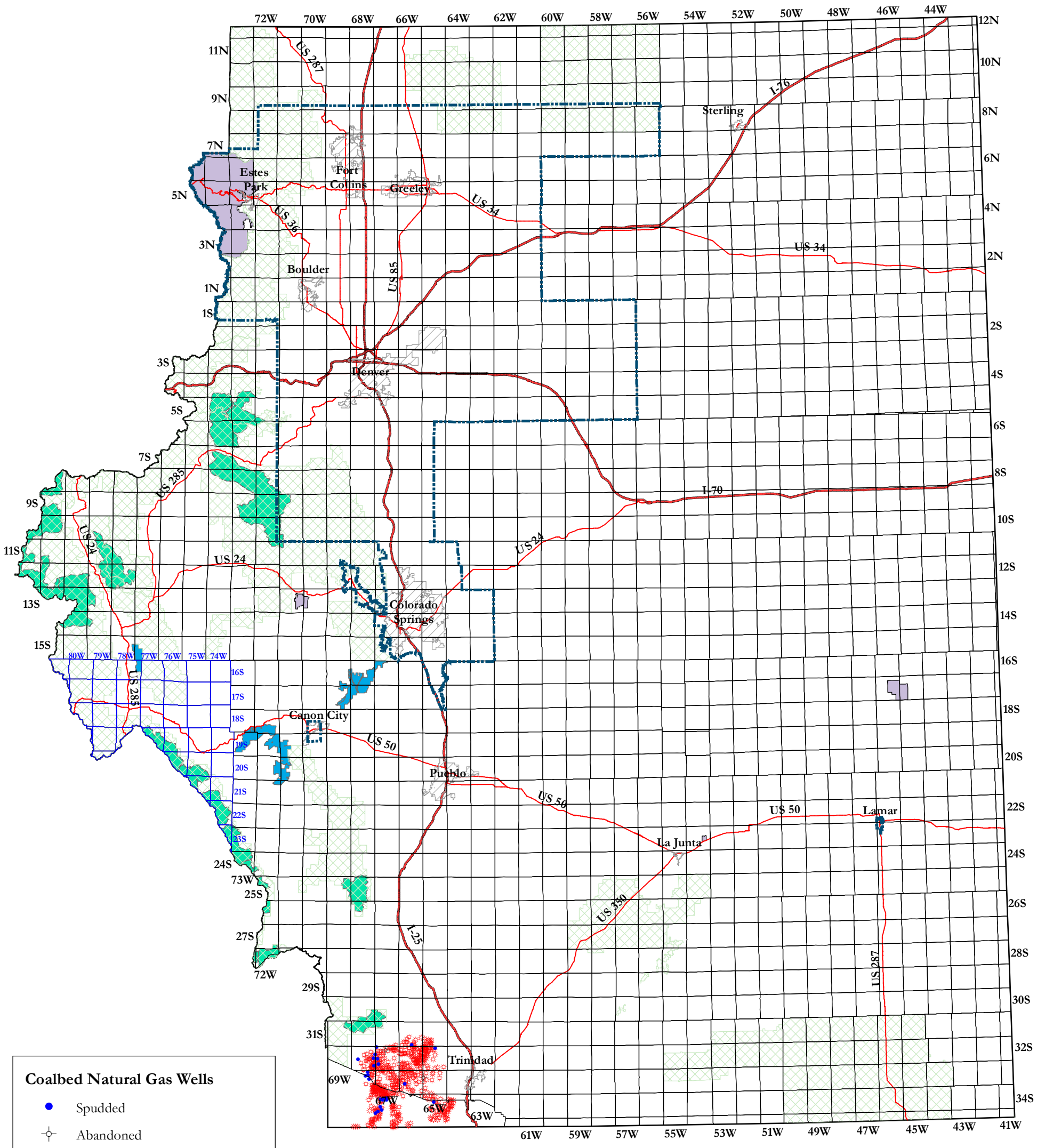
Figure 9b.

Locations of coalbed natural gas wells spudded between January, 2007 and December, 2011 within the Royal Gorge Planning Area. Data from IHS Energy Group (2012).



Coalbed Natural Gas Wells

- Spudded
- Abandoned
- Coalbed Natural Gas

Air Quality Non-Attainment Areas

Forest Lands

No Leasing

- BLM Wilderness Study Areas
- Forest Service Wilderness
- Park Service

0 25 50 100 Miles

1:1,625,000

N

March, 2012

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Figure 10.

Locations of directional and horizontal wells spudded in the Royal Gorge Planning Area from January, 2007 through December, 2012. Data from IHS Energy Group (2012).

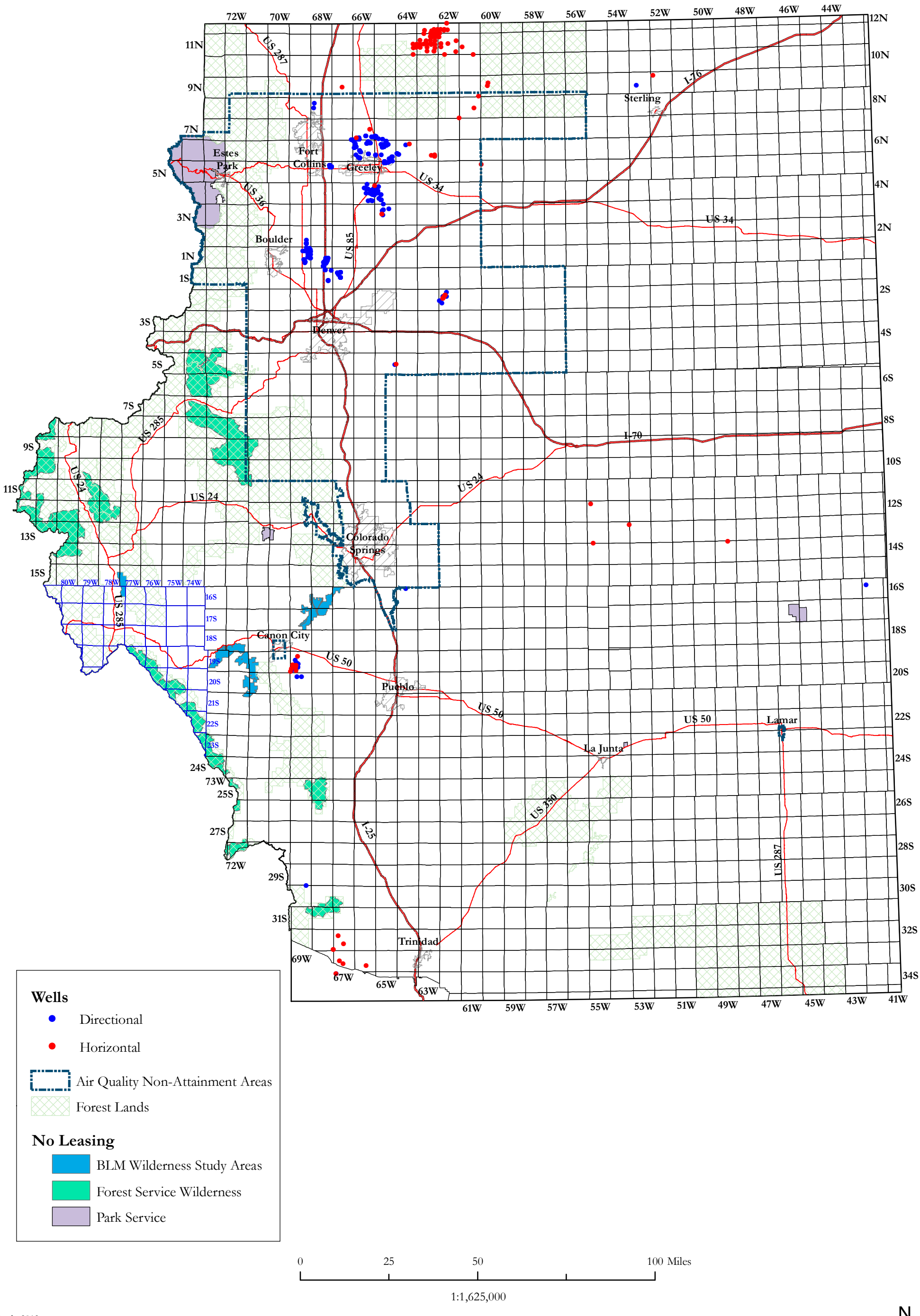

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Figure 11a.

Location of conventional oil and gas wells spudded between January, 2007 and December, 2011 within the Greater Wattenberg AQNAA of the Royal Gorge Planning Area. Field data from IHS Energy Group (2012).

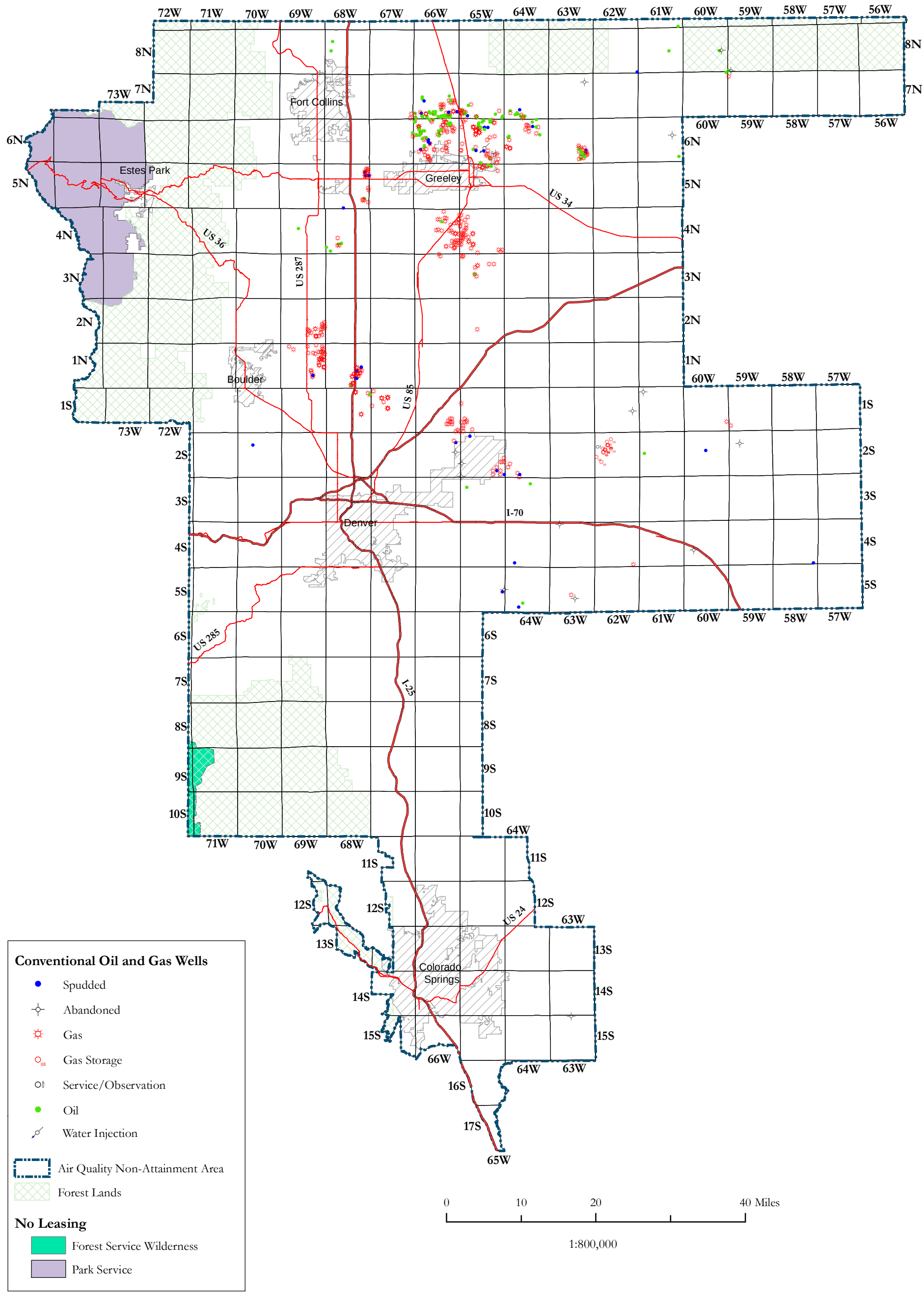

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Figure 11b.

Location of conventional well spudded between January, 2007 and December, 2011 within the Canon City AQNAA of the Royal Gorge Planning Area. Field data from IHS Energy Group (2012).

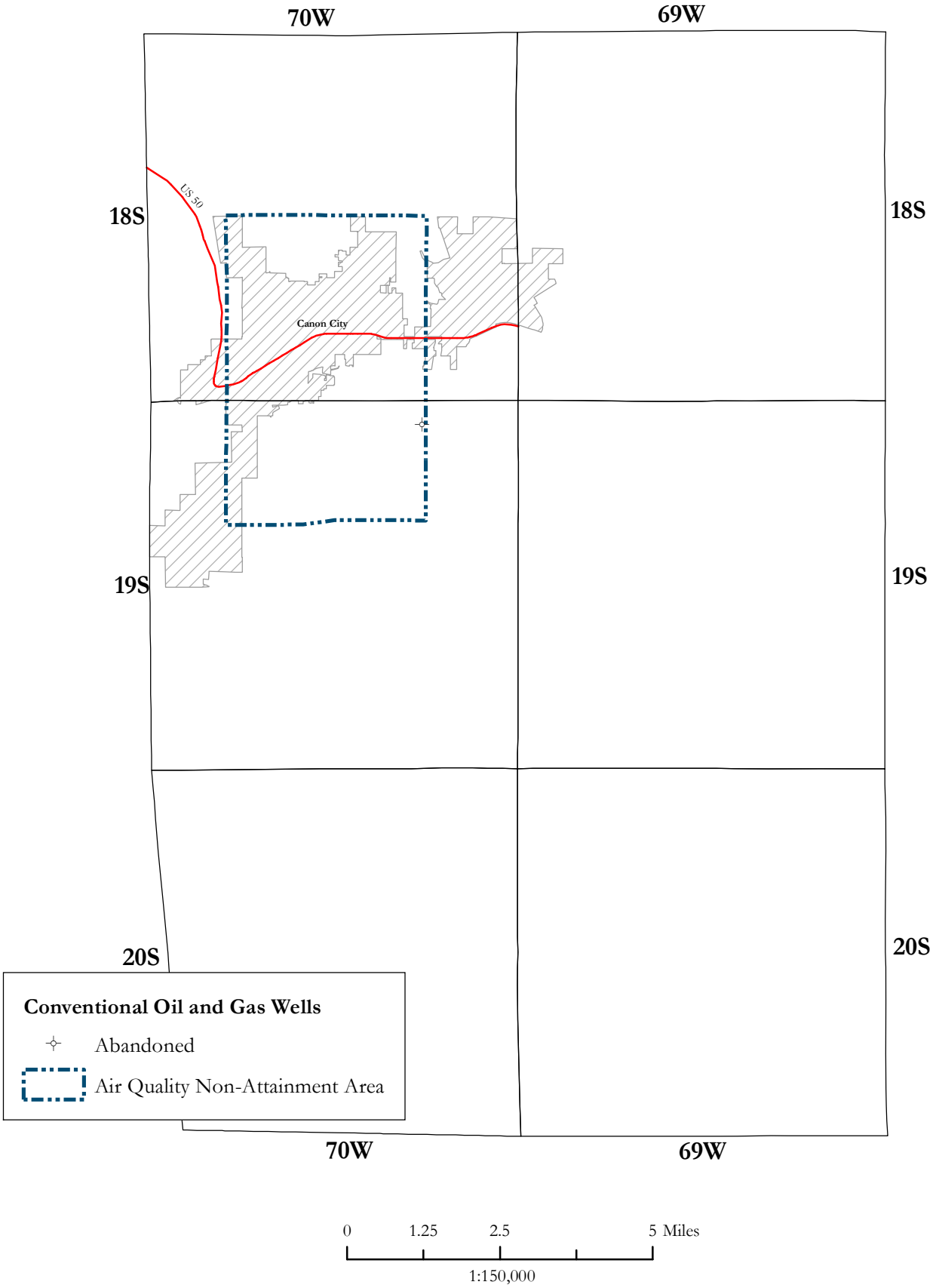

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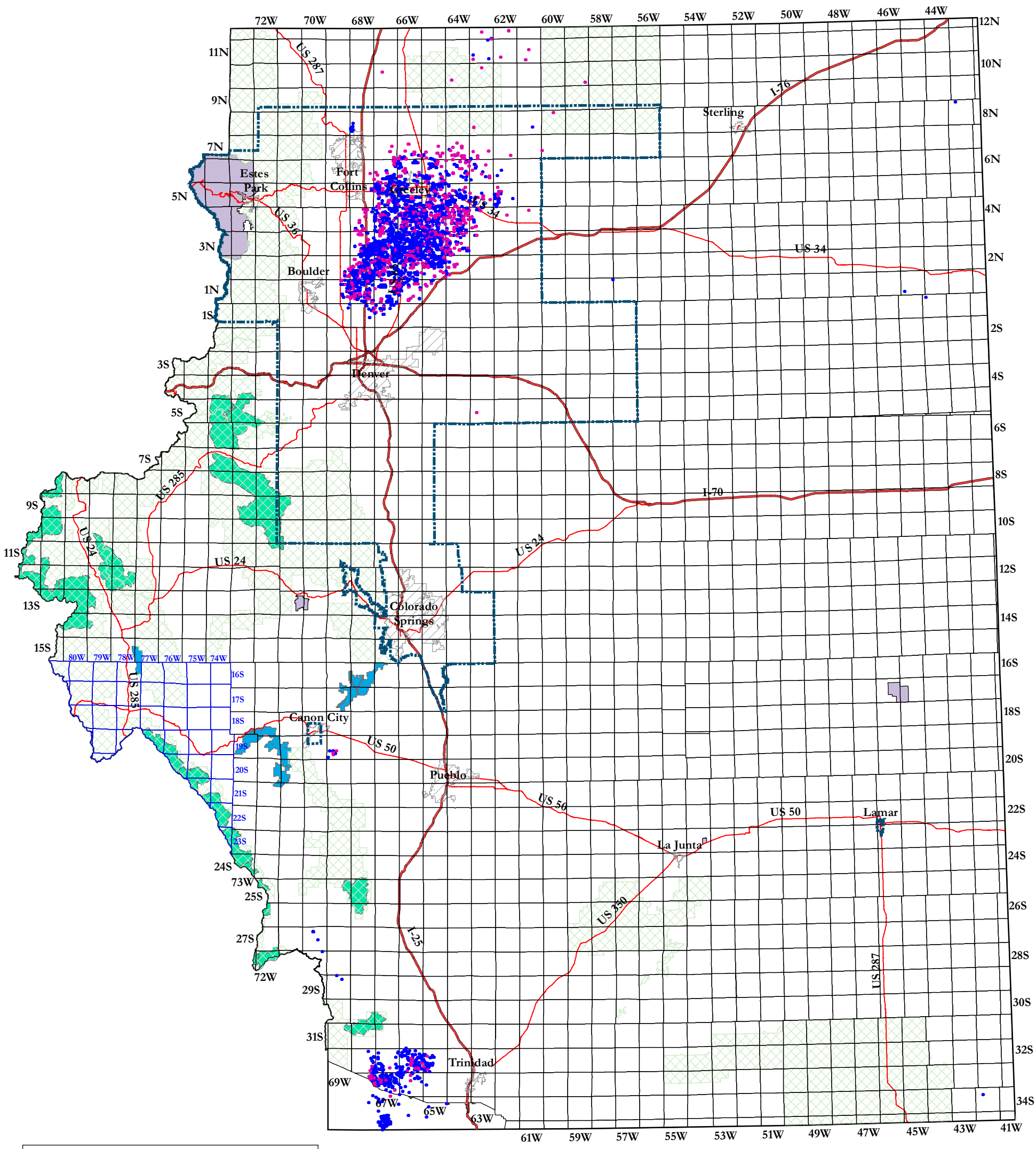
Figure 12a.
Locations of active and permitted wells on well pads with two or more wells per pad, within the Royal Gorge Planning Area. Well data from Colorado Oil and Gas Conservation Commission (2012).



Well Pads

- Active Wells
- Permitted Wells
- Air Quality Non-Attainment Areas
- Forest Lands

No Leasing

- BLM Wilderness Study Areas
- Forest Service Wilderness
- Park Service

0 25 50 100 Miles

1:1,625,000

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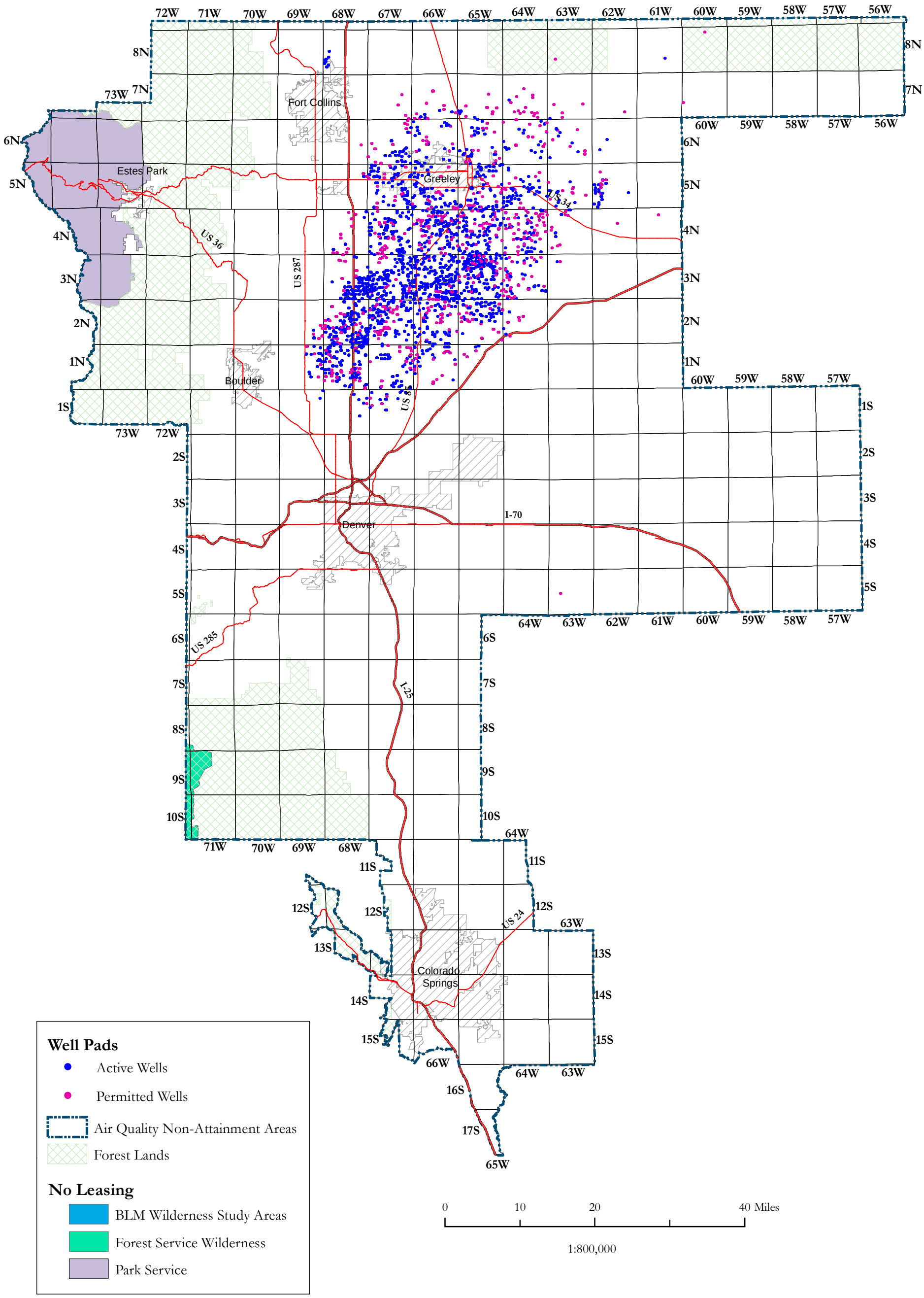
Figure 12b.

Locations of active and permitted wells on well pads with two or more wells per pad, within the Greater Wattenberg AQNAA of the Royal Gorge Planning Area. Well data from Colorado Oil and Gas Conservation Commission (2012).



February, 2012

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Figure 13. Colorado historical natural gas prices with future natural gas price projections (Energy Information Administration, 2011).

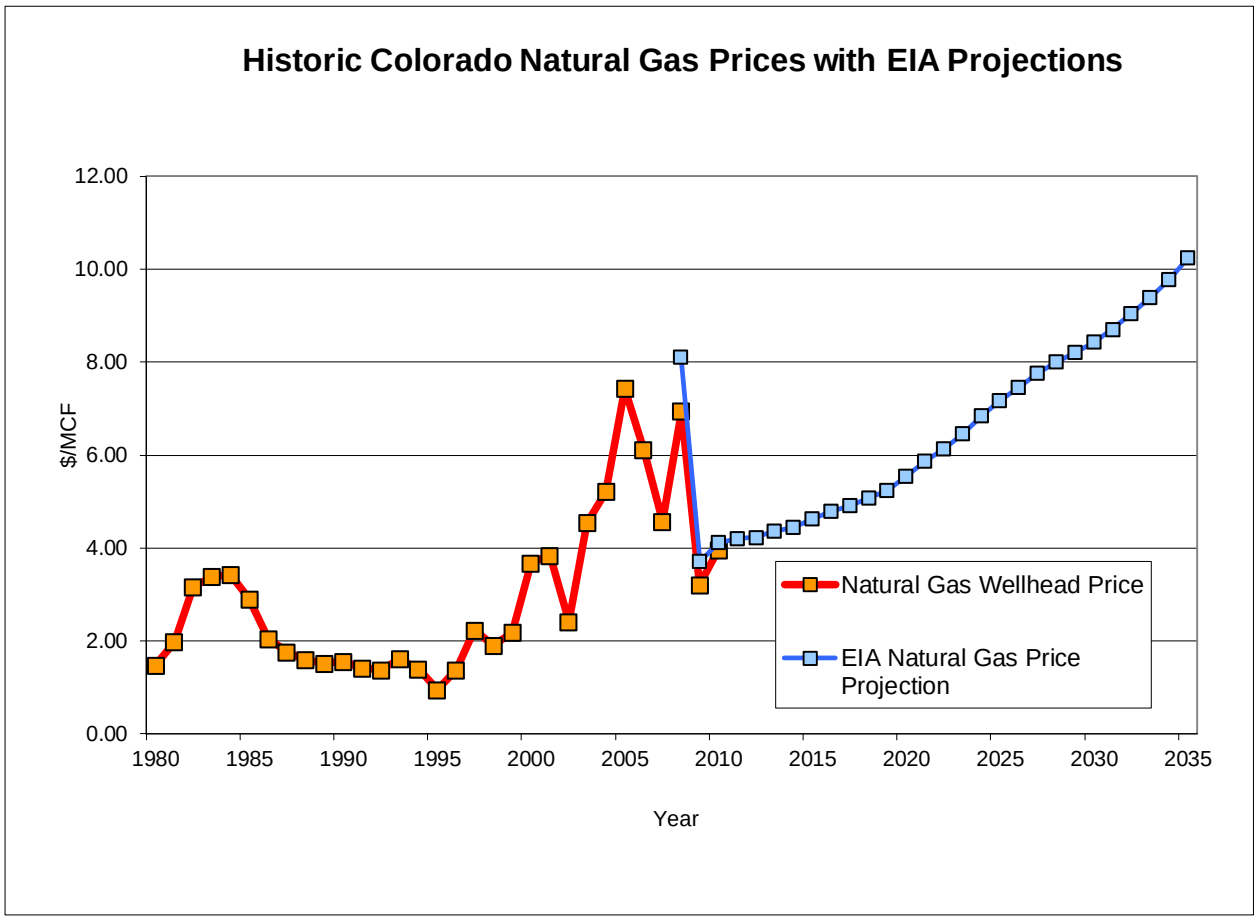


Figure 14. Colorado historical crude oil prices with future oil price projections (Energy Information Administration, 2011).

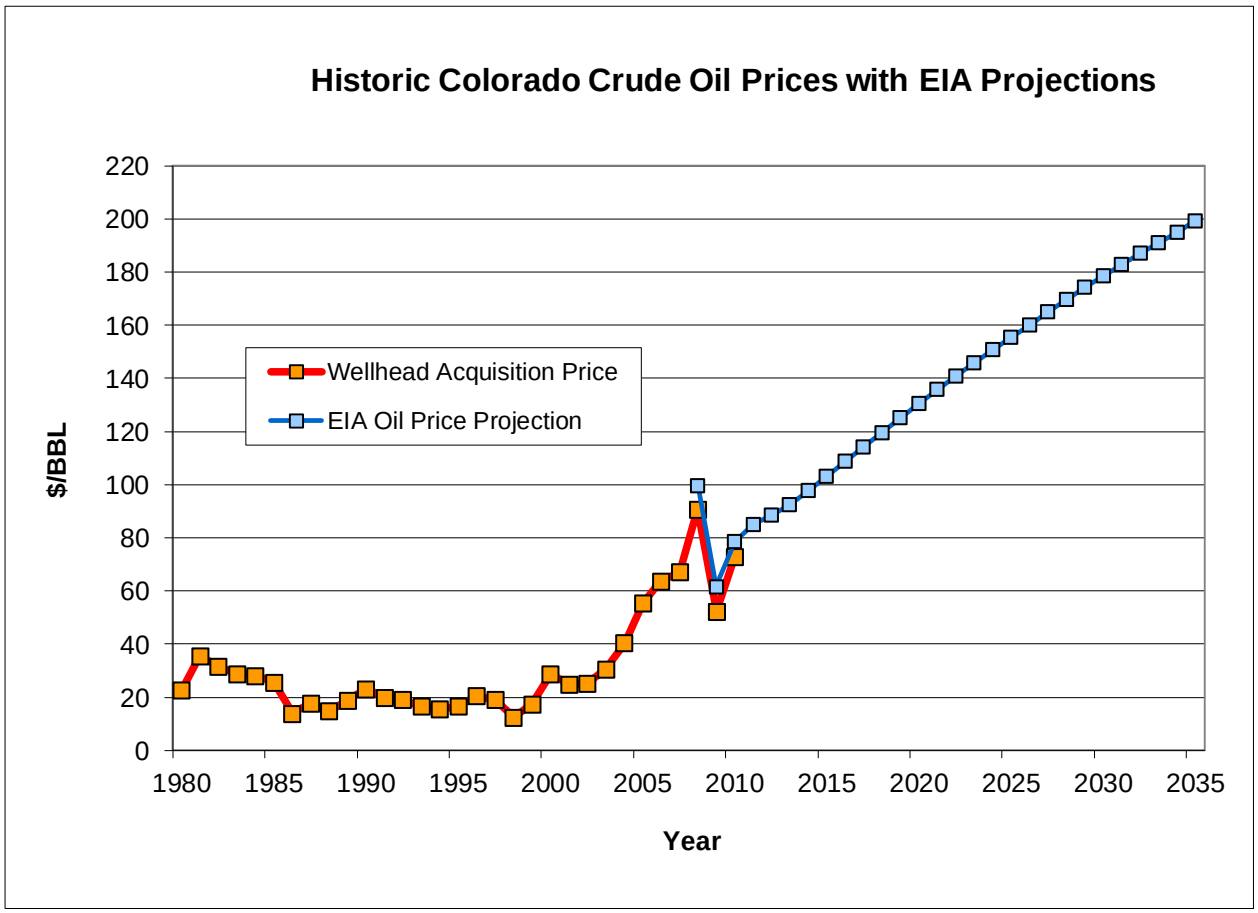
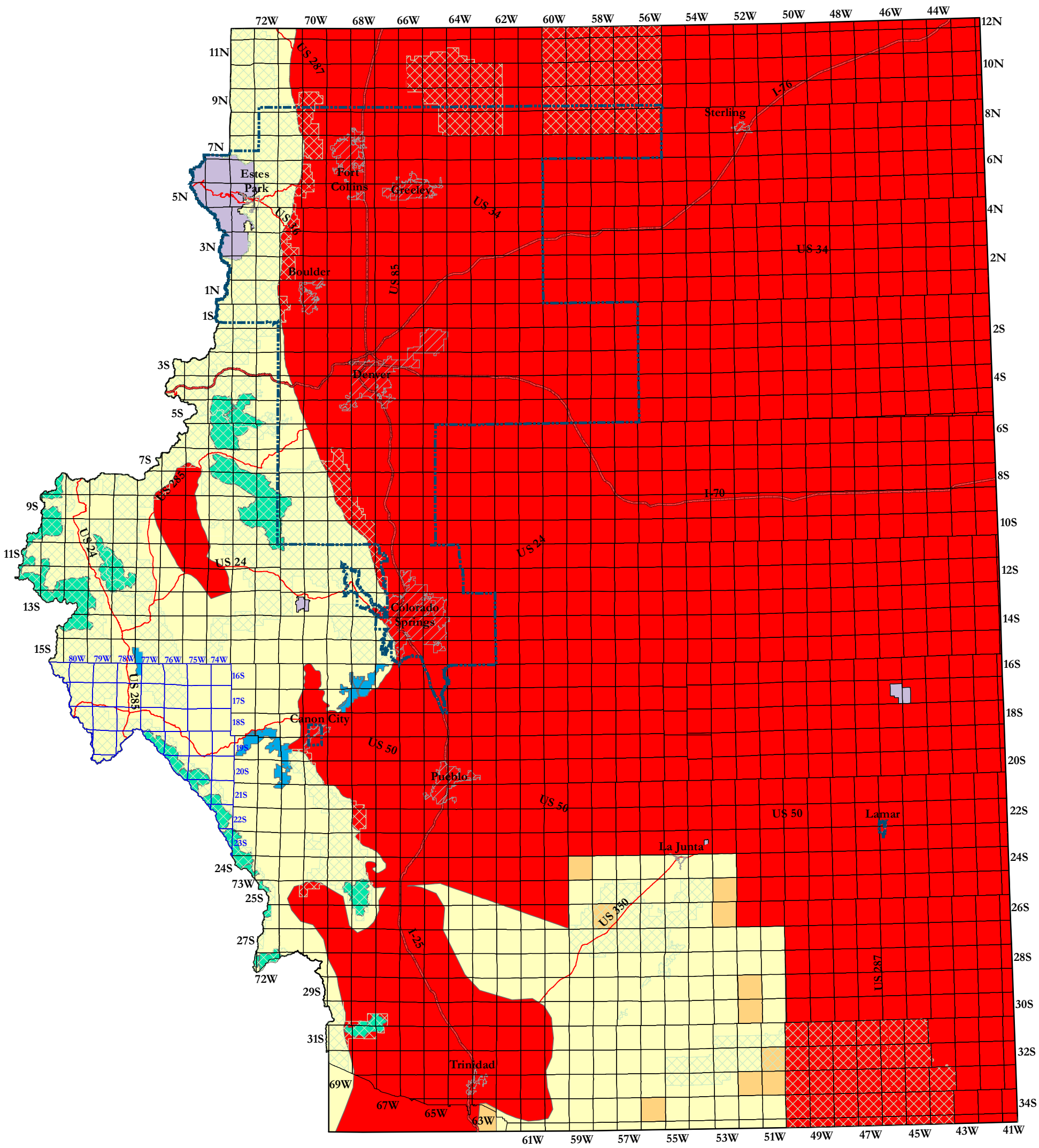


Figure 15.

Potential for occurrence of oil and gas (excluding coalbed natural gas) for the Royal Gorge Planning Area.



Conventional Oil and Gas Occurrence Potential

- High
- Medium
- Low

- Air Quality Non-Attainment Areas
- Forest Lands

No Leasing

- BLM Wilderness Study Areas
- Forest Service Wilderness
- Park Service

0 25 50 100 Miles

1:1,625,000

N

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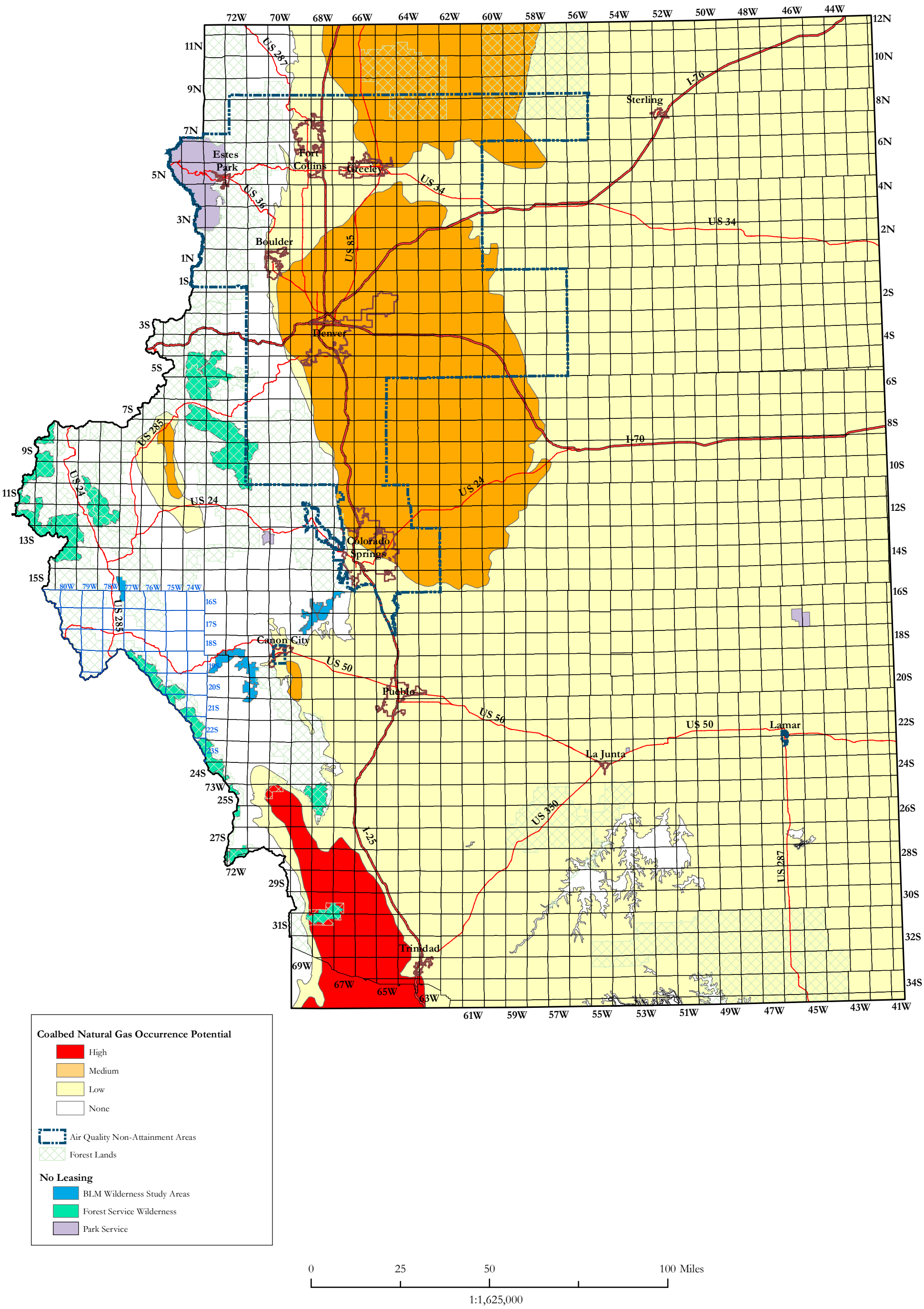
Figure 16.
Potential for occurrence of coalbed natural gas within the Royal Gorge Planning Area.



March, 2012

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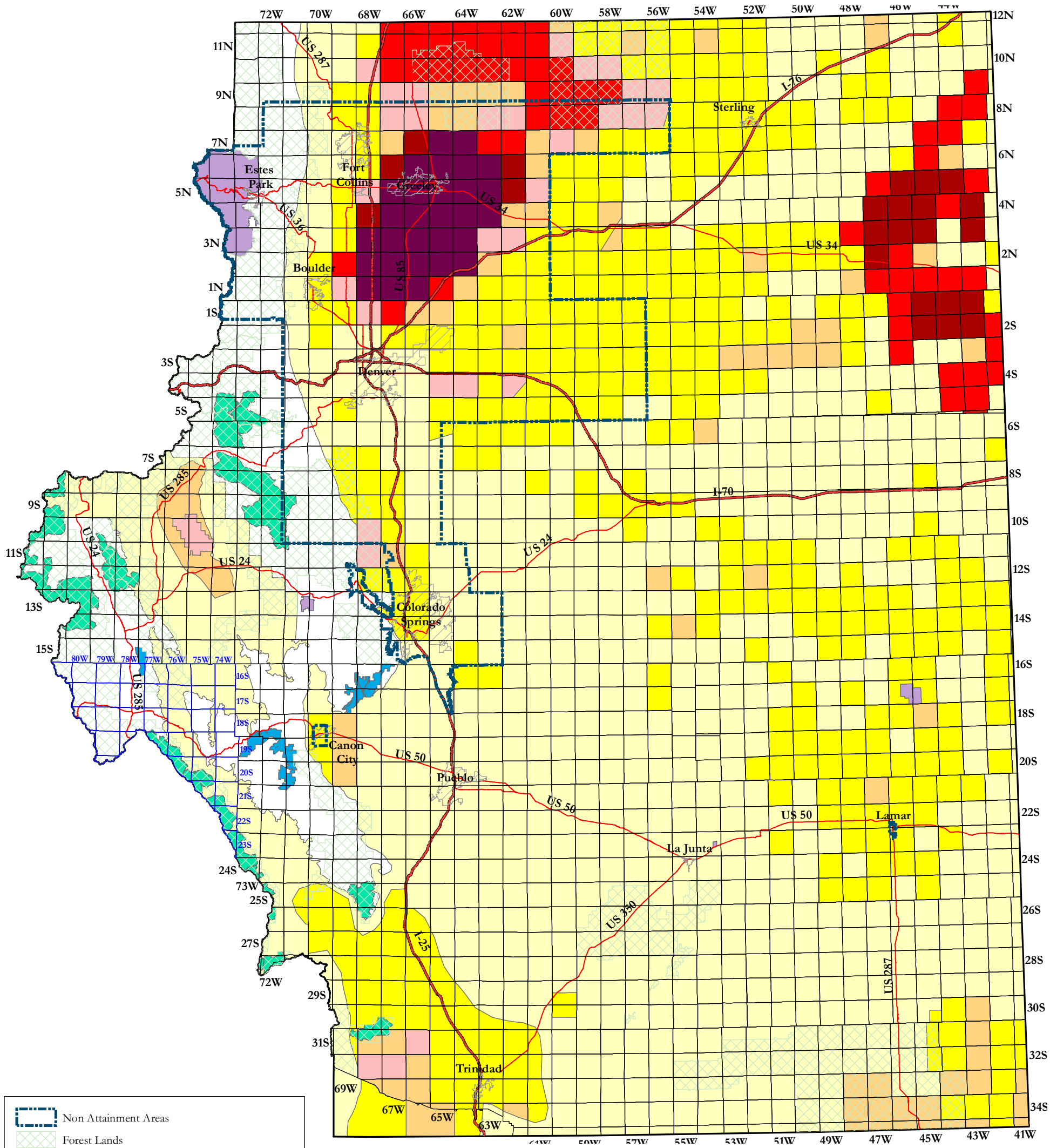
Figure 17.

Oil and Gas development potential (excluding coalbed natural gas) and projected drilling densities within the Royal Gorge Planning Area for 2011 through 2030.



Non Attainment Areas

Forest Lands

Conventional Development Potential

- Very High (Wattenberg) -- > 150 wells/township
- Very High -- > 50 to 150 wells/township
- High -- > 20 to 50 wells/township
- Moderately High -- 10 to 20 wells/township
- Moderate -- 5 to < 10 wells/township
- Low -- 1 to < 5 wells/township
- Very Low -- < 1 well/township
- None
- BLM Wilderness Study Areas--Not Assessed
- Forest Service Wilderness--Not Assessed
- National Park Service--Not Assessed

0 25 50 100 Miles

1:1,625,000

March, 2012

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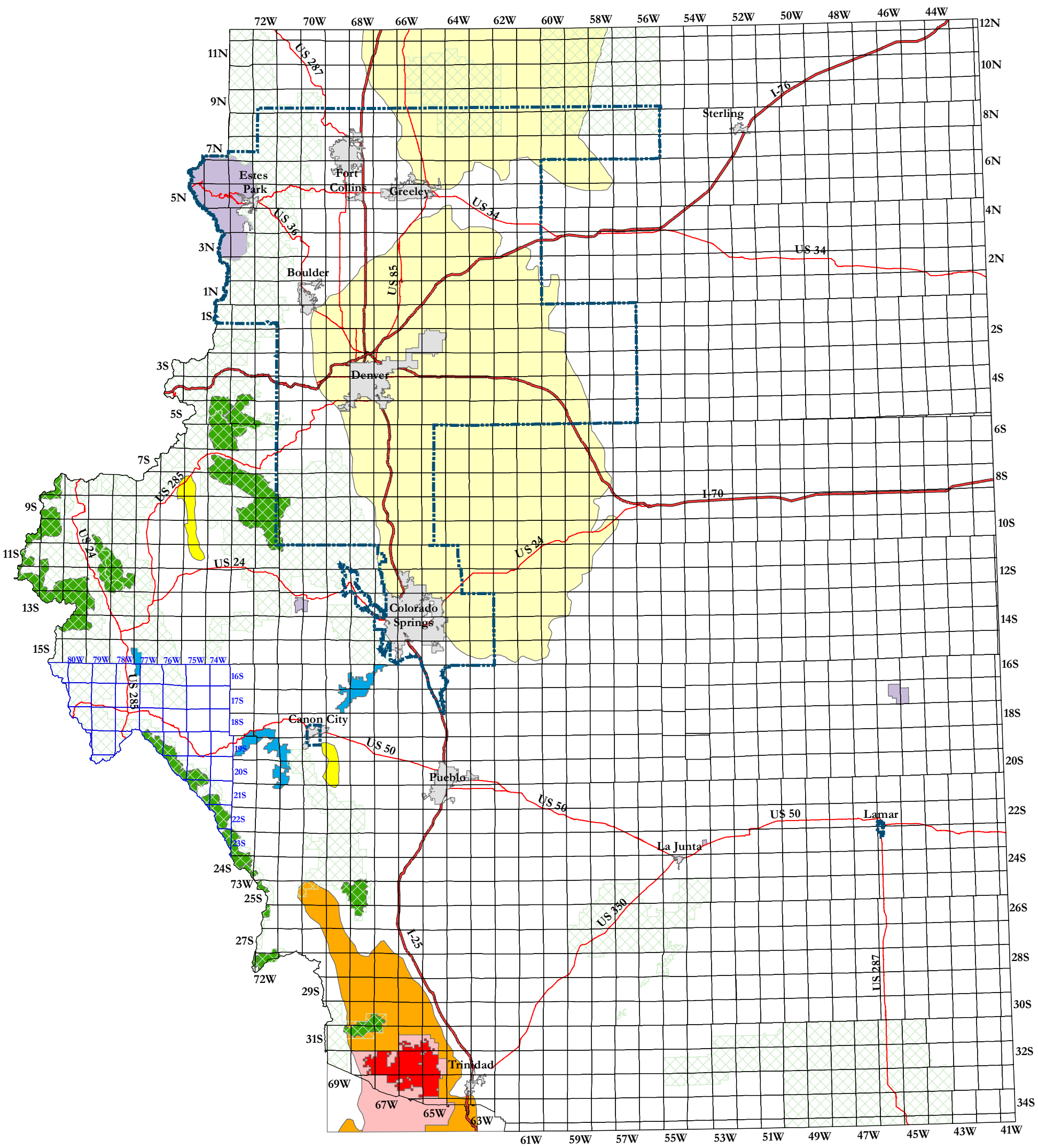
N

Figure 18.

Coalbed natural gas development potential and projected drilling densities within the Royal Gorge Planning Area for 2011 through 2030.



Non Attainment Areas

Forest Lands

Coalbed Natural Gas Development Potential

- Very High = > 30 wells/township
- High = > 10 to 30 wells/township
- Moderate = 5 to 10 wells/township
- Low = < 5 wells/township
- Very Low = < 1 well/township
- None = No wells
- BLM Wilderness Study Areas--Not Assessed
- Forest Service Wilderness--Not Assessed
- National Park Service--Not Assessed

0 25 50 100 Miles

1:1,625,000

March, 2012

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N

Table 1a. Operators in Royal Gorge Planning Area with more than 300 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Noble Energy Inc.	Antelope	2
	Antler	3
	Aristocrat	4
	Aristocrat NE	4
	Baby Doe	1
	Banner Lakes	11
	Barbwire	1
	Baxter Lake	13
	Beecher Island	55
	Bennett	2
	Blizzard	3
	Boulder	1
	Boulder Valley	15
	Bracewell	115
	Bromley	1
	Chieftain	5
	Chinook	1
	Clay Basket	5
	Comanche Creek	3
	Crow Creek	23
	Dance South	1
	Duke	15
	Eaton	78
	Elm Grove	1
	Fence Post	1
	Fury	15
	Galeton	10
	Greasewood	2
	Greeley	80
	Grover	101
	Hambert	51
	Harlech	13
	Hawkeye	3
	Holster	2
	Horse Creek	1
	Irondale	1
	Jamboree	11
	Johnstown	4
	Jupiter	7
	Kersey	80
	Kiowa Creek	1
	Krauthead	3
	Lakeside	1
	Lanyard	5
	Lapoudre	8
	Lapoudre South	5
	Lido	2
	Lilli	61
	Line Camp	2
	Longbranch	2
	Lost Creek	2
	Noonen Ranch S	1
	Owl Creek	22
	Poe	1
	Pommel	3
	Pommel West	3
	Puma	1
	Quail	1
	Quarry	1
	Quill	2
	Radar	4
	Republican	315
	Roggen	1
	Schramm	67
	Severance	2
	Shout	9
	Spindle	30
	Sun	1
	Sun Spot	1
	Surveyor Creek	2
	Tierra Plano	4
	Tom Cat	12
Noble Energy Inc.	Trapper	9
	Tribute	1
	Trigger	1
	Vernon	49
	Warlock	1
	Wattenberg	6,440
	Whistle	1
	Wickiup	1
	Wigwam	1
	Yodel	21
	Zenith	3
	Unnamed	23
	Total	7,871
Kerr-McGee Oil & Gas Onshore LP	Aristocrat	15
	Banner	7
	Baxter Lake	1
	Bracewell	3
	Eaton	2
	Greeley	19
	Hambert	63
	Kersey	7
	Lost Creek	4
	Peacock	2
	Prospect	1
	Spenson	4
	Spindle	237
	Third Creek	5
	Wattenberg	4,969
	Total	5,339
Pioneer Natural Resources USA Inc.	Purgatoire River	2,395
	Unnamed	4
	Total	2,399
Petroleum Development Corp.	Antelope	7
	Armel	5
	Beecher Island	177
	Bonny	2
	Bracewell	6
	Buckboard	4
	Council	26
	Crystal	1
	Duke	15
	Eaton	136
	Greeley	28
	Harlech	2
	Johnson's Corner	1
	Johnstown	9
	Kersey	43
	Krieger	3
	Republican	77
	Schramm	7
	Severance	5
	Shout	5
	Stones Throw	16
	Vernon	57
	Wattenburg	1,242
	Whisper	4
	Unnamed	7
	Total	1,885
Encana Oil & Gas (USA) Inc.	Aristocrat	53
	Hambert	10
	Space City	1
	Spindle	52
	Stage Stop	1
	Wattenberg	975
	Total	1,092

Table 1a. Operators in Royal Gorge Planning Area with more than 300 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Augustus Energy Partners LLS	Beecher Island	16
	Beecher West	9
	Blizzard	7
	Bonny	1
	Buckboard	20
	Buffalo Grass	103
	Duke	73
	Eckley	160
	Mildred	1
	Old Baldy	25
	Peregrine	10
	Phuma	23
	Republican	57
	Rock Creek	97
	Schramm	60
	Shout	4
	Tierra Planno	24
	Unnamed	11
	Vernon	118
	Wages	18
	Waverly	40
	Whisper	14
	Yodel	54
	Total	945
Rosewood Resources Inc.	Armel	18
	Bonny	20
	Buckboard	60
	Buffalo Grass	26
	Eckland	8
	Eckley	45
	Heartstrong	4
	Mildred	91
	Old Baldy	174
	Phuma	8
	Rock Creek	36
	Shout	29
	Stones Throw	2
	Sunrise	14
	Tierra Plano	5
	Wages	31
	Waverly	230
	Whisper	58
	Unnamed	5
	Total	864
KP Kauffman Company Inc.	Banner Lakes	1
	Bombing Range	13
	Boxer	4
	Byers	3
	Cabin Creek	1
	Dandy	1
	Dipper Gap	1
	Fairway	1
	Gazelle	3
	Hambert	14
	Holster	2
	Irondale	2
	Ironhorse	1
	Jamboree	11
	Lonestar	1
	Minto	3
	Peak View	1
	Pronghorn	4
	Quarry	1
	Sidewinder	4
	Spindle	661
	Trapper	5
	Wattenberg	120
	Wild Horse	1
	Total	859
Merit Energy Company	Aristocrat NE	7
	Bear Gulch SW	1
	Bracewell	24
	Chieftain	2
	Eaton	32
	Greeley	25
	Hambert	3
	Jamboree	1
	Kersey	17
	Maria	9
	Spindle	16
	Third Creek	1
	Trapper	2
	Wattenberg	609
	Total	749
XTO Energy Inc.	Purgatoire River	492
Omimex Petroleum Inc.	Ballyneal	234
	Holyoke South	44
	Wauneta	56
	Unnamed	3
	Total	337

Table 1b. Operators in Royal Gorge Planning Area with 100 to 300 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Mountain Petroleum Corp.	Beecher Island	231
	Bromley	1
	De Nova	3
	Duke	2
	Phuma	15
	Pony Express	1
	Republican	2
	Spear	1
	Vernon	20
	Wages	9
	Total	285
Great Western Oil & Gas Co. LLC	Base Line	1
	Bear Gulch	1
	Bracewell	5
	Cable	1
	Chieftain	12
	Coalbank Creek	2
	Cougar	4
	Dance South	1
	Eaton	13
	Ferret	3
	Galeton	3
	Greeley	3
	Guidon	1
	Hawkeye	1
	Jamboree	3
	Krauthead	2
	Lanyard	1
	Lapoudre	14
	Lapoudre South	5
	Little Beaver	3
	Mount Pearl	1
	Porter	1
	Prospect	1
	Quail	1
	Radar	4
	Rimrock	1
	Roggen	1
	Scabbard	7
	Sonar	2
	Spindle	3
	Third Creek	4
	Wattenberg	133
	Wigwam	1
	Unnamed	1
	Total	240
Bonanza Creek Energy Oper. Co. LLC	Hambert	2
	NE Riverside II	2
	North Riverside	28
	Riverside	1
	Wattenberg	177
	Total	210
Unioil	Johnson's Corner	5
	King Lake	1
	Wattenberg	202
	Total	208

Operator	Field Name	Wells Operated
Citation Oil & Gas Corp.	Arapahoe	50
	Arapahoe-East	13
	Archer	1
	Aztecan	1
	Bledsoe Ranch	17
	Castle Peak	2
	Clifford	1
	Dino	1
	Fallow	1
	Fever Pitch	1
	Frontera	26
	Harker Ranch	3
	Jace	7
	Ladder Creek	2
	Longhorn Gulch	1
	Lookout	3
	Mayfield	3
	Mount Pearl	30
	Padroni West	19
	Pennypacker	2
	Smoky Creek	1
	Smoky Hill	1
	Sorrento	9
	Speaker	13
	Total	208
Fidelity Expl. & Prod. Company	Bonny	199
Black Raven Energy Inc.	Adena	163
	Amherst	21
	Marks Butte	1
	Unnamed	4
	Total	189
Foundation Energy Management LLC	Antler	1
	Banner Lakes	3
	Barbwire	1
	Base Line	3
	Big Bend	1
	Bracewell	4
	Chieftain	6
	Deer Trail	1
	Gambrel	1
	Hawkeye	6
	Irondale	1
	Jamboree	7
	Krauthead	6
	Lakeside	2
	Longbranch	2
	Lost Creek	2
	Mandella	3
	Nile	11
	Porter	3
	Quail	2
	Rimrock	1
	Scabbard	2
	Sonar	2
	Spindle	71
	Springdale	3
	Sun	2
	Tampa	3
	Trapper	1
	Trapper South	5
	Trigger	1
	Warlock	6
	Wattenberg	17
	Zenith	3
	Total	183

Table 1b. Operators in Royal Gorge Planning Area with 100 to 300 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Colorado Interstate Gas Company LLC	Flank	74
	Fort Morgan	33
	Latigo	44
	Longbranch	1
	Totem	20
	Young	1
	Total	173
Stelbar Oil Corp. Inc.	Abarr	6
	Black Hollow	7
	Dapper	7
	De Nova	55
	Feral	2
	Longknife	3
	Old Baldy	4
	Pierce	11
	Price Ranch	7
	Spear	13
	Waverly	21
	White Eagle	31
	Unnamed	1
	Total	168
Renegade Oil & Gas Company LLC	Ambush	1
	Bear Gulch	1
	Bennett	2
	Bent's Fort	3
	Beta	6
	Brave	3
	Buckskin East	1
	Caledonia	2
	Chalice	5
	Chieftain	1
	Chinook	1
	Colt	4
	Colt Southeast	1
	Comanche Creek	20
	Cougar	3
	Deadeye	4
	Deer Trail	1
	Doubletree	1
	Dragoon	15
	Dust Devil	1
	Hombre	1
	Irondale	10
	Jamboree	6
	Kitty	1
	Longbranch	7
	Lowry	2
	McClave	1
	Patrol	3
	Peak View	5
	Proghorn	1
	Radar	11
	Roughneck	4
	Sun	2
	Trapper	7
	Trigger	2
	Warlock	1
	Wattenberg	13
	Zenith	2
	Total	155
Bill Barrett Corporation	Ambush	5
	Bracewell	10
	Eaton	15
	Lapoudre	1
	Maria	2
	Severance	9
	Spindle	4
	Third Creek	10
	Wattenberg	88
	Total	144
Mull Drilling Company Inc.	Arapahoe	39
	Brandon	3
	Buscadero	1
	Cavalry	1
	Cheyenne Wells	15
	Clifford	3
	Elephant	1
	Eureka Creek	1
	Frontera	2
	Ladder Creek	2
	Loma	1
	Mayfield	6
	Meteor	2
	Portal	1
	Quiver	12
	Salerno	1
	Salis	3
	Smoky Creek	13
	Sorrento	21
	Spur	1
	Tonto	1
	Trooper North	3
	Unnamed	3
	Total	136
Bayswater Exploration & Production LLC	Badger Creek	3
	Banner Lakes	2
	Bracewell	5
	Eaton	13
	Gunbarrel	1
	Irondale	6
	Jamboree	2
	Krauthead	2
	Ramey	1
	Sidewinder	1
	Spindle	51
	Wattenberg	39
	Total	126

Table 1b. Operators in Royal Gorge Planning Area with 100 to 300 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Western Operating Company	Adena	4
	Amber	1
	Barrel Ranch	6
	Beecher Island	1
	Bijou	1
	Bobcat	19
	Bonanza-North	4
	Brandon	14
	Busy Bee	2
	Canal	2
	Cedar Creek	2
	Cedar Creek N	1
	Chileno	1
	Elm Grove	2
	Emerald	6
	Goat Hill	2
	Jace	2
	Johnson Hill N	2
	Latch String	2
	Liberty West	1
	Noonen Ranch	2
	Oasis	1
	Pawnee Creek	1
	Peetz Table	1
	Ping	2
	Rago North	3
	Redwing	4
	Sand River	12
	Shears Draw	2
	Stem	1
	Surveyor Creek	2
	Vallery	1
	Wattenberg	1
	Woodrow West	1
	Xenia North	1
	Xenia West	4
	Yenter	2
	Unnamed	3
	Total	119

Operator	Field Name	Wells Operated
El Passo E&P Company LP	Archer	1
	Purgatoire River	115
	Unnamed	1
	Total	117
Magpie Operating, Inc.	Beryl	2
	Johnson's Corner	6
	Little Beaver	14
	Loveland	78
	Pleasant Ridge	2
	Rubicon	1
	Shield	1
	Unnamed	2
	Total	106
Petron Development Company	Buckboard	6
	Calhoun	1
	Duke	5
	High Pockets	5
	Hyde	3
	Republican	8
	Rock Creek	11
	Schramm	8
	Shout	10
	Vernon	3
	Waverly	41
	Whisper	9
	Unnamed	1
	Total	111
Synergy Resources Corporation	Eaton	7
	Greeley	3
	Holland	1
	Kersey	1
	Owl Creek	3
	Wattenberg	85
	Total	100

Table 2a. Operators in Greater Wattenberg AQNAA with more than 250 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Noble Energy Inc.	Antelope	2
	Antler	3
	Aristocrat	4
	Aristocrat NE	4
	Banner Lakes	11
	Barbwire	1
	Baxter Lake	13
	Bennett	2
	Boulder	1
	Boulder Valley	15
	Bracewell	115
	Bromley	1
	Chieftain	5
	Chinook	1
	Clay Basket	5
	Crow Creek	23
	Dance South	1
	Eaton	78
	Fence Post	1
	Galeton	10
	Greasewood	2
	Greeley	80
	Grover	1
	Hambert	51
	Harlech	13
	Hawkeye	3
	Holster	2
	Horse Creek	1
	Irondale	1
	Jamboree	11
	Johnstown	4
	Kersey	80
	Kiowa Creek	1
	Krauthead	3
	Lakeside	1
	Lanyard	5
	Lapoudre	8
	Lapoudre South	5
	Lido	2
	Lilli	61
	Line Camp	2
	Longbranch	2
	Lost Creek	2
	Noonen Ranch S	1
	Owl Creek	22
	Pommel	3
	Pommel West	3
	Puma	1
	Quail	1
	Quarry	1
	Quill	2
	Radar	4
	Roggen	1
	Severance	2
	Spindle	30
	Sun	1
	Sun Spot	1
	Tom Cat	12
	Trapper	9
	Tribute	1
	Trigger	1
	Warlock	1
	Wattenberg	6,439
	Wickiup	1
	Wigwam	1
	Zenith	3
	Unnamed	10
	Total	**7,188**

Operator	Field Name	Wells Operated
Kerr-McGee Oil & Gas Onshore LP	Aristocrat	15
	Banner	7
	Baxter Lake	1
	Bracewell	3
	Eaton	2
	Greeley	19
	Hambert	63
	Kersey	7
	Lost Creek	4
	Peacock	2
	Prospect	1
	Spenson	4
	Spindle	237
	Third Creek	5
	Wattenberg	4,969
	Total	**5,339**
Petroleum Development Corp.	Antelope	7
	Bracewell	6
	Crystal	1
	Eaton	136
	Greeley	28
	Harlech	2
	Johnson's Corner	1
	Johnstown	9
	Kersey	43
	Krieger	3
	Severance	5
	Wattenburg	1,242
	Unnamed	1
	Total	**1,484**
Encana Oil & Gas (USA) Inc.	Aristocrat	53
	Hambert	10
	Space City	1
	Spindle	52
	Stage Stop	1
	Wattenberg	975
	Total	**1,092**
KP Kauffman Company Inc.	Banner Lakes	1
	Bombing Range	13
	Byers	3
	Cabin Creek	1
	Dandy	1
	Fairway	1
	Gazelle	3
	Hambert	14
	Holster	2
	Irondale	2
	Jamboree	11
	Pronghorn	4
	Quarry	1
	Sidewinder	4
	Spindle	661
	Trapper	5
	Wattenberg	120
	Wild Horse	1
	Total	**848**
Merit Energy Company	Aristocrat NE	7
	Bear Gulch SW	1
	Bracewell	24
	Chieftain	2
	Eaton	32
	Greeley	25
	Hambert	3
	Jamboree	1
	Kersey	17
	Maria	9
	Spindle	16
	Third Creek	1
	Trapper	2
	Wattenberg	609
	Total	**749**

Table 2b. Operators in Greater Wattenberg AQNAA with 50 to 250 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Great Western Oil & Gas Co. LLC	Base Line	1
	Bear Gulch	1
	Bracewell	5
	Cable	1
	Chieftain	12
	Coalbank Creek	2
	Cougar	4
	Dance South	1
	Eaton	13
	Ferret	3
	Galeton	3
	Greeley	3
	Guidon	1
	Hawkeye	1
	Jamboree	3
	Krauthead	2
	Lanyard	1
	Lapoudre	14
	Lapoudre South	5
	Porter	1
	Prospect	1
	Quail	1
	Radar	4
	Rimrock	1
	Roggen	1
	Scabbard	7
	Sonar	2
	Spindle	3
	Third Creek	4
	Wattenberg	133
	Wigwam	1
	Unnamed	1
	Total	**236**
Bonanza Creek Energy Oper. Co. LLC	Hambert	2
	NE Riverside II	2
	North Riverside	28
	Riverside	1
	Wattenberg	177
	Total	**210**
Unioil	Johnson's Corner	5
	King Lake	1
	Wattenberg	202
	Total	**208**
Foundation Energy Management LLC	Antler	1
	Banner Lakes	3
	Barbwire	1
	Base Line	3
	Big Bend	1
	Bracewell	4
	Chieftain	6
	Deer Trail	1
	Gambrel	1
	Hawkeye	6
	Irondale	1
	Jamboree	7
	Krauthead	6
	Lakeside	2
	Longbranch	2
	Lost Creek	2
	Mandella	3
	Nile	11
	Porter	3
	Quail	2
	Rimrock	1
	Scabbard	2
	Sonar	2
	Spindle	71
	Sun	2
Foundation Energy Management LLC	Tampa	3
	Trapper	1
	Trapper South	5
	Trigger	1
	Warlock	6
	Wattenberg	17
	Zenith	3
	Total	**180**
Bill Barrett Corporation	Ambush	5
	Bracewell	10
	Eaton	15
	Lapoudre	1
	Maria	2
	Severance	9
	Spindle	4
	Third Creek	10
	Wattenberg	88
	Total	**144**
Bayswater Exploration & Production LLC	Badger Creek	3
	Banner Lakes	2
	Bracewell	5
	Eaton	13
	Gunbarrel	1
	Irondale	6
	Jamboree	2
	Krauthead	2
	Sidewinder	1
	Spindle	51
	Wattenberg	39
	Total	**125**
Renegade Oil & Gas Company LLC	Ambush	1
	Bear Gulch	1
	Bennett	2
	Brave	3
	Buckskin East	1
	Chalice	5
	Chieftain	1
	Chinook	1
	Cougar	3
	Deer Trail	1
	Dragoon	15
	Hombre	1
	Irondale	10
	Jamboree	6
	Kitty	1
	Longbranch	7
	Lowry	2
	Proghorn	1
	Radar	11
	Roughneck	4
	Sun	2
	Trapper	7
	Trigger	2
	Warlock	1
	Wattenberg	13
	Zenith	2
	Total	**104**
Synergy Resources Corporation	Eaton	7
	Greeley	3
	Holland	1
	Kersey	1
	Owl Creek	3
	Wattenberg	85
	Total	**100**

Table 2b. Operators in Greater Wattenberg AQNAA with 50 to 250 active wells. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Enervest Operating LLC	Banner Lakes	8
	Barbwire	5
	Base Line	6
	Bromlley	1
	Cable	1
	Chieftain	1
	Double Eagle	1
	Fence Post	3
	Full House	1
	Holster	2
	Irondale	2
	Jamboree	2
	Kiowa Creek	1
	Krauthead	10
	Lakeside	2
	Lost Creek	2
	Peoria North	2
	Porter	3
	Roggen	26
	Scabbard	1
	Spindle	4
	Wattenberg	3
	Total	**87**
Magpie Operating, Inc.	Beryl	2
	Johnson's Corner	6
	Loveland	78
	Total	**86**
City & County of Denver	Ambush	6
	Banner	1
	Box Elder Ck.	2
	Mandella	1
	Third Creek	29
	Wattenberg	38
	Unnamed	1
	Total	**78**
Colorado Interstate Gas Company LLC	Latigo	44
	Longbranch	1
	Totem	20
	Total	**65**
Machii-Ross Petroleum Co.	Hambert	3
	Spindle	42
	Wattenberg	16
	Total	**61**
Matrix Energy LLC	Chalice	1
	Greeley	3
	Kersey	1
	Longbranch	1
	Quail	3
	Sun	3
	Wattenberg	49
	Total	**61**
Prospect Energy LLC	Fort Collins	**56**
Mineral Resources Incorporated	Wattenberg	**55**
Diversified Operating Corporation	Bird Haven	8
	Buckingham	1
	Caretaker	3
	Crow	19
	Greasewood	2
	Greasewood S.	4
	Sooner	15
	Total	**52**
Hilcorp Energy Company	Bombing Range	4
	Brook	1
	Center Pivot	4
	Cougar	1
	Deep Pockets	1
	Fence Post	1
	Hoffman Creek	1
	Holster	3
	Jamboree	2
	Lost Creek	3
	Sun	2
	Trapper South	3
	Waite Lake	12
	Wattenberg	13
	Total	**51**

Table 3. Operators in Royal Gorge Planning Area with more than 30 active well drilling permits. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Noble Energy Inc.	Aristocrat NE	2
	Bracewell	11
	Crow Creek	10
	Eaton	14
	Fury	1
	Galeton	2
	Greeley	7
	Grover	32
	Hambert	8
	Harlech	1
	Hereford	1
	Jupiter	1
	Kersey	10
	Republican	26
	Schramm	19
	Severance	2
	Spindle	2
	Tom Cat	6
	Unnamed	2
	Vernon	6
	Wattenberg	817
	Wildcat	100
	Total	**1,080**
Kerr-McGee Oil & Gas Onshore LP	Spindle	2
	Wattenberg	400
	Total	**402**
Encana Oil & Gas (USA) Inc.	Aristocrat	1
	Hambert	1
	Spindle	13
	Wattenberg	316
	Total	**331**
EOG Resources Inc.	Hereford	3
	Wattenberg	1
	Wildcat	243
	Total	**247**
Blackraven Energy Inc.	Amherst	30
	Unnamed	56
	Wildcat	101
	Total	**187**
Petroleum Development Corp.	Armel	1
	Beecher Island	1
	Eaton	7
	Greeley	2
	Krieger	1
	Maverick	2
	Republican	3
	Severance	5
	Stones Throw	4
	Vernon	3
	Wattenberg	77
	Whisper	3
	Wildcat	6
	Total	**115**
KP Kauffman Company Inc.	Byers	8
	Spindle	4
	Wattenberg	85
	Total	**97**
Pioneer Natural Resources USA Inc.	Purgatoire River	**97**
Synergy Resources Corporation	Eaton	10
	Wattenberg	69
	Total	**79**
Bayswater Exploration & Prod. LLc	Eaton	9
	Galeton	3
	Spindle	17
	Wattenberg	39
	Total	**68**
Rosetta Resources Operating Lp	Beecher Island	1
	Blizzard	3
	Duke	1
	Eckley	3
	Republican	3
	Shout	2
	Vernon	11
	Wildcat	42
	Yodel	2
	Total	**68**
Great Western Oil & Gas Co.	Bracewell	13
	Coalbank Creek	2
	Eaton	2
	Severance	3
	Spindle	3
	Wattenberg	28
	Wildcat	9
	Total	**60**
Bonanza Creek Energy Op. Co. LLC	Wattenberg	**50**
Carrizo Oil & Gas Inc.	Buckinham W	1
	Shivaree	1
	Wildcat	47
	Total	**49**
Augustus Energy Partners LLC	Ballyneal	1
	Beecher Island	1
	Buckboard	2
	Buffalo Grass	1
	Duke	5
	Eckley	4
	Phuma	1
	Republican	1
	Rock Creek	2
	Tierra Plano	1
	Vernon	7
	Wages	2
	Waverly	2
	Wildcat	12
	Yodel	3
	Total	**45**
Rosewood Resources Inc.	Bonny	2
	Buckboard	6
	Council	3
	Old Baldy	1
	Shout	11
	Sunrise	1
	Waverly	16
	Whisper	2
	Wildcat	1
	Total	**43**
Chesapeak Operating Inc.	Wildcat	**33**
Mineral Resources Inc.	Greeley	9
	Wattenberg	24
	Total	**33**
Marathon Oil Company	Wattenberg	5
	Wildcat	26
	Total	**31**
Nighthawk Production LLX	Bolero	2
	Wildcat	29
	Total	**31**

Table 4a. Fields containing 10 or more active well permits in the Royal Gorge Planning Area. Data from Colorado Oil and Gas Conservation Commission.

Field Name	Number of Permits
Spindle	51
Eaton	43
Republican	35
Amherst	34
Grover	32
Bracewell	28
Vernon	27
Florence-Canyon City	21
Schramm	21
Waverly	21
Great Plains	18
Greeley	18
Shout	14
Ballyneal	13
Sedgwick Draw	13
Buckboard	11
Severeance	11
Beecher Island	10
Crow Creek	10
Hambert	10
Kersey	10
Total	**451**

Table 4b. Active well permits and wildcat well permits in Royal Gorge Planning Area, by County. Data from Colorado Oil and Gas Conservation Commission (2012).

County	Permits - All Types	Percent of Total Permits	Wildcat Permits	Percent of Wildcats/County
Weld	2,767	74.04	506	18.29
Yuma	277	7.41	74	26.71
Phillips	179	4.79	91	50.84
Las Animas	126	3.37	1	0.79
Lincoln	66	1.77	45	68.18
Boulder	38	1.02	0	0.00
Sedgwick	34	0.91	16	47.06
Adams	29	0.78	1	3.45
Arapahoe	29	0.78	13	44.83
Broomfield	29	0.78	0	0.00
Larimer	25	0.67	7	28.00
Fremont	22	0.59	1	4.55
Denver	20	0.54	1	5.00
Washington	20	0.54	12	60.00
Kiowa	14	0.37	9	64.29
Morgan	13	0.35	9	69.23
Baca	11	0.29	6	54.55
Cheyenne	10	0.27	4	40.00
Logan	7	0.19	1	14.29
El Paso	6	0.16	6	100.00
Bent	4	0.11	4	100.00
Park	4	0.11	4	100.00
Elbert	2	0.05	1	50.00
Prowers	2	0.05	1	50.00
Huerfano	1	0.03	1	100.00
Jefferson	1	0.03	1	100.00
Kit Carson	1	0.03	0	0.00
Total Permits	**3,737**	**100.00**	**815**	

Table 5. Operators in Greater Wattenberg AQNAA with more than 10 active well drilling permits. Data from Colorado Oil and Gas Conservation Commission (2012).

Operator	Field Name	Wells Operated
Noble Energy Inc.	Aristocrat NE	2
	Bracewell	11
	Crow Creek	10
	Eaton	14
	Galeton	2
	Greeley	7
	Hambert	8
	Harlech	1
	Kersey	10
	Severance	2
	Spindle	2
	Tom Cat	6
	Unnamed	2
	Wattenberg	809
	Wildcat	32
	Total	**918**
Kerr-McGee Oil & Gas Onshore LP	Spindle	2
	Wattenberg	400
	Total	**402**
Encana Oil & Gas (USA) Inc.	Aristocrat	1
	Hambert	1
	Spindle	13
	Wattenberg	316
	Total	**331**
KP Kauffman Company Inc.	Byers	8
	Spindle	4
	Wattenberg	85
	Total	**97**
Petroleum Development Corp.	Eaton	7
	Greeley	2
	Krieger	1
	Maverick	2
	Severance	5
	Wattenberg	77
	Wildcat	1
	Total	**95**
Synergy Resources Corporation	Eaton	10
	Wattenberg	69
	Total	**79**
EOG Resources Inc.	Wildcat	**75**
Bayswater Exploration & Prod. LLc	Eaton	9
	Galeton	3
	Spindle	17
	Wattenberg	39
	Total	**68**
Great Western Oil & Gas Co.	Bracewell	13
	Coalbank Creek	2
	Eaton	2
	Severance	3
	Spindle	3
	Wattenberg	28
	Wildcat	9
	Total	**60**
Bonanza Creek Energy Op. Co. LLC	Wattenberg	**50**
Carrizo Oil & Gas Inc.	Buckinham W	1
	Shivaree	1
	Wildcat	32
	Total	**34**
Mineral Resources Inc.	Greeley	9
	Wattenberg	24
	Total	**33**
Apollo Operating LLC	Wattenberg	**27**
Petro-Canada Res. (USA) Inc.	Wattenberg	**26**
Merit Energy Company	Bracewell	1
	Chieftain	2
	Eaton	1
	Hambert	1
	Wattenberg	17
	Total	**22**
Marathon Oil Company	Wattenberg	5
	Wildcat	14
	Total	**19**
St. James Energy Operating Inc.	Harlech	1
	Wattenberg	16
	Total	**17**
Machii-Ross Petroleum Company	Spindle	9
	Wattenberg	8
	Total	**17**
Peterson Energy Operating Inc.	Wattenberg	**16**
Orr Energy LLC	Bracewell	2
	Wattenberg	14
	Total	**16**
Chesapeak Operating Inc.	Wildcat	**15**
Unioil	Wattenberg	**13**
Continental Resources Inc.	Crow	1
	Keota	1
	Wattenberg	2
	Wildcat	9
	Total	**13**
Tekton Windsor LLc	Wattenberg	**12**

Table 6. Active well permits and wildcat well permits in Greater Wattenberg AQNAA, by County. Data from Colorado Oil and Gas Conservation Commission (2012).

County	Permits - All Types	Percent of Total Permits	Wildcat Permits	Percent of Wildcats/County
Weld	2,399	93.49	195	8.13
Boulder	38	1.48	0	0.00
Adams	29	1.13	1	3.45
Arapahoe	29	1.13	13	44.83
Broomfield	29	1.13	0	0.00
Larimer	18	0.70	0	0.00
Denver	20	0.78	1	5.00
El Paso	3	0.12	3	100.00
Jefferson	1	0.04	1	100.00
Total Permits	**2,566**	**100.00**	**214**	

Table 7. Conventional productive geologic units, their geologic age, number of wells completed as productive, and well type's percent within the Planning Area for the 2007 through 2011 period.

Productive Geologic Unit	Age	Number of Wells	Well Type
Pierre Shale	Cretaceous	39	59% Gas, 41% Oil
Niobrara Formation	Cretaceous	634	78%Gas, 22% Oil
Codell Sandstone Member of Carlile Shale	Cretaceous	124	63 % Gas, 37 % Oil
Greenhorn Limestone	Cretaceous	2	Gas
Dakota/Muddy Formations	Cretaceous	186	69% Gas, 31% Oil
Lyons Sandstone	Permian	1	Oil
Wabaunsee Group	Pennsylvanian	4	Gas
Lansing Group	Pennsylvanian	2	Oil
Marmaton Group	Pennsylvanian	13	8% Gas, 92% Oil
Cherokee Group	Pennsylvanian	15	Oil
Atoka Formation	Pennsylvanian	10	Oil
Morrow Formation	Pennsylvanian	9	78% Gas, 22% Oil
Mississippian	Mississippian	13	8% Gas, 92% Oil
	Total Wells	**1,052**	70% Gas, 30% Oil

Table 8. Conventional oil and gas productive units, their geologic age, number of wells completed as productive, and well type's percent within the Greater Wattenberg AQNAA for 2007 through 2011.

Productive Unit	Age	Number of Wells	Well Type
Niobrara Formation	Cretaceous	458	80%Gas, 20% Oil
Codell Sandstone Member of Carlile Shale	Cretaceous	120	63% Gas 37% Oil
Greenhorn Limestone	Cretaceous	2	Gas
Dakota/Muddy Formations	Cretaceous	69	93% Gas, 7% Oil
Lyons Sandstone	Permian	1	Oil
	Total Wells	**650**	78% Gas, 22% Oil

Table 9. Rates of horizontal, directional, and vertical drilling by five-year period from 1997 thought 2011. Data from IHS Energy Group (2012).

Drilling Period	Horizontal Spuds	Percent	Directional Spuds	Percent	Vertical Spuds	Percent	Total Spuds
1997-2001	7	0.42	6	0.36	1,638	99.21	**1,651**
2002-2006	17	0.84	24	1.18	1,986	97.98	**2,027**
2007-2011	102	4.96	339	16.49	1,615	78.55	**2,056**

Table 10. Estimated oil and gas development potential classification wells (excluding coalbed natural gas), percentages in each classification, and average wells per township.

Potential	Average Wells per Township	All Planning Area Wells Drilled	Percent of Planning Area Wells	All Wells Drilled in AQNAAs	Percent of Planning Area Wells in AQNAAs	Bureau Managed Wells Drilled	Percent of Bureau Managed Wells	Bureau Managed Wells Drilled in AQNAAs	Percent of Bureau Managed Wells in AQNAAs	Forest Service Managed Wells Drilled	Percent of Forest Service Managed Wells	Forest Service Managed Wells Drilled in AQNAAs	Percent of Forest Service Managed Wells in AQNAAs
Very High (Wattenberg)	200	5,800	47	5,800	80	196	42	196	82	0	0	0	0
Very High	100	2,296	19	501	7	116	25	14	6	0	0	0	0
High	35	1,949	16	306	4	50	11	11	5	145	56	71	56
Moderately High	15	469	4	276	4	29	6	12	5	62	24	39	31
Moderate	7	518	4	102	1	33	7	6	2	29	11	9	7
Low	3	1,170	9	240	3	32	7	2	1	16	6	7	5
Very Low	0.2	153	1	11	0	15	3	0	0	7	3	0	0
None	0												
BLM WSAs	0												
FS Wilderness	0												
National Park Service	0												
Totals		**12,355**	**100**	**7,234**	**100**	**471**	**100**	**240**	**100**	**258**	**100**	**126**	**100**

Table 11. Estimated coalbed natural gas development potential classification wells, percentage in each classification, and average wells per township.

Potential	Average Wells per Township	All Planning Area Wells Drilled	Percent of Planning Area Wells	All Wells Drilled in AQNAAs	Bureau Managed Wells Drilled	Percent of Bureau Managed Wells	Bureau Managed Wells Drilled in AQAAs
Very High	75	320	47	0	23	52	0
High	20	171	25	0	4	9	0
Moderate	7	137	20	0	15	34	0
Low	2.5	7	1	0	2	5	0
Very Low	0.25	52	8	30	0	1	1
None	0						
BLM WSAs	0						
FS Wilderness	0						
National Park Service	0						
Totals		**686**	**100**	**30**	**44**	**100**	**1**

Table 12. Projected conventional oil and gas and coalbed natural gas production from new wells in the Royal Gorge Planning Area.

Year	CONVENTIONAL OIL (barrels)	CONVENTIONAL GAS (thousand cubic feet)	COALBED NATURAL GAS (thousand cubic feet)
2011	2,138,298	31,275,305	1,819,700
2012	1,532,001	28,102,925	3,568,415
2013	1,880,130	35,174,226	5,830,392
2014	2,573,885	47,200,484	7,507,011
2015	2,865,352	53,759,639	8,492,296
2016	2,786,226	55,036,620	9,589,064
2017	2,922,133	59,029,044	10,044,252
2018	2,880,301	60,194,910	10,787,935
2019	2,671,608	58,626,127	10,601,225
2020	2,968,560	63,862,536	10,574,196
2021	3,040,656	66,306,265	9,969,625
2022	2,794,802	64,305,738	9,706,259
2023	2,310,503	58,615,930	8,878,875
2024	2,240,116	57,647,351	8,458,598
2025	2,336,184	58,889,324	7,823,651
2026	2,145,256	56,624,244	7,179,325
2027	1,866,756	52,962,074	6,339,977
2028	1,681,502	50,134,934	5,447,114
2029	2,021,844	54,069,464	4,954,949
2030	1,670,431	49,409,743	4,644,366
Total	**47,326,544**	**1,061,226,883**	**152,217,225**

Table 13. Projected conventional oil and gas production from new wells in the AQNAAs of the Royal Gorge Planning Area.

Year	CONVENTIONAL OIL (barrels)	CONVENTIONAL GAS (thousand cubic feet)
2011	2,047,445	25,932,705
2012	1,122,309	20,020,721
2013	1,538,732	27,362,115
2014	1,945,513	34,778,642
2015	1,891,232	36,672,012
2016	1,960,164	39,218,058
2017	1,997,223	41,451,352
2018	2,024,945	43,141,582
2019	1,909,836	42,861,051
2020	1,800,836	42,479,269
2021	1,769,185	42,865,565
2022	1,572,783	40,764,473
2023	1,440,025	39,181,727
2024	1,352,498	38,206,912
2025	1,137,305	34,564,328
2026	1,088,493	33,893,955
2027	955,246	31,476,374
2028	820,679	28,402,871
2029	759,340	27,072,948
2030	694,100	25,536,566
Total	**29,827,889**	**695,883,226**

Table 14a. Royal Gorge Planning Area surface disturbance associated with new drilled wells and existing wells for the baseline scenario (short-term disturbance) for the 2011-2030 period.

Wells				Disturbed Sites				Acres of Surface Disturbance (per site)				
Type	**Total**	**BLM Managed**	**Forest Managed**	**New Wells per pad (average)**	**Total Disturbed Sites**	**BLM Managed Disturbed Sites**	**Forest Managed Disturbed Site**	**Access Roads and Pipelines Acres**	**Well Pad Acres**	**Total Acres**	**BLM Managed Acres**	**Forest Managed Acres**
Conventional Multi-Well Pads in AQNAAs	5,064	168	88	4	1,266	42	22	2.01	10	15,205	504	264
Conventional Single-Well Pads in AQNAAs	2,170	72	38	1	2,170	72	38	2.01	2	8,287	275	145
Conventional Multi-Well Pads North of Greater Wattenberg AQNAA	465	8	42	3	155	3	14	2.01	10	1,862	32	168
Conventional Single-Well Pads North of Greater Wattenberg AQNAA	463	9	44	1	463	9	44	2.01	2	1,754	34	167
Conventional Multi-Well Pads in Remainder of Planning Area	210	10	2	2	105	5	1	2.01	4	631	30	6
Conventional Single-Well Pads in Remainder of Planning Area	3,983	204	44	1	3,983	204	44	2.01	2	15,090	773	167
Coalbed Gas Multipads	172	9	0	2	86	5	0	2.25	0.55	241	13	0
Coalbed Gas Single Well Pads	514	35	7	1	514	35	7	2.25	0.5	1,370	79	18
Total New Exploratory and Development Wells	13,041	515	265	Total New Exploratory and Development Well Disturbed Sites	8,742	374	170	Total New Exploratory and Development Well Surface Disturbance		44,440	1,741	935
Existing Active Coalbed Natural Gas Wells	2,870	65	0	1 & 2	2,575	59	0	0.48	0.5	2,524	58	0
Existing Active Conventional Wells	26,127	425	245	1 to 16	21,529	340	196	0.43	0.5	24,298	395	228
Total Existing Active Wells	28,997	490	245	Total Existing Disturbed Well Sites	24,104	399	196	Total Existing Well Surface Disturbance		26,822	453	228
Total Wells	**42,038**	**1,005**		**Total Short-Term Disturbed Well Sites**	**32,846**	**773**	**366**	**Total Short-Term Disturbance**		**71,261**	**2,194**	**1,163**

Table 14b. Uncompahgre Study Area surface disturbance associated with new active wells and existing wells determined to remain in an active status for the baseline scenario (long-term disturbance) for the 2011-2030 period.

Wells				Disturbed Sites				Acres of Surface Disturbance (per site)				
Type	**Total**	**BLM Managed**	**Forest Managed**	**New Wells per pad (average)**	**Total Disturbed Sites**	**BLM Managed Disturbed Sites**	**Forest Managed Disturbed Site**	**Access Roads and Pipelines Acres**	**Well Pad Acres**	**Total Acres**	**BLM Managed Acres**	**Forest Managed Acres**
Conventional Multi-Well Pads in AQNAAs	4,558	151	79	4	1,266	42	22	0.43	0.9	1,684	56	29
Conventional Single-Well Pads in AQNAAs	1,953	65	34	1	1953	65	34	0.43	0.25	1,328	44	23
Conventional Multi-Well Pads North of Greater Wattenberg AQNAA	405	7	37	3	155	3	14	0.43	0.7	175	3	16
Conventional Single-Well Pads North of Greater Wattenberg AQNAA	403	8	38	1	403	8	38	0.43	0.25	274	5	26
Conventional Multi-Well Pads in Remainder of Planning Area	183	9	2	2	105	5	1	0.43	0.5	98	5	1
Conventional Single-Well Pads in Remainder of Planning Area	3,465	177	38	1	3,465	177	38	0.43	0.25	2,356	121	26
Coalbed Gas Multipads	168	9	0	2	86	5	0	0.48	0.5	84	5	0
Coalbed Gas Single Well Pads	466	34	6	1.0	466	34	6	0.48	0.5	456	33	6
Total New Active Wells	11,600	460	234	Total New Active Disturbed Well Sites	7,899	338	154	Total New Active Well Surface Disturbance		6,455	271	127
Remaining Active Coalbed Natural Gas Wells	2,583	59	0	1	2,288	54	0	0.48	0.5	2,242	53	0
Remaining Active Conventional Wells	20,902	340	196	1	17,641	282	162	0.43	0.5	16,406	262	151
Total Remaining Active Wells	23,485	399	196	Total Remaining Well Sites	19,929	336	162	Total Remaining Wells Surface Disturbance		18,648	315	151
Total Wells	**35,084**	**858**	**430**	**Total Long-Term Disturbed Well Sites**	**27,828**	**674**	**316**	**Total Long-Term Well Disturbance**		**25,104**	**586**	**278**