**DECISION RECORD**
**Resolute Wyoming Incorporated, Hammerhead 1 & 2**
**Environmental Assessment (EA), WY-070-EA14-79**
**Bureau of Land Management, Buffalo Field Office, Wyoming**

**DECISION.** The BLM approves Resolute Wyoming Incorporated's (Resolute) Hammerhead 1 and 2 gas and oil well applications for permit to drill (APDs) described in Alternative B of the environmental assessment (EA), WY-070-EA14-79, all incorporated here by reference. This approval includes the wells' support facilities.

**Compliance.** This decision complies with:

- Federal Land Policy and Management Act of 1976 (FLPMA) (43 USC 1701); DOI Order 3310.
- Mineral Leasing Act of 1920 (MLA) (30 U.S.C. 181); including the Onshore Oil and Gas Orders.
- National Environmental Policy Act of 1969 (NEPA) (42 USC 4321).
- National Historic Preservation Act of 1966 (NHPA) (16 USC 470).
- Buffalo Resource Management Plan (RMP) 1985 and Amendments.
- Buffalo and Powder River Basin Environmental Impact Statements, 1985, 2001, and 2003.

BLM summarizes the details of the approval of Alternative B below. The EA includes the project description, including specific changes made at the onsites, and site-specific mitigation measures.

**Well Site.** BLM approves 2 APDs and support facilities:

| # | Well Name & # | Twn | Rng | Sec | Qtr | Lease # |
|---|---|---|---|---|---|---|
| 1 | Hammerhead 1 | 46N | 70W | 31 | NESW | WYW015456 |
| 2 | Hammerhead 2 | | | | SESW | |

**Limitations.** There are no denials or deferrals. Also see the conditions of approval (COAs).

**THE FINDING OF NO SIGNIFICANT IMPACT (FONSI).** Analysis of Alternative B of the EA, WY-070-EA14-79, and the FONSI (incorporated here by reference) found Resolute's proposal for the Hammerhead 1 and 2 APDs will have no significant impacts on the human environment, beyond those described in the PRB FEIS. There is no requirement for an EIS.

**COMMENT OR NEW INFORMATION SUMMARY.** BLM publically posted the APDs for 30 days, received no comments, and then internally scoped them. BLM received no new applicable policy clarifications after receiving these APDs.

**DECISION RATIONALE**. BLM bases the decision authorizing the selected project on:

1. BLM and Resolute included mitigation measures to reduce environmental impacts while meeting the BLM's need. For a complete description of all site-specific COAs, see the COAs (Appendix B). The PRB FEIS analyzed and predicted that the PRB oil and gas development would have significant impacts to the region's greater sage-grouse (GSG) population. The impact of this development cumulatively contributes to the potential for local GSG extirpation yet its effect is acceptable because it is outside priority habitats and is within the parameters of the PRB FEIS and ROD and current BLM and Wyoming GSG conservation strategies.
2. Resolute will conduct operations to minimize adverse effects to surface and subsurface resources, prevent unnecessary surface disturbance, and conform with currently available technology and practice.

3. The selected alternative will help meet the nation's energy needs, and help stimulate local economies by maintaining workforce stability.
4. The operator committed to:
   - Comply with the approved APD, applicable laws, regulations, orders, and notices to lessees.
   - Obtain necessary permits from agencies.
   - Offer water well agreements to the owners of record for permitted wells.
   - Incorporate several measures to alleviate resource impacts into their submitted surface use plan and drilling plan.
5. The operator certified it has a surface access agreement.
6. The project is clearly lacking in wilderness characteristics as it lacks federal surface.
7. These APDs are pursuant to the Mineral Leasing Act for developing oil or gas and do not satisfy the categorical exclusion directive of the Energy Policy Act of 2005, Section 390 because there was no timely site specific analysis covering the project area.

**ADMINISTRATIVE REVIEW AND APPEAL.** This decision is subject to administrative review according to 43 CFR 3165. Request for administrative review of this decision must include information required under 43 CFR 3165.3(b) (State Director Review), including all supporting documentation. Such a request must be filed in writing with the State Director, Bureau of Land Management, P.O. Box 1828, Cheyenne, Wyoming 82003, no later than 20 business days after this Decision Record is received or considered to have been received. Parties adversely affected by the State Director's decision may appeal that decision to the Interior Board of Land Appeals, as provided in 43 CFR 3165.4.

Field Manager: /s/ Duane W. Spencer Date: 6/25/14

**FINDING OF NO SIGNIFICANT IMPACT**
**Resolute Wyoming Incorporated, Hammerhead 1&2**
**Environmental Assessment (EA), WY-070-EA14-79**
**Bureau of Land Management, Buffalo Field Office, Wyoming**

**FINDING OF NO SIGNIFICANT IMPACT (FONSI).** Based on the information in the EA, WY-070-14-79, which BLM incorporates here by reference; I find that: (1) the implementation of Alternative B will not have significant environmental impacts beyond those addressed in the Buffalo Final Environmental Impact Statement (FEIS) 1985, and the Powder River Basin (PRB) FEIS, 2003 (2) Alternative B conforms to the Buffalo Field Office (BFO) Resource Management Plan (RMP) (1985, 2001, 2003, 2011); and (3) Alternative B does not constitute a major federal action having a significant effect on the human environment. Thus an EIS is not required. I base this finding on consideration of the Council on Environmental Quality's (CEQ) criteria for significance (40 CFR 1508.27), with regard to the context and to the intensity of the impacts described in the EA, and Interior Department Order 3310.

**CONTEXT.** Mineral development is a common PRB land use, sourcing over 42% of the nation's coal. The PRB FEIS foreseeable development analyzed the development of 54,200 wells. The additional development analyzed in Alternative B is insignificant in the national, regional, and local context.

**INTENSITY.** The implementation of Alternative B will result in beneficial effects in the forms of energy and revenue production however; there will also be adverse effects to the environment. Design features and mitigation measures included in Alternative B will minimize adverse environmental effects. The preferred alternative does not pose a significant risk to public health and safety. The geographic area of project does not contain unique characteristics identified in the 1985 RMP, 2003 PRB FEIS, or other legislative or regulatory processes. BLM used relevant scientific literature and professional expertise in preparing the EA. The scientific community is reasonably consistent with their conclusions on environmental effects relative to oil and gas development. Research findings on the nature of the environmental effects have minor controversy, are not highly uncertain, and do not involve unique or unknown risks. The PRB FEIS predicted and analyzed oil development of the nature proposed with this project and similar projects. The selected alternative does not establish a precedent for future actions with significant effects. The proposal may relate to the PRB greater sage-grouse and its habitat decline having cumulative significant impacts; yet the small size of this project is within the parameters of the impacts in the PRB FEIS. There are no cultural or historical resources present that will be adversely affected by the selected alternative. The project area is clearly lacking in wilderness characteristics as it lacks federal surface. No species listed under the Endangered Species Act or their designated critical habitat will be adversely affected. The selected alternative will not have any anticipated effects that would threaten a violation of federal, state, or local law or requirements imposed for the protection of the environment.

**ADMINISTRATIVE REVIEW AND APPEAL.** This finding is subject to administrative review according to 43 CFR 3165. Request for administrative review of this finding must include information required under 43 CFR 3165.3(b) (State Director Review), including all supporting documentation. Such a request must be filed in writing with the State Director, Bureau of Land Management, P.O. Box 1828, Cheyenne, Wyoming 82003, no later than 20 business days after this FONSI is received or considered to have been received. Parties adversely affected by the State Director's finding may appeal that finding to the Interior Board of Land Appeals, as provided in 43 CFR 3165.4.

Field Manager: /s/ Duane W. Spencer Date: 6/25/14

**ENVIRONMENTAL ASSESSMENT (EA), WY-070-EA14-79**
**Resolute Wyoming Incorporated, Hammerhead 1&2**
**Bureau of Land Management, Buffalo Field Office, Wyoming**

# 1. INTRODUCTION

BLM provides an EA for Resolute Wyoming Incorporated (Resolute) Hammerhead 1 & 2 oil and gas well applications for permit to drill (APDs). BLM's jurisdiction for this proposal is federal mineral under fee surface (split estate). This site-specific analysis tiers into and incorporates by reference the information and analysis in the Final Environmental Impact Statement and Proposed Plan Amendment for the Powder River Basin Oil and Gas Project (PRB FEIS), WY-070-02-065, 2003, 2011, and the PRB FEIS Record of Decision (ROD) per 40 CFR 1508.28 and 1502.21. One may review these documents at the BLM Buffalo Field Office (BFO) and on our website: http://www.blm.gov/wy/st/en/field_offices/Buffalo.html. These APDs are pursuant to the Mineral Leasing Act for the purpose of exploring or developing oil or gas and do not satisfy the categorical exclusion directive of the Energy Policy Act of 2005, Section 390 because no timely site-specific analysis adequately covered the project analysis area.

Congress made a 4-part process for federal fluid mineral decisions under the long-term needs of multiple-use. First is the land use / resource management plan (RMP); here the PRB FEIS and ROD amendment to the BFO RMP. Second are the decisions of whether and, if so, under what conditions, to lease lands for fluid mineral development. Courts held leasing decisions are an almost irrevocable resource commitment. Third, (this phase) is deciding on the proposed APD: the site-specific analysis, and mitigation. Fourth is the monitoring and reclamation of wells and their features. (Pendery 2010)

## 1.1. Background

Resolute submitted the Hammerhead 1 & 2 APDs on May 13, 2013 to the BFO to produce oil and gas from federally managed fluid mineral bearing formations of the Powder River Basin.

- July 30, 2013-Resloute representatives, BLM BFO resource staff, and the landowner conducted a pre-approval onsite inspection for the proposed APD wells, roads, utility corridors, and associated infrastructure. The proposals were evaluated and modified to minimize environmental impacts.
- August 19, 2013- BLM sent a post-onsite deficiency letter to Resolute.
- October 25, 2013- BLM received deficiency responses from Resolute.
- February 26, 2014- A second onsite inspection was held to discuss possible changes in the plan to protect the West Fork of Coal Creek.
- March 28, 2014- Resolute submitted revisions to the plan with changes discussed at the second onsite inspection.
- May 5, 2014- BLM considered the APDs complete.

Resolute originally submitted the well locations within 500 feet of the West Fork of Coal Creek. The BLM and Resolute conducted a second onsite to discuss moving the wells and mitigation measures to prevent affecting surface waters. The Hammerhead 1 was moved approximately 200 feet west, and up a hill to prevent any flood events from reaching the pad location. In addition, a production facility pad was submitted to move product off location, to prevent and environmental degradation from spills, flood events, etc. Specific mitigation measures are listed in the surface use plan (SUP).

## 1.2. Need for the Proposed Project

BLM's need for this project is to determine whether, how, and under what conditions to support the Buffalo Resource Management Plan's (RMP) goals, objectives, and management actions (2003 Amendment) with allowing the exercise of the operator's conditional lease rights to develop fluid

minerals on federal leases. BLM incorporates by reference here, the APDs' information (40 CFR 1502.21). Conditional fluid mineral development supports the RMP and the Mineral Leasing Act of 1920, the Federal Land Policy Management Act (FLPMA), and other laws and regulations.

### 1.3. Decision to be Made

The BLM will decide whether or not to approve the proposed development, and if so, under what terms and conditions agreeing with the Bureau's multiple use mandate, environmental protection, and RMP.

### 1.4. Scoping and Issues

BLM posted the proposed APDs for 30 days and will timely publish the EA, any finding, and decision on the BFO website. This project is similar in scope to other fluid mineral development the BFO analyzed. External scoping is unlikely to identify new issues, as verified with recent fluid mineral EAs that BLM externally scoped. External scoping of the horizontal drilling in Crazy Cat East EA, WY-070-EA13-028, 2013, in the PRB area received 3 comments, revealing no new issues.

The BFO interdisciplinary team (ID team) conducted internal scoping by reviewing the proposal, its location, and a resource (issue) list (see administrative record, AR), to identify potentially significantly affected resources, land uses, resource issues, regulations, and site-specific circumstances not addressed in the tiered analysis or other analyses incorporated by reference. This EA will not discuss resources and land uses that are not present, unlikely to receive significant or material affects, or that the PRB FEIS or other analyses adequately addressed. This EA addresses the project's potentially significant site-specific impacts that were unknown and unavailable for review at the time of the PRB FEIS analysis to help the decision maker come to a reasoned decision. The project area is clearly lacking wilderness characteristics as it lacks federal surface. Project issues include:

- Air quality
- Soils and vegetation: site stability, reclamation potential, invasive species.
- Water: surface water, ground water, quality and quantity of produced water.
- Wildlife: raptor productivity, migratory birds, special status species.

BLM analyzed the following issues in the PRB FEIS and they do not present a substantial environmental question of material significance to this proposal. These issues are not present, or minimally so. BLM analyzed them in the PRB FEIS and not in this EA:

| | | |
|---|---|---|
| Geological resources | Recreation | Wilderness characteristics |
| Cave and karst resources | Heritage & Visual Resources | Livestock & grazing |
| Wilderness characteristics | Paleontological resources | Wetlands/Riparian Areas |
| Forest Products | Transportation & Access | Socio-economic resources |
| Lands & Realty | Tribal Treaty Rights | Environmental justice |
| Fire, fuels management, and rehabilitation | Areas of critical environmental concern | |

## 2. PROPOSED PROJECT AND ALTERNATIVES

### 2.1. Alternative A – No Action

The no action alternative would deny these APDs requiring the operator to resubmit APDs that comply with statutes and the reasonable measures in the PRB RMP ROD in order to lawfully exercise conditional lease rights. The PRB FEIS considered a no action alternative, pp. 2-54 to 2-62. The BLM keeps the no action alternative current using the aggregated effects analysis approach – tiering to or incorporating by reference the analyses and developments approved by the subsequent NEPA analyses for adjacent and intermingled developments to the proposal area. See Section 3, leading paragraphs.

### 2.2. Alternative B Proposed Action (Proposal)

**Overview.** Resolute proposes to drill 2 oil and gas wells and construct associated infrastructure at the locations and leases listed in Table 2.1. The proposal is to explore for, and possibly develop oil and gas reserves in the Minnelusa Formation at depths found in the administrative record (AR). The project area is 21 miles northeast of Wright, Campbell County, Wyoming. Well elevations are; 4,650 and 4,646 feet respectively. The topography has gently sloped draws rising to mixed sagebrush and grassland uplands. The West Fork of Coal Creek, which is a tributary of the Belle Fourche River, drains the area. The area climate is semi-arid, averaging 10-14 inches of precipitation annually, about 60% of which occurs between April and September.

**Table 2.1. Well Name/#/Lease/Location:**

| # | Well Name & # | Twn | Rng | Sec | Qtr | Lease # |
|---|---|---|---|---|---|---|
| 1 | Hammerhead 1 | 46N | 70W | 31 | NESW | WYW015456 |
| 2 | Hammerhead 2 | | | | SESW | |

**Drilling, Construction and Production Design Features Include:**

**Access Road and Utilities**

- Primary access for the proposed wells is provided by WY HWY 59, Breene Road, Highlight Road, and existing improved oil and gas access.
- Resolute will use 1935 feet of newly constructed improved template road for the project.
- Cattle guards will be constructed at the entrances of the well locations.
- Pipelines to deliver product to the facility location will be buried within the access corridor.
- Access road and utility corridor disturbances are listed in Table 2.3, maps are included in the SUP.

**Well Location and Ancillary Facilities**

- A well facilities production pad will be built for the project. Product from both wells will be delivered via pipeline in the road/utility corridor.
- Production facilities, i.e. production tanks, water tanks, and a heater treater, will be placed on the production pad.
- The well pad locations will be built with 1:1 ½ slopes.
- Interim reclamation on the well locations will commence as soon as practical and will be reduced to approximately 0.719 acres per location.
- The production pad will be stabilized with erosional BMPs and disturbed areas, not needed for operations, will be seeded.
- Disturbance summaries for the well pads and production facility pad are in Table 2.3.
- Mitigation measures listed in the SUP will ensure that surface water will not be affected.

**Drilling and Completion Operations**

- A lined cuttings pits will be used for semi-closed loop drilling and completion operations.
- Water for drilling and completion operations will be hauled onto location by trucks.
- Perforation and acid stimulation will be used to complete the wells. Flowback water will be placed in tanks and hauled off location to an authorized disposal facility.
- For a detailed description of design features and construction practices associated with the proposed project, refer to the SUP and drilling plan included with the APD. Also see the APD for maps showing the proposed well location and associated facilities described above.
- Approximately 1200 bbls of water will be used to drill and complete each well.

BLM incorporated and analyzed the implementation of committed mitigation measures in the SUP and drilling plan, in addition to the COAs in the PRB FEIS ROD, as well as changes made at the onsite.

**Table 2.2. Anticipated Drilling and Completion Sequence and Timing (per well)**

| Drilling and Completion Step | Approximate Duration |
|---|---|
| Build location (roads, pad, and other initial infrastructure) | 30 days |
| Mob rig | 2-4 days |
| Drilling (24/7) | 20 days |
| Schedule/logistics for completion | 10 days |
| Completion (setup, completion, demobilization) | 5-8 days |

Additionally, the operator, in their APDs, committed to:

- Comply with the approved APD, applicable laws, regulations, orders, and notices to lessees.
- Obtain necessary permits from agencies.
- Offer water well agreements to the owners of record for permitted wells.
- Incorporate measures to alleviate resource impacts in their submitted surface use and drilling plans.
- Certify it has a surface access agreement with the landowners.

**Table 2.3. Disturbance Summary for Hammerhead 1 & 2 well pads and associated infrastructure:**

| Facility | Number or Miles | Factor | Disturbance |
|---|---|---|---|
| Hammerhead 1 Engineered Pad | 350ft x 275ft | 96,250 $ft^2$ | 2.21 acres (pad surface)<br>3.29 acres (total disturbance)* |
| Hammerhead 2 Engineered Pad | 350ft x 255ft | 87,500 $ft^2$ | 2.01 acres (pad surface)<br>2.88 acres (total disturbance)* |
| Improved Roads | 1935ft x 30ft | 58,050 $ft^2$ | 1.33 acres |
| Utility Corridors | 1907ft x 20ft | 38,140 $ft^2$ | 0.88 acres |
| Production Pad | 200ft x 150ft | 30,000 $ft^2$ | 0.69 acres (pad surface)<br>1.05 (total disturbance)* |
| **Total Surface Disturbance** | | | **9.43 acres** |

*Total disturbance is calculated as the fenced area including; pad surface; topsoil piles; spoil piles; and additional unused areas within the fenced area.

**Plan of Operations.**

The proposal conforms to all Bureau standards and incorporates appropriate best management practices, required and designed mitigation measures determined to reduce the effects on the environment. BLM reviewed and approved a surface use plan of operations describing all proposed surface-disturbing activities pursuant to Section 17 of the Mineral Leasing Act, as amended. This analysis also incorporates and analyzes the implementation of committed mitigation measures in the SUP, drilling plan, and the standard conditions of approval (COAs) found in the PRB FEIS ROD, Appendix A.

**Reasonably Foreseeable Activity**.

The reasonably foreseeable activity (RFA) for this and adjacent areas includes oil/gas exploration on 640 acre spacing and possible 320 acre spacing for horizontal wells and 80 acre spacing for vertical wells. (This does not preclude the RFA spacing analysis in the PRB FEIS or applying to drill multiple wells from this pad further reducing the surface disturbance per well.) RFA may use existing well pads and infrastructure put in place for fee and/or federal mineral development. The proposed RFA in the project area consists of 75 oil and gas leases, which have foreseeable potential for activity and 3 proposed notices of staking (NOSs) and APDs. Although there are minimal NOS and APD submittals currently, the area could see further activity for future projects, on the existing leases. The project analysis area is defined as the area within 5 miles of the proposed Hammerhead 1 & 2 wells. Potential APD submittals or reasonably foreseeable activity included in this analysis could consist of multiple wells on an existing pad or tie into existing supporting infrastructure; tank batteries, pipelines, power lines, and transportation networks.

### 2.3. Conformance to the Land Use Plan and Other Environmental Assessments

This proposal does not diverge from the goals and objectives in the Buffalo Resource Management Plan (RMP), 1985, 2001, 2003, 2011, and generally conforms to the terms and conditions of that land use plan, its amendments, supporting FEISs, 1985, 2003 and laws including the Clean Air Act, 42 USC 7401-7671q (2006), the Clean Water Act, 33 USC 1251 et seq. (1972), etc.

## 3. AFFECTED ENVIRONMENT

This section briefly describes the physical and regulatory environment that may be affected by the alternatives in Section 2, or where changes in circumstances or regulations occurred since adoption of analyses to which the EA tiers or incorporates by reference. The PRB FEIS considered a no action alternative (pp. 2-54 to 2-62) in evaluating a development of up to 54,200 fluid mineral wells. Nearly 60% of the deep oil and gas wells are hydraulically fractured; BLM and Goolsby 2012. The BLM uses the aggregated effects analysis approach incorporating by reference the circumstances and developments approved via the subsequent NEPA analyses for adjacent and intermingled developments coincident to proposal area to retain currency in the no action alternative. 615 F. 3d 1122 (9th Cir. 2010). There are 103 producing and 46 plugged and abandoned oil and gas wells in the 5 miles of project area, Wyoming Oil and Gas Conservation Commission (WOGCC) 2014. The total number of conventional wells in the Buffalo planning area is 1313, which includes 783 horizontal wells (federal, fee, and state) (as of April 2013). This represents 41% of the projected 3,200 in the 2003 PRB ROD. (See Table 2.3 for an approximation of the disturbance in the current situation.) This agrees with the PRB FEIS which analyzed the reasonably foreseeable development rolling across the PRB of 51,000 CBNG and 3,200 natural gas and oil wells. The State of Wyoming and BLM also approved 1 well within 5 miles of the project area that operators may develop in the near future. In addition, and other operators are likely to continue seeking permits to develop unconnected leases in or in the affects analysis areas near the project area; decisions to approve or deny future proposals will occur following APD submittal. Development occurring on non-federal surface and non-federal mineral estate would continue.

BLM's position is there is a rare lack of surface disturbance impacts attributable to well type, subject to showing a distinction, not a mere difference. See, State Director Reviews WY-2010-023, Part 2, p. 3, and fn. 7, and 2013-005, pp. 2-3. This supports BLM and national policy in 43 CFR 3160 et seq, leasing, APD Form 3160-3, and 2005's Energy Policy Act (Kreckel 2007). The US Geological Survey noted there is only a remote chance of induced seismic activity from the nations hydraulic fracturing and water injection at volumes contemplated in the PRB.

### 3.1. Air Quality

Wyoming's Department of Environmental Quality (WDEQ) regulates Wyoming's air quality with oversight from the U.S. Environmental Protection Agency (EPA). BLM incorporates by reference the August 2012 Lease Sale EA, WY-070-EA12-44, pp. 17-24 (air quality, greenhouse gas emissions, and visibility); and the Update of Task 3A Report for the Powder River Basin Coal Review Cumulative Air Quality Effects for 2020, BLM (AECOM), 2009, (Cumulative Air Quality Effects, 2009) as it captures the cumulative air quality effects of present and projected PRB fluid and solid mineral development. The EPA established ozone standards in 2011 and oil and gas new source performance standards in 2012, 77 FR 49490. Existing air quality in the PRB is "unclassified/attainment" for all ambient air quality standards. It is also in an area that is in prevention of significant deterioration zone. PRB air quality is a rising concern due to ozone in the oil and gas producing Upper Green River Basin that became 1 of the nation's 40 "nonattainment" zones for ozone in 2012; in addition to PRB-area air quality alerts issued in 2011 - 2014 for particulate matter (PM), attributed to coal dust. Four sites monitor the air quality in the PRB: Cloud Peak in the Big Horn Mountains, Thunder Basin northeast of Gillette, Campbell County south of Gillette, and Gillette. In addition, the Wyoming Air Resource Monitoring System (WARMS) measures meteorological parameters from 6 sites, and particulate concentrations from 5 of those sites,

monitors speciated aerosol (3 locations), and evapotranspiration rates (3 locations). These sites are at Sheridan, Taylor Reservoir, South Coal Reservoir, Buffalo, Juniper, and Newcastle. The northeast Wyoming visibility study is ongoing by the WDEQ. Sites adjacent to the Wyoming PRB-area are at Birney on the Tongue River 24 miles north of the Wyoming-Montana border, Broadus on the Powder River in Montana, and Devils Tower.

Existing air pollutant emission sources in the region include:

- Exhaust emissions (primarily carbon monoxide (CO) and nitrogen oxides (NOx)) from existing natural gas fired compressor engines used in production of natural gas and CBNG; and, gasoline and diesel vehicle tailpipe emissions of combustion pollutants;
- PM (dust) generated by vehicle travel on unpaved roads, windblown dust from neighboring areas, road sanding during the winter months, coal mines, and trains;
- Transport of air pollutants from emission sources located outside the region;
- NOx, PM, and other emissions from diesel trains; and
- Sulfur dioxide (SO2) and NOx from power plants.

### 3.2. Soils, Ecological Sites, and Vegetation

Within the PRB's Northern Rolling High Plains-Southern Part major land resource area (USDA Handbook 296, 2006) are numerous ecological sites - a distinctive kind of land with specific characteristics differing from other kinds of land in its ability to produce a distinctive kind and amount of vegetation. Different soil compositions support an ecological site. BLM obtained detailed soils identification and data for the project area from the South Campbell County Survey Area, Wyoming Soil Survey Geographic (SSURGO) Database (WY605). The Natural Resource Conservation Service (NRCS) performed the soil survey according to National Cooperative Soil Survey standards. The BLM uses county soil survey information to predict soil behavior, limitations, or suitability for a given proposal.

Using the Natural Resource Conservation Service, (NRCS, USDA), Technical Guides for the Major Land Resource Area 58B Northern Rolling High Plains, in the 10-14 inch Northern Plains precipitation zone, the soils of this site are deep to moderately deep (greater than 20 inches to bedrock), well drained and moderately permeable. Layers of the soil most influential to the plant community varies from 3 to 6 inches thick. These layers consist of the A horizon with very fine sandy loam, loam, or silt loam texture and may also include the upper few inches of the B horizon with sandy clay loam, silty clay loam or clay loam texture. The main soil limitations include: low organic matter content and soil droughtiness. The low annual precipitation affects planning a seeding. The predominant ecological site occurring in the area is found to be Loamy and the plant community:

**Rhizomatous Wheatgrasses, Needleandthread, Blue Grama Plant Community**

This plant community is the interpretive plant community for this site and is considered to be the Historic Climax Plant Community (HCPC). This plant community evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and sometimes on areas receiving occasional short periods of rest. The potential vegetation is about 75% grasses or grass-like plants, 15% forbs, and 10% woody plants. This state is dominated by cool season mid-grasses. The major grasses include western wheatgrass, needleandthread, and green needlegrass. Other grasses occurring in this state include Cusick's and Sandberg's bluegrass, bluebunch wheatgrass, and blue grama. A variety of forbs and half-shrubs also occur. Big sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10% of the annual production. Plant diversity is high. This plant community is extremely stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Dominant vegetation surveyed at the onsite includes, but is not limited to; western wheatgrass, green needle grass, thickspike wheatgrass, blue grama, fringed sagewort, lupine, scarlet globemallow, curly cup gumweed, and prickly pear cactus. Presence of downy brome (cheat grass) and Japanese brome exist in minimal amounts.

**Table 3.1. Soils and Ecological Sites in the Project Area**

| Soil Type | AREASYM | SYM | Name | Acres | Percent |
|---|---|---|---|---|---|
| Loamy | WY605 | 119 | Clarkelen-Embry Fine Sandy Loams | 12.8 | 16.8 |
| | | 146 | Forkwood-Cushman Loams | 63.3 | 83.0 |
| Shallow Loamy | | 245 | Wibaux-Shingle Badland Complex | 0.1 | 0.2 |
| **Total** | | | | **76.2** | **100** |

### 3.3. Water Resources

WDEQ regulates Wyoming's water quality with EPA oversight. The Wyoming State Engineer's Office (WSEO) has authority for regulating water rights issues and permitting impoundments for the containment of the State's surface waters. The WOGCC has authority for permitting and bonding off channel pits located over state and fee minerals.

#### 3.3.1. Groundwater

The areas historical use of groundwater was for stock or domestic water. There are 103 oil and gas wells and 4 water injection wells (WIW) within 5 miles of the project area. A search of the WSEO Ground Water Rights Database showed 4 registered stock and domestic water wells within 1 mile of the proposed wells with depths from 70 to 218 feet. Refer to the PRB FEIS for additional information on groundwater, pp. 3-1 to 3-36. The EPA has an expansive, on-going study looking at more aspects of hydraulic fracturing and has yet to issue findings. A 2011-2012 Geological Survey study found no groundwater effects from thousands of deep horizontally fractured oil and gas wells. Another study found no direct link between hydraulic fracturing and studied aquifers, Warner, 2012. Adgate, et. al., and news sources reveal a minor controversy over a state's non-disclosure of proprietary Hydraulic Fracturing HF fluids while release decisions receive administrative and court reviews. The Fox Hills, the deepest penetrated fresh water zone in the PRB lies well above the target formation. Depths to the Fox Hills formation are listed in Table 3.2.

**Table 3.2. Depth to Fox Hills Formation**

| # | Well Name and # | Depth to Fox Hills Formation Total Vertical Distance (TVD) |
|---|---|---|
| 1 | Hammerhead 1 | 4,244 feet |
| 2 | Hammerhead 2 | 4,248 feet |

#### 3.3.2. Surface Water

The project area is in the West Fork of Coal Creek drainage, a tributary to the Belle Fourche River. Most of the area drainages are ephemeral (flowing only in response to a precipitation event or snow melt) to intermittent (flowing only at certain times of the year when it receives water from alluvial groundwater, springs, or other surface source – PRB FEIS, Glossary). The water in the West Fork of Coal Creek is unsuitable for domestic use and fishery habitat as it is classified as Class 3B water by the WDEQ/Water Quality Division. The channels are primarily well vegetated grassy swales, without defined bed and bank. See generally the PRB FEIS for a surface water quality discussion, pp. 3-48 to 3-49.

### 3.4. Invasive or Noxious Species

The BLM's weed database showed the presence of diffuse knapweed, spotted knapweed, and Dalmation toadflax in areas around this project. The operator discovered no state-listed noxious weeds and invasive/exotic plant infestations by a search of inventory maps and/or databases or during subsequent field investigation. Cheatgrass or downy brome (*Bromus tectorum*) and to a lesser extent, Japanese brome

(*B. japonicus*) exist in the affected environment. These species are found in high densities and numerous locations in NE Wyoming. Gelbhard, 2003 and Duniway 2010, showed that surface disturbances increase the proliferation of invasive or noxious species out to 0.5 miles or more from the disturbance while correspondingly compromising native communities in the same footprint. Balch, 2013, linked the proliferation of cheatgrass in semi-arid environments to the increased frequency and severity of wildfire.

## 3.5. Fish and Wildlife

The PRB FEIS identified wildlife species occurring in the PRB, pp. 3-113 to 3-206. BLM performed a habitat assessment in the project area on July, 30 2013. The biologist evaluated impacts to wildlife resources and recommended project modifications where wildlife issues arose. BLM wildlife biologists also consulted databases compiled and managed by BLM BFO wildlife staff, the PRB FEIS, Wyoming Game and Fish Department (WGFD) datasets, and the Wyoming Natural Diversity Database (WYNDD) to evaluate the affected environment for wildlife species that may occur in the project area. This section describes the affected environment for wildlife species known or likely to occur in the project area that are likely to be impacted by the action. Rationale for any specie or species not discussed in detail below can be referenced in the administrative record.

### 3.5.1. Threatened, Endangered, Candidate, Special Status (Sensitive) Species

BLM receives a list periodically from the US Fish and Wildlife Service (FWS) on threatened, endangered, proposed, and candidate species. BLM discusses species on that list the proposal impacts.

### 3.5.2. Greater Sage-Grouse (GSG)

The PRB FEIS has a detailed discussion on GSG ecology and habitat, pp. 3-194 to 3-199. Subsequently the FWS determined the Greater Sage-Grouse (GSG) warrants federal listing as threatened across its range, but precluded listing due to other higher priority listing actions, 75 Fed. Reg. 13910 to 14014, Mar. 23, 2010; 75 Fed. Reg. 69222 to 69294, Nov. 10, 2010. GSG are a WY BLM special status (sensitive) species (SSS) and a WGFD species of greatest conservation need because of population decline and ongoing habitat loss. The 2012 population viability analysis for the Northeast Wyoming GSG found there remains a viable population of GSG in the PRB (Taylor et al. 2012). However, threats from energy development and West Nile virus (WNv) are impacting future viability (Taylor et al. 2012). The BLM IM WY-2012-019 establishes interim management policies for proposed activities on BLM-administered lands, including federal mineral estate, until RMP updates are complete.

The State Wildlife Agencies' Ad Hoc Committee for Consideration of Oil and Gas Development Effects to Nesting Habitat (2008) recommends that impacts to leks occur within 4 miles of oil and gas developments. WGFD records show that there are 2 occupied GSG leks (Coal Creek IV and the Coal Creek II) occur within 4 miles of the project area. There are no occupied leks within 2 miles and the proposed project is not with in any GSG Core Areas. The Thrush lek (undetermined status) is within 2 miles of the proposal, the area provides suitable habitats for GSG and the species is expected to occur.

### 3.5.3. Big Game

The big game species occurring in the project area are pronghorn and mule deer. The PRB FEIS discussed the affected environment for pronghorn, and mule deer on pp. 3-117 to 3-122, and pp. 3-127 to 3-132, respectively. The proposal area provides winter yearlong seasonal habitat for pronghorn and yearlong habitat for mule deer.

### 3.5.4. Raptors

The PRB FEIS discussed the affected environment for raptors, pp. 3-141 to 3-148. According to the BLM raptor database, identified 3 raptor nest of importance within 0.5 miles of the project boundary these nests are in Table 3.3 below. BLM nest 13445 was active in 2012.

Most raptor species nest in a variety of habitats including (but not limited to): native and non-native grasslands, agricultural lands, live and dead trees, cliff faces, rock outcrops, and tree cavities. Suitable nesting habitat is present in the project area. Raptor species known or suspected to occur in the area include golden eagle, northern harrier, Swainson's hawk, American kestrel, short-eared owl, great horned owl, red-tailed hawk, western burrowing owl (SSS), ferruginous hawk (SSS), and rough-legged hawk (winter resident).

**Table 3.3. Nests Within 0.5 Miles of the Proposed Project Area.**

| BLM Nest ID | Species | 2013 Status |
|---|---|---|
| 13445 | FEHA | Inactive |
| 1169 | FEHA | Inactive |
| 1168 | FEHA | Inactive |

### 3.5.5. Migratory Birds

The PRB FEIS discussed the affected environment for migratory birds, pp. 3-150 to 3-153. The BLM also analyzed the affected environment for migratory birds in the Sahara POD EA, WY-070-EA13-72 and this analysis is incorporated here by reference (Section 3.7.2.2, p.16-17) since the habitats are similar. Habitats occurring near the proposed wells include sage-brush steppe grasslands, mixed grass prairie, and mature deciduous trees. Species of management concern likely occurring in the project area are in Table 3.3.

**Table 3.3. Migratory Birds Occurring in Shrub-steppe Habitat, NE Wyoming (Nicholoff 2003)**

| Level | Species | WY BLM Sensitive | Species | WY BLM Sensitive |
|---|---|---|---|---|
| Level I | Brewer's sparrow | Yes | Ferruginous hawk | Yes |
| Level II | Lark bunting | No | Sage thrasher | Yes |
| | Lark sparrow | No | Vesper sparrow | No |

### 3.6. Cultural Resources

In accordance with Section 106 of the National Historic Preservation Act, BLM must consider impacts to historic properties (sites that are eligible for or listed on the National Register of Historic Places (NRHP)). For an overview of cultural resources that are found in BFO area, refer to the Draft Cultural Class I Regional Overview, Buffalo Field Office (BLM, 2010). A Class III (intensive) cultural resource inventory (BFO project no. 70130104, 70130104A) was performed to locate specific historic properties which may be impacted by the proposal. No cultural resources are in the proposal area. Some of the project area analyzed in this EA occurs on deep alluvial deposits. Alluvial deposits typically have a high potential for buried cultural resources, which are nearly impossible to locate during a Class III inventory (Ebert & Kohler 1988:123; Eckerle 2005:43). Buried archeological sites typically preserve artifacts, features, and other materials in situ and are often evaluated as significant resources.

## 4. ENVIRONMENTAL EFFECTS

**No Action Alternative.** BLM analyzed the no action alternative as Alternative 3 in the PRB FEIS and it subsequently received augmentation of the effects analysis in this EA through the analysis of mineral projects, their approval, and construction; and through the analysis and approval of other projects. This updated the no action alternative and cumulative effects. The project area has surface disturbance from existing roads, well pads, and oil and gas facilities. Under the no action alternative, on-going well field operations would continue as would the development of approved single and multi-well pads and associated infrastructure. The production and the drilling and completion of these new wells would result in noise and human presence that could affect resources in the project area; these effects could include the disruption of wildlife, the dispersal of noxious and invasive weed species, and dust effects from traffic on

unpaved roads. Present fluid mineral development in the PRB is under half of that envisioned and analyzed in the PRB FEIS. There is only a remote potential for significant effects above those identified in the PRB FEIS to resource issues as a result of implementing the no action alternative.

**Alternative B, Proposed Action (Proposal)**

### 4.1. Air Quality

In the project area, air quality impacts would occur during construction (due to surface disturbance by earth-moving equipment, vehicle traffic fugitive dust, well testing, as well as drilling rig and vehicle engine exhaust) and production (including well production equipment, booster and pipeline compression engine exhaust). The amount of air pollutant emissions during construction would be controlled by watering disturbed soils, and by air pollutant emission limitations imposed by applicable air quality regulatory agencies. BLM incorporates by reference the analysis found in the August 2012 Lease Sale EA, WY-070-EA12-44, pp. 45-51 (air quality, greenhouse gas emissions, and visibility). Air quality impacts modeled in the PRB FEIS and Cumulative Air Quality Effects, 2009 concluded that PRB projected fluid and solid development would not violate state, tribal, or federal air quality standards and this project is well within the projected development parameters.

### 4.2. Soils, Ecological Sites, and Vegetation

#### 4.2.1. Direct and Indirect Effects

The PRB FEIS discusses most direct and indirect effects to ecological sites and vegetation (p. 4-153 to 4-164). The proposed action would impact the common plant communities that occur on the site and the transition between the communities. Anticipated impacts to soils and vegetation from well pad, road, and utility construction include:

- Soil rutting and mixing, compaction, increased erosion potential, and loss of soil productivity.
- Construction activities mix the soil profiles with a corresponding loss of soil structure. Mixing may result in removal, dilution, or relocation of organic matter and nutrients to depths where it would be unavailable for vegetative use. Less desirable inorganic compounds such as carbonates, salts, or weathered materials could be relocated and have a negative impact on re-vegetation.
- Soils compaction results from the construction of wells and associated facilities, continued vehicle and foot traffic as well as operational activities. Factors affecting compaction include soil texture, moisture, organic matter, clay content and type, pressure exerted, and the number of passes by vehicle traffic or machinery. Compaction leads to a loss of soil structure; decreased infiltration, permeability, and soil aeration; as well as increased runoff and erosion.
- Increased erosion can lead to a decrease in soil fertility and an increase in sedimentation. The duration and intensity of these impacts would vary according to the type of construction activity to be completed and the inherent characteristics of the soils to be impacted.
- The potential for erosion would increase through the loss of vegetation cover and soil structure as compared to an undisturbed state. Soil productivity would decrease, primarily as a result of profile mixing and compaction along with the loss in vegetative cover. These impacts would begin immediately as the soils would be subjected to grading and construction activities and impacts would continue for the term of operations. The impacts on soils would move to a steady state as construction activities were completed and well production/maintenance operations begin.
- Loss of soil vegetation cover, biologic crusts, organic matter and productivity. With expedient reclamation, productivity and stability should be regained in the shortest time frame.
- Direct effects (removal and/or compaction) to vegetation would occur from ground disturbance caused by drilling rig equipment and construction of a well pads, tank batteries, and roads. Short term effects would occur where vegetated areas are disturbed but later reclaimed within 1 to 3 years of the initial disturbance. Long-term effects would occur where well pads, compressor stations, roads, water-handling facilities or other semi-permanent facilities may result in loss of vegetation and affect reclamation success for the life of the project.

- Large cuts and fills on well pad and road construction could lead to increased soil erosion from water or wind. Expedient stabilization and interim reclamation will decrease the potential for erosion from the disturbed lands as outlined in the SUP.

The BLM will evaluate reclamation success using the BLM State Wide Reclamation Policy found at: http://www.blm.gov/wy/st/en/programs/reclamation, incorporated here by reference. The PRB FEIS discusses most direct and indirect effects to ecological sites and vegetation (p. 4-153 to 4-164). The proposal would impact the common plant communities that occur on the site and the transition between the communities. Other impacts anticipated occurring includes those in the direct and indirect effects listed above. Direct effects to ecological sites would occur from surface disturbance from construction of well pads, ancillary facilities, associated pipelines, and roads. Short term effects would occur where vegetated areas are disturbed but later reclaimed within 1 to 3 years of the initial disturbance. Long-term effects would occur where well pads, compressor stations, roads, water-handling facilities or other semi-permanent facilities would result in loss of vegetation and prevent reclamation for the project life.

#### 4.2.2. Cumulative Effects

For details on expected cumulative impacts, refer to the PRB FEIS, pp. 4-151. The PRB FEIS defines the designation of the duration of disturbance (pp. 4-1 and 4-151). Most soil disturbances would be short term impacts with expedient interim reclamation and site stabilization. These impacts, singly or in combination, could increase the potential for valuable soil loss due to increased water and wind erosion, invasive/noxious/poisonous plant spread, invasion and establishment, and increased sedimentation and salt loads to the watershed system, if applicable mitigation measures are not used. The PRB FEIS discusses the cumulative effects to ecological sites (pp. 4-153 to 4-172). Cumulative effects to ecological sites include the further alteration of disturbance regimes from the increased disturbance, increase in noxious weeds, and alterations in vegetation community's diversity and cover.

#### 4.2.3. Mitigation Measures

Company and BLM should apply the following mitigation to reduce impacts to soils and vegetation from surface disturbance. The proponent planned their project to maximize the fluid mineral drainage while avoiding areas with soil limitation where possible. The well pads were designed to minimize cut and fill slopes. Refer to the surface use plan (SUP), Reclamation Plan, and the APD for pad design drawings and a detailed description of design features, operator committed measures and construction practices. Improved roads used in conjunction with accessing the well will be fully built (including all water control structures such as wing ditches, culverts, relief ditches, low water crossings, surfacing, etc.) and functional to BLM standards as outlined in the BLM Manual 9113 prior to drilling of the well. All erosion control products will be applied according to manufacturer's specifications to reduce product failures.

An immediate stabilization requirement from initial disturbance is applied to all wells and all associated infrastructure. Stabilization BMPs include, but are not limited to; straw waddles, rock check dams, surface roughening, ditch and berms, erosion matting/blankets, seeding and mulching, and spraying tackifier on cut/fill slopes and topsoil/spoil piles. If the well is a producer, the location shall be put into interim reclamation as soon as possible after completing well. All areas not needed for production shall be put into interim reclamation. Resolute committed to locating the production facilities for both wells on a production facility pad. Culverts and low water crossings (LWC) will be at the appropriate locations for streams and channels crossed by roads specified in the BLM Manual 9112, Bridges and Major Culverts and Manual 9113, Roads. Stream crossings will be perpendicular to flow, where possible, and all design of stream crossing structures will carry the 25-year discharge event or other capacities as directed by the BLM.

#### 4.2.4. Residual Effects

Residual effects across the project area would include a long-term loss of soil productivity associated with well pad and roads. The PRB FEIS identified residual effects (p. 4-408) such as the loss of vegetative cover, despite expedient reclamation, for several years until reclamation is successfully established. The alteration of biodiversity of ecological sites could result from disturbance, alterations in vegetation in reclaimed areas, and the spread and establishment of weed species. Due to the presence of erosive soils and the topography of the project area erosion will occur. Rilling and gullying of cut and fill slopes on access/utility corridors will take place. Impacts from livestock to stabilized cut and fill slopes will limit soils becoming stable and getting vegetation establish. The PRB FEIS defined the designation of the duration of disturbance, pp. 4-1 and 4-15. "For this EIS, short-term effects are defined as occurring during the construction and drilling/completion phases. Long-term effects are caused by construction and operations that would remain longer".

Impacts to vegetation and soils from surface disturbance will be reduced by following the operator's plans and BLM applied mitigation. Construction of new access roads has been reduced by placing the well locations such that existing oil/gas access roads are used and one existing fee mineral pad location is being used for federal mineral development. This practice results in less surface disturbance and overall environmental impacts. See Section 2.2 for a summary of the disturbance. All disturbances associated with the proposed action are long term. With the reclamation status of the project area being rated as fair and field observations showing areas of reclamation success expedient reclamation of disturbed land with stockpiled topsoil, proper seedbed preparation techniques, and appropriate seed mixes, along with utilization of erosion control measures (e.g., waterbars, water wings, culverts, rip-rap, etc.) would ensure land productivity/stability is regained and maximized. The BLM considers these residual effects from Alternative B with the proposed wells are likely within the parameters for acceptable surface disturbance and surface disturbance reclamation in PRB FEIS ROD and Onshore Oil and Gas Order Number 1.

BLM developed a site specific seed mix for the proposed disturbance area. BLM can only require its use on BLM surface. The seed mix selected on private land is selected by the surface owner and may be designed to be more beneficial to cattle grazing than to soil stabilization. The result may be long term wind and water erosion on the soils with little or no re-vegetation success.

### 4.3. Water Resources

Adherence to the drilling COAs, the setting of casing at appropriate depths, following safe remedial procedures in the event of casing failure, and using proper cementing procedures should protect fresh water aquifers above the drilling target zone. Surface casings will be set to 1,800 feet. The operator will verify that there is competent cement across the aquifer, from 100 feet above to 100 feet below the Fox Hills Formation. This will ensure that ground water will not be adversely impacted by well drilling and completion operations. Compliance with the drilling and completion plans and Onshore Oil and Gas Orders Nos. 2 and 7 minimize an adverse impact on ground water. The volume of water produced by this federal mineral development is unknowable at the time of permitting.

Resolute will have to produce a well for a time to be able to estimate the volume and quantity of water production. To comply with Onshore Order Oil and Gas Order No. 7, Disposal of Produced Water, Resolute will submit a Sundry to the BLM within 90 days of first production, which includes a representative water analysis and the final proposal for water management. The quality of water produced in association with conventional oil and gas historically was such that surface discharge would not be possible without treatment. Initial water production is low in most cases. There are 3 common alternatives for water management: re-injection, deep disposal, or disposal into pits. All alternatives would be protective of groundwater resources when performed in compliance with state and federal regulations.

### 4.3.1. Groundwater

#### 4.3.1.1. Direct and Indirect Effects

The cumulative industry and regulatory experience shows that thousands of wells pierce the nation's largest aquifer in western Texas, Oklahoma, and Kansas with essentially no direct or indirect impact to that groundwater, see, http://www.spe.org/jpt/print/archives/2010/12/10Hydraulic.pdf. Lastly, the EPA 2004 study and its on-going, detailed study of hydraulic fracturing yielded, thus far, no immediate cautions, concerns, or warnings that present industry and regulatory practices endanger ground water or require immediate changes. At the time of permitting, the volume of water that will be produced in association with these federal minerals is unknown. The operator will have to produce the wells for a time to be able to estimate the water production. In order to comply with the requirements of Onshore Oil and Gas Order #7, Disposal of Produced Water, the operator will submit a Sundry to the BLM within 90 days of first production which includes a representative water analysis as well as the proposal for water management. Historically, the quality of water produced in association with conventional oil and gas has been such that surface discharge would not be possible without treatment. Initial water production is quite low in most cases. There are 3 common alternatives for water management: Re-injection, deep disposal or disposal into pits. All alternatives would be protective of groundwater resources when performed in compliance with state and federal regulations. The APDs' surface use and drilling plans show adequate protection of surface lands and ground water, including the Fox Hills Formation (depths listed in Table 3.2) for the project wells. The operator will verify that there is competent cement across the aquifer, from 100 feet above to 100 feet below the Fox Hills Formation. This will ensure that ground water will not be adversely impacted by well drilling and completion operations.

#### 4.3.1.2. Cumulative Effects

BLM foresees minimal cumulative effects either to or from the use of ground water for these proposed wells. BLM anticipates no need for mitigation measures beyond the design features and programmatic COAs. BLM anticipates no residual effects to ground water from this project.

#### 4.3.1.3. Mitigation Measures

Adherence to the drilling COAs, the setting of casing at appropriate depths, following safe remedial procedures in the event of casing failure, and using proper cementing procedures should protect any fresh water aquifers above the target coal zone. This will ensure that ground water will not be adversely impacted by well drilling and completion operations.

### 4.3.2. Surface Water

#### 4.3.2.1. Direct and Indirect Effects

Potential effects to surface water resources may include: (1) changes in surface water quality and suitability to meet designated uses; (2) changes in the quantity and distribution of surface flows; (3) erosion and degradation of the drainage network; and (4) increased sedimentation.

#### 4.3.2.2. Cumulative Effects

Refer to the PRB FEIS, p. 4-115 to 4-122 and Table 4-13 for cumulative effects relative to the watershed and p. 117 for cumulative effects common to all sub-watersheds. The designation of the duration of disturbance is defined in the PRB FEIS (pp. 4-1 and 4-151). Most soil disturbances would be short term impacts with expedient interim reclamation and site stabilization.

#### 4.3.2.3. Mitigation Measures

A WYPDES permit for construction activities would address potential surface water impacts from storm water runoff. The wells will be incorporated into Resolute's discharge stormwater permit associated with large construction activities, as required by WDEQ. Also, refer to the SUPs for operator committed BMPs for the project areas.

#### 4.3.2.4. Residual Effects

Turbidity and sediment loading in the streams would possibly increase due to erosion of project disturbed areas and sediment transport to the associated drainages due to storm water runoff. These impacts are mitigated by expediently stabilizing the disturbance and reducing the sediment reaching the streams.

## 4.4. Invasive Species

### 4.4.1. Direct and Indirect Effects

Resolute committed to the control of noxious weeds and species of concern using the following measures identified in their Integrated Pest Management Plan (IPMP): 1) Control Methods, including frequency; 2) Preventive practices; and 3) Education. Cheatgrass (*Bromus tectorum*) and to a lesser extent, Japanese brome (*B. japonicus*) exist in the affected environment. The use of existing facilities along with the surface disturbance associated with construction of proposed access roads, pipelines, and related facilities would present opportunities for weed invasion and spread. The activities related to the performance of the proposed project would create a favorable environment for the establishment and spread of noxious weeds/invasive plants such as salt cedar, Canada thistle, and perennial pepperweed. However, applicant committed measures will reduce potential impacts from noxious weeds and invasive plants.

### 4.4.2. Cumulative Effects

Cumulative effects across the project area would include a long-term loss of soil productivity associated with well pads and road construction. The activities related to the performance of the proposed project would create a favorable environment for the establishment and spread of noxious weeds/invasive plants.

### 4.4.3. Mitigation Measures

Resolute submitted applicant committed measures in the SUP to identify, reduce opportunities to spread, and treat infestation of noxious weeds and invasive plants, listed in the SUPs Wells Weed Control Program, will reduce potential impacts from these species. Refer to the Weed Control Program in the SUP for a complete listing of general and species-specific applicant committed measures to address this issue.

### 4.4.4. Residual Effects

Resolute's control efforts are limited to the surface disturbance associated the project's implementation. Cheatgrass and other invasive species that are present in non-physically disturbed project areas are anticipated to continue to spread unless control efforts are expanded. Cheatgrass and to a lesser extent, Japanese brome are found in such high densities throughout NE Wyoming that a control program is not considered feasible at this time; these annual bromes would continue to be found within the project area.

## 4.5. Fish and Wildlife

### 4.5.1. Wildlife Threatened, Endangered, Proposed and Candidate Species

#### 4.5.1.1. Candidate Species Greater Sage-Grouse

BLM analyzed and considered mitigation for two leks in the Sahara POD EA, WY-070-EA13-72 and this analysis is incorporated here by reference: Direct and Indirect Effects (Section 4.6.4.1.1, p. 34-39); Cumulative Effects (Section 4.6.4.1.2, pp.49-50); Mitigation (Section 4.6.4.1.3, p. 37); Residual Effects (Section 4.6.4.1.4, p. 37).

##### 4.5.1.1.1. Direct and Indirect Effects

Construction of the wells and the associated infrastructure will cause fragmentation of sagebrush stands and result in the direct loss of approximately 9.43 acres of GSG habitat. Noise and human disturbance associated with roads, construction, drilling, and completion will be disruptive to GSG. Implementation of the project will adversely impact nesting habitat, both through direct loss of suitable habitats and avoidance of the area by GSG due to fragmentation and anthropogenic activity.

During onsite visits, the BLM made specific recommendations to avoid placement of facilities in sagebrush to reduce direct loss of GSG habitat. This included recommendations to consolidate infrastructure where feasible. In some cases, infrastructure could not be moved due to soil or topography.

##### 4.5.1.1.2. Cumulative Effects

The proposed wells will cumulatively contribute to the potential for local GSG extirpation, yet this impact is acceptable because it occurs outside preliminary priority habitats (core, focus and connectivity), is within the parameters of the PRB FEIS/ROD, and is consistent with the coordinated BLM and State of Wyoming GSG conservation strategies (BLM WY-2012-19 and WY Executive Order 2011-5, respectively).

##### 4.5.1.1.3. Mitigation Measures

In order to reduce the likelihood that noise, construction, and human disturbance impact nesting GSG, BLM will implement a timing limitation on all surface-disturbing activities (March 15-June 30) within 2 miles of an occupied or undetermined lek. This affects both wells.

##### 4.5.1.1.4. Residual Effects

The impact of the proposed project development cumulatively contributes to the potential for local extirpation. Alternative B and the COAs applied are consistent with current BLM and Wyoming GSG conservation strategies and the anticipated effects are within the parameters of the PRB FEIS/ROD.

#### 4.5.1.2. Migratory Birds

##### 4.5.1.2.1. Direct and Indirect Effects

The PRB FEIS discussed direct and indirect effects to migratory birds on pp. 4-231 to 4-235. The PRB FEIS states on p. 4-231, "Surface disturbance associated with construction, operation, and abandonment of facilities, including roads, has the potential to result in direct mortality of migratory birds. Most birds would be able to avoid construction equipment; however, nests in locations subject to disturbance would be lost, as would any eggs or nestlings." Direct mortality of a bird or destruction of an active nest due to construction activities could result in a "take" as defined (and prohibited) by the MBTA, a nondiscretionary statute, and in turn a violation of the law. See also, FLPMA, Sec. 302(b) and Raptors – Direct and Indirect Effects (4.6.2.1.1). BLM analyzed effects and mitigation to migratory birds in the Sahara POD EA, WY-070-EA13-72, incorporated here by reference (Section 4.6.2.2.1, p.32-34). Heater treaters, and similar facilities with vertical open-topped stacks or pipes, can attract birds. Facilities without exclusionary devices pose a mortality risk. Once birds crawl into the stack, escape is difficult and the bird may become trapped (U.S. v. Apollo Energies Inc., 611 F.3d 679 (10th Cir. 2010); see also Colorado Oil and Gas Commission, Migratory Bird Policy, accessed February 13, 2012).

##### 4.5.1.2.2. Cumulative Effects

The cumulative effects associated with alternative B are within the analysis parameters and impacts described in the PRB FEIS. For details on expected cumulative impacts, refer to the PRB FEIS, p. 4-235.

##### 4.5.1.2.3. Mitigation Measures

To reduce the likelihood of a "take" under the MBTA, the BLM recommends that pad construction (vegetation removal) occur outside of the breeding season for the greatest quantity of BLM sensitive passerines (May 1- July 31) where suitable nesting habitat for sagebrush obligates is present. This restriction would apply to habitat removal, unless a pre-construction nest search (within approximately 10 days of construction planned May 1-July 31) is completed. If surveys will be conducted, the operator will coordinate with BLM biologists to determine protocol. The nest search will consist of areas where vegetation will be removed or destroyed. The BLM recommends the following well pads and associated infrastructure have timing limitations applied for habitat removal during the nesting season for sagebrush obligate passerines (May 1 to July 31): Hammerhead 1 & 2. The BLM also recommends taking measures

to ensure that migratory birds are excluded from all facilities that pose a mortality risk, including, but not limited to, heater treaters, flare stacks, secondary containment, and standing water or chemicals where escape may be difficult or hydrocarbons or toxic substances are present.

##### 4.5.1.2.4. Residual Effects

Nests initiated after the first week in July may be destroyed by construction after August 1. Migratory birds nesting adjacent to the well pad or road may be disturbed by construction and production activities. A timing limitation does nothing to mitigate loss and fragmentation of habitat. Suitability of the project area for migratory birds will be negatively affected due to habitat loss and fragmentation and proximity of human activities associated with oil and gas development.

#### 4.5.1.3. Raptors

##### 4.5.1.3.1. Direct and Indirect Effects

The PRB FEIS discussed direct and indirect effects to raptors (pp. 4-216 to 4-221). This project would result in disturbance in proximity of nesting raptors, including direct and indirect habitat losses associated with declines in habitat effectiveness. Human activities in close proximity to active raptor nests may interfere with nest productivity. Romin and Muck (1999) indicate that activities within 0.5 miles of a nest are prone to cause adverse impacts to nesting raptors. If mineral activities occur during nesting, they could be sufficient to cause adult birds to remain away from the nest and their chicks for the duration of the activities. This absence can lead to overheating or chilling of eggs or chicks. Prolonged disturbance can also lead to the abandonment of the nest by the adults. Both actions can result in egg or chick mortality. BLM recommends the location of all infrastructures requiring human visitation be designed to provide an adequate biologic buffer for nesting raptors. A biologic buffer is a combination of distance and visual screening that provides nesting raptors with security such that routine activities preclude flushing the raptors. During the onsite visits, BLM and the operator worked to try and reduce impacts to raptors from placement of wells and infrastructure. The proposed well pads are 0.15 and 0.23 miles from the nest numbers 1168, and 1169, although both locations were moved to in order to utilize existing topography to provide biological buffering. Also the production facilities and access road was consolidated to be outside the biological nest buffers. This would minimize impacts to the identified ferruginous hawk territory by reducing human activity associated with the production phase of the project.

##### 4.5.1.3.2. Cumulative Effects

The cumulative effects associated with alternative B are within the analysis parameters and impacts described in the PRB FEIS. For details on expected cumulative impacts, refer to the PRB FEIS, p. 4-221.

##### 4.5.1.3.3. Mitigation Measures

To reduce the risk of decreased productivity or nest failure, the BLM BFO requires a 0.5 mile radius timing limitation during the breeding season around active raptor nests. This timing limitation would be applied. Due to a combination of identified species, nest histories, biological buffering and consolidation of the proposed infrastructure the impacts to nesting raptors should be acceptable.

##### 4.5.1.3.4. Residual Impacts

Even with timing restrictions, raptors may abandon nests due to foraging habitat alteration associated with development or sensitivity to well or infrastructure placement. All raptors using nests in the vicinity of the project would likely be impacted to some extent by the human disturbance associated with operation and maintenance of the project. Routine human activities near these nests can draw increased predator activity to the area and increase nest predation. Declines in breeding populations of some species that are more sensitive to human activities may occur.

## 4.6. Cultural Resources

### 4.6.1. Direct and Indirect Effects

BLM policy states that a decision maker's first choice should be avoidance of historic properties (BLM Manual 8140.06(C)). If historic properties cannot be avoided, mitigation measures must be applied to resolve the adverse effect. No historic properties will be impacted by the proposed project. Following the 2006 State Protocol Between the Wyoming Bureau of Land Management State Director and The Wyoming State Historic Preservation Officer, Section VI(A)(1), the BLM notified the Wyoming State Historic Preservation Officer (SHPO) on May 7, 2014, that no historic properties exist in the area of potential effect (APE). If any cultural values (sites, features or artifacts) are observed during operation, they will be left intact and the Buffalo Field Manager notified. If human remains are noted, the procedures described in Appendix L of the PRB FEIS must be followed. Further discovery procedures are explained in Standard COA (General)(A)(1).

### 4.6.2. Cumulative Effects

Construction and development of oil and gas resources impacts cultural resources through ground disturbance, unauthorized collection, and visual intrusion of the setting of historic properties. This results in fewer archaeological resources available for study of past human life-ways, changes in human behavior through time, and interpreting the past to the public. Additionally, these impacts may compromise the aspects of integrity that make a historic property eligible for the National Register of Historic Places. Recording and archiving basic information about archaeological sites and the potential for subsurface cultural materials in the proposal area serve to partially mitigate potential cumulative effects to cultural resources.

Fee actions constructed in support of federal actions can result in impacts to historic properties. Construction of large plans of coalbed natural gas development on split estate often include associated infrastructure that is not permitted through BLM. Project applicants may connect wells draining fee minerals, or previously constructed pipelines on fee surface with a federal plan of development. BLM has no authority over such development which can impact historic properties. BLM has the authority to modify or deny approval of federal undertakings on private surface, but that authority is limited to the extent of the federal approval. Historic properties on private surface belong to the surface owner and they are not obligated to preserve or protect them. The BLM may go to great lengths to protect a site on private surface from a federal undertaking, but the same site can be legally impacted by the landowner at any time. The cumulative effect of numerous federal approvals can result in impacts to historic properties. Archeological inventories reveal the location of sites and although the BLM goes to great lengths to protect site location data, information can potentially get into the wrong hands. BLM authorizations that result in new access can inadvertently lead to impacts to sites from increased visitation by the public.

### 4.6.3. Mitigation Measures

If any cultural values (sites, features or artifacts) are observed during operation, they will be left intact and the Buffalo Field Manager notified. If human remains are noted, the procedures described in Appendix L of the PRB FEIS must be followed. Further discovery procedures are explained in Standard COA (General)(A)(1). When a project is constructed in an area with a high potential for buried cultural material, archaeological monitoring is often included as a condition of approval. Construction monitoring is performed by a qualified archeologist working in unison with construction crews. If buried cultural resources are located by the archeologist, construction is halted and the BLM consults with the State Historic Preservation Office (SHPO) about mitigation or avoidance. Due to the presence of alluvial deposits identified by the NRCS soil survey (NRCS n.d.), and BLM Archaeologist, the operator will be required to have an archeologist monitor all earth moving activities associated with certain construction, as described in the site specific COAs.

#### 4.6.4. Residual Effects

During the construction phase, there will be numerous crews working across the project area using heavy construction equipment without the presence of archaeological monitors. Due to the extent of work and the surface disturbance caused by large vehicles, it is possible that unidentified cultural resources can be damaged by construction activities. The increased human presence associated with the construction phase can also lead to unauthorized collection of artifacts or vandalism of historic properties.

## 5. CONSULTATION/COORDINATION:

**BLM Consulted or Coordinated with the Following on this Analysis; OSP (Onsite Presence):**

| Contact | Organization | OSP? |
|---|---|---|
| Mary Hopkins | Wyoming State Historic Preservation Office | No |

**List of Preparers (BFO unless otherwise noted)**

| Position/Organization | Name | Position/Organization | Name |
|---|---|---|---|
| NRS/Team Lead | Dustin Hill | Assistant Field Manager | Chris Durham |
| Supr NRS | Casey Freise | Geologist | Kerry Aggen |
| Petroleum Engineer | Mark Thomason | Supr NRS | Kathy Brus |
| LIE | Christine Tellock | Assistant Field Manager | Clark Bennett |
| Archaeologist | Ardeth Hahn | NEPA Coordinator | John Kelley |
| Wildlife Biologist | Christopher Sheets | | |

## 6. References and Authorities


AHPIS, Animal and Plant Health Inspection Service. 2002. General information available online at http://www.aphis.usda.gov/lpa/issues/wnv/wnv.html.

Aldridge, C. L., and M. S. Boyce. 2007. Linking occurrence and fitness to persistence: a habitat-based approach for endangered greater sage-grouse. Ecological Applications 17:508-526.

American Water Works Association. 2013. Water and Hydraulic Fracturing, a White Paper. www.awwa.org/fracturing. Denver, CO. 17pp.

Approved Resource Management Plan for Public Lands Administered by the Bureau of Land Management Buffalo Field Office. 2001. Prepared by the United States Department of the Interior, Bureau of Land Management, Buffalo Field Office.

Balch, J.K, B.A. Bradley C.M D'Antonio, and J. Gomez-Dans. 2013. Introduced Annual Grass Increases Annual Fire Activity Across the Arid West (1980-2009). Global Change Biology. 19-1, pp. 173-183. http://onlinelibrary.wiley.com/doi/10.1111/gcb.12046/abstract.

Blickley, J. L. & Patricelli, G. L. 2010 Impacts of Anthropogenic Noise on Wildlife: Research Priorities for the Development of Standards and Mitigation. *Journal of International Wildlife Law and Policy* **13**, 274-292.

Blickley, J. L. & Patricelli, G. L. 2012 Potential acoustic masking of greater sage-grouse display components by chronic industrial noise. *Ornithological Monographs* **74**, 23-35.

Blickley, J. L., Blackwood, D. & Patricelli, G. L. 2012 Experimental Evidence for the Effects of Chronic Anthropogenic Noise on Abundance of Greater Sage-Grouse at Leks. *Conservation Biology* **26**, 461-471.

Blickley, J. L., Blackwood, D. L., Hardy, E. L. & Patricelli, G. L. in prep. Temporal flexibility in greater sage-grouse (Centrocercus urophasianus) signaling behavior in response to chronic industrial noise playback.

Blickley, J. L., Word, K. R., Krakauer, A. H., Phillips, J. L., Sells, S. N., Wingfield, J. C. & Patricelli, G. L. In review. Experimental chronic noise exposure is related to elevated fecal corticosteroid metabolites in lekking male greater sage-grouse (*Centrocercus urophasianus*). *PloS ONE*.

Bohne, J., T. Rinkes, and S. Kilpatrick. 2007. Sage-Grouse Habitat Management Guidelines for Wyoming. Wyoming Game and Fish Department. Cheyenne, Wyoming.

Bradley, B. A., J. F. Mustard. 2006. Characterizing the Landscape Dynamics of an Invasive Plant and Risk of Invasion Using Remote Sensing. Ecological Applications, 16(3), pp. 1132-1147.

Braun, C.E., O.O. Oedekoven, and C.L. Aldridge. 2002. Oil and Gas Development in Western North America: Effects on Sagebrush Steppe Avifauna with Particular Emphasis on Sage Grouse. In: Transactions of the 67th North American Wildlife and Natural Resources Conference. pp337-349.

Bureau of Land Management. 1990. Instruction Memorandum No. WY-90-564: Resource Management Plan Action and Wyoming BLM Standard Mitigation Guidelines for Surface Disturbing Activities. Bureau of Land Management, Wyoming State Office. Cheyenne, WY.

Bureau of Land Management. 2004. Instruction Memorandum No. WY-2005-057: Statement of Policy Regarding Sage-Grouse Management Definitions, and Use of Protective Stipulations, and Conditions of Approval. Bureau of Land Management, Wyoming State Office. Cheyenne, WY.

Chapman, S.S., Bryce, S.A., Omernik, J.M., Despain, D.G., ZumBerge, J., and Conrad, M. 2004. Ecoregions of Wyoming (color poster with map, descriptive text, summary tables, and photographs). Reston, Virginia, U.S. Geological Survey (map scale 1:1,400,000).

Connelly, J. W., M. A. Schroeder, A. R. Sands, and C. E. Braun. 2000. Guidelines for management of sage grouse populations and habitats. Wildlife Society Bulletin 28:967-985.

Connelly, J. W., S. T. Knick, M. A. Schroeder, and S. J. Stiver. 2004. Conservation Assessment of Greater Sage-grouse and Sagebrush Habitats. Western Association of Fish and Wildlife Agencies. Unpublished Report. Cheyenne, Wyoming.

Cornish, Todd; Terry Creekmore; Walter Cook; and Elizabeth Williams. 2003. "West Nile Virus - Wildlife Mortality in Wyoming 2002-2003". In: The Wildlife Society Wyoming Chapter Program and Abstracts for the Annual Meeting at the Inn in Lander, WY November 18-21, 2003. Wildlife Society Wyoming Chapter. 17pp.

Curtis, Jan and K. Grimes. 2004. Wyoming Climate Atlas. Wyoming Water Research Program, University of Wyoming; the U.S. Geological Survey; and the Wyoming Water Development Commission. 328 pp. http://www.wrds.uwyo.edu/sco/climateatlas/toc.html.

Doherty, K.E., D.E. Naugle, B.L. Walker, J.M. Graham. 2008. Greater sage-grouse winter habitat selection and energy development. Journal of Wildlife Management 72:187-195.

Duniway, M.C. J. E. Herrick, D. A. Pyke, and D. P. Toledo. 2010. Assessing Transportation Infrastructure Impacts on Rangelands: Test of a Standard Rangeland Assessment Protocol. Rangeland Ecol Manage 63:524-536.

Ebert, Jamies I., and Timothy A. Kohler. 1988. The Theoretical Basis of Archaeological Predictive Modeling and a Consideration of Appropriate Data-Collection Methods, in *Quantifying the Present and Predicting the Past: Theory, Method, and Application of Archaeological Predictive Modeling* edited by W. James Judge and Lynne Sebastian, pp. 97-171. U.S. Department of the Interior, BLM Service Center, Denver, CO.

Eckerle, William. 2005. Experimental: Archaeological Burial Model for Powder River and Tongue River Hydrological Basins, Wyoming. In *Adaptive Management and Planning Models for Cultural Resource in Oil and Gas Fields in New Mexico and Wyoming*, by Eric Ingbar, Lynne Sebastian, Jeffrey Altschul, Mary Hopkins, William Eckerle, Peggy Robinson, Judson Finley, Stephen A. Hall, William E. Hayden, Chris M. Rohe, Tim Seaman, Sasha Taddie, and Scott Thompson, pp. 39-102. Prepared for the Department of Energy, National Energy Technology Laboratory by Gnomon, Inc. Electronic Document, http://www.gnomon.com/DOEPumpIII/FinalCombinedReport.pdf, accessed August and September 2010.

Garton, E.O., J.W. Connelly, C.A. Hagen, J.S. Horne, A. Moser, and M.A. Schroeder. 2011. Greater Sage-grouse Population Dynamics and Probability of Persistence. Pages 293-381 in Greater sage-grouse: ecology and conservation of a landscape species and its habitats, S. T. Knick, J. W. Connelly, C. E. Braun (editors). Studies in Avian Biology, Number 38, University of California Press, Berkeley, CA, USA.

Gelbard J. L., and J. Belnap. 2003. Roads as conduits for exotic plant invasions in a semiarid landscape. Conservation Biology. 17:420–432.

Goolsby, J. 2012. Evolution & Revolution of Drilling Technologies & the Impact on Wyoming. Goolsby, Finley, and Associates, LLC. Presentation.

Holloran, M J.; B. J. Heath; A. G. Lyon; S. J. Slater; J. L. Kuppiers; and S. H. Anderson. 2005. Greater sage-grouse nesting habitat selection and success in Wyoming. J. Wildl. Manage. 69(2):638-649.

Holloran, M. J, and S. H. Anderson. 2005. Spatial distribution of Greater Sage-Grouse nests in relatively contiguous sagebrush habitats. Condor 107:742-752.

Holloran, M. J. 2005. Greater sage-grouse (Centrocercus urophasianus) population response to natural gas field development in western Wyoming. Dissertation, University of Wyoming, Laramie.

Holloran, M. J., R. C. Kaiser, and W. A. Hubert. 2007. Population Response of yearling greater sage-grouse to the infrastructure of natural gas fields in southwestern Wyoming. Completion report. Wyoming Cooperative Fish and Wildlife Research Unit, Laramie, WY, USA. 34pp.

Ken Kreckel. 2007. Direction Drilling: The Key to Smart Growth of Oil and Gas Development in the Rocky Mountain Region. The Wilderness Society, http://wilderness.org/files/Directional-Drilling.pdf .

Knick, S. T., and J. W. Connelly. 2011. Greater Sage-grouse: Ecology and Conservation of a Landscape Species and Its Habitats. University of California Press, Berkeley, California.

Lyon, A.G. and S.H. Anderson. 2003. Potential Gas Development Impacts on Sage Grouse Nest Initiation and Movement. *Wildlife Society Bulletin* 31:486-91.

Moynahan, B. J. and M. S. Lindberg. 2004. *Nest Locations of Greater Sage-Grouse in Relation to Leks in North-Central Montana*. *Presented at* Montana Sage-Grouse Workshop, Montana Chapter of The Wildlife Society, Billings.

Naugle, D. E. K. E. Doherty, B. L. Walker, M. J. Holloran, and H. E. Copeland. 2011. Energy Development and Greater Sage-Grouse. Pp. 489-529 in Greater Sage-Grouse: ecology and conservation of a landscape species and its habitats, S. T. Knick, J. W. Connelly, C. E. Braun (eds.) Studies in Avian Biology, Number 38, University of California Press, Berkley.

Naugle, D. E.; C. L. Aldridge; B. L. Walker; T. E. Cornish; B. J. Moynahan; M. J. Holloran; K. Brown; G. D. Johnson; E. T. Schmidtmann; R. T. Mayer; C. Y. Kato; M. R. Matchett; T. J. Christiansen; W. E. Cook; T. Creekmore; R. D. Falise; E. T. Rinkes; and M. S. Boyce. 2004. West Nile virus: Pending Crisis of Greater Sage-grouse. Ecology Letters. 7:704-713.

Naugle, David E.; Brett L. Walker; and Kevin E. Doherty. 2006. Sage Grouse Population Response to Coal-bed Natural Gas Development in the Powder River Basin: Interim Progress Report on Region-wide Lek Analyses. May 26, 2006. University of Montana. Missoula, MT. 10pp

Nicholoff, S. H., compiler. 2003. Wyoming Bird Conservation Plan, Version 2.0. Wyoming Partners in Flight. Wyoming Game and Fish Department, Lander, WY.

North Dakota Industrial Commission Oil and Gas Research Program. 2011. Investigation of Methodologies to Control Dust on County Roads in Western North Dakota. Grant Applicants: Dunn and Mckenzie County.

Northeast Wyoming Sage-grouse Working Group. 2006. Northeast Wyoming Sage-Grouse Conservation Plan.

Patricelli, G. L., J. L. Blickley, and S. L. Hooper. 2012. The impacts of noise on greater sage-grouse: A discussion of current management strategies in Wyoming with recommendations for further research and interim protections. University of California, Davis, CA. 25pp.

Pendery, Bruce M. 2010, BLM's Retained Rights: How Requiring Environmental Protection Fulfills Oil and Gas Lease Obligations, 40 Environmental Law, 599-685.

Powder River Oil and Gas Project Environmental Impact Statement and Resource Management Plan Amendment. 2003. Department of the Interior, Bureau of Land Management, Wyoming State Office in Campbell, Converse, Johnson and Sheridan Counties, Wyoming.

Romin, Laura A., and Muck, James A. May 1999. Utah Field Office Guidelines For Raptor Protection From Human And Land Use Disturbances. U.S. Fish and Wildlife Service, Salt Lake City, Utah.

Rowland, M. M., M. Leu, , S. P. Finn, S. Hanser, L. H. Suring, J. M. Boyd, C. W. Meinke, S. T. Knick, and M. J. Wisdom. 2005. Assessment of threats to sagebrush habitats and associated species of concern in the Wyoming Basins. Version 1.1, June 2005, unpublished report on file at USGS Biological Resources Discipline, Snake River Field Station, 970 Lusk St., Boise, ID 83706.

Saab, V., and T. Rich. 1997. Large-scale conservation assessment for neotropical migratory landbirds in the Interior Columbia River Basin. USDA Forest Service General Technical Report PNW-GTR-399, Portland, Oregon.

State wildlife agencies' ad hoc committee for sage-grouse and oil and gas development. 2008. Using the best available science to coordinate conservation actions that benefit greater sage-grouse across states affected by oil and gas development in Management Zones I-II (Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming). Unpublished report. Colorado Division of Wildlife, Denver; Montana Fish, Wildlife and Parks, Helena; North Dakota Game and Fish Department, Bismarck; Utah Division of Wildlife Resources, Salt Lake City; Wyoming Game and Fish Department, Cheyenne.

Stiver, S. J., A. D. Apa, J. R. Bohne, S. D. Bunnell, P. A. Deibert, S. C. Gardner, M. A. Hilliard, C. W. McCarthy, and M. A. Schroeder. 2006. Greater Sage-grouse comprehensive conservation strategy. WAFWA, Cheyenne, WY. 21 August 2009.

Taylor, R. L., D. E. Naugle, L. S. Mills. 2012. Viability analyses for conservation of sage-grouse populations: Buffalo Field Office, Wyoming. Final Report. February 27, 2012. University of Montana, Missoula, MT.

Taylor, R. L., D. E. Naugle, L. S. Mills. 2012. Viability analyses for conservation of sage-grouse populations: Buffalo Field Office, Wyoming. Final Report. February 27, 2012. University of Montana, Missoula, MT.

U.S. Department of the Interior 2011, Bureau of Land Management. BLM National Greater Sage-Grouse Land Use Planning Strategy. IM 2012-044. December 27, 2011. 2 Attachments.

U.S. Department of the Interior, Fish and Wildlife Service (FWS). 2010. Endangered and Threatened Wildlife and Plants; 12-Month Findings for Petitions to List the Greater Sage-Grouse (*Centrocercus urophasianus*) as Threatened or Endangered. 50 CFR Part 17.

University of Wyoming, Norton, J., Strom, C., Reclamation Considerations for Oil and Gas Lease Contracts on Private Lands, Bulletin B-1242, Apr. 2013.

US Department of Agriculture, 2006, Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin, Handbook 296, Washington, DC.

US Department of the Interior 2009, Bureau of Land Management, High Plains District, Update of Task 3A Report for the Powder River Basin Coal Review Cumulative Air Quality Effects for 2020, (AECOM).

US Department of the Interior 2009, Bureau of Land Management, Instruction Memorandum 2009-078. Processing Oil and Gas Applications for Permit to Drill for Directional Drilling into Federal Mineral Estate from Multiple-Well Pads on Non-Federal Surface and Mineral Estate Locations.

US Department of the Interior 2011, Bureau of Land Management. State Director Review, SDR WY-2011-010.

US Department of the Interior, Geological Survey. 2007. Organic Compounds in Produced Waters from Coalbed Natural Gas Wells in the Powder River Basin, Wyoming. Applied Geochemistry 22, 2240–2256.

US Department of the Interior, Geological Survey. 2010. Assessment of Potential Effects of Water Produced from Coalbed Methane Natural Gas Development on Macroinvertebrate and Algal Communities in the Powder River and Tongue River, Wyoming and Montana.

US Department of the Interior, Geological Survey. 2012. Hydraulic Fracturing – The State of the Science. Induced Seismicity. Leith, B. http://www.usgs.gov/solutions/ppt/2012june08_leith.pptx. Congressional Briefing hosted by the Honorable Gerry Connelly (D-VA). June 8, 2012. View at: http://www.youtube.com/watch?v=XnRH9i8hpbo&feature=youtu.be See, Earthquakes Induced by Fluid Injection. http://www.usgs.gov/faq/index.php?sid=54684&lang=en&action=show&cat=125

US Department of the Interior, Geological Survey. 2012. Kresse, T.M., Warner, N.R., Hays, P.D., Down, A., Vengosh, A., and Jackson, R.B., 2012, Shallow groundwater quality and geochemistry in the Fayetteville Shale gas-production area, north-central Arkansas, 2011: Investigations Report 2012–5273, 31 p.

US Environmental Protection Agency, 2012, Oil and Natural Gas Sector: New Source Performance Standards and National Emission Standards for Hazardous Air Pollutants Reviews, 77 FR 49490.

US Environmental Protection Agency. 2004. Evaluation of Impacts to Underground Sources of Drinking Water by Hydraulic Fracturing of Coalbed Methane Reservoirs Study, EPA 816-R-04-003, http://water.epa.gov/type/groundwater/uic/upload/completestudy.zip .

US National Academy of Sciences, 2012. Induced Seismicity Potential in Energy Technologies. Washington, D.C.

Walker B, Naugle D, Rinkes T. 2003. The Response of Sage Grouse to Coal-bed Methane Development and West Nile virus in the Powder River Basin: Is There a Link ? Page 6 in: Program and Abstracts for the Annual Wildlife Society Meeting, Wyoming Chapter.

Walker, B. L., and D. E. Naugle. 2011.West Nile virus ecology in sagebrush habitats and impacts on greater sage-grouse populations. Pages 127-142 in Greater sage-grouse: ecology and conservation of a landscape species and its habitats, S. T. Knick, J. W. Connelly, C. E. Braun (eds). Studies in Avian Biology, Number 38, University of California Press, Berkley.

Walker, B. L., D. E. Naugle, K. E. Doherty, and T. E. Cornish. 2007. West Nile virus and greater sage-grouse; estimating infection rate in a wild bird population. Avian Diseases 51:691-696.

Walker, B.L., D. E. Naugle, and K.E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.

Walker, B.L., D. E. Naugle, and K.E. Doherty. 2007. Greater sage-grouse population response to energy development and habitat loss. Journal of Wildlife Management 71:2644-2654.

Warner, N.R., Jackson, R.B., Darraha, T.H., Osbornc, S.G., Downb, A., Zhaob, K., Whitea, A. and Vengosha, A., 2012, Geochemical evidence for possible natural migration of Marcellus Formation brine to shallow aquifers in Pennsylvania, Proceedings Natl Acad Sciences

WGFD. 2003. Wyoming Greater Sage-Grouse Conservation Plan. WGFD. Cheyenne, WY.

WGFD. 2005. Northeast Wyoming Local Working Group Area: Annual Sage-Grouse Completion Report for 2005. Wyoming Game and Fish Department. Buffalo, WY. 42pp.

WGFD. 2009. Minimum Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats on BLM Lands. WGFD. Cheyenne, WY

WGFD. 2009. Minimum Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats on BLM Lands. WGFD. Cheyenne, WY.

WGFD. 2011b. 2011 Sheridan Region Lek Monitoring Results

Wyoming Department of Environmental Quality, June 14, 2004. Compliance Monitoring for Ground Water Protection Beneath Unlined Coalbed Methane Produced Water Impoundments

Wyoming Game and Fish Department (WGFD). 2004. Minimum Recommendations for Development of Oil and Gas Resources within Crucial and Important Wildlife Habitats on BLM Lands. WGFD. Cheyenne, WY.
Wyoming Oil and Gas Conservation Commission. 2013. Well Files, http://wogcc.state.wy.us/ .