4. ENVIRONMENTAL CONSEQUENCES

4.0.1 Introduction

The purpose of this chapter is to assess and disclose the environmental effects of the Continental Divide-Creston Natural Gas Development Project. The analysis is guided by the regulations set forth by the Council on Environmental Quality (CEQ), which call for analysis of the direct, indirect, and cumulative effects of the Proposed Action and the alternatives (40 CFR 1500-1508). Direct effects are those caused by an action and occurring at the same time and place as the action—for example, the surface disturbance that occurs when a well pad is constructed. Indirect effects are caused by the action but "are later in time or farther removed in distance"—for example, the effects on watersheds if a well pad is not successfully reclaimed. Cumulative impacts are those that result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions. Direct and indirect impacts of the CD-C project are described in this chapter; cumulative impacts are described in **Chapter 5**. Throughout the EIS, the words *impact* and *effect* are used interchangeably.

The CEQ regulations also call for a discussion of the significance of the impacts. Significance requires considerations of both context and intensity. Significance can vary dependent on the setting in which the Proposed Action and the alternatives are to take place. Each resource section in this chapter includes a brief description of the considerations made in determining the significance of the environmental effects for the resource under discussion.

The regulations also direct the resource specialist to describe ways in which adverse environmental impacts may be mitigated. For the Proposed Action and all of the alternatives, a broad set of discretionary mitigation measures would be applied when appropriate as a matter of course by the BLM. These measures are frequently referred to as Best Management Practices (BMPs) and are often applied by the BLM as Conditions of Approval (COAs) on natural gas Applications for Permit to Drill (APDs). BMPs that may be applicable to the CD-C project and the standard set of oil and gas COAs applied by the Rawlins Field Office (RFO) are described in **Appendix C**. The Rawlins Resource Management Plan (RMP) also contains descriptions of BMPs that could be applied by the BLM as necessary. Each resource section may contain additional recommended mitigation measures if the resource specialist determines that mitigation measures in the standard suite of BMPs would not be sufficient.

The Proposed Action and five alternatives are considered in this document. The requirements of each of the alternatives apply only to public lands administered by the BLM and to federal mineral estate.

- **The Proposed Action**. The Operators propose to drill up to 8,950 additional natural gas wells throughout the CD-C project area, on public and private mineral estate, over 15 years, with a project life of up to 55 years. About 42 percent of the 8,950 new wells would be directional wells from multiple-well pads. One result of directional drilling is reduced surface disturbance per well bore.
- **Alternative A: 100-Percent Vertical Drilling**. This alternative (and all the other action alternatives) would also include up to 8,950 additional wells in the project area. However, it is assumed that directional drilling would not be used at all—that there would be no multiple-well pads—and that consequently project surface-disturbance would be greater than for the Proposed Action.
- **Alternative B: Enhanced Resource Protection.** The Enhanced Resource Protection Alternative requires protections and mitigation beyond the measures ordinarily applied for certain resources that are of high value or may be at greater risk of adverse impacts, such as pronghorn and mule deer crucial winter range. The alternative also describes surface disturbance and species population thresholds that, if crossed, would signal the need for still more protections and mitigation and outlines the additional measures that may be needed.

- **Alternative C: Surface Disturbance Cap—High and Low Density Development Areas.** This alternative places a cap of 60 acres per section on the amount of unreclaimed surface disturbance on public land in those parts of the CD-C project area that have had high-density development. For the remainder of the project area—the low-density development areas—the cap on surface disturbance would be 30 acres per section. All prior surface disturbance committed to long-term use for roads or on-pad production facilities and all disturbance that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap.
- **Alternative D: Directional Drilling.** This alternative requires that all future natural gas wells on federal mineral estate be drilled from multi-well pads, which would require the use of directional drilling technology to reach targeted downhole locations. One new multi-well pad per section (or per lease if the lease area is less than a section) would be permitted. In sections that have already had oil and gas development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes would be permitted. In sections that have not had oil and gas development at all, one new well pad would be permitted for all future development. One road and pipeline corridor per well pad would be permitted. Under certain conditions, Operators may request that an APD be excepted from the general rule.
- **Alternative E: No Action**. Under the No Action Alternative, it is assumed that none of the natural gas development activities proposed by the CD-C Operators would occur. The analysis of the No Action alternative assumes that previously authorized activities would continue but that no new development would take place under this proposal.

The Proposed Action and alternatives are described in more detail in **Chapter 2, Alternatives Including the Proposed Action.** None of the alternatives is designated as the BLM's preferred alternative. The BLM NEPA Handbook (H-1790-1) calls for expression of the BLM's preferred alternative in the Draft EIS if one exists (BLM 2008c). The BLM does not have a preferred alternative for the CD-C Natural Gas Development Project at this time. The BLM believes that the Proposed Action and the action alternatives all have elements that would address the project purpose and need and will review public comment on the Draft EIS before determining a preferred alternative. A preferred alternative will be designated in the Final EIS.

4.0.2 Historic and Future Impacts

The CD-C natural gas development project is an in-fill project. This means that future natural gas development in the project area would be a continuation of activity that has been ongoing there for some time. Natural gas exploration and development in the Continental Divide-Creston area began in the 1950s. The Wamsutter field was the first field established in the area, in 1958, followed by the Creston field in 1960, the Continental Divide field in 1964, and the Blue Gap field in 1974. Since initiation of drilling, about 4,400 natural-gas wells have been drilled in the project area. **Map 4.0-1** displays the locations of those wells. The annual rate of development increased from the late 1990s until 2008 when 304 gas wells were drilled. Since then, drilling has proceeded at a rate of about 200 wells per year.

This previous natural gas development has generated substantial surface disturbance. As shown in **Table 4.0-1**, oil and gas development in the project area prior to 2006 had resulted in the disturbance of an estimated 49,218 acres, of which 8,472 acres remain unvegetated and in use for facilities such as well pad access roads, well-production facilities, and pipeline facilities. The many pipelines that cross the area contributed about half the historic surface disturbance—over 26,500 acres. Wamsutter is a major pipeline hub that serves many natural gas pipelines, all of which cross the CD-C project area. An additional 10,958 acres were disturbed for purposes other than oil and gas development, principally federal, state, and county highways and roads, but also ranching and agricultural activities. Taken together, these figures indicate that 5.6 percent of the surface of the CD-C project area's 1.1 million acres has been disturbed at

some time in the past. Depending on the success of reclamation efforts, about 42,500 acres of that initial disturbance are in various stages of ecological restoration.

Map 4.0-1 displays the spread and the density of the past natural gas surface disturbance. Individual sections are color-coded from dark green to red according to the amount of surface disturbance that has occurred in the section. Dark green represents a section that has seen no disturbance at all; red represents a section that has had more than 75 acres of disturbance (12 percent or more of the surface area of the section).

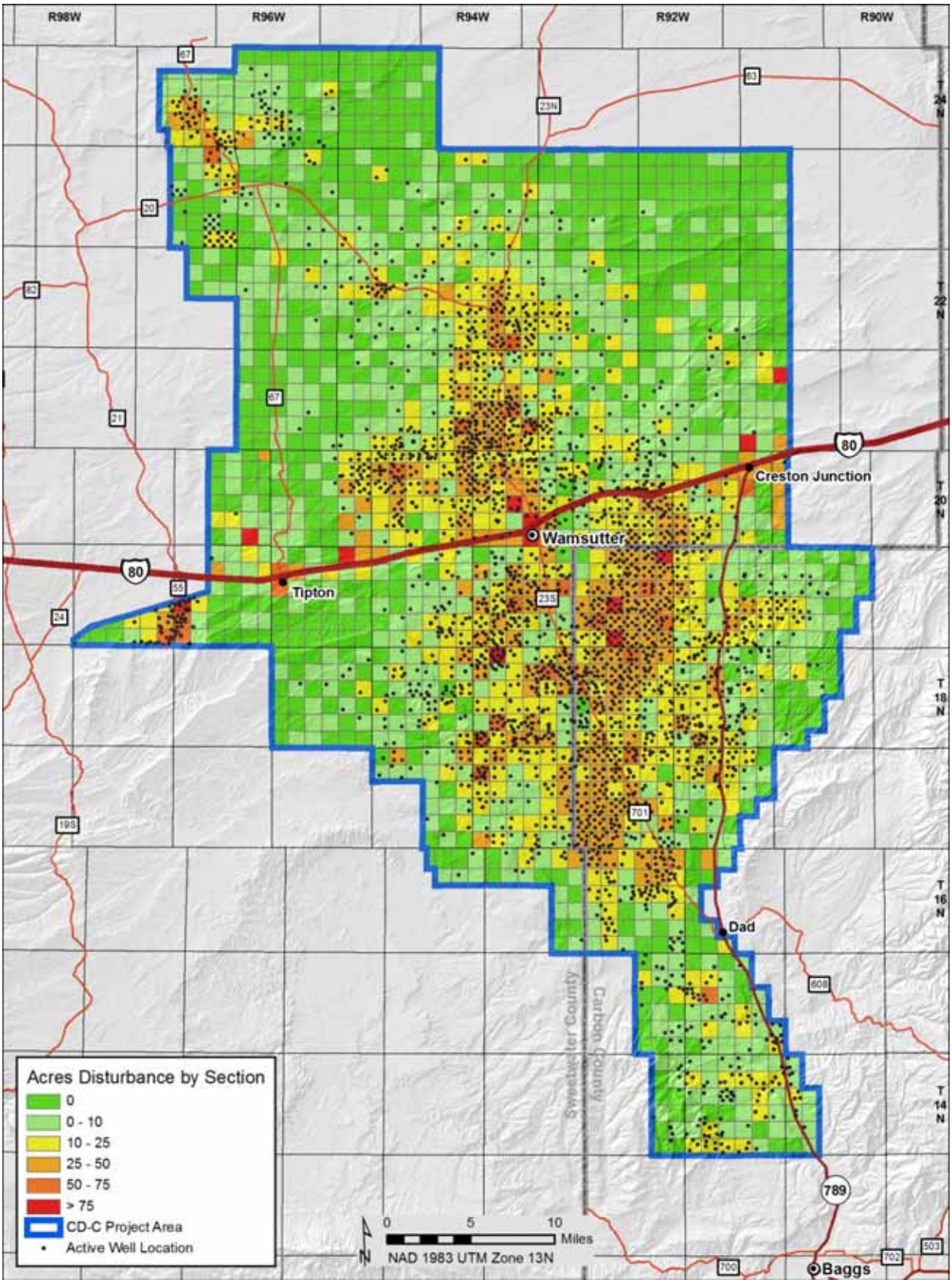
For the most part, the greatest disturbance is located in the same areas with the greatest amount of drilling. The exceptions are those sections that have major industrial facilities. The past development and the disturbance have primarily been located in the central part of the project area, along either side of the Wamsutter Road, south of I-80, and on either side of the Crooks Gap Road, north of I-80. Large areas in the northeast and the western parts of the project area have seen relatively little development.

Table 4.0-1 also shows the additional disturbance that would be generated by the Proposed Action and each alternative. Displayed immediately below the figures for the initial and long-term disturbance that would be produced by each alternative are the comparable figures for the combined initial disturbance (*Combined IN*) and the combined long-term disturbance (*Combined LT*) of previous actions and those of the alternative.

Adding the estimated 47,200-acre disturbance associated with the Proposed Action to the 60,176 acres previously disturbed would mean that ten percent of the project area—107,376 acres—would be disturbed by the time the Proposed Action is completed. To the extent that past reclamation efforts have been successful and that future reclamation is also successful, a minimum of 3.4 percent—36,524 acres—of the lands within the project area would remain in an unvegetated state on a long-term basis (the *Combined LT* disturbance).

The CD-C project area is managed under the provisions of Federal Land Policy and Management Act for multiple use. Range, minerals, recreation, wild horses, wildlife, and other resources and uses are considered in the BLM's management of the federal lands and balance is sought between them. Rangeland health assessments are guided by the "Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands" (Standards and Guidelines) (BLM 2001a). The Standards apply to all resource uses for public lands including oil and gas development. Guidelines provide for, and guide the development and implementation of, reasonable, responsible, and cost-effective management practices at the grazing allotment and watershed level.

There are two primary watersheds within the CD-C area. If a watershed assessment reveals that a Standard(s) is not being met, factors contributing to the non-attainment are identified and management recommendations are developed so the Standard(s) may be attained. When a Standard(s) is failed, corrective action must be taken by whatever permitted entity is causing the failure. During the CD-C implementation period, any failures to attain Standards may be due to ranching practices, oil and gas development activities, other activities that have been permitted, or a combination of many factors. If oil and gas operators are found to be causing or contributing to non-attainment of a standard, the BLM will require their participation and contribution to corrective actions that may be required. Further monitoring and adaptive management may be required from any parties contributing to the problem. This provision applies to all rangelands/habitat found within the project area. Close cooperation between the BLM, range permittees, oil and gas companies, and perhaps others may be required to successfully attain any Standards that are not being met. The environmental effects assessed in this chapter take into account compliance with the Standards and Guidelines and related periodicmonitoring of rangelands.



Map 4.0-1. Past surface disturbance, by section, within the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

Table 4.0-1. CD-C surface disturbance – historic, Proposed Action and Alternatives (acres)

Category	Surface Disturbance						
	Oil and Gas			Grand Total	*Percent of Project Area*	Change from Proposed Action	
	Well Pads (incl. roads)	Related Facilities[1]	Total			acres	%
Historical							
Initial	20,524	28,694	49,218	60,176	*5.6%*	—	—
Long-term	6,403	2,069	8,472	17,663	*1.7%*	—	—
Proposed Action							
Initial	41,889	5,311	47,200	47,200	*4.4%*	—	—
Long-term	17,998	863	18,861	18,861	*1.8%*	—	—
Combined IN[2]	62,413	34,005	96,418	107,376	*10.0%*	—	—
Combined LT[2]	24,401	2,932	27,333	36,524	*3.4%*	—	—
Alternative A: 100-Percent Vertical Drilling							
Initial	56,385	5,311	61,696	61,696	*5.8%*	14,496	*30.7%*
Long-term	23,270	863	24,133	24,133	*2.3%*	5,272	*28.0%*
Combined IN[2]	76,909	34,005	110,914	121,872	*11.4%*	14,496	*13.5%*
Combined LT[2]	29,673	2,932	32,605	41,796	*3.9%*	5,272	*14.4%*
Alternative B: Enhanced Resource Protection Alternative							
Initial	40,205	5,311	45,516	45,516	*4.3%*	-1,684	*-3.6%*
Long-term	17,386	863	18,249	18,249	*1.7%*	-611	*-3.2%*
Combined IN[2]	60,729	34,005	94,734	105,692	*9.9%*	-1,684	*-1.6%*
Combined LT[2]	23,789	2,932	26,721	35,912	*3.4%*	-611	*-1.7%*
Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section							
Initial	37,644	5,311	42,955	42,955	*4.0%*	-4,245	*-9.0%*
Long-term	16,455	863	17,318	17,318	*1.6%*	-1,543	*-8.2%*
Combined IN[2]	58,168	34,005	92,173	103,131	*9.6%*	-4,245	*-4.0%*
Combined LT[2]	22,858	2,932	25,790	34,981	*3.3%*	-1,543	*-4.2%*
Alternative D: Directional Drilling							
Initial	31,138	5,311	36,449	36,449	*3.4%*	-10,751	*-22.8%*
Long-term	14,089	863	14,952	14,952	*1.4%*	-3,908	*-20.7%*
Combined IN[2]	51,662	34,005	85,667	96,625	*9.0%*	-10,751	*-10.0%*
Combined LT[2]	20,492	2,932	23,424	32,615	*3.0%*	-3,908	*-10.7%*
Alternative E: No Action							
Initial	0	0	0	0	*0.0%*	-47,200	*-100.0%*
Long-term	0	0	0	0	*0.0%*	-18,861	*-100.0%*
Combined IN[2]	20,524	28,694	49,218	60,176	*5.6%*	-47,200	*-44.0%*
Combined LT[2]	6,403	2,069	8,472	17,663	*1.7%*	-18,861	*-51.6%*

[1] *Estimated future disturbance is unchanged under each alternative for "Related O&G Facilities," except for No Action, which has no disturbance.*

[2] *"Combined IN" equals the sum of historic initial disturbance and future initial disturbance.*
"Combined LT" equals the sum of historic long-term disturbance and future long-term disturbance.

Alternative A, 100-Percent Vertical Drilling, would result in the greatest surface disturbance—61,696 acres—a 31 percent increase over the Proposed Action. When combined with previous disturbance, 11.4 percent of the project area—121,872 acres—would be disturbed by the time Alternative A is implemented. A minimum of 3.9 percent—36,524 acres—of the lands within the project area, the *Combined LT* disturbance, would remain in an unvegetated state on a long-term basis. The remaining action alternatives, Alternatives B through D, would each produce successively less surface disturbance than either the Proposed Action or Alternative A. Alternative B, Enhanced Resource Protection, would generate an estimated initial disturbance of 45,516 acres, 3.6 percent less than the Proposed Action. Alternative C, Cap on Surface Disturbance, would generate an estimated initial disturbance of 42,955 acres, 9.0 percent less than the Proposed Action. Alternative D, Directional Drilling, would produce the lowest initial surface disturbance—an estimated 36,499 acres—and a 22.8 percent reduction from the Proposed Action. It would also produce the lowest combined initial disturbance—96,625 acres—and the lowest combined long-term disturbance—32,615 acres. Alternative E, No Action, would produce no new disturbance and thus no addition to the previous totals.

Another indicator of the degree of disturbance that an alternative would generate is the number of well pads likely to be used to implement the Operators' drilling plans. The Proposed Action and all the action alternatives would each permit the drilling of the proposed 8,950 wells but the requirements of the alternatives would alter the degree to which directional drilling is used and therefore the number of wellpads. As indicated earlier, the Proposed Action assumes that about 42 percent of the 8,950 wells would be drilled using directional techniques from multi-well pads. A total of 6,126 well pads is implied. **Table 4.0-2** shows the estimated number of well pads that would be used in each of the alternatives. Alternative A assumes only vertical drilling would apply so the number of well pads is the same as the number of wells: 8,950. Under Alternative D, it is estimated that virtually all wells drilled to federal mineral estate would be drilled from a multi-well pad, with the construction of an estimated 4,032 well pads, a 34.2 percent reduction from the Proposed Action. The relative distribution of vertical and directional wells on private and state minerals would remain unchanged.

Table 4.0-2. CD-C estimated well pad numbers by alternative

Alternative	Well Pads	% Change
Proposed Action	6,126	—
Alternative A: 100-Percent Vertical Drilling	8,950	46.1%
Alternative B: Enhanced Resource Protection	5,798	-5.4%
Alternative C: Surface Disturbance Cap	5,299	-13.5%
Alternative D: Directional Drilling	4,032	-34.2%
Alternative E: No Action	0	-100.0%

The amount of surface disturbance generated by the project is an important indicator of the overall level of direct impacts that would be produced. This figure is directly related to the soils, watershed, and vegetation impacts that would result from the project. The number of well pads used to drill out the project is also an important indicator, not only because it is a major determinant of the amount of surface disturbance needed, but also because it indicates the number of sites that will be disturbed and the degree to which the landscape would be fragmented by the well sites and the access roads to them. Each disturbance site is also the focal point of impacts that extend outward from the site and the fewer the number of sites, the less these impacts would be felt. The presence of industrial facilities, in particular the noise and the regular human activity associated with the sites, alters the way that the surrounding landscape serves as wildlife habitat. For example, not only is browse and forage removed by construction of a well pad, but access to forage may be inhibited by the noise, activity, and dust produced around a well pad. The impact may differ for each species. In terms of wildlife impacts, the effect is generally captured by the term "habitat fragmentation." It is not just a wildlife phenomenon, however, as the same

factors apply to visual and recreation resources, grazing management, watershed management, and other resources.

Past disturbance is a direct indicator of the degree to which environmental and human resources in the project area have already been affected. It represents changes to the visual environment, wildlife habitat, transportation system, recreation, and other resources that are already in place. Unlike analyses of other projects where there has been little or no prior development, the impact analysis of future development in the CD-C project area must be described in the context of the substantial impacts that have already occurred.

Two examples illustrate the ways in which the analysis of future impacts can be altered by impacts that have already taken place.

- Visual impacts are generally discussed in terms of the degree to which a proposal would alter the natural visual environment. In the case of the CD-C project area, past development has already introduced a substantial industrial element into many viewsheds in the area. This is reflected in the Rawlins RMP's current classification of its visual resources and therefore the level of landscape change future actions would be allowed to have. The Rawlins RMP's current land classifications (expressed as Visual Resource Management, or VRM, classes) are the basis for the visual resources analysis presented in this chapter (see **Section 3.11.3**).
- The transportation system and the traffic it carries is often a major cause of environmental impacts produced by a natural gas development project. In the CD-C project area, most of the collector and arterial roads and many of the local roads that would be needed for full-field development have already been constructed and are in use. This means that the disturbance associated with future road construction would be substantially less than if the infrastructure were not already in place. On the other hand, the wildlife habitat fragmentation and disturbance associated with natural-gas access roads and traffic is already a fact in much of the area. The analysis of impacts on wildlife reflects this existing state.

4.0.3 Distribution and Density of Future Impacts

The Proposed Action does not define the specific locations of any natural gas wells or associated facilities proposed for the CD-C project area. The analysis of impacts described in this chapter assumes that facility construction and well-drilling could occur anywhere within the project area and that all parts of the area would be affected. However, the historic development in the project area provides an indicator as to the likely spatial distribution and density of future development.

Map 4.0-2 shows the locations of natural gas wells drilled to date in the CD-C project area and the current well spacing designated by the Wyoming Oil and Gas Conservation Commission (WOGCC) throughout the project area. *Spacing* refers to the spatial density of wells per section (640 acres) producing from the same reservoir, usually stated in terms of acres. It is a formal designation that has been approved by the WOGCC. In **Map 4.0-2**, the currently approved spacing in the yellow areas is 160 acres, meaning one well is permitted in each 160-acre parcel. Currently approved spacing in the orange areas is 80 acres (one well per 80 acres) and in the red areas is 40 acres, with a variant in some parcels—pink—that is about 60 acres.

Spacing designations refer not to the number of surface locations of the wells (well pads) but to the number of down-hole (bottom-of-hole) locations. Thus, an 80-acre spacing that allowed for eight wells per section could result in as many as eight well pads or as few as one, if all wells were drilled from the same pad. If all wells in this example were drilled from their own individual pad, 50 or more acres of surface disturbance could result (at 6.3 acres of disturbance per well pad). However, with application of directional drilling techniques, perhaps only one or two surface locations (well pads) per section would be needed, and the resultant surface disturbance could be 20 acres or less. A central feature of Alternatives C

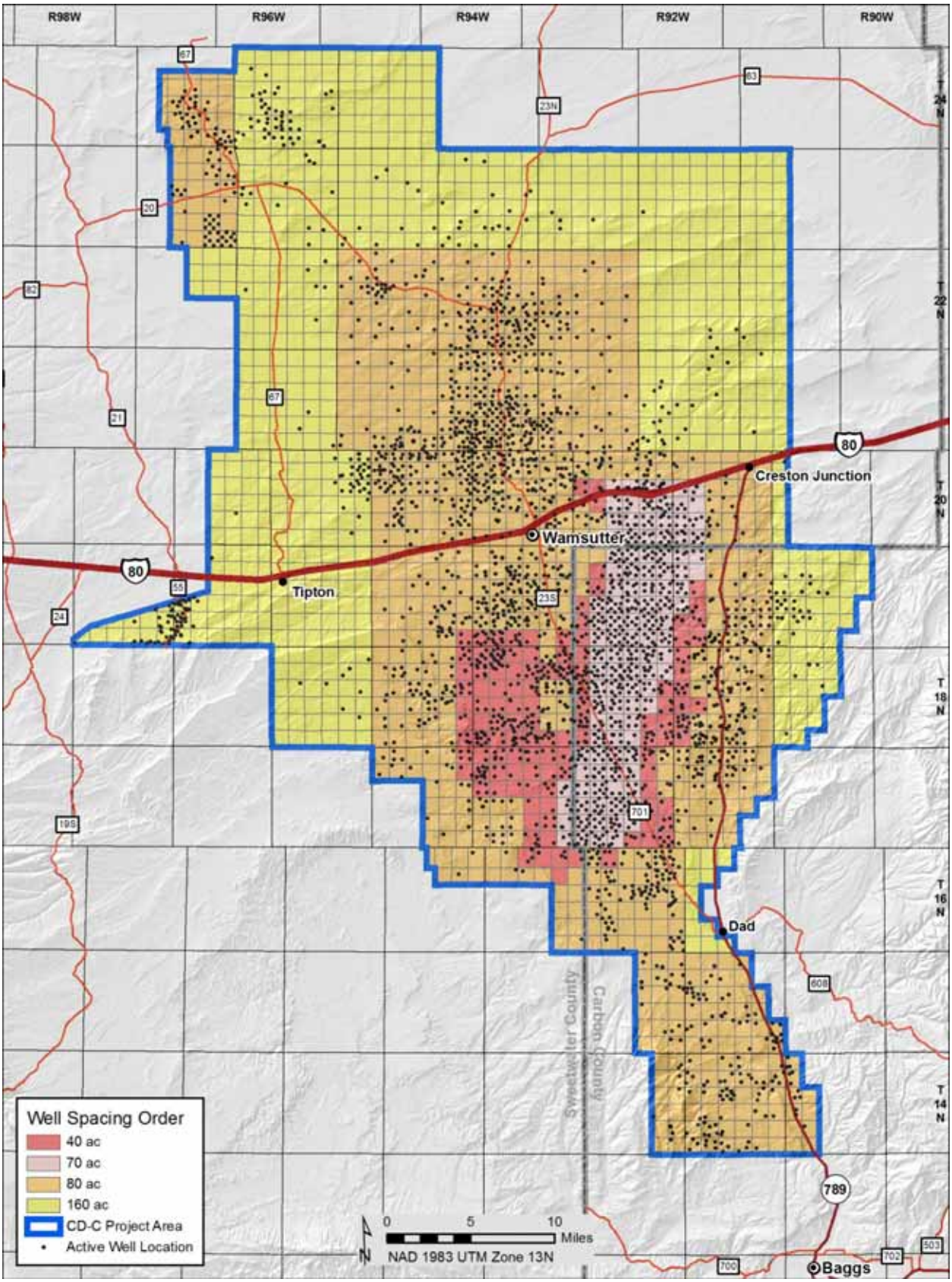
and D is the effort to constrain the number of surface locations used to achieve the down-hole locations rather than the number of down-hole well locations.

Generally, spacing units reflect the judgment of the Operators—with WOGCC concurrence—as to the number of wells that would be required to efficiently develop and recover the natural gas resource in an area. It is not uncommon to begin development of a field with relatively low well spacing, e.g., one well per 160 acres, and then seek approval from WOGCC for "tighter" spacing to 80 acres, 40 acres, or less, as production occurs and more is learned about the gas reservoir. As the map shows, the "tightest" spacing is in the areas with the greatest number of wells. As the CD-C's natural gas resource was developed over the last six decades, operators determined that more wells would be needed to fully recover the gas and so more dense spacing was sought by the operators and approved by the WOGCC.

The analysis of impacts in the CD-C project area assumes that the spacing units depicted in **Map 4.0-2** would likely be realized as the area's natural gas resource is developed. That means that at full development, in areas with 40-acre spacing, there would be one well every 40 acres, or 16 wells per section. Areas with 80-acre spacing would have eight wells per section and areas with 160-acre spacing would have four wells per section. In general terms, that would result in the most intense future development occurring on either side of the Wamsutter and Crooks Gap Roads in the central part of the CD-C project area as those areas that have seen the most development to date are "filled in." The areas surrounding this area of intense development would also be "filled-in" but with lower density: eight wells per section. The remainder of the project area would see less-intense development with its 160-acre spacing, or potentially four wells per section.

The analysis assumption anticipates that, as development proceeds, some operators are likely to conclude that full development of the natural gas resource in certain parts of the CD-C project area requires tighter spacing. In those cases, they would request a reduction from 160-acre spacing to 80-acre spacing, or from 80-acre to 40-acre spacing, with well densities increasing from four to eight wells per section or from eight to 16 wells per section. The areas where this might occur cannot be predicted but such increases in density are within the scope of the analysis.

While the same number of wells is proposed for the Proposed Action and Alternatives A through D, the disturbance area for each would vary according to the degree to which directional drilling is pursued. Directional drilling allows more than one well to be drilled at a location, resulting in an estimated average initial disturbance of 2.45 acres per well bore, including both an allowance for the well pad and for the access road to the location. For a vertically drilled well, the estimated initial disturbance would be 6.3 acres per well, including well pad and access road. The total estimated disturbance for each alternative is shown in **Table 4.0-1**. Since **Alternative A, 100-Percent Vertical Drilling**, has no directional drilling, it has the highest total surface disturbance, an estimated 61,696 acres. The Proposed Action, with an estimated 42-percent directional drilling component, would produce an initial surface disturbance of 47,200 acres. **Alternatives B** through **D** have successively less surface disturbance as the amount of directional drilling increases with each. **Alternative E, No Action**, would have no drilling and no surface disturbance at all.



Map 4.0-2. Current well spacing orders in the CD-C project area

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

■ PHYSICAL ENVIRONMENT

4.1 GEOLOGY

4.1.1 Introduction

Of the geological features described in **Section 3.1 Geology**, the surface environment would be impacted by the Proposed Action and the action alternatives, affecting the geology of the CD-C project area and causing mass movement, a geological hazard. Removing vegetation and soils could lead to altered hydrology, decreased infiltration rates, and increased overland flow rates. Unmitigated, accelerated erosion could cause gullying in some areas and rapid deposition or siltation in other areas with associated erosion effects. Mass movements, including landslides, could be triggered in areas that become over-steepened by erosional removal of slope-supporting material. Altering existing topography, particularly by steepening slopes, could also trigger mass movements and accelerated erosion.

The magnitude of impacts to the geology and associated geological hazards in the project area would be reduced by the implementation of mitigation measures for geology, soils, vegetation, and water resources as described in **Appendix C**.

4.1.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes no management objectives or significance criteria for geology.

The following significance criterion for geology was adapted from the Atlantic Rim Field Development Natural Gas Development Project Final EIS (BLM 2006a):

1. Impacts to geology would be significant if project implementation results in increased runoff and erosion that leads to mass movement (including landsliding), subsidence, flooding, or increased deposition or siltation that alters the landscape.

4.1.3 Direct and Indirect Impacts

4.1.3.1 Impacts Common to All Action Alternatives

Impacts could occur to the geologic environment caused by project implementation and operation (e.g., alteration of existing topography, initiation of mass movements, including landslides). Impacts could occur to project facilities as a result of inherent geologic hazards. The likelihood of these impacts occurring as a result of project implementation is remote, particularly with adoption of the mitigation measures for geology, soils, vegetation, and water resources described in **Appendix C** and adherence to Wyoming Department of Environmental Quality (WDEQ) and WOGCC requirements. The potential for impacts depends on where surface disturbance occurs and the total amount and distribution of disturbance both spatial and temporally.

4.1.3.2 Proposed Action and Alternatives

Impacts to the geological environment would be more likely with alternatives that have the greatest amount of concentrated (spatially and temporally) surface disturbance. The Proposed Action and the Alternatives would result in differing amounts of initial and long-term ground disturbance, largely because of varying numbers of wells drilled directionally from multiple-well pads. The Proposed Action, with mixed vertical and directional drilling, would produce 47,200 acres of disturbance. Alternative A has only vertical drilling and consequently would result in an estimated 61,696 acres of disturbance, a 30-percent increase (**Table 4.0-1**). Because surface disturbance would be greater, Alternative A would have a greater chance of impacting the geological environment. Alternatives B, C, and D would each have

decreasing levels of surface disturbance and hence decreasing risks of impact. Alternative E, No Action, would have no potential for impacts. With application of appropriate mitigation measures, the significance criterion would not be met.

4.1.4 Impact Summary

While the likelihood of geological impacts occurring as a result of project implementation is remote, the Proposed Action and all of the alternatives have the potential for direct and indirect impacts to geology to the extent that the ground is disturbed by development activities. Successful application of mitigation measures described in **Appendix C** would minimize the risk of those impacts occurring and remove the likelihood of meeting the significance criterion.

4.1.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Mitigation measures for geology, soils, vegetation, and water resources described in **Appendix C** would avoid or minimize impacts to the surface geologic environment and lessen the possibility of mass movement and flooding; therefore, no additional mitigation measures are necessary.

4.2 PALEONTOLOGIC RESOURCES

4.2.1 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives associated with paleontology:

- Identify paleontological resources by defining priority inventory areas based on probability of occurrence of high-value resources.
- Assess the need for project or site-specific treatment plans or other protective measures in areas of high risk for development or at high risk for adverse effects.
- Develop, maintain, and encourage opportunities for scientific research of paleontological resources.
- Provide educational opportunities and public outreach programs.
- Develop and maintain interpretation of paleontological resources in areas of high public interest and access.

Impacts to paleontological resources would be considered significant if the following were to occur:

1. An action or development causes substantial direct or indirect damage or destruction to important paleontological resources.

4.2.2 Direct and Indirect Impacts

4.2.2.1 Impacts Common to All Action Alternatives

Excavation of pipeline trenches and construction of well pads, access roads, and ancillary facilities associated with the Proposed Action or its alternatives could result in the exposure and possible destruction of paleontological resources (frequently referred to here as *fossils* or *fossil resources*), either directly as a consequence of construction or indirectly as a result of increased erosion rates. Increased access resulting from development may increase the visibility of fossil resources and lead to increased illegal fossil collection. The potential for impacts increases in areas where geological formations rated as having a moderate to very high PFYC (3, 4, or 5) are exposed at the surface or shallow enough to be affected by excavation. The CD-C project area is underlain by geological units that have a moderate to very high potential of producing scientifically important fossils. These units (with their PFYC in parentheses) include the Battle Spring (3), Fort Union (3), Green River (5) and Wasatch (5) formations.

Excavation of pipelines and construction of other project facilities could also result in the discovery of new paleontological resources. If these newly discovered resources are properly recovered and catalogued into the collections of a museum repository, the Proposed Action and its alternatives could result in a better understanding and knowledge of this resource. In addition, increased access would allow easier access by professional, permitted paleontologists and geologists, who hope to make scientifically significant discoveries.

Implementation of mitigation measures described in **Appendix C** would lessen the chance that scientifically important fossils would be damaged or destroyed directly or indirectly. The Paleontological Resource Preservation Act (PRPA) described in **Section 3.2.1** broadened the guidance for surveying for paleontological resources and mitigating potential impacts. That guidance is captured in BLM Instruction Memorandum [IM] No. 2009-011, *Assessment and Mitigation of Potential Impacts to Paleontological Resources* (BLM 2008d). The IM is summarized here and is included in its entirety in **Appendix D, Paleontological Resources Program Guidance**.

IM 2009-011 calls for the BLM to assess the possible effects on paleontological resources of all proposed surface-disturbing activities on public lands or split-estate lands. If the assessment indicates "(a) the presence or high probability of occurrence of vertebrate fossils or uncommon nonvertebrate fossils (PFYC Class 4 or 5), or that the probability is unknown (Class 3), in the area of a proposed federal action or transfer of title, and (b) a reasonable probability that those resources will be adversely affected by the proposed action," then measures such as a field survey, onsite monitoring, special stipulations, avoidance, or other mitigation may be required.

The preferred mitigation technique is to change the project location based on the results of the field survey. Monitoring may be required as part of overall mitigation for a project, arising out of the NEPA process, or upon the discovery of paleontological resources during project activities. The purpose of onsite monitoring is to assess and collect any previously unknown fossil material uncovered during the project activities or soon after surface-disturbing actions.

4.2.2.2 Proposed Action and Alternatives

Impacts to paleontological resources would be more likely with alternatives that have the greatest amount of concentrated surface disturbance, both spatially and temporally. The Proposed Action and the alternatives would result in differing amounts of initial and long-term ground disturbance, largely because of varying numbers of wells drilled directionally from multiple-well pads. The Proposed Action, with mixed vertical and directional drilling, would produce 47,200 acres of disturbance. Alternative A would have only vertical drilling and consequently would result in an estimated 61,696 acres of disturbance, a 30-percent increase (**Table 4.0-1**). Alternatives B, C, and D would each have decreasing levels of surface disturbance—with 45,516 acres, 42,955 acres, and 36,449 acres respectively—and hence decreasing risks of impact. Because surface disturbance would be greater, Alternative A would have the greatest chance of impacting paleontological resources. Under Alternative E, No Action, no paleontological impacts would occur in the CD-C project area. With application of appropriate mitigation measures, the significance criterion would not be met.

4.2.3 Impact Summary

Implementation of the Proposed Action or the alternatives has the potential to impact paleontological resources to the extent that the ground is disturbed by development activities. Successful application of mitigation measures described in **Appendix C** and **Appendix D** would minimize and mitigate these impacts and remove the possibility of causing substantial direct or indirect damage or destruction to important paleontological resources. The significance criterion would not be met.

4.2.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Because the potential for substantial adverse impacts on important paleontological resources would be minimized by the mitigation measures described in **Appendix C** and in **Appendix K**, no additional mitigation measures would be necessary.

4.3 SOILS

4.3.1 Introduction

Impacts to the soil resource resulting from construction and installation of well pads and wells, access roads, pipelines, and compressor stations include the removal of vegetation and soil, exposure of soil, soil compaction, and undesirable mixing of soil horizons. In addition, saline and/or sodic soil conditions could be created from the release of fracturing fluids, drilling fluids, or produced water. These impacts could subsequently result in a loss of soil productivity, increased susceptibility of the soil to wind and water erosion, increased surface runoff, increased sedimentation and elevated salt loads within project area water resources, and the spread of invasive/noxious plants.

4.3.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives associated with the soil resource:

- Soils should be stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.
- Soil productivity should be maintained.

The following criteria serve as a basis to assess the intensity, duration, and magnitude of soil impacts associated with implementation of the Proposed Action and action alternatives. Soil impacts would be considered significant if:

1. Soil productivity is reduced to a level that prevents the disturbed area from recovering to pre-disturbance soil/vegetation productivity levels;
2. Reclamation monitoring does not indicate a trajectory towards success within two to five years of reclamation; or
3. Disturbed areas are not adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality.

4.3.3 Direct and Indirect Impacts

Impacts to the soil resource under the Proposed Action and all alternatives include removal of vegetation and soil, exposure of soil, soil compaction, undesirable mixing of soil horizons, and the creation of saline and/or sodic soil conditions.

Removal of Vegetation and Soil Resulting in Exposure of Soil. Removal of vegetation and soil during construction and production activities, and the subsequent exposure of the soil, can lead to increased susceptibility to erosion and loss of soil productivity. Soils are more susceptible to erosion if they are not protected by vegetation cover or are left exposed to wind or water flow. This is exacerbated during intensive storm events, floods, or drought conditions. Removal of vegetation and litter from the construction/production sites removes organic material that eventually could become soil organic matter. Loss of topsoil, from removal during construction or production activities or from erosion, can result in the loss or reduction of soil organisms, viable seed-bank, and soil nutrients. Finally, exposed soils are more susceptible to invasive plant establishment. The effects of vegetation and soil removal and exposed soils can be minimized through the implementation of proper soil-salvaging techniques and prompt

attention to soil stabilization (see the Rawlins RMP Record of Decision (ROD), Appendix 36 [BLM 2008b]).

Soil Compaction. Soil compaction from construction and production activities on the disturbed areas can reduce soil productivity and increase surface runoff. Soil compaction affects soil structure and reduces pore size. Excessive compaction can lead to reduced water infiltration into the soil and reduced permeability of water through the soil; reduced diffusion of oxygen, carbon dioxide, and other gases into and out of the soil; reduced plant-root penetration; and reduced plant growth and production. The effects of compaction can be reduced at the time of reclamation through sound site-preparation practices, including ripping.

Undesirable Mixing of Soil Horizons. Loss of soil productivity could result when construction and production activities disturb the soil resource. The mixing of soil horizons, where subsurface soil horizons are brought to the surface and mix with or replace surface-soil horizons, can result in less biologically productive surface soils. Soil-horizon mixing can result in elevated soil pH, increased soil salinity, higher sodium and calcium carbonate concentrations, decreased levels of soil nutrients and organic matter, and altered soil structure, texture, and rock content. The effects of soil mixing can be minimized or eliminated through proper soil salvaging (see the Rawlins RMP ROD, Appendix 36 [BLM 2008b]).

Creation of Saline/Sodic Soil Conditions. Spilled fracturing fluids, drilling fluids, and produced water could lead to loss of soil productivity through the creation of saline/sodic soil conditions at production facilities during construction and production activities. Depending on the size and type of spill, the effect on soils would vary considerably. Saline soils can interfere with plant germination and growth, and sodic soils can become hard and crusted with effects similar to those of compacted soils. The effects of spilled fracturing fluids, drilling fluids, and produced water can be minimized through proper implementation of the Spill Prevention, Control, and Countermeasure (SPCC) Plan, and the use of approved disposal methods for produced water.

While the types of soil impacts would be similar for the Proposed Action and the action alternatives, the impacts of each alternative would vary according to the amount of surface disturbance and the effectiveness of reclamation efforts. Impacts to soils are assumed to be proportional to the amount of new surface disturbance for each alternative (i.e., increased disturbance would result in a proportionate increase in adverse impacts to soils). To a great extent, the amount of surface disturbance is directly correlated with the degree to which directional drilling is pursued in an alternative, since directional drilling results in an estimated average initial disturbance of 2.45 acres per well bore, including well pad and access road, while the average vertical well produces 6.3 acres of initial disturbance. **Section 4.0.2, Historic and Future Impacts**, in **Table 4.0-1,** provides detailed information on the estimated disturbance by alternative. Section 4.0.2 also describes the extent of past surface disturbance in the CD-C project area. Historic disturbance in the area amounts to an estimated 60,176 acres, almost 82 percent—49,218 acres—of which is related to historic oil and gas development. All of the surface disturbance and soil impacts described in the subsections below would be in addition to those that have already occurred.

In general, the extent of impacts to the soil resource would be greatly influenced by the success of mitigation and reclamation efforts. Emphasis would be placed on the stabilization of disturbed soils, particularly via the establishment of vegetative ground-cover during the first growing season following disturbance. Reclamation potential of soils in the CD-C project area is primarily poor with major limitations being saline/sodic soil conditions and either clayey or sandy soil textures (**Table 3.3-1**). In addition to these soil limitations, low annual precipitation of 10–14 inches in conjunction with erosion by wind and water could make successful reclamation more difficult to attain. Revegetation may be challenging on the estimated 75 percent of the project area indicated as possessing fair or poor reclamation potential (Table 3.3-1). However, current technology exists to stabilize disturbances, minimize erosion, and increase reclamation success provided that construction, maintenance, and

operation of well pads and associated disturbances are in accordance with planned mitigation measures and reclamation.

For the Proposed Action and Alternatives, strict adherence to the Rawlins RMP and required Conditions of Approval and Best Management Practices (**Appendix C**) is vital to minimize impacts to sensitive soils. Included in the RMP guidance are Appendix 1 – Wyoming Bureau of Land Management Mitigation Guidelines for Surface Disturbing and Disruptive Activities, Appendix 13 – Reducing Nonpoint Source Pollution with Best Management Practices, Appendix 15 – Best Management Practices for Reducing Surface Disturbance and Disruptive Activities, and Appendix 36 – Reclamation Plan (BLM 2008b). In accordance with RMP Appendix 36, each Operator will be required to develop and submit to the BLM for approval a site specific reclamation plan for each well location that describes how the Operator will achieve the following goals for interim and final reclamation (found in Instruction Memorandum No. WYD-03-2011-002):

- Protection of existing native vegetation;
- Minimal disturbance of existing environment;
- Soil stabilization through establishment of ground cover;
- Establishment of native vegetation consistent with land use planning; and
- Monitoring and management of the reclamation sites to evaluate reclamation success.

Full and successful implementation of the above measures would insure that none of the three significance criteria would be exceeded. Soil productivity would not be reduced such that pre-disturbance conditions could not be recovered, the reclamation trajectory would be toward success, and disturbed areas would be adequately stabilized. Failure to successfully implement the required measures could produce significant impacts.

4.3.3.1 Proposed Action

The Proposed Action would result in adverse soil impacts including the removal of vegetation and soil resulting in exposure to erosion, soil compaction, undesirable mixing of soil horizons, and creation of saline/sodic soil conditions, directly related to the amount of surface disturbance that would occur. Initial (short-term) soil disturbance associated with the construction and operation of 8,950 natural gas wells, associated access roads and related facilities is estimated at 47,200 acres (**Table 4.0-1**). This disturbance comprises 4.4 percent of the total project area. Combined with the historic disturbance of 60,176 acres, 10 percent of the surface of the CD-C project area would be affected. The initial CD-C project-related disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the initial disturbance area. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 18,861 acres, or 1.8 percent of the total project area.

The soils assessment described in Chapter 3 ranked the project area soil limitations related to wind erosion, water erosion, runoff potential, road construction potential, and reclamation success (**Table 3.3-1**). The current number of wells drilled in each of the rating class areas for each limitation was also summarized in the table.

The distribution of soil limitations for the Proposed Action, assuming that future drilling would occur at the same spatial distribution as current wells drilled, is provided in **Table 4.3-1.** For the 47,200 acres of initial disturbance for the Proposed Action, this translates to 34,343 acres with a slight limitation for water erosion, 36,656 acres with a moderate limitatiofor wind erosion, 16,775 acres with a moderate limitation for runoff potential, 30,115 acres with a moderate limitation for road construction, and 27,095 acres with a poor reclamation potential.

Table 4.3-1. Distribution of soil limitations based on current well locations within the CD-C project area[1]

Potential Limitation	Rating Class/Limiting Features	Percentage of Existing Wells in Each Rating Class	ACRES OF DISTURBANCE IN EACH RATING CLASS					
			Proposed Action	Alternative A 100-Percent Vertical Drilling	Alternative B Enhanced Resource Protection	Alternative C Cap on Surface Disturbance, High & Low Density	Alternative D Directional Drilling	Alternative E No Action
Water Erosion	Slight	73.00	34,343	44,890	33,118	31,254	26,520	16,367
	Moderate	21.00	10,148	13,264	9,786	9,235	7,836	4,836
	Severe	3.00	1,398	1,827	1,348	1,272	1,079	666
	Not Rated / Water	2.80	1,312	1,714	1,265	1,194	1,013	625
Wind Erosion	Slight	14.00	6,437	8,414	6,207	5,858	4,971	3,068
	Moderate	78.00	36,656	47,913	35,348	33,359	28,306	17,470
	Severe	5.90	2,796	3,654	2,696	2,544	2,159	1,332
	Not Rated / Water	2.80	1,312	1,714	1,265	1,194	1,013	625
Runoff Potential	Low	0.48	224	293	216	204	173	107
	Low To Moderate	0.88	414	541	399	377	320	197
	Low to High	6.60	3,106	4,060	2,996	2,827	2,399	1,480
	Moderate	36.00	16,775	21,926	16,176	15,266	12,954	7,995
	Moderate to High	30.00	13,962	18,249	13,463	12,706	10,781	6,654
	High	25.00	11,614	15,182	11,200	10,570	8,969	5,535
	Not Rated / Water	2.30	1,104	1,444	1,065	1,005	853	526
Road Construction Limitations	Moderate	64.00	30,115	39,364	29,040	27,406	23,255	14,352
	Moderate / Severe	0.00	0	0	0	0	0	0
	Severe	33.00	15,791	20,641	15,227	14,371	12,194	7,526
	Not Rated / Water	2.70	1,294	1,692	1,248	1,178	1,000	617
Reclamation Potential	Good	14.00	6,454	8,437	6,224	5,874	4,984	3,076
	Fair	26.00	12,357	16,151	11,916	11,245	9,542	5,889
	Poor	57.00	27,095	35,416	26,128	24,658	20,923	12,913
	Not Rated / Water	2.70	1,294	1,692	1,248	1,178	1,000	617

Notes

[1] *Information from two soil surveys completed by the BLM was used to assess the potential limitations of the CD-C project area soils (Texas Resource Consultants, 1981; Wells et al., 1981). Information from individual soil map units was used to evaluate the soil limitations. If multiple soil series existed within a single map unit, rankings were assigned based on the soil series that comprised the greatest acreage within the unit.*

Although the extent of areas with soil limitations makes it likely that implementation of the Proposed Action would occur on soils that possess severe limitations, total avoidance of these areas would not be feasible. Adherence to the Rawlins RMP and required Conditions of Approval (COAs) and Best Management Practices (BMPs) (**Appendix C**) would ensure that disturbed areas are stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality, and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.2 Alternative A: 100-Percent Vertical Drilling

Adverse soil impacts under Alternative A would be similar to the Proposed Action but the extent and the degree of the impacts would be greater because the amount of surface disturbance would be greater. The construction of 8,950 natural gas wells using only vertical drilling techniques, together with associated access roads and related facilities, would produce initial (short-term) soil disturbance estimated at 61,696 acres, 30.7 percent greater than the Proposed Action. This disturbance would comprise approximately 5.8 percent of the total project area. Combined with the historic disturbance of 60,176 acres, over 11 percent of the surface of the CD-C project area would be affected. The initial CD-C project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) from 6.3 acres to approximately 2.6 acres, reducing the long-term surface disturbance to approximately 40 percent of the initial disturbance area. During the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 24,133 acres, or 2.3 percent of the total project area.

While the same number of wells is proposed for both the Proposed Action and Alternative A, the disturbance area would be 14,496 acres (30.7 percent) greater for Alternative A because all of the wells would be drilled using vertical drilling techniques. With the use of vertical drilling techniques, only one well can be drilled at a single location, resulting in approximately 6.3 acres of initial disturbance per well. For a directionally drilled well, the initial disturbance would be 2.45 acres per well bore.

The distribution of soil limitations for Alternative A, assuming that future drilling would occur at the same spatial distribution as current wells drilled, is provided in **Table 4.3-1**. For the 61,696 acres of initial disturbance for Alternative A, this translates to 44,890 acres with a slight risk for water erosion, 47,913 acres with a moderate risk for wind erosion, 21,926 acres with a moderate runoff potential, 39,364 acres with a moderate limitation to road construction, and 35,416 acres with a poor reclamation potential (**Table 4.3-1**).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative A would occur on soils that have severe limitations, total avoidance of these areas would not be feasible, especially given the increased surface disturbance under this alternative. Adherence to the Rawlins RMP and required COAs and BMPs (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.3 Alternative B: Enhanced Resource Protection

Adverse soil impacts under Alternative B would be similar to the Proposed Action but the extent and the degree of the impacts would be less because the amount of surface disturbance would be less. The construction of 8,950 natural gas wells using a combination of vertical and directional drilling techniques, together with associated access roads and related facilities, under the terms of Alternative B would produce initial (short-term) soil disturbance estimated at 45,516 acres, 3.6 percent less than the Proposed Action. This disturbance would comprise 4.3 percent of the total project area. Combined with the historic disturbance of 60,176 acres, almost 10 percent of the surface of the CD-C project area would be affected. The initial project disturbance is considered temporary, as successful interim reclamation is expected to

reduce the average drill-pad size (including access road) to approximately 40 percent of the short-term disturbance area. Reclamation of pipeline right-of-way disturbances would be initiated immediately upon completion of construction. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 18,249 acres, or 1.7 percent of the total project area. While the same number of wells is proposed for both the Proposed Action and Alternative B, the total disturbance area would be 1,684 acres (3.6 percent) less for Alternative B. Alternative B would disturb less area than the Proposed Action since more directional wells would be drilled—an estimated 438 more—resulting in less disturbance per well.

The distribution of soil limitations for the 8,950 wells included under Alternative B, assuming that future drilling would occur at the same spatial distribution as current wells drilled, is projected to follow the distribution of wells in each rating class as provided in **Table 4.3-1**. For the 45,516 acres of initial disturbance for Alternative B, this translates to 33,118 acres with a slight risk for water erosion, 35,348 acres with a moderate risk for wind erosion, 16,176 acres with a moderate runoff potential, 29,040 acres with a moderate limitation to road construction, and 26,128 acres with a poor reclamation potential (**Table 4.3-1**).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative B would occur on soils that have severe limitations, total avoidance of these areas would not be feasible, although the risk of adverse impacts would be reduced slightly because of the slightly reduced disturbance (3.6 percent). Adherence to the Rawlins RMP and required Conditions of Approval and Best Management Practices (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and potential impacts to water quality and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.4 Alternative C: Cap on Surface Disturbance for High and Low Density Development Areas

Adverse soil impacts under Alternative C would be similar to the Proposed Action but the extent and the degree of the impacts would be less because the amount of surface disturbance would be less. The construction of 8,950 natural gas wells using a combination of vertical and directional drilling techniques under the terms of Alternative C, together with associated access roads and related facilities, would produce initial (short-term) soil disturbance estimated at 42,955 acres, 9.0 percent less than the Proposed Action. This disturbance would comprise 4.0 percent of the total project area. Combined with the historic disturbance of 60,176 acres, almost 10 percent of the surface of the CD-C project area would be affected. The initial CD-C project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the initial disturbance area. Reclamation of pipeline right-of-way disturbances would be initiated immediately upon completion of construction. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 17,318 acres, or 1.6 percent of the total project area. While the same number of wells is proposed for both the Proposed Action and Alternative C, the total disturbance area would be 4,245 acres (9 percent) less for Alternative C. Alternative C would have less total disturbance than the Proposed Alternative since additional directional wells would be drilled—an estimated 1,103 more—resulting in less disturbance per well.

The distribution of soil limitations for the 8,950 wells included under Alternative C, assuming that future drilling would result in the same spatial distribution as current wells in the project area, is projected to follow the distribution of wells in each rating class as provided in **Table 4.3-1**. For the 42,955 acres of initial disturbance for Alternative C, this translates to 31,254 acres with a slight risk for water erosion, 33,359 acres with a moderate risk for wind erosion, 15,266 acres with a moderate runoff potential, 27,406 acres with a moderate limitation to road construction, and 24,658 acres with a poor reclamation potential (Table 4.3-1).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative C would occur on soils that have severe limitations, total avoidance of these areas would not be feasible. However, the risk of adverse impacts would be reduced because of the reduced disturbance under this alternative (9.0 percent). Adherence to the Rawlins RMP and required COAs and BMPs (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.5 Alternative D: Directional Drilling

Adverse soil impacts under Alternative D would be similar to the Proposed Action but the extent and the degree of the impacts would be less because the amount of surface disturbance would be less. The construction of 8,950 natural gas wells using a combination of vertical and directional drilling techniques under the terms of Alternative D, together with associated access roads and related facilities, would produce initial (short-term) soil disturbance estimated at 36,449 acres, 22.8 percent less than the Proposed Action. This disturbance would comprise 3.4 percent of the total project area. Combined with the historic disturbance of 60,176 acres, 9 percent of the surface of the CD-C project area would be affected. The initial CD-C project disturbance is considered temporary, as successful interim reclamation is expected to reduce the average drill-pad size (including access road) to approximately 40 percent of the initial disturbance area. Reclamation of pipeline right-of-way disturbances would be initiated immediately upon completion of construction. Therefore, during the life of the project (45 to 55 years), the long-term disturbance area is expected to decrease to 14,952 acres, or 1.4 percent of the total project area. While the same number of wells is proposed for both the Proposed Action and Alternative D, the total disturbance area would be 10,751 acres (22.8 percent) less for Alternative D. Alternative D would have less total disturbance than the Proposed Alternative since additional directional wells would be drilled—an estimated 2,793 more—resulting in less disturbance per well.

The distribution of potential soil limitations for the 8,950 wells included under Alternative D, assuming that future drilling would result in the same spatial distribution as current wells in the project area, is projected to follow the distribution of wells in each rating class as provided in **Table 4.3-1**. For the 36,449 acres of initial disturbance for Alternative D, this translates to 26,520 acres with a slight risk for water erosion, 28,306 acres with a moderate risk for wind erosion, 12,954 acres with a moderate runoff potential, 23,255 acres with a moderate limitation to road construction, and 20,923 acres with a poor reclamation potential (Table 4.3-1).

Although the extent of areas with soil limitations makes it likely that implementation of Alternative D would occur on soils that have severe limitations, total avoidance of these areas would not be feasible. However, the risk of adverse impacts would be reduced because of the reduced disturbance under this alternative (22.8 percent less). Adherence to the Rawlins RMP and required COAs and BMPs (**Appendix C**) would ensure that disturbed areas are adequately stabilized to reduce soil erosion, surface runoff, and associated impacts to water quality, and would minimize the reduction of soil productivity. Annual monitoring and adaptation of reclamation practices would be used to establish a trajectory to successful reclamation.

4.3.3.6 Alternative E: No Action

Under the No Action Alternative, it is assumed that no new natural gas drilling would occur. Adverse soil impacts would be limited to those related to historical disturbance in the project area. The No Action Alternative assumes that previously authorized activities would continue but that no new programmatic development would occur under this proposal. Historic development has resulted in the disturbance of 60,176 acres, about 5.6 percent of the surface of the CD-C project area. This disturbance level would not increase under the No Action Alternative. The historic disturbance is considered temporary, because it is

assumed that successful interim reclamation would reduce the average unvegetated disturbance to approximately 30 percent of the initial disturbance area. Therefore, the long-term historic disturbance area is expected to decrease to 17,663 acres, or 1.7 percent of the total project area.

For the No Action Alternative, no new impact to the soil resource would occur. Soil impact would be greatly reduced since no new disturbance would occur under this alternative (47,200 acres less than the Proposed Action).

4.3.3.7 Impacts Summary

For the Proposed Action, the total area of disturbance is estimated to be 47,200 acres, which would comprise approximately 4.4 percent of the project area. For Alternative A, the total area of disturbance is estimated to be 61,696 acres, which would comprise approximately 5.8 percent of the project area; Alternative A would result in a 30.7 percent increase over the disturbance anticipated for the Proposed Action. Alternative B would have a total disturbance area of 45,516 acres, which would comprise 4.3 percent of the project area; Alternative B would result in a 3.6percent decrease from the disturbance anticipated for the Proposed Action. Alternative C would have a total disturbance of 42,955 acres, which consists of 4.0 percent of the project area; Alternative C would result in a 9percent decrease from the disturbance anticipated for the Proposed Action. Alternative D would have a total disturbance of 36,449 acres, which consists of 3.4 percent of the project area; Alternative D would result in a 22.8percent decrease from the disturbance anticipated for the Proposed Action. Finally, for Alternative E, the No Action Alternative, no new surface disturbance would occur.

Full and successful implementation of the required mitigation measures and BMPs would ensure that none of the three significance criteria would be exceeded. Soil productivity would not be reduced such that pre-disturbance conditions could not be recovered, the reclamation trajectory would be toward success, and disturbed areas would be adequately stabilized. Failure to successfully implement the required measures could result in significant impacts.

4.3.3.8 Unavoidable Adverse Impacts and Additional Mitigation Measures

The Proposed Action and alternatives would result in adverse soil impacts including the removal of vegetation and soil resulting in exposure to erosion, soil compaction, and undesirable mixing of subsurface soil horizons with potential saline/sodic soil conditions. However, full and successful implementation of the required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs would ensure that none of the three significance criteria would be exceeded.

No additional mitigation measures would be required.

4.4 WATER RESOURCES

4.4.1 Introduction

Authorization of the proposed project would require full compliance with the Rawlins RMP, the Federal Clean Water Act (CWA), EO 11990 (wetlands protection), and EO 11988 (floodplain protection). These regulations require that certain permits/authorizations be obtained from the State of Wyoming (WDEQ-WQD and WOGCC) and the BLM and other federal agencies. Permits are required from WDEQ-WQD or WOGCC for disposal of produced water. State and federal approval is required for Applications for Permit to Drill (APDs); Federal Lease Obligations; development of surface runoff, erosion, and sediment control plans; injection-well permitting; oil-spill containment and contingency plans; Stormwater Pollution Prevention Plans; Spill Prevention Control and Countermeasures Plans; and CWA Section 404 permits.

For the purposes of this analysis, the evaluation of the Proposed Action and alternatives assumes adherence to these plans, permits, leases, and regulations for the protection of water resources. Many impacts associated with natural gas development are common to all alternatives and therefore are analyzed for general impacts in **Section 4.4.3**. The magnitude of impacts varies by alternative, so the magnitude of impacts is discussed as they relate to each alternative.

Up to 500 of the 8,950 proposed wells could be coalbed natural gas (CBNG) wells. The volume of water produced in CBNG development is much greater than for conventional natural gas production. During initial coal-seam depressurization, CBNG wells can produce from 500–1,000 bbls/day of produced water compared to the average of 18 bbls/day for a conventional well. The actual volumes produced and the methods by which the produced water would be managed are greatly dependent on the site-specific development proposals. For that reason, this document does not contain any description of produced-water disposal for CBNG development and does not analyze the impacts of such development. Should the BLM receive site-specific CBNG proposals in the project area, the proposals, including the treatment of produced water, will be analyzed in a separate NEPA document at that time.

4.4.2 Assumptions for Analysis

Under all alternatives, the following would be adhered to: Operator-committed measures, required BMPs, including BMPs for Non-Point Source Pollution as applicable, as well as the regulations and plans described in **Section 4.4.1**. Per NEPA guidance, this analysis will be based on the premise that standard operating procedures including these BMPs and regulations would be followed under each alternative. **Appendix C** includes a summary description of the BMPs and APD Conditions of Approval typically used by the BLM in the Rawlins Field Office to implement the federal laws, regulations and policy aimed at mitigating environmental impacts.

4.4.2.1 Surface Water Analysis Assumptions

The analysis for surface water is based on the following specific assumptions:

- Disturbance to soil and vegetation, including compaction of soil, would increase water runoff and downstream sediment loads and lower soil productivity, thereby degrading water quality, channel structure, and overall watershed health.
- The degree of impact attributed to any one disturbance or series of disturbances is influenced by several factors including location within the watershed, time and degree of disturbance, existing vegetation, soil characteristics, type of disturbance, and precipitation.
- Increased pollutants in surface waters would degrade habitat used by aquatic life and would affect other uses (e.g., stock-watering, irrigation, and drinking-water supplies).
- The BLM would continue to develop and maintain water sources in upland areas to reduce impacts on wetland/riparian areas and provide a resource for livestock grazing.
- Access roads would follow standard construction practices. However, even properly designed roads would still alter hillslope hydrology and concentrate overland flow, increasing erosion in some areas. In areas with steep topography, roads are expected to be longer, resulting in greater impacts to surface-water resources.
- Fine-textured soils are more susceptible to water erosion and compaction when wet than medium- or coarse-textured soils; coarse-textured soils are more susceptible to wind erosion.

4.4.2.2 Groundwater Analysis Assumptions

Groundwater would be affected during construction of wells or by other subsurface project-development activities. The most likely pathway for groundwater contamination would be undetected spills and leachate from leaking produced-water facilities or mud pits. Additionally, undetected defects in either

casing installation or cementing would be the most likely scenario for groundwater contamination to occur from actual gas well drilling and completion activities. Leakage from freshwater storage pits (used in fracturing operations) or other storage pits needed for well completion has the potential to leach salts from soils and impact shallow groundwater. Chemicals used for production drilling could cause local contamination of soils and groundwater if not managed properly. By design, the BLM approves APDs and associated drilling plans to protect potentially potable/usable groundwater intervals. Construction of well pads, proper disposal practices, proper well casing and cementing, and recycling of drilling fluids would be in accordance with BLM guidelines and should minimize adverse effects on groundwater quality. Withdrawal of produced water during production activities would impact target aquifers as would injection of the produced water.

4.4.3 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives associated with water resources (cited appendices are in the Rawlins RMP ROD, BLM 2008b):

- Maintain or improve water quality by managing surface land use and groundwater resources, where practical and within the scope of the BLM's authority, according to the State of Wyoming Water Quality Rules and Regulations (Appendix 11).
- Maintain the hydrologic and water-quality conditions needed to support riparian/wetland areas; minimize flood and sediment damage to water resources from human and natural causes; analyze and, where possible, minimize levels of salt-loading in watersheds; and protect water resources used by the public (including impoundments, reservoirs, pipelines, and irrigation ditches) and by federal, state, and local agencies for fisheries, wildlife, wild horses, livestock, agricultural, recreational, municipal, and industrial uses.
- Address all accidental spills of environmental pollutants on federal lands according to Appendix 32.
- Implement intensive management of surface-disturbing activities (Appendix 13) in watersheds contributing to water bodies listed on the Wyoming 303(d) list of water bodies with water-quality impairments or threats, within the BLM's authority.
- Maintain or improve wetland/riparian areas as required by the Wyoming Standards for Healthy Rangelands (BLM 1997).
- Avoid playas when locating infrastructure due to poor soils and potential flooding.
- Ensure that activities that would cause water depletion within the Colorado River system or the North Platte River system comply with existing agreements, decrees, rules, and regulations (Appendix 11).

Significance criteria are developed to gauge the magnitude of an impact on the human and natural environment. An impact on water resources as a result of project actions would be considered significant if its magnitude is such that mitigation measures discussed in Appendix C are insufficient and additional mitigation measures are warranted or if it were to persist indefinitely.

4.4.3.1 Surface-Water Significance Criteria

Impacts to surface water supplies would be considered significant if any of the following were to occur:

1. Degradation of water quality beyond the designated use of the receiving water body, or other violations of federal or state water-quality standards, or negatively impacting a water body listed on the State 303(d) list of Impaired or Threatened Waterbodies.
2. Project activities that elevate salt-loading to the Colorado River system above background conditions.
3. Unmitigated loss of wetlands or wetland function (EO 11990 and 11988).

4. Project-related activities that degrade wetland/riparian areas such that, as a minimum physical state, Standards for Healthy Rangelands (BLM 1997) are not being maintained.
5. Streamflow characteristics of intermittent drainages or perennial streams are altered such that established uses are affected.
6. Alteration of stream-channel geometry or gradient by accelerated runoff and erosion (e.g., undesirable aggradation, degradation, or side-cutting) beyond what would be expected by natural processes.
7. Contamination of surface water from spilled fracking fluids, drilling fluids, and produced water.
8. Soil loss greater than 2 tons per acre per year in areas attributed to surface disturbance.

4.4.3.2 Groundwater Significance Criteria

Impacts to groundwater resources or springs caused by project activities would be considered significant if any of the following were to occur:

1. Interruption of the natural flow or level of groundwater to existing local springs, seeps, or flowing artesian wells, regardless of use or non-use.
2. Degradation of groundwater quality in any aquifer such that it can no longer meet its classified current use(s). This includes impacts to underground sources of drinking water (USDW) or sole source aquifers (SSAs).
3. Spills or releases of fuels, liquids, chemicals, or hazardous materials (including but not limited to fracking fluids, drilling fluids, and produced water) that affect the quality of groundwater.

4.4.4 Direct and Indirect Impacts

The following impact discussions consider whether project impacts will result in the exceedance of one or more of the water resources significance criteria detailed above. The potential for an impact meeting or exceeding one or more of the significance criteria listed above is based on legal requirements (i.e., government regulatory standards), public perception, available scientific and environmental documentation, and professional judgment of resource specialists, as specified in 40 CFR 1508.27. The evaluation assumes successful implementation of BMPs and COAs.

4.4.4.1 Impacts Common to the Proposed Action and All Alternatives

The project area encompasses approximately 1.1 million acres. Existing development in the project area has resulted in 56,647 acres of surface disturbance, of which 13,706 acres remain unvegetated (**Table 4.0-1**). The project area contains several active gas fields. To date, over 4,800 wells have been drilled in the project area; about 3,000 are still active producing natural-gas wells with accompanying production-related facilities, roads, and pipelines. Impacts to Muddy Creek have already occurred and two portions of Muddy Creek are now listed on the State 303(d) list of Impaired or Threatened Waterbodies due to habitat degradation (WDEQ 2012). According to WDEQ, the impairment to the middle portion of Muddy Creek is primarily due to livestock grazing, exacerbated by accelerated erosion associated with oil and gas activities (WDEQ 2010). The impairment to the lower portion of Muddy Creek is primarily due to exceedances of the chloride and selenium criteria (WDEQ 2012). Watershed restoration projects in the Muddy Creek sub-basin have also been implemented through the Grizzly Wildlife Habitat Management Area (WHMA), which includes the upper Littlefield Creek drainage and other portions of the upper Muddy Creek drainage (BLM 2008a). Under all action alternatives, revised and newly implemented BMPs and COAs, as outlined in Appendix C, would be attached to individual APDs. Given that there could be up to 30 companies operating within the project area, each with a unique approach to environmental protection measures, implementation of the BMPs and COAs will not be uniform.

Variability in approaches will lead to differences in the level of environmental protection afforded. While these BMPs and COAs would not completely eliminate the potential for significant impacts, they would become the basis for enhanced environmental protection and offer a level of safeguard throughout the project area not present in earlier phases of development. Per NEPA guidance, this analysis is based on the premise that standard operating procedures including these BMPs, COAs, and regulations would be followed under each alternative and by each individual operator.

Since specific locations for well sites or areas of concentrated development have not been identified in the Proposed Action or alternatives, this analysis will consider general project impacts. The Proposed Action and all action alternatives assume the construction of up to 8,950 wells and associated roads and pipelines over the course of 15 years. As discussed in **Section 4.0.3**, the well spacing would vary by area and includes: 40- to 60-acre spacing (12 to 16 wells per section), 80-acre spacing (eight wells per section), and 160-acre spacing (four wells per section) (**Map 4.0-2**). The areas of proposed dense (40- to 60-acre) well spacing are generally associated with active gas fields. Overall, approximately 60 percent of the project area may not undergo concentrated development (i.e. 40 to 60 or 80-acre well spacing). The extent of the unused (or less-used) portion of the project area would be defined by the suitability of production of natural gas and may or may not be continuous. Those areas without concentrated well locations would potentially experience surface disturbance from roads and pipelines to access wells and could also include areas of less-dense conventional well development. The Operators have indicated that they would vary well spacing when geology, permeability, and other conditions allow, but such areas have not yet been defined.

Approximately 30 injection wells for produced-water disposal would be utilized for the project. Both injection and natural gas wells could share pads, although specific locations cannot be predicted. A very small percentage of the conventional well locations would be unsuccessful and would be plugged, abandoned, and reclaimed.

Surface Water Impacts Common to All Alternatives

The differing amounts of surface disturbance by alternative result from the varying number of well pads and the extent of required access roads and pipelines needed for resource development. The magnitude of impacts to surface water versus the acres of surface disturbance is not a one-to-one ratio. Roads and well pads will impact surface hydrology beyond their initial disturbance footprint. For the purposes of this impacts analysis, a change (increase or decrease) in the amount of surface disturbance generally translates to a corresponding change in the magnitude of impacts to surface water.

The main impacts to surface-water resources from this project are brought about by contamination of surface water from the authorized discharge of hydrostatic test water and the accidental discharge (spill) of fracking fluids, drilling fluids, and produced water, and the impacts (including sediment loading) from surface disturbance related to project development/maintenance.

Discharge/Spills. The authorized discharge of hydrostatic test water (water used to test the integrity of pipelines) and the accidental surface discharge of fracking fluids, drilling fluids, and produced water would impact nearby surface-water quality by degrading water quality (related to Criteria 1 and 7), which could in turn impact wetlands (related to Criteria 3 and 4) and increase salinity levels (related to Criterion 2). There would be no authorized surface discharge of produced water as a result of the action alternatives. The magnitude of any impact would depend on the quality and quantity of the hydrostatic test water and any fluids accidentally discharged and the distance of the discharge/spill from a regulated water body (e.g. wetland, riparian area, and ephemeral, intermittent, or perennial stream). The following considers whether project impacts will result in the exceedance of water resources significance criteria based on discharge/spill impacts.

Use or discharge of hydrostatic test water would be accomplished in a manner that should not affect soils, stream channels, surface water, and groundwater quality. After testing operations are completed, the

water would be pumped into water-hauling trucks and transported to drilling locations within the project area to be used in conjunction with drilling operations or reused for other aspects of the construction and/or production process. However, if such water is not reused it must be disposed of in such a manner that soil-scouring and water-quality impairment would not result. Hydrostatic test water would be evaluated for compliance with state water-quality standards and no test water would be discharged unless such water meets these standards. Test water not utilized for drilling operations that meets water-quality standards would be disposed of onto undisturbed land having vegetative cover or into an established drainage channel in a manner that would not cause erosion (appropriate erosion control measures would be utilized). Furthermore, use and disposal of hydrostatic test water would comply with the mandatory right-of-way stipulation for hydrostatic testing, as well as the CWA required plan of development and the Wyoming Pollutant Discharge Elimination System (WYPDES) permit that would be required for the proposed project. The quantity of test water discharged would be dependent on the length of the pipelines needed for the handling of produced water (the longer the pipeline segment the more water is needed for testing).

Spills of oil from production facilities would be controlled with the site-specific implementation of Spill Prevention Control and Countermeasures (SPCC) Plans, which would be developed by the Operators in accordance with 40 CFR Part 112. Each Operator would maintain a complete copy of the SPCC plan at the facility or at the nearest field office and have the plan available to the Regional Administrator for onsite review. BLM Notice NTL-3A requires the reporting of spills, accidents, blowouts, or other undesirable events that occur from federal minerals or on BLM-managed surface and IM WY-2009-21 provides guidance and standards for spills and cleanup criteria for on-lease spills; otherwise, spills of hydrocarbon and hazardous materials meeting the requirements outlined in Section 4 of Chapter 4 of WDEQ Wyoming Water Quality Rules and Regulations would be reported to WDEQ-WQD.

Surface Disturbance/Sediment Loading. Project development could result in up to approximately 61,700 acres (Alternative A) of new surface disturbance related to road, pipeline, well pad, and facilities construction. These activities would result in a loss of vegetation and subsequent increased soil-surface exposure (related to Criteria 2, 3, 4, 5, 6, and 8); mixing of soil horizons (related to Criteria 2 and 8); soil compaction resulting in decreased infiltration capacity (related to Criteria 5, 6, and 8); loss of topsoil productivity (related to Criteria 5, 6, and 8); an increased susceptibility of the soil to water erosion (related to Criteria 2, 5, and 6); and off-site sedimentation that would cause channel instability and degradation of surface-water quality (related to Criteria 1, 2, 5, and 6). The magnitude of any impact would depend on the amount and type of disturbance and will be discussed by alternative.

Matherne (2006) noted increased sediment production from well pad locations and confirmed that roads and well pads can provide conditions for focusing runoff and locally increasing erosion. Based on field observations, Matherne found that roads on sideslopes facilitate the erosional process in three ways: (1) they cut across and collect runoff from previously established drainages; (2) where they are cut into hillsides or into the land surface, roads provide focal points for the initiation of erosion; and (3) they provide conduits for sediment transport. Once mobilized, a portion of this sediment (resulting from these erosional processes) would move into channels in pulses that occur in relation to storm events. Some of this sediment would be temporarily stored in drainage bottoms and on hillslopes and a portion would be stabilized by vegetation and not travel to nearby drainages. Soil loss to water erosion is discussed in detail in **Section 3.3.2.1**.

As described in **Section 3.3 Soils**, the project area contains many soils that are saline or sodic. These soils, when eroded as a result of surface disturbance, will make salt available to surface waters. **Table 3.3-1** summarizes the soil limitations within the project area for the following five categories: water erosion, wind erosion, runoff potential, road construction, and reclamation potential. Overall the risk of water erosion is slight (69.9 percent of the total project area has a slight water erosion potential). Only 4.3 percent of the project area contains soils rated as having severe water-erosion potential. Soil characteristics such as depth, permeability, runoff rate, water capacity, and susceptibility to erosion vary

widely. The diversity of soil parameters would require a broad spectrum of reclamation techniques. In addition, low annual precipitation and wind and water erosion would make successful reclamation in the project area difficult to attain. Therefore, the overall potential for successful reclamation is poor to fair.

Revegetation would likely be difficult in a large portion of the project area due to the high concentration of salts in the soils. Salt concentrations are exacerbated by surface-disturbing activities. Due to the scarcity of wetland/riparian sites in the project area, the probability of well pads, roads, pipelines, and ancillary facilities directly impacting these resources is low. Impacts to wetland/riparian sites would occur as a result of sediment transported down drainages but the extent of impacts to wetland/riparian sites would be influenced by the distance of the disturbance from the wetland/riparian sites and the success of mitigation and reclamation efforts. Revegetation may be challenging on the estimated 75 percent of the project area indicated as possessing fair or poor reclamation potential (84 percent of area with historic disturbance) (**Table 3.3-1**). Current technology exists to stabilize disturbances, minimize erosion, and increase reclamation success provided that construction, maintenance, and operation of well pads and associated disturbances are in accordance with planned mitigation measures and reclamation. The Rawlins RMP (BLM 2008a) specifies that a buffer of 500 feet be maintained around perennial waters, springs, wells, wetlands and a buffer of 100 feet be maintained around the inner gorge of ephemeral channels. Formal wetland delineations have not been confirmed by the USACE for the entire project area. Wetlands have been confirmed along Muddy Creek, which is a Waters of the U.S. A relevant Nationwide Permit as authorized by Section 404 of the CWA would be required from the U.S. Army Corps of Engineers (USACE) Wyoming Regulatory Office for any disturbance activities in wetlands or Waters of the U.S. Additional BMPs and COAs that would protect wetland/riparian sites are included in **Appendix C**.

Reclamation Success and Surface Water Impacts. Successful reclamation does not necessarily return an area to its previous hydrologic function. For example, re-establishing 80 percent of pre-disturbance ground-cover in 5 years would be considered successful (BLM 2008b). Perennial forbs, brush, and trees generally are more effective at reducing rain splash and can provide structure on the soil surface that can reduce surface runoff energy, but are generally not required for reclamation. Anderson (1975), in a study of 23 watersheds, found that conversion of steep forest and brush-lands to a grassland increased sediment yields by five times. Although this is an extreme case, it points out that not all vegetation functions the same at reducing surface runoff. Where interim reclamation has been successful, sagebrush and other shrub reestablishment would occur within the project life; however, many areas would not return to pre-disturbance function until 30 to 50 years after final reclamation.

Surface Water Use. One of the management objectives included in the Rawlins RMP (BLM 2008a) associated with water resources prescribes that activities that would cause water depletion within the Colorado River system or the North Platte River system comply with existing agreements, decrees, rules, and regulations (Appendix 11). No surface water would be utilized to satisfy water demand, as the water needed for drilling and completion activities would come from new and existing State Engineer's Office (SEO)-approved local water wells.

Summary. An estimated 60,176 acres of surface disturbance has already occurred within the project area, a majority prior to stringent regulatory oversight, which may have resulted in the exceedance of some of the surface-water significance criteria listed above. As such, surface water impacts from the proposed project could exacerbate the magnitude of existing deteriorated conditions. The magnitude of any project related impacts and the potential to meet or exceed the significance criteria would depend on the disturbance associated with each alternative and will be discussed by alternative. Successfully utilizing BMPs and COAs listed in **Appendix C** to stabilize disturbance, minimize erosion, and increase reclamation success would reduce the potential for adding to the magnitude of existing impacts.

Groundwater Impacts Common to All Alternatives

All of the action alternatives would result in the same number of new wells drilled (8,950 natural gas and 30 injection), with the difference being the number of well pads and the extent of required access roads and pipelines needed for resource development. Because the action alternatives adjust the number of well pads, the alternative with the lowest number of pads would minimize risk of contamination of the groundwater resource; a lower number of well pads would reduce the probability of a pad being near a water well or above a shallow aquifer, which could then be impacted by development activity. Also, fewer pads would require fewer roads; both factors would reduce the amount of groundwater use for construction and dust suppression.

Groundwater impacts would occur during the removal of groundwater for drilling, extraction of natural gas, and dust abatement; from improper drilling operations, especially poor casing and cementing of the well bore; from accidental releases of fluids (spills) associated with drilling and fracking operations, produced water, and other hazardous liquids to soils and surface-water systems; and through subsurface disposal (injection) of produced water.

Groundwater Removal. Impacts from groundwater removal are associated with impacts to groundwater quantity and the potential to impact springs and flowing wells. There are no significance criteria related to impacts to groundwater quantity from groundwater removal. Criterion 1 is related to impacts to springs, seeps and flowing wells from groundwater removal.

In terms of subsurface impacts, the development in the proposed project area would consist of natural gas wells completed primarily in the Almond Formation, a member of the late Cretaceous Mesaverde Group. There is no current practical beneficial use for water in this stratum due to the high level of total dissolved solids (TDS), the presence of hydrocarbons, and the availability of higher quality water from shallower aquifers. Secondary natural gas reserves may also be encountered in other formations. There are 288 existing non-energy related/non-industrial domestic, municipal, or stock wells within the project area or 1 mile adjacent to it (SEO 2011). Only four of these wells are completed at depths that would include aquifers of the Mesaverde Group and, depending on their location respective to the deeper natural gas development, could be affected by groundwater withdrawals relating to conventional oil and gas production. Due to the low density of non-energy related water wells in the project area, impacts related to groundwater removal would not be considered significant.

While the number of natural gas wells proposed remains the same, each alternative results in a different number of well pads. As such, there would be a slight difference between alternatives based on the quantity of water needed for road and well pad construction and dust suppression and this difference is reflected in the per-well range of water needed discussed below. Applying the expected per-well water volume of 24,000 to 42,000 bbls/well needed for drilling and completion and well pad and road construction and assuming 600 wells/year, the water demand for the proposed action and the action alternatives would be between 1,856 ac-ft (14.3 million bbls) and 3,248 ac-ft (25.1 million bbls) per year (based on information provided in **Section 2.2.1.2 Drilling and Completion**). The total water demand over the 15 years required for well drilling would be between 27,840 ac-ft (214.1 million bbls) and 48,720 ac-ft (375.9 million bbls). This total amount of water needed for drilling and completion activities would come from new and existing SEO-approved local water wells. While estimates of available water in all aquifers beneath the project area are not available, using estimates of the volume of producible groundwater from Cleary *et al.* (2010), the volume of groundwater above 1,000 feet in the Tertiary age aquifers under the project area alone is approximately 9.67 million ac-ft. Therefore, the total for all water needed for well development and pad and road construction represents between 0.3 and 0.5 percent of the available water in the Tertiary age aquifers under the project area. As discussed in **Section 3.4.3.1**, available water is also found in Quaternary, Upper and Lower Cretaceous, and Jurassic age aquifers. Fisk (1967) estimated that the volume of moderately good-quality groundwater within the Great Divide Structural Basin was 500 million ac-ft and 300 million ac-ft within the Washakie Structural Basin. The

combined annual recharge for the Great Divide and Washakie structural basins was estimated at 11,300 ac-ft (Fisk 1967), which is well above the estimated annual 1,856 ac-ft to 3,248 ac-ft water demand for the CD-C project.

Due to technological difficulties and regulatory constraints related to water quality, relatively little produced water can be beneficially used at this time (based on information provided by the Operators). Reuse of drilling mud is currently being employed and is reducing the water demands. As described in **Section 3.4.3.2 Groundwater Use**, there are presently 1,081 groundwater wells (including the 288 non-energy related wells referenced above) permitted within 1 mile of the project area. The total water demand would not likely adversely affect the existing surface-water or groundwater rights in the project area, provided full coordination is implemented with the SEO and the BLM. The total water demand would not cause significant adverse impacts on the groundwater resources within the project area.

The project area contains springs and flowing wells that are important local water sources for livestock, wildlife, and wild horses. The springs in the area occur south of I-80 in the Green River Formation and north of I-80 in the Wasatch and Battle Springs Formations (Mason and Miller 2005; Bartos *et al.* 2006). Impacts related to groundwater removal would not be considered significant for Criterion 1 resulting from the Proposed Action or any action alternatives, as the source aquifers are stratigraphically higher than the natural gas exploration targets. Groundwater withdrawals from water wells have the potential to interrupt flowing wells only if supply wells are completed in the same aquifer as the flowing well and close enough to this flowing well to cause interference.

One of the management objectives associated with water resources that is included in the Rawlins RMP (BLM 2008a) prescribes that activities that would cause water depletion within the Colorado River system comply with existing agreements, decrees, rules, and regulations. Water needed for drilling and completion activities would come from new and existing State Engineer's Office (SEO)-approved local water wells; most (96 percent) SEO-approved wells are completed in Tertiary age aquifers, particularly the Wasatch Formation. According to Mason and Miller (2005), the Wasatch Formation has the potential to lose groundwater to the southeast and ultimately to the Colorado River system. Roughly 20 percent of the Wasatch Formation within the CD-C project area is within that portion of the Washakie Structural Basin that loses groundwater to the southeast toward the Little Snake River, a tributary of the Colorado River. As such, an interruption of this groundwater flow could lead to depletions to the Colorado River system, although the proportion of flow in the Little Snake River that comes from groundwater discharge from the Wasatch Formation has not been quantified. The most important agreement affected by depletions in the project area is the Upper Colorado River Endangered Fish Recovery Program, a partnership working to recover the endangered fish of the Upper Colorado River Basin. Under the Recovery and Implementation Program (RIP) for Endangered Fish Species in the Upper Colorado River Basin, "any water depletions from tributary waters within the Colorado River drainage are considered as jeopardizing the continued existence of these fish." **Section 4.9.3.1** includes a brief description of the Upper Colorado River Endangered Fish Recovery Program and how depletion fees defined under the RIP are calculated.

The magnitude of depletions is difficult to determine at this time since the specific locations of the drill pads and associated roads and pipelines are not known, but the estimated annual freshwater use within the CD-C project area would range from 1,856 to 3,248 ac-ft /yr and would average 2,552 ac-ft /yr. Assuming that CD-C project groundwater use from the Wasatch Formation is evenly distributed across the project area, approximately 20 percent of the groundwater would come from that portion of the Wasatch Formation that could contribute water to the Little Snake River. Therefore, an average of 510 ac-ft/yr of groundwater would be removed from the Wasatch Formation in this area. Fisk (1967) estimated that the Wasatch Formation within the Washakie Structural Basin holds some 300,000,000 ac-ft of groundwater in storage. In light of this volume of groundwater in storage, the 510 ac-ft/yr withdrawn from the Wasatch Formation within the Washakie Structural Basin would likely have no measurable effect on Colorado River Flows. If, however, it is determined that groundwater withdrawals result in a depletion in the

Colorado River, an agreement would be reached prior to operation between the BLM and the USFWS as to how much each Operator would contribute to the Upper Colorado River Endangered Fish Recovery Program for water depletions.

Drilling Operations. Well-drilling, completion, and operation activities would impact groundwater resources (related to Criteria 2 and 3). Construction of well pads, disposal practices, well casing and cementing, and recycling of drilling fluids would be in accordance with BLM guidelines and should minimize the risk of degrading groundwater quality.

Well-drilling and completion activities are not likely to impact existing groundwater quality if the project is in compliance with the BLM's Onshore Oil and Gas Order No. 2. These guidelines specify the following:

> *…proposed casing and cementing programs shall be conducted as approved to protect or isolate all usable water zones, potentially productive zones, lost-circulation zones, abnormally pressured zones, and any prospectively valuable deposits of minerals. Any isolating medium other than cement shall receive approval prior to use* (BLM 1988).

The BLM's Onshore Oil and Gas Order No. 2 defines "usable water" as groundwater with TDS of 10,000 parts per million or less encountered at any depth. This definition of useable water corresponds to the EPA's definition of a USDW. To comply with the order, wells must be completed using state-of-the-art techniques, such as cementing and other proven technologies, such that usable water and unusable water do not mix. Assuming compliance with this order, no contamination of usable groundwater would likely occur. Well-drilling and completion as proposed in **Chapter 2 Proposed Action and Alternatives** complies with Onshore Order No. 2. However, improper drilling and completion techniques, especially poor casing and cementing of the well bore, would result in degradation of groundwater quality due to the potential release of drilling fluids and hydrocarbons and the mixing of variable-quality waters from different water-bearing strata that are pierced by the borehole.

A central feature of the well completion process is hydraulic fracturing (fracking), which involves injecting fracturing fluids into the target formation at a force exceeding the parting pressure of the rock, thus inducing a network of fractures through which oil or natural gas can flow to the wellbore. The fractures are filled with sand or other porous materials which serve as proppants to facilitate recovery of natural gas. Hydraulic fracturing has been used for decades in the CD-C area. It is currently excluded from Underground Injection Control regulation under the Safe Drinking Water Act (SDWA) except when diesel fuel is used as a component of the fracking fluid.

The EPA is currently conducting an industry-wide study that seeks to understand any relationships between hydraulic fracturing and drinking water. As part of that study, the EPA issued information requests to leading national and regional hydraulic fracturing service providers. The EPA is seeking information on the chemical composition of fluids used in the hydraulic fracturing process, data on the impacts of the chemicals on human health and the environment, standard operating procedures at hydraulic fracturing sites and the locations of sites where fracking has been conducted (EPA 2010a). No studies related to impacts from hydraulic fracturing have been conducted in the CD-C project area and no occurrences of drinking water contaminated by fracking have been recorded.

Newly adopted WOGCC regulations require Operators to provide the Commission with the exact chemical content of their fracking fluid. While the information may be held as proprietary, the Commission will be able to provide WDEQ with the chemical composition of the fracking fluid if there is ever a question of aquifer contamination. The BLM has issued a proposed rule governing "Oil and Gas; Well Stimulation, Including Hydraulic Fracturing, on Federal and Indian Lands." As proposed, this rule would (1) provide disclosure to the public of chemicals used in hydraulic fracturing on public land and Indian land, (2) strengthen regulations related to well bore integrity, and (3) address issues related to flowback water (BLM 2012e).

The BLM is also proposing a rule to ensure that fracturing operations conducted on the public mineral estate (including split estate where the federal government owns the subsurface mineral estate) follow certain best practices, including the public disclosure of chemicals used in hydraulic fracturing operations on federal lands, confirmation that wells used in fracturing operations meet appropriate construction standards, and a requirement that operators put in place appropriate plans for managing flowback waters from fracturing operations (Federal Register 2012b).

It is expected that fracking effects would not extend beyond 500 feet from the well bore (EPA 2002). Accordingly, the potential for contamination of groundwater by the fracking fluids would be limited to this distance from each well over the production interval. Because fracking would be conducted at considerable depths (8,000 to 12,000 feet below ground surface), groundwater resources near the surface, such as springs, the shallow alluvium, and domestic wells would not be affected.

Due to the use of state-of-the-art drilling and well-completion techniques, including techniques incorporated in the BLM's Onshore Oil and Gas Order No. 2, and if BMPs and COAs related to drilling are implemented, impacts related to degradation of groundwater quality would not be considered significant for Criteria 1, 2 and 3. In addition, the likelihood of mixing, which could occur during the relatively short period of time during drilling, would be low and impacts would not be considered significant for Criterion 2.

Spills. Reserve pits would be used to contain drilling fluids, cuttings, and wastewater produced from the well-drilling operations (related to Criterion 3). The reserve pits would be constructed with an impermeable liner to prevent seepage and possible contamination of surface and groundwater. Likewise, the storage of fresh water, either in lined pits, tanks, or storage pits would be in accordance with WOGCC rules on private and state mineral estate and with BLM's IM WY-2012-007 on public minerals. Reserve and storage pits on federal mineral estate are evaluated and approved by the BLM through the APD, right-of-way grant, or Sundry Notice permitting processes.

Spills could also occur from water and condensate gathering pipelines. State-of-the-art pipeline construction techniques, including hydrostatic pressure testing, would limit the impacts from the project and impacts from spills would not be considered significant for Criterion 3.

Accidental spills of oil from production facilities would be addressed through implementation of SPCC Plans, which would be developed by the Operators in accordance with 40 CFR Part 112. Each Operator would maintain a complete copy of the SPCC plan at the facility or at the nearest company field office and have the plan available to the Regional Administrator for onsite review. BLM Notice NTL-3A requires the reporting of spills, accidents, blowouts, or other undesirable events that occur from federal minerals or on BLM-managed surface and IM WY-2009-21 provides guidance and standards for spills and cleanup criteria for on-lease spills; otherwise, spills of hydrocarbon and hazardous materials meeting the requirements outlined in Section 4 of Chapter 4 of WDEQ Wyoming Water Quality Rules and Regulations would be reported to WDEQ-WQD.

If state-of-the-art pit construction techniques are used, if Hazardous Materials Emergency Response Plan and SPCC Plans are implemented, and with the implementation of BMPs and COAs related to handling of fluids, the likelihood of degradation of groundwater as a result of spills would be limited and the impacts would not be considered significant for Criterion 3.

Subsurface Disposal. Groundwater aquifers would be affected during disposal of produced water from oil and gas activities (related to significance Criterion 2). Produced water would be transported by truck to approved water-disposal injection wells or evaporation ponds, or by pipeline to treatment facilities. A majority of the produced water would likely be injected with a smaller portion disposed of via water treatment facilities/surface evaporative pits (based on information provided by the Operators). Subsurface water disposal methods are administered by the EPA under the underground injection control (UIC) program (40 CFR 144). The UIC program ensures that injection wells meet appropriate performance

criteria for protecting USDWs. There are five classes of injection wells permitted under the UIC program based on similarity in the fluids injected, activities, construction, injection depth, design, and operating techniques. Class II and Class V injection wells would likely be used to dispose of produced water resulting from the CD-C project. Class II injection well permits are issued by the WOGCC for injection of fluids associated with oil and conventional natural gas production by an individual operator (EPA 2011a). Class V injection wells are permitted through WDEQ-WQD and cover wells not included in Classes I-IV. In general, Class V wells inject non-hazardous fluids into or above USDWs and are typically shallow, onsite disposal systems, such as septic systems and for disposal of CBM produced water. An average of 98 percent of produced water from natural gas wells in the vicinity of the project area is disposed of by injection, based on 2010 production and injection rates for wastewater from eight local gas production fields (WOGCC 2011a).

During the period of full production for the Proposed Action and action alternatives, there would be approximately 7,600 ac-ft of water produced per year that would require disposal, based on an average of 18 bbls/day/well for each of the 8,950 wells. Lesser amounts would be produced each year prior to and following the period of peak water production. Using the current 98 percent average rate of injection of produced water, approximately 7,500 ac-ft/year of the CD-C produced water would be injected during the height of the CD-C project under the action alternatives.

The construction of an estimated 30 additional injection wells and 20 other water handling facilities is planned in order to dispose of produced water related to the action alternatives. The Operators have not identified the anticipated well class or reservoirs capable of taking injected water at the volumes needed by the production rates projected in the area. The minimum and maximum volumes currently permitted for injection into existing disposal wells in the area range between 1,000 bbls/day (47 ac-ft/year) and 33,000 bbls/day (1,552 ac-ft/year) per well, respectively, depending on the hydraulic properties of the target aquifer (WOGCC 2011a). If all of the project-related produced water were to be injected, the average per-well volume of injected water for the 30 additional injection wells would need to be approximately 252 ac-ft /year (to achieve the approximate 7,500 ac-ft/year needed for well disposal). This is well within the range of permitted injection volumes of existing disposal wells.

There are currently 22 permitted oil and gas related wastewater disposal facilities within 20 miles of the project area (not including subsurface disposal wells) (WDEQ 2011). A majority of these facilities utilize some variation on evaporation. Other forms of disposal include a variety of separation methods (reverse osmosis or ion exchange). It is expected that these facilities would continue to be utilized to the extent possible. Project plans include an estimated 20 additional produced water handling facilities. According to Boysen *et al.* (2002), individual facility evaporation rates of 30 gallons per minute (48 ac-ft/year) at wastewater disposal facilities utilizing misting towers are achievable. Given the proposed 20 additional wastewater disposal facilities, the capacity is more than adequate to dispose of produced wastewater that is not injected (100 ac-ft/year).

If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of water disposal would be limited and the impacts related to Criterion 3 would not be considered significant.

Groundwater Impacts Summary. Impacts from groundwater removal are associated with impacts to groundwater quantity and the potential to impact springs and flowing wells. Groundwater removal by the project is expected to be well below the annual recharge of the structural basins underlying the project area. The likelihood of these withdrawals interrupting flowing wells is low. The 510 ac-ft/yr withdrawn from the Wasatch Formation within the Washakie Structural Basin would likely have no measurable effect on Colorado River flows.

Drilling and completion would result in degradation of groundwater quality if drilling fluids, hydrocarbons, or variable-quality water from different strata are released into water-bearing strata that are pierced by the borehole. With use of state-of-the-art drilling and well-completion techniques, including

proper casing and cementing of the well bore, and implementation of drilling BMPs and COAs, impacts related to drilling of natural gas wells would not be considered significant for Criteria 1, 2, or 3.

If state-of-the-art pit construction techniques are used, if Hazardous Materials Emergency Response Plan and SPCC Plans are implemented, and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of spills would be limited and the impacts would not be considered significant for Criterion 3.

If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of subsurface disposal of produced water disposal would be limited and the impacts related to Criterion 3 would not be considered significant.

4.4.4.2 Impacts Associated with the Proposed Action

The types of impacts would be the same as those discussed in **Section 4.4.4.1 Impacts Common to the Proposed Action and All Alternatives**, but would vary in magnitude when compared to the other alternatives. Under the Proposed Action, 6,126 pads would be required for the 8,950 wells. Total construction-phase surface disturbance would be 47,200 acres (approximately 4.4 percent of the project area). With successful reclamation during the life of the project (45 to 55 years), total disturbances would be reduced to about 19,000 acres (about 1.8 percent of the project area). The construction disturbance would not be uniformly distributed across the project area, but rather, project facilities would be located where the efficiency and feasibility of extracting the natural gas would be the highest. As described earlier, most of the project area has fair/poor reclamation potential, which is considered difficult to reclaim. Where sagebrush, juniper, or other vegetation that is difficult to reestablish is disturbed, the location would not return to pre-disturbance hydrologic function until 30 to 50 years after the end of the project in some locations, as described in Section 4.4.4.1.

Surface Water. As with all following action alternatives, the magnitude of the surface water impacts would be primarily related to the amount of sediment mobilization resulting from disturbance (the number and size of the drill pads, the distance and width of the roads, and the distance and width of the pipeline corridors). The quality and quantity of the hydrostatic test water discharged, the quality and quantity of any fluids accidentally discharged, and the distance of the discharge/spill from a water body or water course (e.g. wetland, riparian area, and ephemeral, intermittent, or perennial stream) would also be of concern. No test water would be discharged unless such water meets State water-quality standards. The quantity of test water discharged would be dependent on the length of the pipelines needed to manage produced water (volume related to pipe length) and the amount of test water not reused for other purposes.

Impacts related to disturbance/sediment would be considered significant (depending on the amount of disturbance) for surface water Criteria 1, 2, 5, 6 and 8 as a result of the fair/poor reclamation potential for a majority of the project area. Impacts related to disturbance/sediment loading would not be considered significant for Criteria 3 and 4.

Impacts related to the discharge/spill of water would not be considered significant for Criteria 1, 2, 3, 4, and 7. The State water quality standards regulating discharge of test water, the BMPs and COAs for construction and maintenance of pipelines and reserve pits, and the Hazardous Materials Management and Release Contingency Plans and SPCC Plans would minimize effects of spills.

Groundwater. The magnitude of the groundwater impacts from the Proposed Action (and all following action alternatives) would be related to the number of wells and well pads proposed and the extent of required access roads and pipelines needed for resource development. Groundwater impacts would occur during the removal of groundwater (Criterion 1), from improper drilling operations, especially poor well casing and cementing practices (Criteria 1, 2, and 3), through subsurface disposal (injection) of produced water (Criterion 2), and from accidental releases of fluids [spills] (Criteria 2 and 3).

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets.

Impacts related to improper drilling techniques would be not be considered significant for groundwater Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the implementation of drilling BMPs and COAs.

4.4.4.3 Alternative A: 100-Percent Vertical Drilling

The types of impacts for Alternative A would be the same as those described in **Section 4.4.4.1**, but the disturbance (initial and long-term) would increase when compared to the Proposed Action. This alternative assumes that no wells would be drilled using directional-drilling techniques. Under Alternative A, 8,950 pads would be required for the 8,950 wells. Total construction-phase surface disturbance would be 61,696 acres, 56,400 acres related to well pads and roads. This is 31 percent more than the Proposed Action.

Surface Water. Impacts from both authorized and accidental surface discharge of fluids related to surface water Criteria 1, 2, 3, 4, and 7 would be greater than the Proposed Action. Considering the significant increase in the amount of surface disturbance, impacts would be considered significant related to discharge/spill of water, depending on the locations of the drill pads and associated roads and pipelines.

Impacts related to disturbance/sediment loading would be considered significant for surface water Criteria 1, 2, 4, 5, 6, and 8, primarily as a result of the significantly greater amount of surface disturbance.

Groundwater. Under Alternative A, the per-well water use would be skewed toward the maximum of 42,000 bbls/well due to the additional water needed for road and pad construction and dust abatement. Because produced water cannot be used for dust abatement and since this alternative has the greatest amount of surface disturbance, Alternative A would likely place the greatest demand on the aquifers targeted for water supplies. Because this alternative increases the number of well pads, the risk of contamination of the groundwater resource would increase due to the greater probability of a pad being near a water well or above a shallow aquifer, which, by proximity, raises the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

The potential to meet or exceed groundwater Criterion 1 from impacts related to groundwater removal would be greater than the Proposed Action because of increased water demands for hydrostatic testing and dust suppression but the impacts would not be considered significant since the source aquifers for the springs or seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative A would not significantly impact groundwater quantities. Impacts from degradation of groundwater from disposal wells would not be considered significant for Criterion 2 since disposal wells would be installed according to EPA and WDEQ requirements and since BMPs and COAs related to handling of fluids would be implemented. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and the impacts from spills resulting from Alternative A would not be considered significant for Criterion 3.

4.4.4.4 Alternative B: Enhanced Resource Protection

The types of impacts for Alternative B would the same as those described in **Section 4.4.4.1**, but the short- and long-term disturbance would decrease when compared to the Proposed Action. Under Alternative B, 5,798 pads would be required for the drilling of 8,950 wells. Total construction-phase surface disturbance would be 45,516 acres, 4 percent less than the Proposed Action. This alternative identifies the resources that may be more at risk from natural gas development and the enhanced resource

protections that would be implemented for these resources, which include enhanced protections and mitigation. The alternative also recognizes that future development may be more intensive than currently expected or may have unintended consequences, resulting in impacts to wildlife habitats and populations in areas that were not anticipated or impacts that occur at a faster pace than anticipated. Under Alternative B, RMP development restrictions would be expanded near perennial waters, springs, wells, and wetlands from 500 feet to 0.25 mile and the avoidance distance within the Muddy Creek/Red Wash sensitive fish habitat area would be expanded to 0.5 mile. Water quality monitoring on upper Muddy Creek would be extended to lower Muddy Creek within the CD-C area, which has been designated a 305(b) threatened stream. Although this alternative describes protections and mitigations for specifically identified resources, the overall purpose of the alternative would be to maintain healthy ecosystem function at the landscape level over the entire project area. In so doing, the alternative thus strives to ensure that the Wyoming Standards for Healthy Rangelands will be satisfied, as well as State water quality state standards.

Surface Water. Impacts to the surface-water resource would be less in magnitude than those for the Proposed Action due to the reduced amount of surface disturbance and the enhanced protection of the specific resources and habitats (particularly along Muddy Creek and its tributaries, where setback distances on federal minerals and surface would be increased from 500 feet to 0.25 mile or even 0.5 mile in some cases), which would reduce surface-water impacts. While this alternative does not significantly reduce the acres of disturbance compared to the Proposed Action and impacts would still occur, it does identify surface disturbance and population thresholds that, if exceeded, would signal the need for still more protections and mitigation and then outlines the additional measures that may be required.

Impacts from both authorized and accidental surface discharge of fluids related to surface water Criteria 1, 2, 3, 4, and 7 would be less than the Proposed Action. Impacts related to the discharge/spill of water would not be considered significant considering the decrease in the amount of surface disturbance and the increased buffers around surface-water features.

Impacts related to the disturbance/sediment loading would be considered significant for Criterion 6, depending on the locations of the drill pads and associated roads and pipelines. Impacts related to disturbance/sediment loading would not be considered significant for Criteria 1, 2, 3, 4, 5, 6, and 8. Even though this alternative is directed primarily at habitat protection, it would reduce the potential for creating impacts that exceed surface-water Criteria 2 and 8 compared to the Proposed Action, given the reduced number of well pads, reduced surface disturbance, and increased setback distances from specified high value water resources.

Groundwater. Because this alternative reduces the number of well pads, the risk of contamination of the groundwater resource would decrease compared to the Proposed Action due to the decreased probability of a pad being near a water well or above a shallow aquifer, which, by proximity, lowers the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative B would not significantly impact groundwater quantities. Impacts related to improper drilling techniques would not be considered significant for Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs related to drilling that would be implemented. Disposal wells are installed according to EPA and WDEQ requirements and BMPs and COAs related to handling of fluids would be implemented so the likelihood of degradation of groundwater as a result of water disposal would be limited and impacts would not be considered significant for Criterion 2. State-of-the-art pit and pipeline

construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and the impacts from spills resulting from Alternative B would not be considered significant for Criteria 2 and 3.

4.4.4.5 Alternative C: Surface Disturbance Cap—60 Acres and 30 Acres per Section

The types of impacts for Alternative C would be the same as those described in **Section 4.4.4.1**, but would be reduced in magnitude when compared to the Proposed Action because of the decrease in disturbance (initial and long-term). Under Alternative C, 5,299 pads would be required for the drilling of 8,950 wells. Total construction-phase surface disturbance would be 42,955 acres, 9 percent less than the Proposed Action. This alternative designates parts of the project area as "high-density" areas—those areas that have undergone the greatest natural gas development to date. Within the high-density areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance at any one time per section of public land. For the remainder of the project area—the low-density areas—the disturbance cap would be 30 acres per section. All prior surface disturbances related to long-term use for roads or on-pad production facilities and all disturbances that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap. The aim of this alternative is to encourage better reclamation and reduced surface disturbance, primarily through increased directional drilling.

Surface Water. Impacts to surface water from Alternative C would be less in magnitude than those for the Proposed Action due to the capping of disturbance within a 640-acre section of public land. The disturbance cap in place under this alternative would be closely related to the density of existing disturbance and the amount of existing reclamation in the project area and would incentivize successful reclamation.

Impacts related to the discharge/spill of water would not be considered significant for Criteria 1, 2, 3, 4, and 7 considering the decrease in the amount of surface disturbance.

Impacts related to disturbance/sediment loading would be considered significant for Criteria 2 and 6.

Impacts related to the disturbance/sediment loading would not be considered significant for Criteria 1, 3, 4, 5, and 8. This is primarily due to the large reduction in surface disturbance compared to the Proposed Action.

Groundwater. Because this alternative reduces the number of well pads, the risk of contamination of the groundwater resource would decrease compared to the Proposed Action due to the decreased probability of a pad being near a water well or above a shallow aquifer, which, by proximity, lowers the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative C would not significantly impact groundwater quantities. Impacts related to improper drilling techniques would not be considered significant for Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs related to drilling that would be implemented. If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of water disposal would be limited and impacts would not be considered significant for Criterion 2. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and impacts from spills resulting from Alternative C would not be considered significant for Criteria 2 and 3.

4.4.4.6 Alternative D: Directional Drilling

The types of impacts for Alternative D would be the same as those described in **Section 4.4.4.1**, but would be reduced in magnitude when compared to the Proposed Action because of the decrease in initial and long-term disturbance. Under Alternative D, 4,032 pads would be required for the drilling of 8,950 wells. Total construction-phase surface disturbance would be 36,449 acres, 23 percent less than the Proposed Action. All natural gas wells on public lands and federal mineral estate would be drilled from multi-well pads. In sections that have not had oil and gas development at all, one new well pad would be permitted for all future development. No numerical disturbance caps, no rollover credits, and no new requirements on reclamation are part of this alternative.

Surface Water. Impacts to surface water would be less in magnitude than those for the Proposed Action due to the significant reduction in the amount of surface disturbance. Alternative D has the least amount of surface disturbance of the action alternatives.

Impacts from both authorized and accidental surface discharge of fluids related to surface water would not be considered significant for Criteria 1, 2, 3, 4, and 7 considering the decrease in the amount of surface disturbance.

Impacts related to disturbance/sediment loading would be considered significant for Criteria 2 and 6.

Impacts related to the disturbance/sediment loading would not be considered significant for Criteria 1, 3, 4, 5, and 8. This is largely the result of reduced disturbance acreage compared with the Proposed Action.

Groundwater. Because this alternative reduces the number of well pads, the risk of contamination of the groundwater resource would decrease compared to the Proposed Action due to the decreased probability of a pad being near a water well or above a shallow aquifer, which, by proximity, raises the chance of contamination resulting from leaks, spills, or improper drilling techniques, especially poor well casing and cementing practices.

Impacts related to groundwater removal would not be considered significant for Criterion 1 since the source aquifers for the springs and seeps are stratigraphically higher than the natural gas exploration targets and the areas in the vicinity of flowing wells can be avoided when and if new water supply wells are developed. Due to the amount of available groundwater in storage, groundwater removal resulting from Alternative D would not significantly impact groundwater quantities. Impacts related to improper drilling techniques would not be considered significant for Criteria 1, 2 and 3 due to the use of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs related to drilling that would be implemented. If disposal wells are installed according to EPA and WDEQ requirements and if BMPs and COAs related to handling of fluids are implemented, the likelihood of degradation of groundwater as a result of water disposal would be limited and the potential of meeting or exceeding Criterion 2 would be low. State-of-the-art pit and pipeline construction techniques, including the use of pit liners and hydrostatic pressure testing, would protect the groundwater resource and impacts from spills resulting from Alternative D would not be considered significant for Criteria 2 and 3.

4.4.4.7 Alternative E: No Action

Under the No Action Alternative (**Section 2.2.6**), there would be no new surface water or groundwater impacts.

4.4.5 Summary of Impacts

All action alternatives would result in increased natural gas development in the CD-C project area, with the principal difference between the alternatives being the amount of surface disturbance. Surface water impacts resulting from drill pad, access road, facility site, and pipeline right-of-way disturbance would

include: increased sediment loads due to removal of vegetation; exposure of the soil; mixing of soil horizons; soil compaction; and changes in water quality, channel geometry, and channel stability.

Groundwater impacts would result from the removal of groundwater and subsurface disposal (injection) of produced water. Impacts to groundwater could also be caused by improper drilling operations—especially poor well casing and cementing practices—and by accidental releases of fluids associated with drilling operations, produced water, and other hazardous liquids to soils and surface-water systems. The following discussion reviews impacts by alternative and discusses the potential to meet or exceed significance criteria for surface water and groundwater for each action alternative. The evaluation assumes successful implementation of state-of-the-art drilling and well-completion techniques included in the BLM's Onshore Oil and Gas Order No. 2 and the BMPs and COAs included in **Appendix C**. **Table 4.4-1** summarizes the impacts discussion.

Table 4.4-1. The potential for Significant (S) or Not Significant (NS) impacts for surface water and groundwater significance criteria.

Surface-Water Significance Criteria								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Proposed Action	S	S	NS	NS	NS	S	NS	S
Alternative A	S	S	S	S	S	S	S	S
Alternative B	NS	NS	NS	NS	NS	S	NS	NS
Alternative C	NS	S	NS	NS	NS	S	NS	NS
Alternative D	NS	S	NS	NS	NS	S	NS	NS
Groundwater Significance Criteria								
	1	**2**	**3**					
Proposed Action	NS	NS	NS					
Alternative A	NS	NS	NS					
Alternative B	NS	NS	NS					
Alternative C	NS	NS	NS					
Alternative D	NS	NS	NS					

A summary of the water resources impact significance criteria is included here. The full description of the criteria is found in **Section 4.4.3.1, Surface Water Significance Criteria**, and **Section 4.4.3.2 Groundwater Significance Criteria**.

Surface-Water Significance Criteria

1. Degradation of water quality.
2. Elevated salt-loading to the Colorado River system.
3. Loss of wetlands or wetland function.
4. Degradation of wetland/riparian areas.
5. Alteration of streamflow characteristics.
6. Alteration of stream-channel geometry or gradient.
7. Surface water contamination from spilled fluids.
8. Soil loss greater than 2 tons per acre per year.

Groundwater Significance Criteria

1. Impairment of springs, seeps, or flowing artesian wells.
2. Degradation of groundwater quality in any aquifer.
3. Groundwater contamination from spilled fluids.

Under the Proposed Action, 6,126 pads would be required for 8,950 wells. The primary surface water impacts of the Proposed Action would be brought about by contamination from the authorized and accidental discharge of fluids and the impacts from surface disturbance related to project development and maintenance. Groundwater impacts would occur during the removal of groundwater and through subsurface disposal (injection) of produced water. Impacts to groundwater could also be caused by improper drilling operations and from accidental releases of fluids (spills). Impacts to surface water would be considered significant for Criteria 1, 2, 6, and 8, depending on the locations of the drill pads and associated roads and pipelines. Impacts would not be considered significant for groundwater.

Alternative A (100-Percent Vertical Drilling) assumes that all of the wells would be drilled vertically, resulting in an increase in the number of pads (to 8,950) and associated roads and pipelines. Alternative A would increase the amount of construction-phase surface disturbance by 31 percent compared to the Proposed Action. The types of surface water and groundwater impacts would be the same as for the Proposed Action but the magnitude of the impacts would increase. Impacts to surface water would be considered significant for all eight criteria. Impacts would not be considered significant for groundwater.

Alternative B (Enhanced Resource Protection) would reduce the number of pads (to 5,798) and reduce the amount of construction-phase surface disturbance by nearly 4 percent compared to the Proposed Action. The magnitude of surface water impacts would decrease when compared to the Proposed Action as a result of the reduced number of well pads—and hence the amount of surface disturbance—and specifically from the enhanced protection of the Muddy Creek watershed. Impacts to surface water would be considered significant for Criterion 6. Impacts would not be considered significant for groundwater.

Alternative C (Surface Disturbance Cap—60 Acres and 30 Acres per Section) would reduce the number of pads (to 5,229) and thus reduce the amount of surface disturbance by 9 percent compared to the Proposed Action, which would reduce the magnitude of surface-water impacts. In addition to the reduction of surface disturbance, the aim of this alternative is to encourage improved reclamation success, primarily through increased directional drilling. Impacts to surface water would be considered significant for Criteria 2 and 6. Impacts would not be considered significant for groundwater.

Alternative D (Directional Drilling) would reduce the amount of construction-phase surface disturbance by 23 percent compared to the Proposed Action, which would reduce the magnitude of surface-water impacts. This alternative reduces surface disturbance primarily through increased directional drilling, which would reduce the number of pads (to 4,032) and associated roads, pipelines, and other facilities. This alternative has the least amount of surface disturbance of the action alternatives. Impacts to surface water would be considered significant for Criteria 2 and 6. Impacts would not be considered significant for groundwater.

Under Alternative E (No Action Alternative), it is assumed that the development activities proposed by the CD-C Operators would not occur and there would be no new surface water or groundwater impacts.

4.4.6 Unavoidable Adverse Impacts and Additional Mitigation Measures

Surface Water. All of the impacts defined in the eight surface water significance criteria (**Section 4.4.3.1**) would be mitigated to some extent by the measures found in the BMPs and COAs in **Appendix C** and by the measures found in state and federal law and regulation. Some of the impacts would be further mitigated by provisions of the different alternatives. For the most part, loss of wetland function and degradation of wetland/riparian areas (Criteria 3 and 4), alteration of streamflow characteristics (Criterion 5), and contamination from spilled industrial fluids and produced water (Criterion 7) would be addressed by these existing protections and mitigations. The exception is Alternative A where surface disturbance would be at such a level that impacts would not be adequately mitigated.

Total surface disturbance also contributes to the exceedance of significance criteria related to degradation of water quality and potential soil loss (Criteria 1 and 8). Under the Proposed Action and Alternative A,

total surface disturbance would be great enough that existing protection and mitigation measures would not necessarily prevent exceedance of significance levels for these criteria. Alternative B specifies an increase in set-back distances within the Muddy Creek watershed, from 500 feet to 0.25 mile for springs, wells, and wetlands and to 0.5 mile from perennial streams. This increased set-back would ensure that Criteria 1 and 8 are not exceeded if state and private lands are included in the set-back. The reduction in surface disturbance brought about by Alternatives C and D (9 and 23 percent, respectively) combined with existing mitigation measures would reduce the likelihood of these alternatives exceeding Criteria 1 and 8.

Alternative B would also avoid exceedance of Criterion 2—salt loading—because of the increased set-back. The Proposed Action and Alternatives A, C, and D would exceed Criterion 2.

Criterion 6—alteration of stream-channel geometry or gradient by accelerated runoff and erosion—would be exceeded by the Proposed Action and all action alternatives.

Impacts could be reduced for the Proposed Action and Alternatives A, C, and D with the application of features found in Alternative B. Increased set-back distances would decrease impacts with regard to Criteria 1 through 4. Such a measure would be most effective if private and state lands were included in the setback. Implementation of preconstruction planning and design activities that emphasize proper placement, construction, and maintenance of roads, culverts, drainage ditches would also reduce impacts.

Alternatives C and D would have reduced impacts with regard to all the significance criteria because they are structured to decrease both the number of well pads—disturbance sites—as well as the total acreage of disturbance. Any measures applied to the Proposed Action or Alternatives A and B that decrease the number of disturbance sites and the amount of surface disturbance would also reduce the risk of those alternatives exceeding the significance criteria.

Groundwater. Groundwater resources would not incur significant adverse impacts with the appropriate application of protections and mitigation measures found in **Appendix C** and in state and federal laws and regulations. No additional mitigation measures would be necessary.

4.5 AIR QUALITY

4.5.1 Introduction

The air quality analysis addresses the potential impacts on ambient air quality and Air Quality Related Values (AQRVs) from air emissions due to the Proposed Action and alternatives and from other regional emissions sources within a defined study area. Potential ambient air quality impacts were quantified and compared to applicable state and Federal ambient air quality standards and Prevention of Significant Deterioration (PSD) increments, hazardous air pollutant (HAP) thresholds, and AQRV impacts (impacts on visibility, atmospheric deposition, and potential increases in acidification to acid-sensitive lakes) were determined and compared to applicable thresholds.

A near-field ambient air quality impact assessment was performed to evaluate maximum pollutant impacts within and adjacent to the CD-C project area resulting from project-related development and production emissions. The EPA's Guideline (EPA, 2005) model, AERMOD (version 11353), was used to assess these near-field impacts. The near-field criteria pollutant assessment was performed to estimate maximum impacts of CO, oxides of nitrogen (NOx), SO_2, PM_{10}, and $PM_{2.5}$ from project emissions sources that are likely to operate during the development and production phases of the Proposed Action and alternatives. Near-field HAP (benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde) concentrations were calculated for assessing impacts both in the immediate vicinity of project area emission sources for short-term (acute) exposure assessment and for calculation of long-term risk.

A far-field ambient air quality impact assessment was carried out to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of CO, NOx, SO_2, PM_{10},

$PM_{2.5}$, and volatile organic compounds (VOCs) expected to result from the development of the CD-C project as well as the combined effects of the CD-C project and other new sources of emissions in the region.

The far-field analysis described in this document differs significantly from previous natural gas development EIS air quality analyses performed for the BLM in Wyoming. Previous BLM analyses used the CALPUFF dispersion model to assess AQRV impacts in nearby PSD Class I Areas and sensitive PSD Class II Wilderness Areas from project and cumulative source emissions. For the CD-C impact analysis, the BLM and Wyoming Department of Environmental Quality Air Quality Division (WDEQ-AQD) elected to use the CAMx (Comprehensive Air quality Model with Extensions; ENVIRON 2010) photochemical grid model (PGM), which is a type of computer model that simulates the formation, transport, and fate of ozone and other pollutants in the atmosphere. PGMs represent the "state of the science" in tools and methods for both air quality (including ozone) and AQRV analyses. CAMx was used to predict maximum potential ambient air quality and AQRV impacts at mandatory federal PSD Class I and other sensitive PSD Class II areas, as well as designated acid-sensitive lakes. The CAMx analysis includes mid-field analyses which quantify impacts within the CD-C project area. Mid-field air quality impacts are compared to applicable ambient air quality standards.

The far-field modeling approach was determined by ozone air quality levels in Wyoming. Recent high levels of observed ozone dictated the choice of far-field modeling tools and methods. Ozone (O_3) is an important component of photochemical smog. Ozone is not emitted directly into the atmosphere, but is formed from photochemical reactions of precursor species in the presence of sunlight. The most important precursors are NO_x and VOCs. High ozone episodes occur most typically in urban areas during summer. Under these conditions, there is an abundance of ozone precursors from human activities and the high angle of the summer sun means there is sufficient sunlight available to drive the photochemical reactions which produce ozone. High summer temperatures enhance VOC emissions and speed the chemical reactions which produce ozone from its precursors.

In 2005, high ozone was measured in Sublette County, WY during winter. The phenomenon of winter high ozone under conditions with low sun angles and cold temperatures was novel, particularly because Sublette County is a relatively rural area whose main source of emissions is oil and gas exploration and production. High ozone levels were recorded again in Sublette County in 2006, 2008, and 2011. High winter ozone has also been measured in the Uinta Basin region in rural eastern Utah in recent years. Oil and gas production also occurs in the Uinta Basin.

In March 2009 the Governor of Wyoming recommended to the EPA that Sublette County and parts of northeastern Lincoln and northwestern Sweetwater Counties be designated ozone non-attainment areas under the 2008 75 parts per billion (ppb) ozone standard. Because of the importance of ozone as an air quality issue in Wyoming, the CD-C air quality impact analysis included evaluation of the effects of emissions from the Proposed Action on ozone throughout the study area (**Map 3.5-1**)..

The CD-C project area is located in eastern Sweetwater and western Carbon Counties. Although the project does not lie within the area proposed for non-attainment designation, the CD-C impact analysis evaluated potential ozone impacts from the Proposed Action emissions on ozone in Sublette, northeastern Lincoln, and northwestern Sweetwater Counties as well as the rest of the study area.

An emission inventory was developed for the Proposed Action and alternatives for each year over the expected life of the project. This emission inventory was used in the near-field, mid-field and far-field analyses. Emission inventories for all regional emissions sources from human activities and natural sources (e.g. wildfires) were compiled for use in the far-field modeling. In the following sections, the emission inventory development is described. Next, the modeling approaches for both near- and far-field analyses are detailed, and finally, the results of the analyses are given.

4.5.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives and impact significance criteria associated with air quality:

Management Objectives

1. Maintain concentrations of criteria pollutants associated with management actions in compliance with applicable state and federal ambient air quality standards.
2. Maintain concentrations of PSD pollutants associated with management actions in compliance with the applicable increment.
3. Reduce visibility-impairing pollutants in accordance with the reasonable progress goals and time frames established within the State of Wyoming's Regional Haze State Implementation Plan (SIP).
4. Reduce atmospheric deposition pollutants to levels below generally accepted Levels of Concern and Limits of Acceptable Change.

Significance Criteria

If and when specific activities are proposed at the implementation stage requiring quantitative analysis, impacts to air quality would be compared to the following significance criteria:

- The National Ambient Air Quality Standards (NAAQS) or Wyoming Ambient Air Quality Standards (WAAQS)
- The applicable PSD increments
- Federal guidelines for visibility impairment and atmospheric deposition.

More detailed information on the significance criteria is included in **Section 3.5.2**.

4.5.3 Emission Inventory Development

4.5.3.1 CD-C Project Alternative Emission Inventory Development

Emission inventories for CD-C project area development and production activities were compiled for the air quality impact assessment for all existing sources and for all new sources associated with the Proposed Action and alternatives.

There are two different types of activities (field development and production) associated with the CD-C project for which emission inventories were compiled. Emission-generating activities during field development include well pad and access road construction, drilling, fracking/completion, vehicle travel during the drilling and completion phase, and construction and vehicle travel during installation of gathering and sales pipeline systems. Production emissions were calculated for dehydration units, separators, gathering pipelines, blowdown tanks, and water/condensate storage tanks. Ancillary facilities included new compressor engines at current and proposed sites as well as central gas processing facilities. The specific components of field development and production emissions and total field-wide emissions are discussed in the Air Quality Technical Support Document (AQTSD) and its Appendices (available on the CD-C Natural Gas Development Project EIS website).

The CD-C project emission inventory was developed using data from the CD-C Operators as the primary source of information. The inventory accounted for all applicable emissions controls such as New Source Performance Standards (NSPS) and new Tier standards for non-road engines. The most important of these emissions controls are those specifically targeted at Wyoming oil and gas sources.

The WDEQ-AQD regulates emissions from oil and gas sources through the Oil and Gas Permitting Guidance (WDEQ-AQD, 2010). Different regulations apply in different regions of the state, with the most stringent level of controls applied to the areas with highest measured ambient ozone concentrations

that occur in the Jonah-Pinedale Anticline Development (JPAD) area shown in **Figure 4.5-1**. The CD-C project lies within a region of intensive oil and gas development known as the Concentrated Development Area (CDA). Under the WDEQ-AQD 2010 guidance, emissions controls are required in the CDA for the following source categories:

- Tank flashing
- Dehydration units
- Pneumatic pumps
- Pneumatic controllers
- Produced-water tanks
- Blow-down / venting

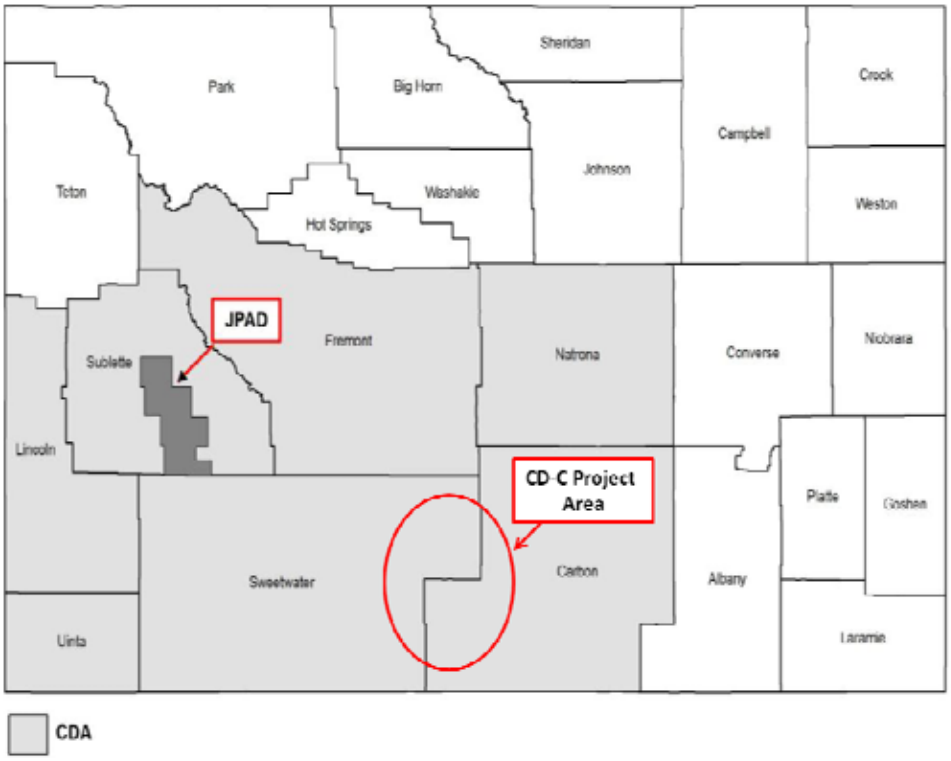


Figure 4.5-1. The Concentrated Development Area (CDA)

Source: WDEQ-AQD, 2010

These control measures were taken into account in the development of the CD-C project emission inventory. **Table 4.5-1** shows the emissions control measures for each emissions source category modeled in this analysis.

Table 4.5-1. Modeled CD-C project emissions control measures

CD-C Project Emissions Source Category	Type of Control Applied
Well Pad Const Equipment (diesel ICE)	Change in fuel sulfur content
Completion Equipment (diesel ICE)	Change in fuel sulfur content
Construction Traffic, Road and Well Pad	Change in emissions due to fleet turnover
Construction Traffic, Road and Well Pad – Fugitive Dust	Watering
Drilling Equipment (diesel ICE)	Change in fuel sulfur content and emission reductions due to Tier 2 engine technology
Drilling Traffic	Change in emissions due to fleet turnover
Drilling Traffic – Fugitive Dust	Watering
Completion Traffic	Change in emissions due to fleet turnover
Completion Traffic – Fugitive Dust	Watering
Completion Venting	96% of Gas to Green Completions and 4% of Gas Flared
Completion Flaring	N/A
Well Pad and Access Road Construction – Fugitive Dust	Watering
Construction Wind Erosion – Fugitive Dust	None
Workover Equipment (diesel ICE)	Change in fuel sulfur content
Workover Rig Traffic	Change in emissions due to fleet turnover
Workover Rig Traffic – Fugitive Dust	Watering
Heaters	None
Fugitives	None
Pneumatic Devices	No bleed devices
Pneumatic Pump	WDEQ BACT
Dehydrator Venting	WDEQ BACT
Tank Loadout (vapor losses)	None
Well Venting	None
Production Traffic	Change in emissions due to fleet turnover
Production Traffic - Fugitive Dust	Watering
Condensate Tank Flashing Losses	WDEQ BACT
Condensate Tank Working Losses	WDEQ BACT
Condensate Tank Breathing Losses	WDEQ BACT
Production Flaring	--
Compressor Station	WDEQ BACT assumed to limit NO_x and CO emissions for reciprocating engines
Gas Plant	WDEQ BACT assumed to limit NO_x and CO emissions for reciprocating engines
Evaporation Ponds	None

The field-wide emissions for the Proposed Action and alternatives are summarized in **Table 4.5-2**. The first column shows emissions for existing project area sources in the year 2008. The second column shows emissions from these 2008 sources within the project area forecast to the year 2022. These emissions represent the No Action Alternative in which the CD-C project is not developed. The Proposed Action column shows emissions from Proposed Action sources in the year 2022, and the total project area emissions in year 2022 gives the sum of emissions from existing sources and Proposed Action sources within the CD-C project area. The column furthest to the right shows the difference in emissions between the total CD-C field wide emissions in 2022 and year 2008 field-wide emissions. Year 2022 emissions are shown since the peak emissions for the Proposed Action alternative are estimated to occur during 2022.

Table 4.5-2. CD-C project alternative emission summary (tpy)

Pollutant	2008 Existing Project	No Action 2022	Proposed Action 2022	Total Project Area 2022	2008 to 2022 Increase in Emissions Resulting from Proposed Action and No Action Alternatives
NO_x	3,587	1,757	4,959	6,715	3,129
CO	3,185	1,852	8,621	10,473	7,289
SO_2	135	2	2	4	-131
PM_{10}	1,352	498	2,255	2,753	1,401
$PM_{2.5}$	403	203	475	678	275
VOC	58,672	42,249	14,791	57,039	-1,633

4.5.4 Greenhouse Gases

The U.S. Supreme Court ruled in 2007 that the EPA has the authority to regulate greenhouse gases (GHGs) such as methane (CH_4) and carbon dioxide (CO_2) as air pollutants under the Clean Air Act; however, there are currently no ambient air quality standards for GHGs, nor are there currently any emissions limits on GHGs that would apply to sources developed under the Proposed Action and alternatives. There are, however, applicable reporting requirements under the EPA's Greenhouse Gas Reporting Program. These GHG emission reporting requirements, finalized in 2010 under 40 CFR Part 98, will require the CD-C project proponents to develop and report annual methane and CO_2 emissions from equipment leaks and venting, and emissions of CO_2, methane and nitrous oxide from flaring, onshore production stationary and portable combustion emissions, and combustion emissions from stationary equipment. At present, there are no rules related to GHG emissions or impacts that would affect development of the Proposed Action and action alternatives, besides these GHG reporting requirements.

Both the exploration/construction and production phases of the Proposed Action and the development alternatives will cause emissions of GHGs. Methane comprises much of the chemical composition of natural gas, and nitrous oxide, CO_2, and methane are emitted by engines used for drill rigs, compressor engines, etc. As part of the development of the CD-C project emission inventory, an inventory of CO_2, methane, and nitrous oxide was prepared for all emissions source categories. GHGs were not modeled in either the near-field or far-field impact analyses, but the GHG inventory is presented here for informational purposes and is compared to other U.S. GHG emission inventories in order to provide context for the CD-C project GHG emissions. This inventory is presented in the AQTSD, Section 2.1.6.

In the CD-C project emission inventory, emissions of the greenhouse gases CO_2, CH_4, and N_2O from new and existing sources are quantified in terms of CO_2 equivalents. Measuring emissions in terms of CO_2 equivalents allows for the comparison of emissions from different GHGs based on their Global Warming Potential (GWP). GWP is defined as the cumulative radiative forcing of a gas over a specified time horizon relative to a reference gas resulting from the emission of a unit mass of gas. The reference gas is taken to be CO_2. The CO_2 equivalent emissions for a greenhouse gas are derived by multiplying the emissions of the gas by the associated GWP. The GWPs for the inventoried GHGs are CO_2:1, CH_4:21, N_2O:310 (EPA, 2011). Details of the greenhouse gas emissions calculations are provided in the AQTSD (greenhouse gas emissions over the life of the project are shown in AQTSD Figure 2-13.) The CD-C project's peak CO_2 equivalent emissions year will be 2022. Field-wide GHG emissions for the existing project in year 2008, the existing 2008 project projected for year 2022 (No Action Alternative), the CD-C Proposed Action in year 2022, the total project area emissions in year 2022 (existing sources taken together with the Proposed Action), and the difference in emissions between the total CD-C field emissions (including the Proposed Action emissions) and year 2008 field-wide emissions are summarized in **Table 4.5-3**.

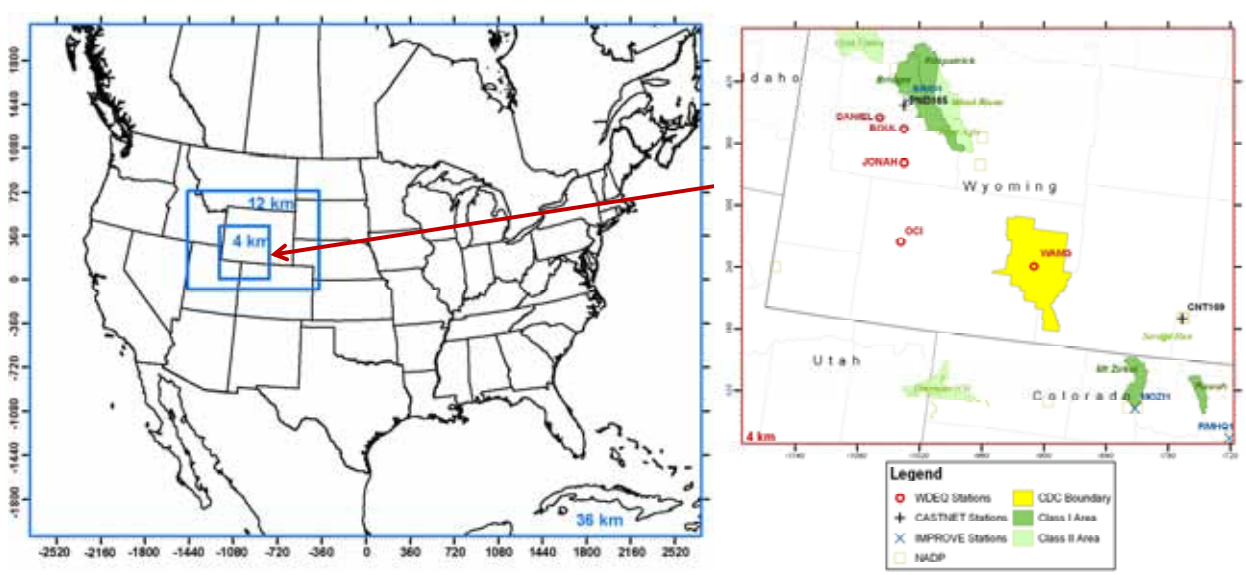
Table 4.5-3. CD-C project alternative GHG emission summary (metric tpy)

Pollutant	2008 Existing Project	No Action 2022	Proposed Action 2022	Total Project Area 2022	2022-2008 Increase in Emissions Resulting from Proposed Action and No Action Alternatives
CO_2	3,396,718	3,155,654	4,328,247	7,483,901	4,087,183
CH_4	89,165	76,097	38,291	114,388	25,223
N_2O	91	75	67	142	51
CO_2e*	5,298,295	4,777,792	5,153,746	9,931,538	4,633,242

* *CO_2 equivalent*

4.5.5 Regional Emission Inventory Development

In addition to the CD-C project emissions, emission inventories for other regional existing and proposed emissions sources within a continental-scale modeling domain (**Map 4.5-1**) were constructed and used for cumulative modeling analyses. Emission inventories prepared by the Western Regional Air Partnership (WRAP), Carter Lake, and BP and other Operators formed the basis for the regional emission inventories for the CD-C project far-field air quality impact analysis. Sources of PM_{10}, $PM_{2.5}$, NO_x, CO, SO_2, and VOC emissions within the study area were inventoried. Emission inventories and projections from various state and federal agencies were used to update the WRAP analyses as appropriate for each of the years modeled. Three categories of regional emissions inventories were compiled: two base case years (2005-6), a baseline year (2008), and a future year (2022). These inventories are described in detail in the AQTSD and its Appendices. The project and regional emissions were used in air quality modeling analysis of near-field and far-field impacts.



Map 4.5-1. Study area showing 36/12/4 kilometer (km) nested modeling grid used for photochemical grid modeling (left panel) and expanded view of the 4-km domain that was the focus of the far-field modeling impact analysis showing boundary of CD-C project area (yellow) and nearby Class I/sensitive Class II areas.

No warranty is made by the BLM for use of the data for purposes not intended by the BLM.

4.5.6 Air Quality Modeling

4.5.6.1 Near-Field Modeling

A near-field ambient air quality impact assessment was performed to evaluate maximum pollutant impacts within and adjacent to the CD-C project area resulting from the Proposed Action and alternative development and production emissions. AERMOD (version 11353), combined with three years (2008-2010) of hourly meteorological data collected near Wamsutter, Wyoming were used in the analysis to assess these near-field impacts. The near-field criteria pollutant assessment was performed to estimate maximum potential impacts of CO, NOx, SO_2, PM_{10}, and $PM_{2.5}$ from project emissions sources that are likely to operate during the development and production phases of the Proposed Action and action alternatives. Production activities include well production, expanded field compression and a new gas processing facility. Well field development activities that were modeled included well pad and access road construction, and well drilling. Modeling scenarios were also developed that included wells in production in close proximity to well pads where well drilling operations are occurring.

For 1-hour NO_2 NAAQS compliance demonstrations, where 1-hour NAAQS is defined as the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum concentrations, all modeled impacts presented represent the 3-year average of the eighth-highest daily maximum 1-hour concentrations. For scenarios where drilling operations were modeled, drilling operations were assumed to occur for a maximum of 2 years during the 3-year averaging period. Since drill rigs move to different locations during field development, it is not likely that a drilling operation would occur over 3 consecutive years in the same location.

For all criteria pollutant modeling scenarios, two model receptor grids were used for disclosing modeled impacts: one assuming a 100-meter distance from project sources, and another using a 250-meter distance from project sources. Representative background pollutant concentrations were added to modeled impacts and the total impacts compared to applicable Wyoming and National Ambient Air Quality Standards (WAAQS and NAAQS). Direct modeled pollutant impacts from project emission were compared with applicable PSD Class II increments. The comparisons to the PSD Class II increments are intended to evaluate a threshold of concern for potential impacts and do not represent a regulatory PSD increment comparison.

Near-field HAP (benzene, toluene, ethyl benzene, xylene, n-hexane and formaldehyde) concentrations were calculated for assessing impacts both in the immediate vicinity of project alternative sources for short-term (acute) exposure assessment and for calculation of long-term risk. Short-term (1-hour) HAP concentrations were compared to acute Reference Exposure Levels (RELs). Long-term exposures to HAPs emitted by project alternative sources were compared to Reference Concentrations for Chronic Inhalation (RfCs), and were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. Two estimates of cancer risk were made: one that corresponds to a most-likely-exposure (MLE) over a national residency average of 9 years with some time spent away from home, and one reflective of the maximally-exposed-individual (MEI) residing at one location for a lifetime with no time spent away from home. The cancer risks for all constituents were then summed to provide an estimate of the total inhalation cancer risk.

For all HAP modeling scenarios, 100-meter and 250-meter receptor distances from project sources were used. In addition, for risk assessments the distance from a source where the cancer risk is expected to fall below the level of one in one million is disclosed.

4.5.6.1 Far-Field Modeling

The purpose of the far-field modeling was to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of NOx, SO_2, PM_{10}, $PM_{2.5}$, VOC, and CO expected to result from the development of the CD-C project as well as the combined effects of the CD-C

project and other new sources of emissions in the region. The CAMx model was used to estimate impacts throughout the study area shown in the right-hand panel of **Map 4.5-1**. Impacts were estimated using two meteorological modeling years (2005 and 2006). Wind fields for these two meteorology years were developed using the PSU/NCAR Mesoscale Model version 5 (MM5; Anthes and Warner 1978; Dudhia 1993).

The PSD Class I areas and sensitive PSD Class II areas analyzed in the far-field analyses include the following:

- Bridger Wilderness Area, Wyoming (Class I);
- Fitzpatrick Wilderness Area, Wyoming (Class I);
- Savage Run Wilderness Area, Wyoming (Federal Class II, Wyoming Class I)
- Mount Zirkel Wilderness Area, Colorado (Class I);
- Rawah Wilderness Area, Colorado (Class I);
- Popo Agie Wilderness Area , Wyoming (Class II);
- Wind River Roadless Area, Wyoming (Class II); and
- Dinosaur National Monument, Colorado-Utah (Federal Class II, Colorado Class I (SO2 only).

Twelve lakes within the Class I and sensitive Class II areas were identified as being sensitive to atmospheric deposition, as follows:

Bridger Wilderness Area, Wyoming

- Black Joe Lake
- Deep Lake
- Hobbs Lake
- Upper Frozen Lake
- Lazy Boy Lake

Fitzpatrick Wilderness Area, Wyoming

- Ross Lake

Popo Agie Wilderness Area, Wyoming

- Lower Saddlebag Lake

Mount Zirkel Wilderness Area, Colorado

- Lake Elbert
- Seven Lakes
- Summit Lake

Rawah Wilderness Area, Colorado

- Island Lake
- Rawah Lake #

The CAMx model was used to estimate ambient air quality impacts of CO, NO_2, SO_2, O_3, PM_{10}, and $PM_{2.5}$ throughout the study area, and to estimate nitrogen and sulfur deposition at the Class I and sensitive Class II areas. CAMx concentration estimates were used to calculate visibility impacts at the Class I and sensitive Class II areas. Impacts to potential sensitive lake acidification were calculated using CAMx estimated sulfur and nitrogen deposition values.

The impact analysis includes an assessment of CD-C project source contributions to regional ozone formation, comparisons of modeled criteria pollutant impacts to applicable Class I and Class II increments at the Class I and sensitive Class Il areas, and assessments of project impacts to AQRVs (visibility, atmospheric deposition, and sensitive lake acidification) at the Class I and sensitive Class II areas compared with applicable threshold values. The far-field analysis includes mid-field criteria pollutant analyses which compare CAMx-estimated criteria pollutant levels within the CD-C project area to applicable ambient air quality standards.

Far-Field Modeling Approach

The basic modeling strategy used in any analysis that employs a photochemical grid model, such as CAMx, is to first evaluate the ability of the model to reproduce ambient observations of trace pollutants during a recent historical episode (the “current year” or “base case year”); then, once confidence in the model is established, a future year case can be run and the potential impacts of the project evaluated.

A current year base case is simulated using a comprehensive regional emission inventory of actual emissions from all sources (including motor vehicles, power plants, oil and gas exploration and production sources, biogenic sources, etc.). It is preferable to run the model for more than one year so that as many different meteorological regimes as possible are simulated. Pollutants emitted from project sources may only influence a particular sensitive receptor under certain conditions (wind direction, atmospheric stability) and a conservative estimate of AQ and AQRV impacts requires that those conditions be simulated. While it is not possible to ensure that all possible meteorological conditions that might lead to transport of pollutants from project sources to sensitive receptors are simulated, modeling two full years increases the likelihood that the relevant conditions would occur.

The base case simulation is evaluated with respect to ambient air quality measurements. If the base case simulation reproduces concentrations of observed species with reasonable accuracy, then the model can be used in the future year impact assessment. The next step is to prepare a baseline model for use in future year projections. The only difference between the base case model and the baseline model is that the baseline model uses typical emissions while the base case model uses actual emissions. An example of an emissions source category for which the base case and baseline emissions are different is electrical generating units (EGUs). The base case emission inventory uses hourly EGU emissions derived from continuous emissions monitoring (CEM) data because the base case model is evaluated against concurrent observations to determine whether the model provides a realistic simulation of atmospheric processes. The purpose of the baseline model, on the other hand, is to serve as the base year from which future year projections are made. The baseline EGU emissions are used to represent typical conditions (no shutdowns for maintenance, for example) in order to be consistent with the future year emissions, which also represent typical conditions. The baseline emission inventory, therefore, is usually identical to the base case emission inventory, except for the difference in emissions from EGUs and other source categories with large variability in time, such as drill rigs.

The future year modeling involves development of a future year project emission inventory as well as a future year regional emission inventory. In the future year regional emission inventory, the emissions from human activities are projected from the base year to the future year and changes such as population growth and planned emissions controls (such as controls on motor vehicle emissions) are accounted for. Emissions that are not controllable, such as biogenics and wildfire emissions, are held fixed. The project emissions are included in the future year emission inventory. The model is run using the future year regional emission inventory with the rest of the model (meteorological fields, boundary conditions, model settings, etc.) in the same configuration as in the base case. If multiple years were simulated in the base case, then the meteorological conditions for those same years are used together with the future year emissions scenario in the future year modeling. Project AQ and AQRV impacts are determined from the future year simulations.

In the CD-C analysis, CAMx was used to perform modeling of the base case years (2005-6), the baseline year (2008), and the future year (2022).

4.5.7 Direct and Indirect Impacts

Direct, indirect, and cumulative air quality impacts were analyzed to predict maximum potential near-field (surrounding the CD-C project area), mid-field (within the CD-C project area) and far-field (regional and PSD Class I and sensitive PSD Class II areas) ambient air pollutant concentrations, as well as maximum impacts to visibility (regional haze), and atmospheric deposition (acid rain) impacts. Analyses were also performed to predict maximum mid-field (within the CDC-project area) pollutant concentrations. Summaries of the impacts for each of the Proposed Action and alternatives are provided below.

4.5.7.1 Proposed Action

The Proposed Action includes the construction and operation of 8,950 natural gas wells, associated roads and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled either conventionally (with a single vertical well bore on each well pad) or with multiple directional well bores from a single pad.

Near-Field Modeling

Near-field modeling analyses were performed for the Proposed Action production and well field development activities. Criteria pollutant impacts were evaluated for both production and construction activities; however, HAP pollutant impacts were evaluated for only production activities since HAP emissions result primarily from well production activities. Production activities include well production, expanded field compression and a new gas processing facility. Well field development activities that were modeled included well pad and access road construction, and well drilling. Modeling scenarios were also developed that included wells in production in close proximity to well pads where well drilling operations are occurring, including a case where four drill rigs are operating within one land section. Two model receptor grids were used for disclosing modeled impacts; one assuming a 100-meter distance from project sources, and another using a 250-meter distance from project sources.

For 1-hour NO_2 NAAQS compliance demonstrations, all modeled impacts represent the 3-year average of the eighth-highest daily maximum 1-hour concentrations. For scenarios where drilling operations were modeled, drilling operations were assumed to occur for a maximum of 2 years during the 3-year averaging period. Since drill rigs move to different locations during field development, it is not likely that a drilling operation would occur over 3 consecutive years in the same location. The yearly maximum eighth-highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.

For 24-hour $PM_{2.5}$ NAAQS compliance demonstrations from well pad and access road construction, all modeled impacts represent the 3-year average of the maximum 24-hour concentrations from three separate activities, assuming well pad and access road construction occurs over 1 year, drilling operations occur for 1 year and well production activities occur for 1 year. Since well pad and access road construction would be temporary (occurring over a 5 –7 day period) and in isolation, this scenario represents a conservative estimate of $PM_{2.5}$ concentrations in the vicinity of a well pad. The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.

The maximum modeled criteria pollutant impacts from any of the production activities associated with the Proposed Action are shown in **Tables 4.5-4a** and **4.5-4b**. Table 4.5-4a presents the model results at the 100-meter distance from project sources and Table 4.5-4b presents the results for the 250-meter receptor distance. As indicated in Tables 4.5-4a and 4.5-4b, impacts from Proposed Action production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Table 4.5-4a. Production sources, criteria pollutant modeling results: 100-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Gas Plant	CO	1-hour	514.1	n/a	1,026.0	1,540.1	40,000	40,000
		8-hour	315.8	n/a	798.0	1,113.8	10,000	10,000
Gas Plant	NO_2	1-hour	105.6[2]	n/a	75.0	180.6	n/a	188
		Annual	11.9	25	9.1	21.0	100	100
Well Production (16 well pad)	NO_2	1-hour	112.6[2]	n/a	75.0	187.6	n/a	188
		Annual	7.3	25	9.1	16.4	100	100
Gas Plant	SO_2	1-hour	0.6[3]	n/a	19.7	20.3	n/a	196
		3-hour	0.6	512	11.5	12.1	1,300	1,300
		24-hour	0.2	91	4.2	4.4	260	365
		Annual	0.03	20	3.8	3.8	60	80
Gas Plant	PM_{10}	24-hour	11.5	30	56.0	67.5	150	n/a
		Annual	1.4	17	13.5	14.9	50	50
Gas Plant	$PM_{2.5}$	24-hour	7.9[4]	9	9.2	17.1	n/a	35
		Annual	1.4	4	4.2	5.6	n/a	15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations.*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[4] *$PM_{2.5}$ 24-hour concentration is calculated as the 3-year average of the highest 24-hour concentrations.*

Table 4.5-4b. Production sources, criteria pollutant modeling results: 250-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Gas Plant	CO	1-hour	388.2	n/a	1,026.0	1,414.2	40,000	40,000
		8-hour	236.2	n/a	798.0	1,034.2	10,000	10,000
Gas Plant	NO_2	1-hour	99.5[2]	n/a	75.0	174.5	n/a	188
		Annual	8.3	25	9.1	17.4	100	100
Well Production (16 well pad)	NO_2	1-hour	101.4[2]	n/a	75.0	176.4	n/a	188
		Annual	3.5	25	9.1	12.6	100	100
Gas Plant	SO_2	1-hour	0.4[3]	n/a	19.7	20.1	n/a	196
		3-hour	0.4	512	11.5	11.9	1,300	1,300
		24-hour	0.2	91	4.2	4.4	260	365
		Annual	0.02	20	3.8	3.8	60	80
Gas Plant	PM_{10}	24-hour	7.2	30	56.0	63.2	150	n/a
		Annual	0.9	17	13.5	14.4	50	50
Gas Plant	$PM_{2.5}$	24-hour	5.6[4]	9	9.2	14.8	n/a	35
		Annual	1.4	4	4.2	5.6	n/a	15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations.*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[4] *$PM_{2.5}$ 24-hour concentration is calculated as the 3-year average of the highest 24-hour concentrations.*

The maximum modeled criteria pollutant impacts from well development activities associated with the Proposed Action are shown in **Tables 4.5-5a and 4.5-5b** for both the 100-meter and 250-meter receptor

distances from project sources. As described earlier in this section, the 1-hour NO_2 and the 24-hour $PM_{2.5}$ results are calculated as a three-year average based on modeling the Proposed Action field development and field production sources of air emissions. The scenarios modeled for determining air quality impacts from NO_x emission sources included Tier 2 drill rig operation and multi-well pads with 16 wells in production. For $PM_{2.5}$ emission sources, the scenario modeled includes the emissions from 4 single well pads and access roads under construction, 4 Tier 2 drill rigs operating, and 4 single wells in production. As indicated in T**ables 4.5-5a and 4.5-5b** the Proposed Action field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance. However, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS.

Tables providing the individual annual modeled 8th highest daily maximum 1-hour NO_2 concentrations and the individual annual modeled maximum 24-hour $PM_{2.5}$ concentrations predicted for all modeling scenarios are presented in Appendix L of the AQTSD, and the results are discussed in AQTSD Section 3.5.4.

In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through the application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation** could be implemented.

Note that the emissions from field development activities would be temporary and would not consume PSD increment, and as a result are excluded from increment comparisons.

Additional details on the near-field criteria pollutant modeling impact assessment are provided in Section 3.5 of the AQTSD.

Table 4.5-5a. Field development sources, criteria pollutant modeling results: 100-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	123.5[1] 23.7	75.0 9.1	198.5 32.8	n/a 100	188 100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	125.6[1] 25.6	75.0 9.1	200.6 34.7	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	27.6[2] 17.5 9.9 1.4	19.7 11.5 4.2 3.8	47.3 29.0 14.1 5.2	n/a 1,300 260 60	196 1,300 365 80
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	123.2 7.5	56.0 13.5	179.2 21.0	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	31.4[3] 4.8	9.2 4.2	40.6 9.0	n/a n/a	35 15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 8 wells in production)*

[2] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities)*

Table 4.5-5b. Field development sources, criteria pollutant modeling results: 250-meter receptor distance, Proposed Action

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	308.6 131.0	1,026.0 798.0	1,334.6 929.0	40,000 10,000	40,000 10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	102.0[1] 12.0	75.0 9.1	177.0 21.1	n/a 100	188 100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	101.1[1] 14.8	75.0 9.1	176.1 23.9	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	14.8[2] 8.2 3.1 0.5	19.7 11.5 4.2 3.8	34.5 19.7 7.3 4.3	n/a 1,300 260 60	196 1,300 365 80
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	308.6 131.0	1,026.0 798.0	1,334.6 929.0	40,000 10,000	40,000 10,000
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	76.2 3.0	56.0 13.5	132.3 16.5	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	23.7[3] 2.4	9.2 4.2	32.9 6.6	n/a n/a	35 15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 8 wells in production)*

[2] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities)*

The maximum predicted acute and chronic (long-term) HAP impacts from production activities compared with applicable REL and RfC exposure thresholds are shown in **Tables 4.5-6** through **4.5-7**. **Tables 4.5-6a and 4.5-6b** present the acute impacts for both and 100-meter and 250-meter receptor distances, and **Tables 4.5-7a and 4.5-7b** present the long-term impacts for both receptor distances. As indicated in these tables, HAP emissions resulting for Proposed Action production activities would result in impacts that are below the HAP threshold exposure levels.

Table 4.5-6a. Production sources, maximum long-term (1-hour) HAP modeling results: 100-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m^3)	REL or IDLH (µg/m^3)
16 Well Pad Production	Benzene	6.2	1,300[1]
16 Well Pad Production	Toluene	8.4	37,000[1]
16 Well Pad Production	Ethylbenzene	0.2	350,000[2]
16 Well Pad Production	Xylene	3.8	22,000[1]
16 Well Pad Production	n-Hexane	33.6	390,000[2]
16 Well Pad Production	Formaldehyde	47.3	55[1]
Gas Plant	Formaldehyde	5.8	55[1]

[1] *Reference Exposure Level*

[2] *Immediately Dangerous to Life or Health value divided by 10.*

Table 4.5-6b. Production sources, maximum long-term (1-hour) HAP modeling results: 250-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m^3)	REL or IDLH (µg/m^3)
16 Well Pad Production	Benzene	5.5	1,300[1]
16 Well Pad Production	Toluene	7.4	37,000[1]
16 Well Pad Production	Ethylbenzene	0.2	350,000[2]
16 Well Pad Production	Xylene	3.2	22,000[1]
16 Well Pad Production	n-Hexane	29.6	390,000[2]
16 Well Pad Production	Formaldehyde	41.6	55[1]
Gas Plant	Formaldehyde	5.3	55[1]

[1] *Reference Exposure Level*

[2] *Immediately Dangerous to Life or Health value divided by 10.*

Table 4.5-7a. Production sources, maximum long-term (annual) HAP modeling results: 100-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m^3)	Non-carcinogenic RfC (µg/m^3)
16 Well Pad Production	Benzene	0.2	30
16 Well Pad Production	Toluene	0.3	5,000
16 Well Pad Production	Ethylbenzene	0.01	1,000
16 Well Pad Production	Xylene	0.1	100
16 Well Pad Production	n-Hexane	1.2	700
16 Well Pad Production	Formaldehyde	1.7	9.8
Gas Plant	Formaldehyde	0.4	9.8

Table 4.5-7b. Production sources, maximum long-term (annual) HAP modeling results: 250-meter receptor distance, Proposed Action

Modeling Scenario	HAP	Modeled Concentration (µg/m3)	Non-carcinogenic RfC (µg/m3)
16 Well Pad Production	Benzene	0.1	30
16 Well Pad Production	Toluene	0.1	5,000
16 Well Pad Production	Ethylbenzene	0.003	1,000
16 Well Pad Production	Xylene	0.06	100
16 Well Pad Production	n-Hexane	0.6	700
16 Well Pad Production	Formaldehyde	0.8	9.8
Gas Plant	Formaldehyde	0.4	9.8

Two estimates of cancer risk were made: one that corresponds to most-likely-exposure (MLE) over a national residency average of 9 years with some time spent away from home, and one reflective of the maximally-exposed-individual (MEI) residing at one location for a lifetime with no time spent away from home. The cancer risks for all constituents were then summed to provide an estimate of the total inhalation cancer risk.

Near-field modeling was also performed to estimate the long-term risk, for both the most-likely-exposure (MLE) and maximally-exposed-individual (MEI) scenarios, from benzene, ethyl benzene, and formaldehyde emissions resulting from production activities. **Table 4.5-8** presents the cancer risk

estimates for the proposed compression and gas plant facilities, for both the 100-meter and 250-meter receptor cases, and at the distance required to be below a one-in-one-million cancer risk level for either the MLE or MEI analysis. The modeling results indicate that for the MLE analysis the cancer risk is below one-in-one-million at the 100-meter distance for both the proposed compression and gas plant facilities. For the MEI analysis the distance where the cancer risk would fall below a one-in-one-million cancer risk level is 0.25 miles for the proposed compression facility, and 1.0 miles for the proposed gas plant. Note that the risk estimates for the compression and gas plant facilities only considered formaldehyde emissions, since benzene and ethyl benzene emissions for these facilities would be negligible.

Table 4.5-8. Long-term modeled formaldehyde MLE and MEI cancer risk analyses for proposed compression and gas plant, Proposed Action

Modeling Scenario	Receptor Distance	Analysis	Modeled Concentration ($\mu g/m^3$)	Unit Risk Factor $1/(\mu g/m^3)$	Exposure Adjustment Factor	Cancer Risk
Compression	100 meters	MLE	0.19	1.3×10^{-5}	0.0949	0.2×10^{-6}
Compression	100 meters	MEI	0.19	1.3×10^{-5}	0.86	2.1×10^{-6}
Gas Plant	100 meters	MLE	0.36	1.3×10^{-5}	0.0949	0.4×10^{-6}
Gas Plant	100 meters	MEI	0.36	1.3×10^{-5}	0.86	4.0×10^{-6}
Compression	250 meters	MLE	0.14	1.3×10^{-5}	0.0949	0.2×10^{-6}
Compression	250 meters	MEI	0.14	1.3×10^{-5}	0.86	1.6×10^{-6}
Gas Plant	250 meters	MLE	0.36	1.3×10^{-5}	0.0949	0.4×10^{-6}
Gas Plant	250 meters	MEI	0.36	1.3×10^{-5}	0.86	4.0×10^{-6}
Compression	0.25 miles	MLE	0.08	1.3×10^{-5}	0.0949	0.1×10^{-6}
Compression	0.25 miles	MEI	0.08	1.3×10^{-5}	0.86	0.9×10^{-6}
Gas Plant	1.0 miles	MLE	0.08	1.3×10^{-5}	0.0949	0.1×10^{-6}
Gas Plant	1.0 miles	MEI	0.08	1.3×10^{-5}	0.86	0.9×10^{-6}

Table 4.5-9 presents the cancer risk estimates for a multi-well pad, with 16 wells in production, for both the 100-meter and 250-meter receptor cases, and at the distance required to be below a one-in-one-million cancer risk level for either the MLE or MEI analysis. The modeling results indicate that for the MLE analysis the cancer risk is one-in-one-million at the 250-meter distance. For the MEI analysis the distance where the cancer risk would fall below a one-in-one-million cancer risk level is 1.25 miles. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Additional details on the near-field HAP modeling impact assessment are provided in Section 3.6 of the AQTSD.

Table 4.5-9. Long-term modeled MLE and MEI cancer risk analyses for production well case: 16 wells, 1 multi-well pad, Proposed Action

Receptor Distance	Analysis	HAP Constituent	Modeled Concentration ($\mu g/m^3$)	Unit Risk Factor $1/(\mu g/m^3)$	Exposure Adjustment Factor	Cancer Risk
100 meters	MLE	Benzene	0.23	7.8×10^{-6}	0.0949	0.2×10^{-6}
		Ethyl Benzene	0.007	2.5×10^{-6}	0.0949	0.001×10^{-6}
		Formaldehyde	1.7	1.3×10^{-5}	0.0949	2.1×10^{-6}
					Total Combined[1]	2.3×10^{-6}
100 meters	MEI	Benzene	0.23	7.8×10^{-6}	0.86	1.5×10^{-6}
		Ethyl Benzene	0.007	2.5×10^{-6}	0.86	0.01×10^{-6}
		Formaldehyde	1.7	1.3×10^{-5}	0.86	19.1×10^{-6}
					Total Combined[1]	20.7×10^{-6}
250 meters	MLE	Benzene	0.10	7.8×10^{-6}	0.0949	0.08×10^{-6}
		Ethyl Benzene	0.003	2.5×10^{-6}	0.0949	0.001×10^{-6}
		Formaldehyde	0.79	1.3×10^{-5}	0.0949	1.0×10^{-6}
					Total Combined[1]	1.0×10^{-6}
250 meters	MEI	Benzene	0.10	7.8×10^{-6}	0.86	0.7×10^{-6}
		Ethyl Benzene	0.003	2.5×10^{-6}	0.86	0.006×10^{-6}
		Formaldehyde	0.79	1.3×10^{-5}	0.86	8.8×10^{-6}
					Total Combined[1]	9.5×10^{-6}
1.25 miles	MLE	Benzene	0.01	7.8×10^{-6}	0.0949	0.008×10^{-6}
		Ethyl Benzene	0.0003	2.5×10^{-6}	0.0949	0.00001×10^{-6}
		Formaldehyde	0.08	1.3×10^{-5}	0.0949	0.09×10^{-6}
					Total Combined[1]	0.1×10^{-6}
1.25 miles	MEI	Benzene	0.01	7.8×10^{-6}	0.86	0.07×10^{-6}
		Ethyl Benzene	0.0003	2.5×10^{-6}	0.86	0.001×10^{-6}
		Formaldehyde	0.08	1.3×10^{-5}	0.86	0.9×10^{-6}
					Total Combined[1]	0.9×10^{-6}

[1] *Total risk is calculated here; however, the additive effects of multiple chemicals are not fully understood and this should be taken into account when viewing these results.*

Far-Field Modeling

Far-field modeling using the CAMx model was performed to quantify potential air quality impacts to both ambient air concentrations and AQRVs from air pollutant emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, VOC, and CO expected to result from the development of the Proposed Action as well as the combined effects of the CD-C project and other new sources of emissions in the region. Key results of the analysis of the air quality and AQRV impacts of the Proposed Action are described below. Additional detail is provided in Section 4.5 of the AQTSD.

Criteria Pollutants Including Ozone

The results of the far-field modeling showed that the Proposed Action would make no significant contribution to modeled exceedances of the NAAQS, WAAQS or Colorado Ambient Air Quality Standards (CAAQS) for ozone (see AQTSD Section 4.5.4) or any other criteria pollutant (see AQTSD Section 4.5.3).

The Proposed Action source contribution to future year ozone formation was assessed using two methods: the EPA's Modeled Attainment Test Software (MATS; Abt, 2009) and absolute modeled concentrations. The MATS-estimated Proposed Action maximum impact on future year 8-hour average ozone concentrations would be less than or equal to 0.8 ppb. The two-year approximation to future-year 8-hour average ozone concentrations estimated using absolute CAMx model concentrations shows the Proposed

Action maximum ozone impact would be 1.6 ppb or less. For both the absolute modeled concentration and MATS results, the largest ozone impacts due to the Proposed Action emissions were in the vicinity of the CD-C project area. In Sublette County, where the only MATS-projected exceedances of the 75 ppb NAAQS within the study area would occur, ozone impacts due to the Proposed Action were extremely small, and were less than or equal to 0.04 ppb. The highest CD-C ozone contributions to ozone in the study area occurred on days when regional 8-hour ozone would be low (<60ppb).

PSD increments were not exceeded at any Class I or sensitive Class II area within the study area.

Mid-Field Impacts

CAMx estimated criteria pollutant impacts from Proposed Action sources and from Proposed Action sources and regional sources, within and near the CD-C project area are shown in **Table 4.5-10**. As indicated in Table 4.5-10 the cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II Increments.

Table 4.5-10. Mid-Field criteria pollutant modeling results, Proposed Action

Pollutant	Averaging Time	Modeled Concentration from CD-C Project Sources (µg/m^3)	Modeled Concentration from All Sources (µg/m^3)	PSD Class II Increment1 (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
CO_4	1-hour	--	491.3	n/a	40,000	40,000
	8-hour	--	357.0	n/a	10,000	10,000
NO_2	1-hour	47.1	81.4[2]	n/a	n/a	188
	Annual	6.6	17.1	25	100	100
O_3	8-hour	4.3	142.4	n/a	147	147
SO2	1-hour	0.02	30.8[3]	n/a	n/a	196
	3-hour	0.02	30.0	512	1,300	1,300
	24-hour	0.01	11.3	91	260	365
	Annual	0.003	3.1	20	60	80
PM_{10}	24-hour	7.3	55.8	30	150	n/a
	Annual	2.5	7.5	17	50	50
$PM_{2.5}$	24-hour	2.4	18.7	9	n/a	35
	Annual	0.6	3.8	4	n/a	15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*
[2] *NO_2 1-hour concentration is 8th highest daily maximum 1-hour concentration. Value includes contribution from NO.*
[3] *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*
[4] *No value is given for the CD-C project CO concentration contribution because the CAMx source apportionment tool does not track CO.*

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Proposed Action source emissions are shown in **Table 4.5-11**. An additional method (BLM method) was used to evaluate visibility impacts and the results are presented in the AQTSD, Section 4.6.1.

The visibility analysis indicated a maximum of 5 days with CD-C project emissions resulting in impacts greater than the 0.5 delta-deciviews (Δdv) threshold at any of the Class I and sensitive Class II areas analyzed for both the 2005 and 2006 meteorological data. Using the 98th percentile or eighth-highest value as a threshold (as recommended in the FLAG 2010 document) there would be zero days above the 0.5 Δdv threshold at any of the Class I or sensitive Class II areas.

Table 4.5-11. Visibility impacts using FLAG 2010 screening method, Proposed Action

Class I or Sensitive Class II Area	Number of Days > 0.5 Δdv	Maximum Δdv	98th Percentile Maximum Δdv
Bridger Wilderness Area	0	0.20	0.03
Fitzpatrick Wilderness Area	0	0.16	0.03
Savage Run Wilderness Area	1	0.61	0.20
Mount Zirkel Wilderness Area	1	0.65	0.24
Rawah Wilderness Area	0	0.24	0.12
Popo Agie Wilderness Area	0	0.22	0.03
Wind River Roadless Area	0	0.14	0.04
Dinosaur National Monument	5	0.85	0.34

Deposition Impacts

Modeling results for Proposed Action source emissions indicated that there were no nitrogen or sulfur deposition impacts that exceeded the BLM critical load values at any Class I/sensitive Class II area; however, the deposition analysis threshold (DAT) for nitrogen was exceeded at several Class I areas near/downwind of CD-C project area. Deposition impacts are summarized in Section 4.6.2 of the AQTSD.

Acidification at Sensitive Lakes. Modeling results for Proposed Action sources indicated that there would be no ANC changes at any of the 12 analyzed lakes that exceeded the 10-percent threshold or the ΔANC<1 μeq/L threshold for the two extremely sensitive lakes. Lake ANC impacts are summarized in Section 4.6.3 of the AQTSD.

Regional Climate Change and Greenhouse Gas Emissions

The current scientific consensus is that the warming of the climate system is "unequivocal" and "continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century." (IPCC, 2007). Specific regional effects of climate change are highly uncertain (see section **3.5 Air Quality**), but may include extreme weather, adverse health impacts due to increased intensity and duration of heat waves, and seasonally decreasing water supplies that exacerbate competition for over-allocated water resources. As discussed in Chapter 3, it is not possible to attribute emissions of GHGs from any particular source as having a specific climate impact, globally or regionally, due to the longevity of GHGs in the atmosphere. GHG emissions from all sources contribute to increased incremental concentrations in the earth's atmosphere and to the global climate response.

The maximum greenhouse gas emissions resulting from the Proposed Action source emissions are estimated at 5.2 tg/yr of CO_2 equivalent emissions. The CD-C project's peak CO_2 equivalent emissions year is 2022, in which the combined emissions from new Proposed Action sources and existing sources would be approximately 10 tg/year. To place the CD-C project's GHG emissions in context, the GHG emissions from the top four emitting coal-fired power plants in Wyoming range from 3-15 tg/year (data from <http://epa.gov/-climatechange/emissions/ghgdata/2010data.html>). CD-C project GHGs would be comparable to the total GHG emissions from the City of San Francisco (10 tg/year; <http://www.sfenvironment.org/-downloads/library/climateactionplan.pdf>) during the year 2000).

4.5.7.2 Alternative A: 100-Percent Vertical Drilling

Alternative A includes the construction and operation of 8,950 natural gas wells, associated roads, and production facilities, including compression and gas processing facilities. All the proposed natural gas wells would be drilled conventionally, with a single vertical well bore on each well pad.

Near-Field Modeling

The maximum modeled criteria pollutant impacts from any of the production activities associated with Alternative A production facilities would be similar to the Proposed Action; however, pollutant impacts from individual well sites would be less given the wells would be drilled on single well pads. The impacts for Alternative A production facilities are shown in **Tables 4.5-12a and 4.5-12b**. As indicated in these tables, impacts from Alternative A production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Table 4.5-12a. Production sources, criteria pollutant modeling results: 100-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Gas Plant	CO	1-hour	514.1	n/a	1,026.0	1,540.1	40,000	40,000
		8-hour	315.8	n/a	798.0	1,113.8	10,000	10,000
Gas Plant	NO_2	1-hour	105.6[2]	n/a	75.0	180.6	n/a	188
		Annual	11.9	25	9.1	21.0	100	100
Single well pad production	NO_2	1-hour	18.1[2]	n/a	75.0	93.1	n/a	188
		Annual	0.9	25	9.1	10.0	100	100
Gas Plant	SO_2	1-hour	0.6[3]	n/a	19.7	20.3	n/a	196
		3-hour	0.6	512	11.5	12.1	1,300	1,300
		24-hour	0.2	91	4.2	4.4	260	365
		Annual	0.03	20	3.8	3.8	60	80
Gas Plant	PM_{10}	24-hour	11.5	30	56.0	67.5	150	n/a
		Annual	1.4	17	13.5	14.9	50	50
Gas Plant	$PM_{2.5}$	24-hour	7.9	9	9.2	17.1	n/a	35
		Annual	1.4	4	4.2	5.6	n/a	15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

Table 4.5-12b. Production sources, criteria pollutant modeling results: 250-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Gas Plant	CO	1-hour 8-hour	388.2 236.2	n/a n/a	1,026.0 798.0	1,414.2 1,034.2	40,000 10,000	40,000 10,000
Gas Plant	NO_2	1-hour Annual	99.5[2] 8.3	n/a 25	75.0 9.1	174.5 17.4	n/a 100	188 100
Single well pad production	NO_2	1-hour Annual	12.0[2] 0.4	n/a 25	75.0 9.1	87.0 9.5	n/a 100	188 100
Gas Plant	SO_2	1-hour 3-hour 24-hour Annual	0.4[3] 0.4 0.2 0.02	n/a 512 91 20	19.7 11.5 4.2 3.8	20.1 11.9 4.4 3.8	n/a 1,300 260 60	196 1,300 365 80
Gas Plant	PM_{10}	24-hour Annual	7.2 0.9	30 17	56.0 13.5	63.2 14.4	150 50	n/a 50
Gas Plant	$PM_{2.5}$	24-hour Annual	5.6[4] 1.4	9 4	9.2 4.2	14.8 5.6	n/a n/a	35 15

[1] *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

[2] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[3] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

The maximum modeled criteria pollutant impacts from well development activities associated with Alternative A would differ slightly from the Proposed Action, given Alternative A is a vertical well drilling alternative. The maximum modeled criteria pollutant impacts from well development activities are shown in **Tables 4.5-13a and 4.5-13b** for both the 100-meter and 250-meter receptor distances from project sources. As described in **Section 4.5.7,1** the 1-hour NO_2 and the 24-hour $PM_{2.5}$ results are calculated as a three-year average based on modeling Alternative A field development and field production sources of air emissions. The scenarios used for modeling air quality impacts from NO_x emission sources included Tier 2 drill rig operation and single wells in production. For $PM_{2.5}$ emission sources, the scenario modeled includes the emissions from a 4 single-well pads and access roads under construction, 4 Tier 2 drill rigs operating, and 4 single wells in production. As indicated in T**ables 4.5-13a and 4.5-13b,** Alternative A field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance. However, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS.

Tables providing the individual annual modeled 8th highest daily maximum 1-hour NO_2 concentrations and the individual annual modeled maximum 24-hour $PM_{2.5}$ concentrations predicted for all modeling scenarios are presented in Appendix L of the AQTSD, and the results are discussed in AQTSD Section 3.5.4.

In order to demonstrate compliance with the NAAQS and WAAQS, additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**.

Note that the emissions from field development activities are temporary and do not consume PSD increment, and as a result are excluded from increment comparisons.

Additional detail on near-field modeling methods and results is provided in Section 3.5 of the AQTSD.

Table 4.5-13a. Field development sources, criteria pollutant modeling results: 100-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
Single Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	105.4[1] 25.1	75.0 9.1	180.4 34.2	n/a 100	188 100
4, Single Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	133.6[1] 27.3	75.0 9.1	208.6 36.4	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	27.6[2] 17.5 9.9 1.4	19.7 11.5 4.2 3.8	47.3 29.0 14.1 5.2	n/a 1,300 260 60	196 1,300 365 80
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	626.8 380.1	1,026.0 798.0	1,652.8 1,178.1	40,000 10,000	40,000 10,000
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	123.2 7.5	56.0 13.5	179.2 21.0	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	31.4[3] 4.8	9.2 4.2	40.6 9.0	n/a n/a	35 15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (Single well pad case includes 2 years of drill rig operation concurrent with 4 wells in production, and 1 year with 5 wells in production),4, single-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 2 wells in production). (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[2] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

Table 4.5-13b. Field development sources, criteria pollutant modeling results: 250-meter receptor distance, Alternative A

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
4 Tier 2 Drill Rigs	CO	1-hour 8-hour	308.6 131.0	1,026.0 798.0	1,334.6 929.0	40,000 10,000	40,000 10,000
Single Well Pad, Tier 2 Drill Rig	NO_2	1-hour Annual	78.0[1] 13.3	75.0 9.1	153.0 22.4	n/a 100	188 100
4, Single Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour Annual	101.5[1] 15.8	75.0 9.1	176.5 24.9	n/a 100	188 100
4 Tier 2 Drill Rigs	SO_2	1-hour 3-hour 24-hour Annual	14.8[2] 8.2 3.1 0.5	19.7 11.5 4.2 3.8	34.5 19.7 7.3 4.3	n/a 1,300 260 60	196 1,300 365 80
Single Well Pad and Access Road Construction	PM_{10}	24-hour Annual	76.2 3.0	56.0 13.5	132.3 16.5	150 50	n/a 50
	$PM_{2.5}$	24-hour Annual	23.7[3] 2.4	9.2 4.2	32.9 6.6	n/a n/a	35 15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (Single well pad case includes 2 years of drill rig operation concurrent with 4 wells in production, and 1 year with 5 wells in production), 4, single-well pad case includes 1 year with 4 drill rigs in operation and 2 years with 2 drill rigs in operation and 2 wells in production). (The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD).*

[2] *SO_2 1-hour concentration are 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad andaccess road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be less than the impacts presented in **Section 4.5.4** for the Proposed Action since there would be no multi-well pads developed. HAP impacts for the proposed compression and gas plant facilities would be the same as the Proposed Action. HAP impacts under Alternative A would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or MEI analysis would be 1.0 miles as a result of the gas plant emissions. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact associated with formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those for the Proposed Action. Alternative A sources would not contribute to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative A criteria pollutant impacts from project sources and regional sources, within and near the CD-C project area, would be similar to the results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II Increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative A emissions would be the similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative A would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Potential sensitive lake acidification resulting from nitrogen and sulfur deposition impacts under Alternative A would be similar to the impacts for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative A sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.3 Alternative B: Enhanced Resource Protection

Alternative B includes the construction and operation of 8,950 natural gas wells, associated roads and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled using a combination of vertical and directional drilling techniques.

Near-Field Modeling

Near-field modeling impacts for Alternative B would be similar to those presented in **Section 4.5.4** for the Proposed Action. Impacts from Alternative B production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Alternative B field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance; however, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. In order to demonstrate compliance with the NAAQS and WAAQS, additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Additional Mitigation**.

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts for the Proposed Action. HAP impacts under Alternative B would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those presented in **Section 4.5.4.1** for the Proposed Action. Alternative B sources would not contribute to modeled exceedances of the NAAQS, WAAQS or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative B criteria pollutant impacts from project sources and regional sources, within and near the CD-C project area would be similar to the results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources are below the applicable ambient air quality standards and the direct project impacts are below the PSD Class II Increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative B emissions would be similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative B would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Potential sensitive lake acidification resulted from nitrogen and sulfur deposition impacts under Alternative B would be similar to the impacts for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative B sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.4 Alternative C: Cap on Surface Disturbance for High and Low-Density Development Areas

Alternative C includes the construction and operation of 8,950 natural gas wells, associated roads, and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled using a combination of vertical and directional drilling techniques.

Near-Field Modeling

Near-field modeling impacts for Alternative C would be similar to those presented in **Section 4.5.4** for the Proposed Action. Impacts from Alternative C production sources would be below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

Alternative C field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance; however, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Additional Mitigation**.

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts presented in **Section 4.5.4.1** for the Proposed Action. HAP impacts under Alternative C would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those for the Proposed Action. Alternative C sources would not contribute to modeled exceedances of the NAAQS, WAAQS or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

CD-C Alternative C criteria pollutant impacts from project sources and regional sources within and near the CD-C project area would be similar to the results shown in **Table 4.5-10** for the Proposed Action. The cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative C emissions would be similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative C would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Sensitive lake acidification resulting from nitrogen and sulfur deposition impacts under Alternative C would be similar to the impacts presented in **Section 4.4.1** for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceed threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative B sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.5 Alternative D: Directional Drilling

Alternative D includes the construction and operation of 8,950 natural gas wells, associated roads, and production facilities, including compression and gas processing facilities. The proposed natural gas wells would be drilled either conventionally, with a single vertical well bore on each well pad, or with multiple directional well bores from a single pad; however, the majority of the wells would be directional.

Near-Field Modeling

Near-field modeling impacts for Alternative D production facilities would be similar to those presented in **Section 4.5.4.1** (**Tables 4.5-4a and 4.5-4b**) for the Proposed Action. Impacts from Alternative D production sources would below the NAAQS or WAAQS, and would not exceed the PSD Class II increments.

The maximum modeled criteria pollutant impacts from well development activities associated with Alternative D would be similar to the Proposed Action; however, given that Alternative D is mainly a directional well drilling alternative, additional modeling scenarios are presented in this section for only multi-well cases. The maximum modeled criteria pollutant impacts from well development activities are shown in **Tables 4.5-14a and 4.5-14b** for both the 100-meter and 250-meter receptor distances from project sources.

As described earlier in **Section 4.5.7.1**, the 1-hour NO_2 and the 24-hour $PM_{2.5}$ results are calculated as a three-year average based on modeling Alterative D field development and field production sources of air emissions. The scenarios modeled for determining air quality impacts from NO_x emission sources included Tier 2 drill rig operation and multi-well pads with 16 wells in production. For $PM_{2.5}$ emission

sources, the scenario modeled includes the emissions from 4 multi-well pads and access roads under construction, 4 Tier 2 drill rigs operating, and 4, 4-well pads in production. As indicated in T**ables 4.5-14a and 4.5-14b** Alternative D field development source emissions would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance. However, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS.

Tables providing the individual annual modeled 8th highest daily maximum 1-hour NO_2 concentrations and the individual annual modeled maximum 24-hour $PM_{2.5}$ concentrations predicted for all modeling scenarios are presented in Appendix L of the AQTSD, and the results are discussed in AQTSD Section 3.5.4.

In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**.

Note that the emissions from field development activities would be temporary and would not consume PSD increment, and as a result are excluded from increment comparisons.

Additional detail on near-field modeling methods and results is provided in Section 3.5 of the AQTSD.

Table 4.5-14a. Field development sources, criteria pollutant modeling results: 100-meter receptor distance, Alternative D

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m³)	Background (µg/m³)	Total Predicted (µg/m³)	WAAQS (µg/m³)	NAAQS (µg/m³)
4 Tier 2 Drill Rigs	CO	1-hour	585.6	1,026.0	1,611.6	40,000	40,000
		8-hour	311.3	798.0	1,109.3	10,000	10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour	123.5[1]	75.0	198.5	n/a	188
		Annual	23.7	9.1	32.8	100	100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour	125.6[1]	75.0	200.6	n/a	188
		Annual	25.6	9.1	34.7	100	100
4 Tier 2 Drill Rigs	SO_2	1-hour	24.6[2]	19.7	44.3	n/a	196
		3-hour	15.9	11.5	27.4	1,300	1,300
		24-hour	8.2	4.2	12.4	260	365
		Annual	1.2	3.8	5.0	60	80
Multi-Well Pad and Access Road Construction	PM_{10}	24-hour	83.3	56.0	139.3	150	n/a
		Annual	4.9	13.5	18.4	50	50
	$PM_{2.5}$	24-hour	23.9[3]	9.2	33.1	n/a	35
		Annual	3.1	4.2	7.3	n/a	15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rig operation and 2 years with 2 drill rigs operation and 8 wells in production). The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

[2] *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

Table 4.5-14b. Field development sources, criteria pollutant modeling results: 250-meter receptor distance, Alternative D

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
4 Tier 2 Drill Rigs	CO	1-hour	287.5	1,026.0	1,313.5	40,000	40,000
		8-hour	119.3	798.0	917.3	10,000	10,000
16 Well Pad, Tier 2 Drill Rig	NO_2	1-hour	102.0[1]	75.0	177.0	n/a	188
		Annual	12.0	9.1	21.1	100	100
4, 4-Well Pads, 4 Tier 2 Drill Rigs	NO_2	1-hour	101.1[1]	75.0	176.1	n/a	188
		Annual	14.8	9.1	23.9	100	100
4 Tier 2 Drill Rigs	SO_2	1-hour	13.1[2]	19.7	32.8	n/a	196
		3-hour	6.9	11.5	18.4	1,300	1,300
		24-hour	2.8	4.2	7.0	260	365
		Annual	0.5	3.8	4.3	60	80
Multi-Well Pad and Access Road Construction	PM_{10}	24-hour	60.1	56.0	116.1	150	n/a
		Annual	2.5	13.5	16.0	50	50
	$PM_{2.5}$	24-hour	15.8[3]	9.2	25.0	n/a	35
		Annual	1.6	4.2	5.8	n/a	15

[1] *NO_2 1-hour concentrations are calculated as the 3-year average of the 8th highest daily maximum 1-hour concentrations. (16 well pad case includes 2 years of drill rig operation concurrent with 15 wells in production, and 1 year with 16 wells in production, 4, 4-well pad case includes 1 year with 4 drill rig operation and 2 years with 2 drill rigs operation and 8 wells in production). The yearly maximum 8th highest daily maximum 1-hour NO_2 concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

[2] *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

[3] *$PM_{2.5}$ 24-hour concentration calculated using 3-year average of the maximum modeled 24-hour concentrations (includes well pad and access road construction, tier 2 drill rig operation, and well production activities). The yearly maximum 24-hour $PM_{2.5}$ concentrations for all modeled scenarios are provided in Appendix L of the AQTSD.*

The maximum predicted acute and chronic (long-term) HAP impacts from well site production would be similar to the impacts presented in **Section 4.5.4.1** for the Proposed Action. HAP impacts under Alternative D would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single-well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts andAdditional Mitigation**).

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be similar to those for the Proposed Action. Alternative D sources would not contribute to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative D criteria pollutant impacts from project sources and regional sources within and near the CD-C project area would be similar to results shown in **Table 4.5-10** for the Proposed Action. The

cumulative impacts resulting from project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II increments.

AQRV Impacts

Visibility Impacts. Visibility impacts estimated using the FLAG 2010 method at Class I and sensitive Class II areas resulting from Alternative D emissions would be similar to those presented in **Table 4.5-11** for the Proposed Action.

Deposition Impacts. Nitrogen and sulfur deposition impacts under Alternative D would be similar to the impacts for the Proposed Action.

Acidification at Sensitive Lakes. Sensitive lake acidification resulting from nitrogen and sulfur deposition impacts under Alternative D would be similar to the impacts presented for the Proposed Action, where modeling results indicated that there would be no ANC changes at any of the analyzed lakes that exceeded threshold values.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative D sources would be comparable to the emissions estimated for the Proposed Action.

4.5.7.6 Alternative E: No Action

Under the No Action Alternative, it is assumed that no new natural gas wells would be developed. Air pollutant concentration impacts would remain near current levels as a result of existing development.

Near-Field Modeling

There would be no new development under Alternative E (No Action). Therefore there would be no increase in ambient air concentrations and the existing project impacts would be below the NAAQS, WAAQS, and PSD Class II increments. There would be no change in current criteria pollutant and HAP concentrations impacts resulting from existing project area sources.

Far-Field Modeling

Criteria Pollutants Including Ozone. Criteria pollutant impacts would be less than the impacts presented in **Section 4.5.4** for the Proposed Action, since there would be no new sources proposed under Alternative E. The existing CD-C project area sources would not contribute to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant. PSD increments would not be exceeded at any Class I or sensitive Class II areas.

Mid-Field Impacts

Alternative E criteria pollutant impacts from existing project sources and regional sources within and near the CD-C project area are shown in **Table 4.5-15**. The cumulative impacts resulting from existing CD-C project and regional sources would be below the applicable ambient air quality standards and the direct project impacts would be below the PSD Class II increments.

Table 4.5-15. Mid-Field criteria pollutant modeling results, Alternative E

Pollutant	Averaging Time	Modeled Concentration from CD-C Project Sources (µg/m^3)	Modeled Concentration from All Sources (µg/m^3)	PSD Class II Increment[1] (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
CO[4]	1-hour	--	492.7	n/a	40,000	40,000
	8-hour	--	357.6	n/a	10,000	10,000
NO_2	1-hour	47.6	44.1[2]	n/a	n/a	188
	Annual	9.9	11.5	25	100	100
O_3	8-hour	3.3	142.4	n/a	147	147
SO_2	1-hour	0.08	30.8[3]	n/a	n/a	196
	3-hour	0.08	30.0	512	1,300	1,300
	24-hour	0.03	11.3	91	260	365
	Annual	0.01	3.1	20	60	80
PM_{10}	24-hour	1.9	54.9	30	150	n/a
	Annual	0.8	7.4	17	50	50
$PM_{2.5}$	24-hour	1.4	17.9	9	n/a	35
	Annual	0.5	3.7	4	n/a	15

1 *The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis*

2 *NO_2 1-hour concentration is 8th highest daily maximum 1-hour concentration. Value includes contribution from NO.*

3 *SO_2 1-hour concentration is 4th highest daily maximum 1-hour concentration.*

4 *No value is given for the CD-C Project CO concentration contribution because the CAMx source apportionment tool does not track CO.*

AQRV Impacts

Visibility Impacts. Visibility impacts for Alternative E source emissions, estimated using both the FLAG 2010 and BLM methods, would be below the 0.5 Δdv threshold at all of the Class I and sensitive Class II areas analyzed for both the 2005 and 2006 meteorological data. Visibility results are summarized in Section 4.6.1 of the AQTSD.

Deposition Impacts. Modeling results for Alternative E source emissions indicated that there would be no nitrogen or sulfur deposition impacts that exceeded the BLM critical load values at any Class I or sensitive Class II area. Deposition impacts would be below the DAT for all Class I and sensitive Class II areas, with the exception of the Savage Run Wilderness Area, where impacts are above the DAT for nitrogen. Deposition impacts are summarized in Section 4.6.2 of the AQTSD.

Acidification at Sensitive Lakes. Modeling results for Alternative E sources indicated that there would be no ANC changes at any of the 12 analyzed lakes that exceed the 10-percent threshold or the ΔANC<1 µeq/L threshold for the two extremely sensitive lakes. Lake ANC impacts are summarized in Section 4.6.3 of the AQTSD.

Regional Climate Change and Greenhouse Gas Emissions

The maximum greenhouse gas emissions resulting from Alternative E source emissions in year 2022 (the peak emissions year for the Proposed Action and for any of the action alternatives) are estimated at 4.8 tg/yr of CO_2 equivalent emissions. This represents a 0.5 tg/yr reduction in GHG emissions from year 2008 CD-C existing project emissions levels. To place the Alternative E GHG emissions in context, the GHG emissions from the top five emitting coal-fired power plants in Wyoming range from 3 to 15 tg/year (data from <http://epa.gov/climatechange/emissions/ghgdata/-2010data.html>).

4.5.8 Impact Summary

4.5.8.1 Summary of Near-Field Modeling Results

Air pollutant impacts resulting from production activities associated with any of the CD-C Project alternatives over the life of the project would be below the NAAQS and WAAQS, and would not exceed the PSD Class II Increments.

Well field development activities from the Proposed Action and project development alternatives (Alternatives A through D) including well pad construction and well drilling would not result in any exceedances of the NAAQS or WAAQS at the 250-meter distance; however, modeled impacts for the 100-meter receptor distance case did result in short-term concentrations that were predicted to be above the 1-hour NO_2 NAAQS, the 24-hour $PM_{2.5}$ NAAQS, and the 24-hour PM_{10} WAAQS. In order to demonstrate compliance with the NAAQS and WAAQS additional mitigation measures will be required through the application of one or more emission control measures, such as those described in **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**.

There would be no new development under Alternative E (No Action). Therefore there would be no increase in ambient air concentrations and the existing project impacts would be below the NAAQS, WAAQS, and PSD Class II Increments.

The maximum predicted acute and chronic (long-term) HAP impacts from well field production for all project alternatives would be below all applicable REL and RfC exposure thresholds. For the suspected carcinogens (benzene, ethyl benzene, and formaldehyde) the maximum distance required to be below a one-in-one-million cancer risk level for production activities for either the MLE or the MEI analysis would be 1.25 miles as a result of the emissions for a single well pad with 16 wells in production. Mitigation measures for NO_x emissions that will be required to demonstrate compliance with the 1-hour NO_2 NAAQS will also decrease the predicted cancer risk impact for formaldehyde (see **Section 4.5.9 Unavoidable Adverse Impacts and Additional Mitigation**).

4.5.8.2 Summary of Far-Field Modeling Results

Air pollutant emissions resulting from any of the CD-C project alternatives would make no significant contribution to modeled exceedances of the NAAQS, WAAQS, or CAAQS for ozone or any other criteria pollutant in the 2022 future year. The PSD increments would not be exceeded at any Class I or sensitive Class II area within the 4-km domain.

The far-field assessment was performed using the Proposed Action emissions. The impacts resulting from all project development alternatives (Alternatives A through D) would be similar to impacts of the Proposed Action. Under Alternative E (No Action Alternative) there would be no additional impacts to air quality or AQRVs.

For all pollutants except ozone, the modeling results show attainment throughout the 4-km domain except in the immediate vicinity of point sources unrelated to the CD-C project sources. Modeled exceedances of the CO, PM_{10} and $PM_{2.5}$ standards are the result of impacts from a 2005 fire in Lincoln County, and the lone SO_2 exceedance is highly localized and due to emissions from a Fremont County source. An ozone exceedance occurs at Boulder, Colorado, where CD-C has no significant contribution to ozone concentrations.

Examination of the spatial scale and magnitude of the CD-C project contribution to criteria pollutant concentrations within the 4-km grid shows that exceedances of the ambient air quality standards in the 2022 future year modeling would not be related to emissions from the CD-C project.

The MATS-estimated maximum impact of the CD-C project on the 2022 future year 8-hour ozone Design Value is less than or equal to 0.8 ppb for both meteorological years. The two-year approximation to a 2022 design value obtained using absolute model concentrations shows the CD-C project maximum

ozone impact would be 1.6 ppb. For both the absolute modeled concentration and MATS results, the largest ozone impacts due to the CD-C project emissions would be in the vicinity of the project area. In Sublette County, where the only modeled exceedances of the 75 ppb NAAQS occurred, ozone impacts due to the CD-C project would be less than or equal to 0.04 ppb. The highest CD-C ozone contributions to ozone at Southwest Wyoming monitors would occur on days when modeled regional 8-hour ozone was low (<60 ppb).

The visibility analysis showed 1 to 5 days with CD-C project visibility impacts greater than 0.5 dv at Class I and sensitive Class II areas over the course of the 2-year simulation of the future year emissions scenario. The simulation showed 1 day with CD-C project visibility impacts >1.0 dv during this period. The largest visibility impacts would occur at the Savage Run, Dinosaur, and Mount Zirkel areas. No other Class I or sensitive Class II areas had any day with visibility impacts >0.5 dv as a result of the CD-C project emissions.

There would be no nitrogen or sulfur deposition impacts from any of the CD-C project alternatives exceeding BLM critical load values at any Class I/sensitive Class II areas; however, the DAT for nitrogen could be exceeded at several Class I areas near or downwind of the project area under the Proposed Action and action alternatives.

There would be no ANC changes exceeding the 10-percent threshold or sensitive lake impacts where ΔANC<1 μeq/L due to emissions from any of the CD-C project alternatives.

4.5.9 Unavoidable Adverse Impacts and Additional Mitigation Measures

Substantial mitigation of air quality impacts from CD-C project NO_x, CO, PM_{10}, $PM_{2.5}$, VOC, and HAP emissions would be achieved by the uniform application of WDEQ BACT and the Presumptive BACT permitting requirements following the WDEQ Oil and Gas Permitting Guidance. The Operators' commitment to use only Tier 2 or better drill rigs (**Section 2.2.1.7 Operator-Committed Practices**) would further mitigate project impacts, reducing emissions of NO_x, CO, PM_{10}, $PM_{2.5}$, and VOCs.

Additional mitigation of predicted air quality impacts could be implemented by the following control measures:

- Use of Tier 4 or equivalent drill rig engines, reducing NO_x, CO, PM_{10}, $PM_{2.5}$, and VOC emissions.
- Use of Tier 2 or better construction equipment, reducing NO_x, CO, PM_{10}, $PM_{2.5}$, and VOC emissions.
- Application of chemical suppressant on unpaved roads and additional watering during construction activities to minimize fugitive dust, reducing particulate (PM_{10} and $PM_{2.5}$) impacts.
- Centralization of well pad production facilities (e.g., heaters, flares, dehydration units), reducing NO_x, CO, PM_{10}, $PM_{2.5}$, VOC, and HAP emissions and reducing truck traffic.
- Field electrification, reducing NO_x, CO, PM_{10}, $PM_{2.5}$, and VOC emissions.

These and other mitigation options or control measures may already be in practice in the CD-C project area to varying degrees. The reduction in emissions brought about by application of any of these measures could be estimated with additional modeling based on more detailed descriptions of the actual drilling and production processes used by the Operators. However, additional and more detailed information related to those practices would be needed from the Operators. This information will be gathered, and additional modeling analyses will be performed, during preparation of the FEIS. The results of the revised modeling analyses based on the selection of mitigation measures will be presented in the FEIS. Mitigation measures determined to be necessary to demonstrate compliance with the applicable NAAQS and WAAQS, as predicted in the revised modeling analyses, will be a required condition in the Record of Decision.

■ BIOLOGICAL ENVIRONMENT

4.6 VEGETATION

4.6.1 Introduction

Direct impacts to existing native shrub/grassland communities on the CD-C project area resulting from project implementation include a short-term reduction of herbaceous vegetation and a long-term loss of shrubs due to soil disturbance and related construction activities. Indirect impacts to the vegetation resource may occur as a result of damage to biological soil crusts (BSCs); soil compaction; mixing of soil horizons; loss of topsoil productivity; increased soil-surface exposure; soil loss due to wind and water erosion; short- to long-term increased potential for invasive weed introduction and establishment; shifts in plant species composition and density; a potential reduction of livestock, wild-horse, and wildlife habitat quantity and/or quality; and changes in visual aesthetics.

4.6.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes management objectives associated with vegetation. Those applicable to the CD-C project are:

1. Maintain, restore, and enhance vegetation communities to facilitate a healthy mix of successional stages (identified in activity plans) that incorporate age class, structure, and species composition into each vegetation type, consistent with site potential.
2. Control the introduction and proliferation of noxious and invasive species and reduce established populations to acceptable levels determined through cooperation, consultation, and coordination with local, state, other federal plans, policies, and agency agreements.
3. Maintain, restore, and enhance the health and diversity of plant communities through the use of management prescriptions (such as prescribed natural fire, burning, planting, seeding, and chemical, mechanical, biological, and grazing treatments or other treatments) in coordination with local, state, and federal management plans and policies.
4. Maintain, restore, and enhance riparian, wetland, and upland vegetation to meet the Wyoming Standards for Healthy Rangelands.
5. Maintain, restore, and enhance Special Status Plant Species (Threatened, Endangered, and BLM State Sensitive plant species) and unique plant communities.
6. Utilize inventory and monitoring data to support vegetation management.
7. Maintain connectivity between large, contiguous blocks of federal land by minimizing fragmentation of vegetative communities.

The following criteria were considered in the assessment of impacts associated with the Proposed Action and alternatives and are the same as those contained in the Rawlins RMP FEIS (BLM 2008b). The impact on vegetation would be considered significant if any of the following were to occur:

1. Any action or event that would remove a community's unique attributes or ability to support other resource values within the planning period, or corrective actions that were beyond the scope of this document.
2. The viability of protected plant species is jeopardized, with little likelihood of reestablishment after disturbance, or actions result in the need to list a species under the ESA.
3. Actions that have the potential to remove sensitive plant species or substantially alter the habitat's ability to support the species.

4. Reclaimed areas do not attain adequate vegetation groundcover and species composition to stabilize the site within five years from disturbance, or there is invasion and establishment of noxious or invasive weeds that contribute to unsuccessful reclamation.
5. Introduction of noxious and invasive weeds into areas considered weed-free, or an increase in weeds where they already exist.

4.6.3 Direct and Indirect Impacts

Direct impacts to the vegetation resource would principally occur during the construction phase of the proposed project and would include removal of existing native vegetation and removal of topsoil and BSCs. To some extent, these impacts could be mitigated by successful implementation of reclamation practices, but about 40 percent of the disturbance would remain in an unvegetated state for the life of the project—30 to 50 years at each individual well site—while in use for access roads and well pad facilities. The remaining 60 percent would have reduced productivity while reclamation is in progress and would have an altered species composition and density for the life of the project and beyond, including a long-term loss of shrubs.

Vegetation could be impacted indirectly as a result of soil and BSC compaction, mixing of soil horizons, loss of topsoil productivity, and increased soil-surface exposure resulting in soil loss due to wind and water erosion. Other indirect impacts could occur as a result of altered runoff hydrology due to roads, well pads, and other facilities, particularly on moderate to steep slopes. These sites reduce natural runoff to downslope locations and increase channelization of flows and gullying, which results in desertification effects including a lower water table, lower productivity and cover, and altered species composition below these facilities.

Additional indirect impacts would occur due to deposition of dust on vegetation near roads and construction sites, reducing plant productivity and vitality. The increased surface disturbance as a result of project implementation would also provide opportunities for invasive plant species to establish and spread (See **Section 4.7 Invasive, Non-Native Plant Species**).

4.6.3.1 Proposed Action

Under the Proposed Action (**Section 2.2.1**), 8,950 new natural gas wells and construction of required ancillary facilities would be anticipated over the course of 15 years (development phase) within the project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. Over the estimated 10- to 15-year development phase, the Proposed Action is estimated to initially disturb a total of 47,200 surface acres (**Table 4.0-1**), which represents about 4.4 percent of the total land surface of the project area. During the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres depending upon time required for successful reclamation, future land uses, and future climatic conditions. Construction and installation of well pads, access roads, and ancillary facilities (compressors, pipelines, and other required features.) would directly reduce the extent of vegetation cover types.

In addition to the 47,200 acres initially disturbed by implementation of the Proposed Action, an estimated 60,176 historic disturbance acres already exist within the project area (**Table 4.0-1**). The addition of historic disturbance to Proposed Action disturbance would result in a grand total of 107,376 acres or about 10 percent of the total project area. Much of that earlier disturbance remains unvegetated and in use, an estimated 17,663 acres. Together with long-term disturbance from the Proposed Action, up to 36,524 acres, or about 3.4 percent of the total project area would remain in an unvegetated state.

The time required to achieve successful reclamation of disturbed areas is largely dependent upon Operator commitment, compliance with BLM reclamation guidelines and recommendations, future land uses, and environmental variables, especially the timing and amount of precipitation events. This would hold true for reclamation of herbaceous species, but not necessarily for native shrub establishment, especially in the

more xeric portions of the project area—approximately 590,272 acres, representing about 55 percent of the project's land surface area—where Wyoming big sagebrush and saltbush flats and fans are the primary cover types (**Table 3.6-1**).

The majority of development would likely occur in the Wyoming big sagebrush, greasewood flats and fans, and saltbush flats and fans primary cover types, which collectively occupy about 78 percent (**Table 3.6-1**) of the project's land surface area. Wyoming big sagebrush plant communities typically occur on sites with low precipitation and poor soil development, which increases the difficulty of reclamation and makes it likely that only initial shrub re-establishment would occupy disturbed sites during the estimated 45- to 55-year life of the project. Greasewood communities occupy about 246,000 acres (Table 3.6-1) within the project area. They are primarily located within the Muddy Creek drainage in the southern portion of the project area and within several large greasewood-dominated flats in the Red Desert Basin area in the northern portion of the project area. These flats usually have clayey soils with a high salt content which increases the difficulty of reclamation. The saltbush flats and fans cover type occupies about 173,000 acres within the project area. This primary cover type is found on saline soils in small to large openings or can occur as "stringer" inclusions within the ATW or greasewood primary cover types. These saltbush stands are sparsely vegetated and bare soil often exceeds 60 percent of the total ground cover. Reclamation of saltbush/mixed desert-shrub cover type habitats can be difficult and the use of seed mixes with appropriate native, saline, and drought-tolerant plant species is mandatory. The ability to re-establish native vegetation on sensitive soil types (i.e., clayey, sandy, saline/sodic) is not well-documented in this area of Wyoming. Although current technology exists to stabilize these areas and minimize soil erosion as revegetation is being carried out, there is currently a lack of local seed sources for native forb and shrub species, and the recovery rate to restore native shrubs such as saltbush and shadscale to their pre-existing condition is unknown.

Due to the scarcity of wetland/riparian sites in the project area, the probability of well pads, roads, pipelines, and ancillary facilities impacting these resources is low. The Rawlins RMP (BLM 2008a) specifies that a 500-foot buffer be maintained around perennial waters, springs, wells, wetlands, and areas within 100 feet of the inner gorge of ephemeral channels be avoided. These restrictions not only protect perennial water sources and wetland/riparian sites, but basin big sagebrush sites which are often located in or adjacent to ephemeral drainages that provide pygmy rabbit habitat and serve as mid-summer Greater sage-grouse foraging areas. In addition, an applicable Nationwide Permit as authorized by Section 404 of the Clean Water Act would be required from the U.S. Army Corps of Engineers, Wyoming Regulatory Office, for any disturbance activities in wetlands or Waters of the U.S. The probability of removing wetland vegetation or disturbing any Waters of the U.S. is low due to their low occurrence within the project area and existing stringent federal and state laws and regulations providing for their protection.

In general, in addition to the initial area of disturbance, the extent of impacts to all vegetation cover types would be influenced by the success of mitigation and reclamation efforts and the time period required for disturbed areas to return to pre-existing conditions. Reclamation success depends, in part, on the quality of topsoil salvaged, stockpile/redistribution methods in disturbed areas, precipitation, appropriate seed mixes, soil type(s), and soil pre-seeding preparation and moisture availability.

In March 2011, the RFO issued reclamation guidelines for its management area (Instruction Memorandum [IM] WYD-03-2011-002). The guidelines provide direction for implementing the reclamation requirements of the Rawlins RMP and the Wyoming BLM Reclamation Policy (IM WY-2009-022). The reclamation requirements of the RMP are found in Appendix 36 of that document and essentially require a site-specific reclamation plan for any surface-disturbing activity and annual monitoring and reporting of reclamation status. A full description of the new RFO reclamation guidelines and recommendations can be found in **Appendix E** and at <http://www.blm.gov/wy/st/en/field_offices/Rawlins/reclamation.html>.

Indirect impacts to vegetation due to dust from unpaved roads would be variable throughout the project area, depending upon the primary factors cited in **Section 3.6.4, Fugitive Dust Effects on Vegetation Health**.

Project operations could result in increased traffic in the project area with an increased potential to create fugitive dust that could affect vegetation quality and quantity as well as general plant health. Specific plant communities would experience varying degrees of impact depending on location, general abundance, browse use, topography, site reclamation potential, soil type, and precipitation regime. Recommendations to mitigate dust impacts to vegetation and long-term loss of sagebrush habitat would include constructing roads to a 95-percent compaction rating, and instituting an effective dust-suppression program using water and/or periodic applications of BLM-approved dust-suppression chemicals to more heavily traveled roads.

4.6.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the vegetation resource resulting from implementation of Alternative A would be similar to the Proposed Action with the notable exception that the total amount of initial disturbance would increase from 47,200 acres to 61,696 acres, or 31 percent. Long-term disturbance following successful reclamation would increase from a total of 18,861 acres to 24,133 acres. Combined with the present historic disturbed acres, the grand total of disturbance as a result of Alternative A would be 121,872 acres of initial disturbance and 41,796 long-term acres, assuming successful reclamation.

Implementation of Alternative A would affect a greater proportion of the vegetation resource due to the larger area of surface disturbance associated with additional well pads and their associated access road and pipeline rights-of-way. In addition, construction activities, increased soil-surface disturbance, and higher traffic volumes associated with Alternative A would likely increase the potential for the introduction and spread of invasive weed species and increase the total fugitive dust load within the project area.

4.6.3.3 Alternative B: Enhanced Resource Protection

Alternative B (**Section 2.2.3**) identifies those resources that may be more at risk from natural gas development and provides enhanced protections and mitigations for those resources. Alternative B also recognizes that development may be more intensive than currently expected and may result in impacts that occur faster than anticipated. This alternative would combine a prescriptive and adaptive management approach, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. The enhanced resource protections would go into effect immediately and be applied to all future APDs.

Under Alternative B, the types of impacts to the vegetation resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the initial disturbance would encompass 45,516 acres, an approximate 4-percent reduction from the Proposed Action, due largely to an increase in the amount of directional drilling. Assuming successful reclamation efforts, long-term disturbance would decrease to 18,249 acres, a reduction of 612 acres compared to the Proposed Action. Factoring in the existing historic disturbance with future disturbance results in a grand total of 105,692 acres of initial disturbance and 35,912 acres of long-term disturbance.

Although no vegetation communities are specifically targeted in Alternative B, measures that are aimed at protecting wildlife, riparian, and aquatic habitats and minimizing surface disturbance and dust produced by project activity would all benefit vegetation communities. Indirect effects of fugitive dust on sensitive vegetation in or near riparian areas and aquatic habitats are anticipated to be low to none. Avoidance of

riparian and aquatic sites (including playas) is an RMP requirement (BLM 2008b). Consequently, most roads and permanent ancillary structures would be constructed outside the 500-foot perennial water buffer and/or the 100-foot ephemeral drainage buffer previously discussed, thus reducing the fugitive dust load in/near these habitats.

4.6.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), the types of impacts to the vegetation resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**). For this alternative, the scope and intensity of the impacts would be less widespread because of the surface-disturbance caps on unreclaimed areas. Maximum surface disturbance for this alternative would represent a decrease of 4,245 acres of initial disturbance and 1,543 acres of long-term disturbance (4 percent and 1.6 percent of the project area, respectively) compared to the Proposed Action.

Under Alternative C, fewer well locations (approximately 5,300) would be developed. Therefore, fewer access roads would be developed and habitat fragmentation would be less extensive than under the Proposed Action. If development were to occur in the majority of undeveloped areas according to current spacing orders (160-acre well spacing, or four wells per section), then vegetation impacts in these areas that support large tracts of continuous shrub-steppe habitat types would be less than the Proposed Action. If, on the other hand, future development in these areas were to occur at greater densities (80- or 40-acre well spacing), then effects on vegetation would be greater than under the Proposed Action (**Section 4.6.3.1**).

4.6.3.5 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), the types of impacts to the vegetation resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the scope and intensity of the impacts would be less widespread because of the expected reduction in surface disturbance. Estimated initial surface disturbance for this alternative would be approximately 36,449 acres, a decrease of 10,751 acres (23 percent) from the Proposed Action (**Table 2.4-1).** The estimated 14,952 acres of long-term disturbance would be 3,909 acres less than the Proposed Action. The implementation of Alternative D would reduce the number of well locations developed to an estimated 4,032 compared to the estimated 6,126 for the Proposed Action. In addition to not disturbing almost 11,000 acres of native herbaceous and woody vegetation, the 35-percent reduction in well locations associated with this alternative would likely lead to similar reductions in the number of access roads and road miles which would reduce the total fugitive dust load on nearby forage thus increasing its palatability to wildlife and livestock (depending upon the primary factors cited in **Section 3.6.4, Fugitive Dust Effects on Vegetation Health**). Healthy, undisturbed rangeland vegetation is recognized by range managers as the best natural defense against invasive-plant establishment and soil loss due to wind and water erosion.

4.6.3.6 Alternative E: No Action

Under the No Action Alternative, there would be no new disturbance to the vegetation resource.

4.6.4 Impact Summary

Direct impacts to existing native shrub/grassland communities within the CD-C project area would be similar under the Proposed Action and all alternatives—an initial reduction of herbaceous vegetation and a long-term loss of shrubs due to soil disturbance and related construction activities. Indirect impacts to the vegetation resource would also be similar under the Proposed Action and all action alternatives. The principal difference in impacts for each alternative is related to the amount of surface disturbance that would occur for each. The Proposed Action would initially disturb 47,200 acres. Alternative A would increase surface disturbance by 31 percent to 61,696 acres. Alternatives B, C, and D would each decrease surface disturbance and hence impacts to vegetation communities: Alternative B by about 4 percent to

45,516 acres, Alternative C by 9 percent to 42,955 acres, and Alternative D by 23 percent to 36,449 acres. Alternative E, because it would have no new development, would not add to surface disturbance. Surface disturbance for the Proposed Action and each alternative would be in addition to 60,176 acres of historic surface disturbance in the project area. **Table 4.0-1** shows in detail the historic and anticipated surface disturbance figures for the Proposed Action and the alternatives.

After initial disturbance, approximately 40 percent of the disturbance would remain in an unvegetated state for the life of the project and the other 60 percent would undergo interim reclamation. Long-term disturbance by action alternative ranges from a high of 24,133 acres for Alternative A to a low of 14,952 acres for Alternative D. The degree of long-term impact on vegetation by any of the alternatives would depend on the success of reclamation. That in turn would depend upon compliance with current BLM reclamation guidelines and recommendations, future land uses, and future climatic conditions. This would be true for reclamation of the faster-growing herbaceous species, but not necessarily for slow-growing shrubs such as Wyoming big sagebrush and Gardner's saltbush that are located in the more xeric portions of the project area. **Appendix E** describes the process by which the BLM intends to direct reclamation efforts and monitor the progress of reclamation.

Initial impacts to the vegetation resource from the action alternatives would include removal of native shrub species and associated understory herbaceous cover, thus decreasing abundance of these native species. Long-term impacts would be positive, assuming successful revegetation of BLM-approved seed mixes which would provide a younger, more vigorous and nutritious food source for wildlife, livestock, and wild horses on reclaimed areas.

4.6.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Vegetation cover would be unavoidably lost on a short-term basis as a result of the surface disturbance related to construction of well sites and associated facilities on public, state, and private lands within the CD-C project area. The losses would be in addition to historical losses of vegetation from prior surface disturbance, together representing 10 percent or more of the surface of the CD-C project area. For the intermediate to long term, grasses and other herbaceous vegetation would recover with the successful implementation of the BLM reclamation guidelines and recommendations described in **Appendix E**. Because of the extended time needed for the recovery of shrubs and other woody vegetation, a long-term loss of such vegetation is unavoidable. No additional mitigation measures beyond those described in **Appendix C** and Appendix E would mitigate these impacts to the vegetation resource. Those alternatives that most reduce surface disturbance—Alternatives C and D—would minimize both the short- and long-term loss of vegetation. Project operations could result in increased traffic in the project area with an increased potential to create fugitive dust that could affect vegetation quality and quantity as well as general plant health. Recommendations to mitigate dust impacts to vegetation would include constructing roads to a 95-percent compaction rating, and instituting an effective dust-suppression program using water and/or periodic applications of BLM-approved dust-suppression chemicals to more heavily traveled roads.

4.7 INVASIVE, NON-NATIVE PLANT SPECIES

4.7.1 Introduction

Impacts to vegetation and rangeland resources due to the infestation and establishment of invasive weeds would result with the implementation of all alternatives. Impacts would be the greatest during the development phase of the action alternatives but would occur throughout the life of the project due to vegetation and soil disturbance associated with energy-related activities such as road construction and maintenance, pipeline installation, and installation of ancillary facilities.

4.7.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes management objectives associated with vegetation (**Section 4.6.2**). Objective 2 applies specifically to invasive, non-native plant species:

1. Control the introduction and proliferation of noxious and invasive species and reduce established populations to acceptable levels determined through cooperation, consultation, and coordination with local, state, other federal plans, policies, and agency agreements.

Impacts due to invasive weed species would be considered significant if the following were to occur:

1. Introduction of invasive weeds into areas considered weed-free, or an increase in invasive weed density where infestations already exist, to include both upland and wetland/riparian sites.
2. An increase in invasive weeds in any grazing allotment that reduces or eliminates the opportunity to run the livestock of choice.
3. The criteria for Wyoming BLM Standards for Healthy Rangelands cannot be met in any grazing allotment due to invasive weed infestations.
4. Non-compliance with long-term reclamation standards and goals for energy-related disturbed sites.
5. Non-compliance with current BLM reclamation guidelines and recommendations (**Appendix E**), or Appendix 36 of the Rawlins RMP (2008b) due to establishment of and failure to control invasive weeds that contribute to non-attainment of these long-term standards and goals.

4.7.3 Direct and Indirect Impacts

Impacts to vegetation and range resources would occur on public lands under the Proposed Action and all action alternatives due to an increase in surface disturbance, which could provide more suitable habitat for invasive weed infestations.

The existing infestation of halogeton and other invasive species described in **Section 3.7** may be increased by project activities. Vehicles and equipment traveling from weed-infested areas, within and outside the project area, could facilitate the spread of invasive weeds into previously weed-free areas in addition to facilitating the spread of seeds of existing invasive populations. Additional surface-disturbing activities would increase the potential for infestation and spread of invasive plant species. Invasive weed species usually thrive on newly disturbed surfaces and out-compete native plant species. Creation of new sites for weed infestations may occur in proximity to roads where fugitive-dust deposition on roadside plants reduces their density due to chronic diseases in photosynthesis and growth, thus providing a suitable habitat for invasive plants to establish.

Annual production of livestock/wildlife forage could also be impacted through the spread of invasive weeds. The introduction, establishment, and spread of these species would reduce rangeland and forage quantity and quality by replacing preferred forage species, leading to a reduction in grazing capacity, and could lead to a greater amount of RFO rangeland acreage not meeting the national and Wyoming BLM Standards and Guidelines for Healthy Rangelands (BLM 1997).

Without proper management and control, invasive plant species may cause widespread infestations. Additionally, some invasive species such as halogeton, black henbane, and houndstongue are poisonous and can kill or impair livestock if ingested.

The continued establishment and spread of halogeton, an invasive, poisonous plant, due to energy-related activities, could lead to an increase in livestock (especially sheep) mortality. This could result in the reduction or elimination of the opportunity to run the livestock of choice, which would be a significant impact. Project implementation would increase the potential for increased invasive plant density in the project area as a result of increased surface disturbance. The potential for increased invasive weed infestation would be the greatest on project-related disturbances but would also likely occur on the 56,647

historic existing disturbed acres due to natural dissemination of seeds, whether by wind, humans, wildlife, or livestock.

As detailed in the Rawlins RMP, Appendix 36 (2008b), the Operators would be responsible for the management and control of all invasive weed species on or related to project-related surface disturbances during the life of the project and would follow an approved BLM Pesticide Use Proposal (PUP) and reporting requirements.

4.7.3.1 Proposed Action

Implementation of the Proposed Action (**Section 2.2.1**) would increase the potential for increased invasive plant density on the project area as a direct result of increased surface disturbance. Construction and installation of well pads, access roads, and ancillary facilities (compressors, pipelines, and other infrastructure) would remove soil and vegetation. Invasive weed species usually thrive on newly disturbed surfaces such as road and pipeline rights-of-way and out-compete the more desirable native plant species. Under the Proposed Action, 8,950 new natural gas wells and construction of required ancillary facilities would be anticipated over the course of 15 years (development phase) within the project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. Over the estimated 10- to 15-year development phase, the Proposed Action is estimated to initially disturb a total of 47,200 surface acres, which represents about 4.4 percent of the total land surface of the project area. During the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres depending upon time required for successful reclamation, future land uses, and future climatic conditions.

In addition to the 47,200 acres initially disturbed by implementation of the Proposed Action, an estimated 60,176 acres of historic initial disturbance already exist within the project area (**Table 4.0-1**). The addition of this historic disturbance to new disturbance from the Proposed Action would result in a grand total of 107,376 acres of initial disturbance, or about 10 percent of the total project area. Much of that earlier disturbance (an estimated 17,663 acres) remains unvegetated and in use. Together with the CD-C project long-term disturbance, up to 36,524 acres, or about 3.4 percent of the total land surface of the project area, would remain in an unvegetated state.

The potential for increased invasive weed infestations would be the greatest on project-related disturbances but would also likely occur on the 60,176 acres of historic existing disturbance due to natural dissemination of seeds by wind, humans, wildlife, or livestock.

4.7.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the vegetation resource resulting from implementation of Alternative A would be similar to the Proposed Action with the notable exception that the total amount of short-term disturbed acres would increase from a total of 47,200 acres (Proposed Action) to 61,696 acres (Alternative A) and the long-term disturbed acres following successful reclamation would increase from a total of 18,861 acres (Proposed Action) to 24,133 acres (Alternative A). Combined with the present historic disturbed acres, the grand total of disturbed acres as a result of Alternative A would be 121,872 acres of initial disturbance and 41,796 acres of long-term disturbance, assuming successful reclamation.

Impacts on the spread of invasive plant species would be similar to the Proposed Action but Alternative A would be more likely to affect a greater proportion of the vegetation resource due to the larger area of surface disturbance from additional well pads and their associated access road and pipeline rights-of-way. In addition, construction activities, increased soil-surface disturbance, and higher traffic volumes associated with Alternative A would increase the potential for introduction and spread of invasive weed species within the project area.

4.7.3.3 Alternative B: Enhanced Resource Protection

Alternative B (**Section 2.2.3**) identifies those resources that may be more at risk from natural gas development and provides enhanced protections and mitigations for those resources. Alternative B also recognizes that development may be more intensive than currently expected and may result in impacts that occur faster than anticipated. This alternative would combine a prescriptive and adaptive management approach, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. The enhanced resource protections would go into effect immediately and be applied to all future APDs.

Under Alternative B, impacts from the spread of invasive plant species would be similar to the Proposed Action (**Section 4.6.3.1**) but the alternative would create slightly less risk of infestation due to the diminished area of surface disturbance associated with a slight increase in directional drilling. The short-term disturbance acres would be 45,516 acres, an approximate 4 percent reduction from the Proposed Action, due largely to an increase in the amount of directional drilling. Assuming successful reclamation efforts, the long-term disturbance would decrease to 18,249 acres, a reduction of 612 acres. Factoring in the existing historic disturbance acres with future short-term disturbance results in a grand total of 105,692 acres of initial disturbance and 35,912 acres of long-term disturbance.

4.7.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), impacts on the spread of invasive plant species would be similar to the Proposed Action (**Section 4.6.3.1**) but implementation of the alternative would affect a smaller proportion of the project area due to the reduced surface disturbance associated with the anticipated increase in directional drilling. The scope and intensity of the impacts would be less widespread because of the surface-disturbance caps on unreclaimed areas. Maximum surface disturbance for this alternative would be decreased initially by 4,245 acres and 1,543 acres in the long term (4 percent and 1.6 percent of the project area, respectively) when compared to the Proposed Action.

With this alternative, fewer well locations (approximately 5,300) would be developed. Therefore fewer access roads would be developed and habitat fragmentation would be less extensive than the Proposed Action. If development were to occur in the majority of undeveloped areas according to current spacing orders (160-acre well spacing, or 4 wells per section), then invasive weed impacts in these areas would be less than the Proposed Action. If on the other hand, future development in these areas were to occur at greater densities (80- or 40-acre well spacing), then effects of invasive weeds would be greater than the Proposed Action (**Section 4.6.3.1**).

4.7.3.5 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), impacts from the spread of invasive plant species would be similar to the Proposed Action (**Section 4.6.3.1**) but implementation of this alternative would affect a smaller proportion of the project area due to the reduced surface disturbance associated with the anticipated increase in directional drilling (**Table 2.4-1**). The scope and intensity of the impacts would be less widespread because of the reduced density of new surface-disturbing activities per section.

Estimated initial surface disturbance for this alternative would be approximately 36,449 acres, a decrease of 10,751 acres (23 percent) from the Proposed Action. With this alternative there would be fewer well locations developed—an estimated 4,032 compared to the 6,126 estimated for the Proposed Action. Compared to the Proposed Action, this alternative would reduce surface disturbance by almost 11,000 acres (17 sections) of potential new habitat for invasive plants. The 35-percent reduction in well locations associated with this alternative would likely lead to similar reductions in the number of access roads and road miles which often serve as primary dispersal corridors for invasive plant seeds. The reduction of road miles would also decrease total fugitive dust load to roadside vegetation which would be beneficial

to the prevention of weedy annual establishment (see **Section 3.6.4, Fugitive Dust Effects on Vegetation Health**).

4.7.3.6 Alternative E: No Action

Under the No Action Alternative, there would be no new disturbance except where APDs have been approved by the BLM for previously authorized activities. There would be no risk of direct infestation by invasive plant species as a result of this project, but infestations could still occur because of existing infestations.

4.7.4 Impact Summary

The risk of the infestation and spread of invasive plant species within the CD-C project area would be similar under the Proposed Action and all alternatives as initial surface disturbance would create opportunities for invasive species and development activity would increase the degree to which such species spread throughout the project area. The principal difference in impacts for each action alternative is related to the amount of surface disturbance that would initially occur for each. The Proposed Action would initially disturb 47,200 acres. Alternative A would increase surface disturbance by 31 percent to 61,696 acres. Alternatives B, C, and D would each decrease surface disturbance and hence impacts from the spread of invasive species: Alternative B by approximately 4 percent to 45,516 acres, Alternative C by 9 percent to 42,955 acres, and Alternative D by 23 percent to 36,449 acres. Surface disturbance for the Proposed Action and each alternative would be in addition to the 60,176 acres of historic surface disturbance in the project area. **Table 4.0-1** shows in detail the historic and anticipated surface disturbance figures for the Proposed Action and the alternatives.

After initial disturbance, approximately 40 percent of the disturbance would remain in an unvegetated state for the life of the project and the other 60 percent would undergo interim reclamation. Long-term disturbance by alternative ranges from a high of 24,133 acres for Alternative A to a low of 14,952 acres for Alternative D. The degree of long-term impact on vegetation by any of the alternatives would depend on the success of timely reclamation which in turn would depend upon compliance with current RFO reclamation guidelines and recommendations, future land uses, and future climatic conditions. As discussed in the RMP, Appendix 36 (2008a), the Operators would be responsible for the management and control of all invasive weed species related to project-related surface disturbances during the life of the project and would follow an approved BLM Pesticide Use Proposal (PUP) and reporting requirements.

Chenoweth *et al*. (2010) recently completed a cost analysis for Pioneer Natural Resources in the Raton Basin (Trinidad, CO) and Encana Oil and Gas (Piceance Basin, CO) and concluded that estimated costs of proper site reclamation techniques between the two companies averaged about $16,125 to $22,589 per acre depending upon slope steepness. They also concluded that direct and indirect costs for reclamation failures varied between $20,070 and $43,000 per acre. It is evident that cost on reclamation failure sites can be more than twice the cost of initial proper reclamation, depending on severity of site degradation. It is imperative that Operators understand the importance of minimizing initial surface disturbance and re-establishing a competitive grass/forb cover as soon as feasible after disturbance to prevent successful establishment of invasive weeds at the site.

4.7.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Assuming construction, maintenance, and operation of well sites and associated disturbances on public, state, and private lands within the CD-C project area are in accordance with the BMPs and COAs described in **Appendix C** and assuming successful implementation of BLM reclamation guidelines and recommendations described in **Appendix E**, the infestation and spread of invasive plant species would be contained and there would be no long-term adverse impacts. Only one additional mitigation measure may be warranted:

- To prevent the inadvertent introduction of invasive weeds, the Operators and their sub-contractors would thoroughly power-wash all field vehicles, particularly their undercarriages, before entering the project area.

4.8 WILDLIFE

4.8.1 Introduction

The primary wildlife impacts likely to result from the Proposed Action or alternatives include (1) direct and indirect loss of wildlife habitats, (2) displacement of some wildlife species because of increased human access and activity, (3) an increase in the potential for collisions between wildlife and motor vehicles, (4) an increase in stress to wildlife and (5) disruption of life-history requirements of a species or population segment.

The primary wildlife resources of interest within the project area include big game CWRs; big game migration routes; overlapping crucial habitats (multiple species); raptor nests; small mammals and neotropical birds; and upland game birds. A number of wildlife species, such as sage-grouse and mountain plover, are discussed in **Section 4.9, Special Status Species.**

4.8.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008b) prescribes the following management objectives associated with wildlife and fisheries resources (including Special Status Species):

- Maintain, restore, or enhance wildlife habitat in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements. A full range of mitigation options will be considered when developing mitigation for project-level activities for wildlife and Special Status Species habitats.
- Maintain, restore, or enhance T&E species habitat, in coordination and consultation with the USFWS and other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance designated BLM State Sensitive Species habitat to prevent listing under the ESA, in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance habitat function in crucial winter range.

The following criteria were considered in the assessment of impacts associated with the Proposed Action and alternatives and are from the Rawlins RMP FEIS (BLM 2008a). Impacts to wildlife and fish would be considered significant if any of the following were to occur:

1. Substantial loss of the biological integrity and habitat function of terrestrial and aquatic ecosystems that would make a species eligible for listing under the ESA.
2. Management actions that result in substantial disruption or irreplaceable loss of vital and high-value habitats as defined in the Wyoming Game and Fish Commission Mitigation Policy (WGFD 2010a). The policy classifies big game crucial ranges as vital habitat and recommends that habitat function be maintained so that the location, essential features, and species supported by the habitat are unchanged. The policy also defines *Moderate*, *High*, and *Extreme* impact thresholds, of which *High* and *Extreme* impacts will be judged significant.

Additionally, the RFO has determined that the following significance criterion should be included for this project:

3. Any effect, whether direct or indirect, that results in long-term decreases in recruitment and/or survival rates for fish populations.

4.8.3 Direct and Indirect Impacts

4.8.3.1 Proposed Action

The proposed natural gas development would disturb and alter approximately 47,200 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres previously disturbed by natural gas and other development. Reclamation of disturbed habitats would commence immediately and continue throughout the 15-year construction period, resulting in recovery of 18,861 acres of grass-dominated habitat (in one to several years, depending on precipitation and effectiveness of reclamation efforts). Recovery of shrubs to pre-disturbance levels would not occur during the life of the project. As indicated in **Section 4.0.3**, future project surface disturbance is most likely to occur in areas with already moderate to high development as previously developed areas are "filled-in" to the expected 40-acre spacing (16 wells per section). However, some amount of development and surface disturbance can be expected throughout the project area. Depending on the well-spacing orders in an area and the degree to which directional drilling is used, disturbance per section could vary from as low as ten acres (four wells per section, all directionally drilled from one pad) to as high as 100 acres (16 wells, all vertically drilled from individual pads). The 160-acre well spacing orders designated for the undeveloped areas of the project area indicate an expectation of disturbance at the lower end of that spectrum. However, if spacing were to be reduced in any of those areas, the amount of disturbance per section would increase.

Standard environmental protection measures prescribed as Conditions of Approval or used as BMPs (**Appendix C**) would be implemented under the Proposed Action and all alternatives. The Wildlife Monitoring and Protection Plan (**Appendix I**) would be followed to prevent, reduce, and detect impacts to wildlife and fish species throughout the life of the project. This plan serves two purposes: one is to describe the protocols to monitor wildlife responses, habitats, behavioral shifts, etc.; the other is to provide protocols to protect wildlife species and track the effectiveness of the monitoring and mitigation plan. BMPs implemented for other resource concerns may provide indirect protection for a variety of wildlife species.

Wildlife habitats directly affected by the proposed project include areas that are physically disturbed by the construction of well pads, roads, pipelines, and production facilities; wildlife habitats indirectly disturbed include areas surrounding directly impacted habitats. Direct habitat loss from construction of the Proposed Action, equal to approximately 4.4 percent of the project area, would be in addition to the 5.6 percent of the project area that has previously been disturbed.

The long-term loss/reduced usability of shrub habitat within a portion of the project area could lead to an increase in use on remaining shrub habitats. This localized increase of use could lead to a long-term reduction of shrub habitats outside of immediate project disturbance areas. Currently, areas dominated by large and continuous stands of shrub communities have relatively low well densities or occur in sections with the lowest (160-acre) well-spacing orders or allowable well density. Timely reclamation of well pads, pipelines, and rights-of-way would provide grass and forb forage within one to several years depending on precipitation and effectiveness of reclamation efforts, while sagebrush and other important shrub species would require longer for re-establishment to pre-disturbance levels. Consequently, the total acres disturbed would constitute a long-term loss of shrubs and would not be fully usable by shrub-dependent species for forage or shelter for over 20 years, although early seral stage shrubs would provide forage and/or shelter for various species in a shorter period of time.

Disturbance during construction and production, such as human presence, dust, and noise may displace or preclude wildlife use during all seasons. Prohibiting construction, drilling, and other activities potentially disruptive to wildlife during sensitive time-periods (e.g. winter, breeding, or nesting) would reduce the probability of displacement during these critical times. The extent of displacement would be related to the duration, magnitude, and visual prominence of the activity, as well as the extent of construction and operational noise levels above existing background levels. Displacement could result in local reductions

in wildlife populations if adjacent, undisturbed habitats are at carrying capacity. In this situation animals are either forced into less-optimal habitats or they compete with other animals that already occupy unaffected habitats. Possible consequences of such displacement are lower survival, lower reproductive success, lower recruitment, and ultimately lower carrying capacity and reduced populations (WGFD 2010a).

The extent of wildlife displacement is impossible to predict for most species since the response to disturbance varies from species to species and can even vary between different individuals of the same species. After initial avoidance, some species may acclimate to the activity and begin to reoccupy areas previously avoided (Kuck *et al.* 1985). This acclimation and reoccupation may occur following construction and drilling operations when the project moves into the production phases where less noise and human activities would take place. However, there is no guarantee of acclimation, or reoccupation, if the number of roads or level of human activity exceeds tolerance thresholds of the individual animal.

Human-caused surface disturbances such as well pads and roads can reduce use of surrounding habitat by wildlife. There is generally a zone of decreased use surrounding these sites due to the increased human activity. On average this zone extends to approximately 0.7 miles from development for big game species (Hebblewhite 2008). The area of aversion generally is the least for pronghorn and increases for elk and mule deer (Powell 2003, Berger 2006, Sawyer *et al.* 2006a). Consequently, development impacts to wildlife can extend beyond the physically disturbed area.

Habitat fragmentation and isolation are difficult to determine and vary species to species, but they could occur as a result of gas-field developments, which typically are configured as point and linear disturbances scattered throughout broader areas. Although these types of disturbances do not usually create physical barriers to wildlife movement (although in the winter, high snow berms resulting from plowing along multiple access roads may disrupt some wildlife movement), the effective use of adjacent undisturbed habitats could diminish as densities of well pads, ancillary facilities, and roads increase. An increase in habitat fragmentation is not as readily apparent in areas with existing disturbance as in previously undisturbed areas, but adverse effects can be compounded when infill disturbance further reduces available habitat between existing disturbances, effectively eliminating areas of relatively undisturbed habitat to the point that animals are displaced from the general area.

In addition, road/traffic-related dust would likely directly and indirectly impact 24.3 percent of the project area, which may result in some habitat avoidance (**Section 3.6.4**). Indirectly, this may increase inter- and intra-species competition for forage and thermal cover. In areas already at carrying capacity, individuals may be further displaced, possibly outside of the project area. Some animals may be displaced into lower-quality habitats which may lead to a reduction in reproductive rates or an increase in predation. In addition, roads provide access to the general public into areas that were previously undisturbed/ undeveloped. Human encroachment in the form of casual backcountry recreation, hunting, and poaching could occur at higher rates resulting in effects such as disturbance during sensitive periods, displacement, or increased mortality.

Following drilling and well-completion operations, noise levels, vehicle traffic, and human activity would be reduced. As a result, species might acclimate to the well-pad production facilities and use habitats adjacent to such sites, particularly at night when facilities-maintenance activities do not occur (Thompson *et al.* 1998, Dzialak *et al.* 2011a; 2011b, Webb *et al.* 2011).

The reaction of individual animals to noise and human presence varies depending on the intensity of the noise source and whether it is continuous or intermittent. Transient loud noises would provoke alarm responses; however, many animals habituate to more constant, lower-level noise sources that are not associated with negative visual stimuli or experiences such as being chased or hunted (reviewed in Busnel and Fletcher 1978; Weisenberger *et al.* 1996). Increased traffic levels on new and existing roads could increase the potential for wildlife/vehicle collisions for the life of the project.

Pronghorn. The impacts with the potential for the greatest negative effects to pronghorn populations would occur in CWR. Pronghorn CWR encompasses 90,310 acres across the central and southeastern portion of the project area (**Map 3.8-2**). Based on habitat assessments conducted in 2007, 2008, and 2010 at seven sites within the project area (**Map 3.8-2**; **Table 3.8-3),** pronghorn CWR is in largely fair condition (BLM unpublished data). Existing long-term disturbance and post-reclamation early-seral-state communities comprise approximately 2.6 percent of pronghorn CWR within the project area (**Table 4.8-1**). Based on current well-spacing orders, as many as 1,232 new wells could be drilled within pronghorn CWR. Initially, an additional 3.6 percent of pronghorn CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action. Assuming successful interim reclamation, as much as 6.2 percent of pronghorn CWR within the project area would remain disturbed for the life of the project.

Table 4.8-1. Affected pronghorn Crucial Winter Range, new and existing surface disturbance

Pronghorn Crucial Winter Ranges = 90,310[1]		Existing and Proposed Disturbance In Crucial Winter Ranges	
		Acres	Percent
Existing[2]		2,306	2.6%
Proposed Action	New[3]	3,292	3.6%
	Combined[4]	5,598	6.2%
Alternative A	New	7,762	8.6%
	Combined	10,068	11.2%
Alternative B	New	3,175	3.5%
	Combined	5,481	6.1%
Alternative C	New	2,996	3.3%
	Combined	5,302	5.9%
Alternative D	New	2,746	3.0%
	Combined	5,052	5.6%

[1] *Designated CWR within the project area (WGFD 2011b).*
[2] *Based on HWA 2008b.*
[3] *Because the most important constituent vegetation communities within crucial winter ranges would not return to functional condition for the life of the project, anticipated initial disturbance acres are used to represent the effective direct impact on these crucial winter ranges.*
[4] *The combined existing long-term and proposed project initial disturbance represents the worst case scenario for anticipated crucial winter range habitat disturbance.*

The direct loss/reduced usability of sagebrush communities would increase use on remaining shrubs, potentially resulting in shrub health decline outside of the immediate project disturbances. This would have an impact on pronghorn due to their heavy use of sagebrush during winter. Over time, pronghorn habituate to certain disturbances, depending on the spatial relationship (i.e., distance) between these areas of disturbance to available forage, water, and thermal cover; however, Easterly (1991) found that pronghorn density was consistently higher in areas outside of developed areas. Standard mitigations prohibiting construction, drilling, and other activities potentially disruptive to pronghorn within CWR from November 15 to April 30 would reduce the probability of displacement during this critical time of the year. During the production phase, the application of BMPs identified in Appendix 15 of the RMP, if applied, would work to alleviate impacts to the species. This would likely serve to reduce stress, help maintain animal condition, and improve winter survival as the animals travel farther or are displaced to lower-quality range.

Within the project area, pronghorn in the Red Desert herd generally migrate from north to south to CWRs along I-80. Pronghorn in the Bitter Creek and Baggs herds migrate from higher elevations to CWR along Muddy Creek and WY 789. I-80 presents a formidable barrier to north-south migration movements between the Red Desert herd and the Bitter Creek and Baggs herds (**Map 3.8-1**). In addition, fences along

WY 789 create a migration barrier that impedes pronghorn movement across the highway. Pronghorn found east of the highway are generally restricted to crucial winter habitat found along Muddy Creek and against WY 789, creating a trap to animal movement similar to I-80. WGFD (2011) reported, "Direct loss of winter habitat can cause a major impact because of the high sensitivity of pronghorn to wildlife unfriendly fencing, thus possibly causing a situation where pronghorn are trapped on unsuitable habitat increasing winter kill." This situation occurred during the winter of 2007-2008 in the Baggs Herd Unit, when pronghorn were migrating over fences along WY 789. Numerous rangeland fences throughout the project area also impede the movement of individuals to suitable winter habitat. Fences can prevent the animals from escaping human disturbance associated with field-development activity. For example, animals may have to follow migration barriers such as fences for great distances before finding a way through towards better winter habitat (J. Gregson, pers. com. 2012). Development of the project would compound the impacts of barriers to migrations. The inability to move through the area may force individuals to use less-suitable winter habitats, increase physiological stress, increase potential for starvation, and increase mortality and an overall decline in population size. Surface-disturbing and disruptive activities in big game migration and transitional ranges would be managed on a case-by-case basis, while new fences in migration corridors would only be allowed if they meet BLM standards (Rawlins RMP, p. 2-54).

Increased traffic levels on new and existing roads could increase the potential for wildlife/vehicle collisions. New roads also provide access to the general public into areas that were previously undisturbed/ undeveloped. Human encroachment in the form of casual backcountry recreation, hunting, and poaching could occur at higher rates resulting in effects such as disturbance during sensitive periods, displacement, or increased mortality.

The level of development within pronghorn CWR and migration corridors that would occur as a result of the Proposed Action is expected to exceed the significance criteria and to meet or exceed the WGFD (2010) definition of "High Impact" to pronghorn in crucial seasonal habitats, as follows: "Impairment of habitat function increases – the impact will be more difficult or at times impossible to effectively mitigate within the project area. The impact can be reduced but probably not eliminated through seasonal use restrictions and more intensive management and mitigation practices." Implementation of the Proposed Action, compounded by the current condition of the crucial winter habitat, along with the additional stress and displacement of pronghorn during development (and to a lesser degree during production) would likely exceed impact Criterion 2 (substantial disruption or irreplaceable loss of vital habitat).

Mule Deer. The impacts with the potential for the greatest negative effects to mule deer populations would occur in CWRs. Mule deer CWRs encompass 17,849 acres within the southeastern part of the project area (**Map 3.8-4).** Based on habitat assessments conducted in 2007, 2008, and 2010 at two sites within the project area (Map 3.8-4; **Table 3.8-4)**, the condition of mule deer CWR appears to have declined, possibly as a result of the severe winter of 2007–2008 (BLM unpublished data, WGFD 2011).

Existing long-term disturbance and post-reclamation early-seral-state communities comprise less than 2.3 percent of mule deer CWR within the project area (**Table 4.8-2**). Based on current well-spacing orders, as many as 298 new wells could be drilled within mule deer CWR. Initially, an additional 4.5 percent of mule deer CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action. Assuming successful interim reclamation, as much as 6.8 percent of mule deer CWR within the project area would remain disturbed for the life of the project.

The impacts of habitat disruption common to all big game species are discussed in detail earlier in this section. Reduction in winter range size and quality of available habitat may decrease the carrying capacity of the overall winter range (Sawyer *et al.* 2006b). In addition to the direct removal of habitat due to the development of pads and associated ancillary facilities, disturbances from drilling activities and traffic would affect the use of the habitat immediately adjacent to these areas. Indirect habitat loss can be substantially greater than the direct loss of habitat to roads and well-pad construction. Sawyer *et al.*

(2006b) found that winter mule-deer habitat selection and distribution patterns have been affected by development, specifically road networks and well pads; mule deer had a higher probability of use in areas farther away from well pads as development progressed. Predictive maps also suggest that some habitats considered "high probability of use" areas prior to development, changed to "low probability of use" areas as development progressed, and vice-versa (Sawyer *et al.* 2006b).

Table 4.8-2. Affected mule deer Crucial Winter Range, new and existing surface disturbance

Mule Deer Crucial Winter Range = 17,8491		Existing and Proposed Disturbance in Crucial Winter Range	
		Acres	%
Existing[2]		404	2.3%
Proposed Action	New[3]	796	4.5%
	Combined[4]	1,200	6.8%
Alternative A	New	1,877	10.5%
	Combined	2,281	12.8%
Alternative B	New	768	4.3%
	Combined	1,172	6.6%
Alternative C	New	724	4.1%
	Combined	1,128	6.4%
Alternative D	New	664	3.7%
	Combined	1,068	6.0%

1 Designated winter and Winter/Yearlong within the project area (WGFD 2011b).

2 Based on HWA 2008b.

3 Because the most important constituent vegetation communities within crucial winter range would not return to functional condition for the life of the project, anticipated initial disturbance acres are used to represent the effective direct impact on these crucial habitats.

4 The combined existing long-term and proposed project initial disturbance represents the worst case scenario for anticipated crucial winter range habitat disturbance.

As discussed above (**Pronghorn**), prohibiting construction, drilling, and other activities potentially disruptive to mule deer within CWR from November 15 to April 30 would reduce the probability of displacement during this critical time of the year. During the production phase, the application of BMPs identified in Appendix 15 of the RMP would help alleviate impacts to the species. This would likely help reduce stress, maintain animal condition, and improve winter survival of the animals as they travel farther or are displaced to lower-quality range. Over time, mule deer habituate to certain disturbances, depending on the spatial relationship (i.e., distance) between these areas of disturbance to available forage, water, and thermal cover; however, Sawyer *et al*. (2006a) found that areas within 2.3 miles of well pads have lower predicted probabilities of use compared to undeveloped areas. Mule deer are adaptable and may adjust to non-threatening, predictable human activity (Irby *et al.* 1988).

Recent research has identified migration routes used by mule deer adjacent to the project area (Sawyer 2007). Mule deer appear to move between the higher elevations of the Atlantic Rim in the east to lower elevations along Red Creek Rim to the southwest, skirting the eastern edge of The Bluffs, a prominent geographic feature in the extreme southern portion of the project area (Sawyer 2007). Research into mule deer migration routes will continue to better inform and refine mapping. Numerous rangeland fences throughout the project area impede the movement of individuals to suitable winter habitat. Fences also prevent the animals from escaping human disturbance associated with field-development activity. For example, animals may have to follow migration barriers such as fences for great distances before finding a way through towards better winter habitat (J. Gregson, pers. com. January 2012). Development of the project would compound the impacts of barriers to migration. The inability to move through the area may force individuals to use less-suitable winter habitats, increase physiological stress, increase potential for starvation, and increase mortality and an overall decline in population size. Surface-disturbing and

disruptive activities in big game migration and transitional ranges would be managed on a case-by-case basis, while new fences in migration corridors would only be allowed if they met BLM standards (Rawlins RMP, p. 2-54).

Increased traffic levels on new and existing roads would increase the potential for wildlife/vehicle collisions.

The level of development within mule deer CWR and migration corridors that would occur as a result of the Proposed Action is expected to exceed the significance criteria and to meet or exceed the WGFD (2010) definition of "High Impact" to mule deer in crucial seasonal habitats: "Impairment of habitat function increases – the impact will be more difficult or at times impossible to effectively mitigate within the project area. The impact can be reduced but probably not eliminated through seasonal use restrictions and more intensive management and mitigation practices." Implementation of the Proposed Action, compounded by the current condition of the crucial winter habitat, along with the additional stress and displacement of the mule deer during development, and to a lesser degree during production, would likely exceed impact significance Criterion 2 (substantial disruption or irreplaceable loss of vital habitat).

Application of the same additional mitigation measures described for pronghorn could work toward reducing the impacts of the Proposed Action on mule deer.

Elk. No elk CWR has been identified within the project area (**Map 3.8-6**), and migration routes have not been identified and documented. The majority of the project area is classified as "limited/no importance" and "undetermined/ undocumented" for elk use (WGFD 2010a). Small portions of the area are classified as "yearlong" and "winter" elk habitat (**Map 3.8-6**). Therefore, this project is not expected to alter or block elk movements. However, elk are generally believed to be more sensitive to human activities than pronghorn or mule deer, and they may be displaced in construction areas from 0.6 to 1.2 miles depending on the season (Powell 2003). Elk would likely habituate to the physical presence of gas wells (Van Dyke and Klein 1996); however, elk rarely adjust to the continued human presence required during the production phase of the project (Morrison *et al.* 1995). Following drilling and well-completion operations, noise levels, vehicle traffic, and human activity would be reduced. As a result, species might acclimate to the well-pad production facilities and use habitats adjacent to such sites, particularly at night when facilities-maintenance activities do not occur (Thompson *et al.* 1998, Dzialak *et al.* 2011a and 2011b, Webb et al. 2011).

With the increase in roads and potential recreational access to the area, displacement of elk in the limited areas of known elk use is likely during all phases of development. That said, and unless future studies demonstrate otherwise, impacts to elk populations due to habitat removal or modification; displacement, stress, or migration disruption; and increased vehicular collisions are not expected to exceed the impact significance criteria because high-value habitat (CWR and migratory routes) within the project area is very limited.

Application of the same additional mitigation measures described for pronghorn and mule deer would work to reduce the impacts of the Proposed Action on elk.

Overlapping Big Game Crucial Winter Range. Areas of overlapping big game CWR and sage-grouse core population areas are of greater importance because they provide crucial habitat for more than one species (WGFD 2010a); such areas occur within the project area (**Map 3.8-7**). Thirty-eight percent of overlapping big game CWR is on private and state lands where there are no protections against disturbance of animals during crucial time-periods (November 15 – April 30). Indirectly, this may increase inter- and intra-species competition (between different species and among individuals of the same species) for forage and thermal cover. This may force animals to use lower-quality habitats, which may lead to a reduction in reproductive rates or an increase in predation and/or mortality. The level of development of the Proposed Action within big game CWR, compounded by the current condition of the

crucial winter habitat (**Tables 3.8-3** and **3.8-4**), would likely exceed impact significance Criterion 2 and meet the WGFD (2010) definition of "High Impact."

Consistent with the WGFD oil and gas development recommendations (WGFD 2010a), the mitigation measures listed for pronghorn and mule deer in the previous narratives would apply as well to the overlapping big game CWR.

Raptors. The impacts with the potential for the greatest negative effects to raptor populations include nest-abandonment and failure due to increased human disturbance, loss of nesting and feeding habitat, and potential for increased vehicle collisions. There are 938 raptor nest sites (known to date) located in or within one mile of the project area. The BLM places year-round buffers around active raptor nest sites, precluding well locations, roads, ancillary facilities, and other surface structures requiring repeated human presence and applies a larger buffer during the nesting period (BLM 2008a). The size of buffers around active nests varies by species, with the largest buffers being one mile for bald eagles, golden eagles, and ferruginous hawks. Surface-disturbing activities would be prohibited from as early as February 1 (e.g. Great Horned Owl) to as late as September 15 (e.g. Burrowing Owl), depending on species. The amount of short-term change in prey-base populations created by construction is expected to be small in comparison to the overall level of small-mammal populations. While prey populations on the project area would likely sustain some reduction during the development phase of the project, most prey species would be expected to rebound to pre-disturbance levels following initial reclamation. Once reclaimed, these areas would likely promote an increased density and biomass of small mammals that is comparable to those of undisturbed areas (Hingtgen and Clark 1984).

Some raptors feed on carrion on and along the roads, while others (owls) may attempt to capture small rodents and insects that are illuminated in headlights. These raptor behaviors put them in the path of oncoming vehicles where they are in danger of being struck and killed.

Because of the buffers and restriction on activity around raptor nests and the fact that most of the prey utilize habitat that can be reclaimed in a timely fashion, the impact from the Proposed Action is not expected to exceed the significance criteria.

Mitigation could be imposed to reduce the chance of collisions between vehicles and raptors by requiring that drivers undergo training that describes the circumstances under which vehicular collisions are likely to occur and measures that can be taken to minimize them.

Small Mammals and Neotropical Songbirds. Construction disturbances would reduce habitat availability for a variety of small bird and mammal species. The temporary disturbances that would occur during the 15-year construction period would tend to favor early-succession wildlife species such as horned larks and ground squirrels, and would tend to adversely impact mid-to-late-succession species, such as loggerhead shrikes and voles. The long-term disturbance would have a minor effect on wildlife species not dependent upon shrubs. In addition to the direct-disturbance acreage, dust would directly and indirectly impact 24.3 percent of the project area (**Section 3.6.4**). These impacts would include habitat avoidance by birds and small mammals. Indirectly, this could increase inter- and intra-specific competition for nesting and foraging areas. In areas already fully occupied, density-dependent species would be further displaced, possibly outside of the project area.

A variety of shrub-dependent songbirds could be displaced by the reduction in habitat. Although there is no way to accurately quantify these changes, the displacement would be long-term. Birds are highly mobile and would disperse into surrounding areas and use suitable habitats to the extent that they are available. Standard mitigation measures would indirectly help songbirds during critical time-periods, and impacts to nesting and foraging habitats are expected to be minimal. Therefore, impacts from this alternative are not likely to significantly reduce populations within the project area due to the abundance of undisturbed habitat that would remain.

The primary small mammals found in the project area include, but are not limited to, cottontail rabbits, various mouse and vole species, northern pocket gophers, white-tailed jackrabbits, and ground squirrels. The initial phases of surface disturbance would result in some direct mortality and displacement of small mammals from construction sites. Quantifying these changes is not possible because population data are lacking. However, the impact is likely to be minor, and the relatively high reproductive rate of these small mammals would enable populations to quickly repopulate the area following interim reclamation. Most of these species would benefit from an increase in grass-dominated vegetation resulting from reclamation activities.

Development of the project could result in some unintentional, direct mortality of small birds and small mammals from vehicle collisions; however, this mortality is expected to be negligible and is not likely to significantly reduce populations within the project area. Overall, if standard prescribed environmental protection measures and BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan (**Appendix I**) are implemented under the Proposed Action, the impacts on songbird and small-mammal populations are not expected to exceed the impact significance criteria.

Upland Game Birds. Greater sage-grouse, Columbian sharp-tailed grouse, and mourning doves occur or potentially occur within the project area and may be impacted to varying degrees by the project. Mourning doves are highly adaptable habitat generalists; impacts would be negligible and not affect their long-term viability within the project area. Greater sage-grouse is designated as a candidate for listing under the ESA and is discussed in **Section 4.9 Special Status Species**.

Fish. About 10 game-fish species and 20 non-game fish species may occur in the CD-C project area or adjacent to the project area, or in streams upstream or downstream of the project area (**Table 3.8-6**) Of these, 14 species, including six native species, are likely to be present within the project area. Of these 14 species, four are BLM Sensitive Species. All of the 10 species that are not BLM Sensitive Species will be subject to the same types of impacts described in **Section 4.9.3.1, Sensitive Fish Species**. All of the 10 species that are not BLM Sensitive Species, however, have a wide distribution within Wyoming (Baxter and Stone 1995); consequently, the project area and other human activities within the Muddy Creek and Great Basin watersheds may have localized population impacts, but these impacts should not impact their status range-wide. Only one reservoir in the project area has a recreational fishery, and no impacts to that fishery are anticipated.

Part of Muddy Creek within the project area is listed as threatened by WDEQ for water quality (**Section 3.4.2.4**); however, no segments listed as impaired are present within the project area. If any segments were to be classified as impaired, one of the requirements in the RMP is for intensive management of 303(d) listed segments to address the problem.

Refer to **Section 4.9.3.1** for impacts to sensitive fish species.

4.8.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A would proceed with development across the project area similar to the Proposed Action, but would produce greater surface-disturbance due to an increase in the number of well pads, access roads, and pipelines. Initial facility construction within the project area would disturb and alter an estimated 61,696 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres previously disturbed by natural gas and other development. This would be an increase of approximately 31 percent relative to the Proposed Action, and would mean that over 11 percent of the project area surface had been disturbed. Reclamation of disturbed habitats would commence immediately and continue throughout the 15-year construction period, resulting in recovery (in one to several years, depending on precipitation and effectiveness of reclamation efforts) of 24,133 acres of grass-dominated habitat. Recovery of shrubs to pre-disturbance levels would not occur during the life of the project.

The overall increase in the number of well pads and roads and the acreage initially disturbed would substantially increase habitat fragmentation. This would increase the overall habitat loss and displacement

effects to wildlife species, as well as increase impediments within movement corridors. An increase in disturbance of wildlife habitat would impact all species and increase the time required, long-term, to return the functionality of the habitat in the project area. The degree of impact would vary by species.

Impacts would be the same for all species as identified in **Section 4.8.3.1** above, except as discussed below.

Pronghorn. Initially, an additional 8.6 percent of pronghorn CWR would be directly impacted by development of well pads and access roads under Alternative A (**Table 4.8-1**). Even assuming successful interim reclamation, 11.2 percent of pronghorn CWR would remain disturbed for the life of the project.

The direct loss/reduced usability of big sagebrush communities (Wyoming and mountain) would increase use on remaining shrubs, resulting in shrub health decline outside of the immediate project disturbances. This would have the greatest impact on pronghorn due to their reliance upon sagebrush habitats during winter. This level of development within pronghorn CWR and migratory routes (half again as much as the Proposed Action), compounded by the current condition of the crucial winter habitat, along with the additional stress and displacement during the production phase, would exceed impact significance Criterion 2 and the WGFD definition of "Extreme Impact," even if standard mitigations are applied.

Mule Deer. Initially, an additional 10.5 percent of mule deer CWR would be directly impacted by development of well pads and access roads under Alternative A (**Table 4.8-2**). Assuming successful interim reclamation, as much as 12.8 percent of mule deer CWR, including migration routes, within the project area would remain disturbed for the life of the project. This level of development within mule deer CWR (almost twice that of the Proposed Action), compounded by the current condition of CWR forage, along with the additional stress and displacement during the production phase, would exceed Criterion 2 and the WGFD definition of "Extreme Impact."

Elk. No elk CWR exists in the project area; therefore, impacts to elk populations, although higher than the Proposed Action, are not expected to exceed the impact significance criteria.

Overlapping Big Game Crucial Winter Range. This alternative would impact additional acreage of overlapping CWR and correspondingly increase the likelihood of exceeding Criterion 2 and the WGFD definition of "Extreme Impact."

Raptors. With the application of the RMP (BLM 2008a) required avoidance and mitigation measures (Section 4.8.3.1), impacts are not expected to exceed the significance criteria.

Small Mammals and Neotropical Songbirds. Under this alternative, an expansion of total acres of disturbance would increase direct and indirect impacts to small birds and mammals relative to the Proposed Action. However, if standard prescribed environmental protection measures and BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan (**Appendix I**) are implemented, and surface-disturbing and disruptive activities are intensively managed as required in the RMP (BLM 2008a, p. 2-53), impacts are not expected to exceed the impact significance criteria.

Fish. The types of impacts to fish would be the same as for the Proposed Action, but because of the larger surface area affected (~14,500 acres more, ~35 percent more, initial; ~5,000 acres more long-term), the magnitude of impacts would be proportionally greater.

4.8.3.3 Alternative B: Enhanced Resource Protection

The Enhanced Resource Protection (ERP) alternative was developed to avoid significant impacts to resources of concern by implementing additional protections and mitigations beyond those normally applied (e.g. BMPs, Wildlife Monitoring and Protection Plan). The enhanced resource protections would go into effect immediately and be applied to all future APDs.

The ERP alternative also recognizes that development may be more intensive than currently expected and may result in impacts occurring on wildlife habitats and populations faster than anticipated. Therefore,

this alternative includes surface-disturbance and population thresholds for some specifically designated high-value resources. If these surface-disturbance or population thresholds were reached, additional protection measures would be implemented, specific to each species. The alternative would combine prescriptive and adaptive management approaches that include assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. See **Section 2.2.3** for a detailed description of this alternative.

Three general requirements are applied across the board in this alternative: (1) uniform application of dust-abatement procedures, (2) environmental awareness training for all employees and subcontractors, and (3) the BLM will require remote monitoring at well pads when a surface disturbance threshold of 5 percent is reached for applicable resources.

Under the ERP, initial facility construction within the project area would disturb and alter an estimated 45,516 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres previously disturbed by natural-gas and other development. This would be a slight decrease relative to the Proposed Action. Reclamation of disturbed habitats would commence immediately and continue throughout the 15-year construction period, resulting in recovery (in one to several years, depending on precipitation and effectiveness of reclamation efforts) of 18,249 acres of grass-dominated habitat. Recovery of shrubs to pre-disturbance levels would not occur during the life of the project.

Under this alternative, pronghorn and mule deer CWR and migratory corridors would receive enhanced protections. Enhanced protections for **Special Status Species** are discussed in **Section 4.9**.

Pronghorn and Mule Deer Crucial Winter Range and Migration Corridors. Initially, an additional 3.5 percent of pronghorn and 4.3 percent of mule deer CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action (**Table 4.8-1**). Assuming successful interim reclamation, as much as 6.1 percent of pronghorn and 6.6 percent of mule deer CWR within the project area would remain disturbed for the life of the project.

The enhanced protections for big game would decrease the degree of risk associated with impacts of the Proposed Action (**Section 4.8.3.1**). Under this alternative, APDs that would affect pronghorn and mule deer crucial winter/yearlong range and migration corridors would be submitted with an overall development plan. The development plan would be submitted either for an individual lease or several leases. It should aim at reducing surface disturbance and disturbance associated with vehicle traffic and other human activity (**Section 2.2.3**).

In addition, the following requirements would be implemented throughout mule deer and pronghorn crucial winter range or crucial winter/yearlong range and migration corridors:

- Man camps would be prohibited on BLM land;
- Noise-reduction technology would be required at compressor stations; and
- Migration corridors would be monitored to determine which fences restrict movement.

With these protection measures, the risk of big game displacement and stress from increased human activity would be expected to decrease (especially during winter) compared to the Proposed Action. Dust-abatement programs would also help maintain forage palatability adjacent to roads.

In addition to the measures discussed above, to reduce the human impact on big game in their CWR, this alternative contains surface-disturbance and population thresholds developed to maintain pronghorn and mule deer habitat and populations in the face of increasing development pressure. Surface-disturbance thresholds would reduce the impact of habitat removal and modification in CWR. The surface-disturbance thresholds are intended to reduce the amount of habitat disturbed and to mitigate disturbance through reclamation. When surface disturbance for natural gas access roads, pipelines, well pads or other facilities exceeds 5 percent of a lease within pronghorn or mule deer CWR, the BLM would:

- Evaluate reclamation success in the lease and review, approve and oversee the implementation of an Operators' revised reclamation plan to ensure it addresses the reason for the failed reclamation. The calculated percentage disturbance would be adjusted downward for successful interim reclamation.
- Conduct an assessment of the disturbance and determine if enhancement of CWR is needed at this time. If so, begin implementation.
- Install remote monitoring at all well pads.

If surface disturbance reached 10 percent of pronghorn or mule deer CWR in a lease, habitat improvement projects would be required in addition to the requirements above. The BLM would establish an interagency CD-C consultation group and consult with them to determine which projects would be beneficial. These projects could include, but would not be limited to:

- Water developments.
- Vegetation treatments such as herbicide treatments, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs or trees, fencing, establishing food plots, etc.

If the WGFD were to express formal written concern that the herd within the project area was declining at an accelerated rate, all new APDs on leases within pronghorn and mule deer CWR in the CD-C project area would require an approved mitigation plan if the population decrease in those Herd Units were attributable in whole or in part to oil and gas development. The plan would include, but not be limited to:

- Evaluation of reclamation success in the lease and review, approve and oversee the implementation of an Operators' revised reclamation plan to ensure it addresses the reason for the failed reclamation.
- Implementation of BLM-approved habitat-improvement projects such as water developments or vegetation treatments. (BLM may coordinate habitat improvement projects among multiple Operators.) New well pads would not be authorized without Operator participation in habitat-improvement projects.
- Limitation of the number of well pads to no more than four per section within CWR to maintain habitat effectiveness.

If the population status of a species were to change in the future, additional data would be collected and additional protective measures would be developed.

With these protective measures in place the impact from habitat removal and modification in CWR is expected to decrease compared to the Proposed Action. Monitoring of population numbers would ensure that any population decline is identified early on and mitigation applied. This level of development within big game CWR, including migration routes, compounded by the current condition of CWR forage, along with the additional stress and displacement during the production phase, would exceed the WGFD definition of "High Impact" for both species, with the possibility of exceeding the WGFD definition of "Extreme Impact" and would thus exceed significance Criterion 2.

Overlapping Big Game Crucial Winter Range. As in the discussion of both pronghorn and mule deer, the additional protections available under this alternative would likely reduce the impacts to overlapping big game CWR, including migratory routes, but would still exceed Criterion 3 and the WGFD definition of "High Impact," with the possibility of exceeding the WGFD definition of "Extreme Impact."

Raptors. Under this alternative, no additional species-specific protections beyond those required by the RMP (timing and surface stipulations) and BMPs (**Appendix C**) would apply. Because of the buffers and restrictions on activity around raptor nests and the fact that most of the prey utilize habitat that can be reclaimed in a timely fashion, the impact from Alternative B is not expected to exceed the significance criteria.

Small Mammals and Neotropical Songbird Nests. Under this alternative, no additional species-specific protections beyond those required by the RMP (timing and surface stipulations), BMPs (**Appendix C**) and the Migratory Bird Treaty Act would apply. With the application of these mitigation measures and implementation of timely reclamation activities, it is anticipated that local population productivity would be maintained and the impact from Alternative B is not expected to exceed the significance criteria.

Upland Game Birds. No enhanced protection measures would apply; however, the mourning dove is likely to benefit from protection measures under this alternative. Impacts to greater sage-grouse under this alternative are discussed in detail in **Section 4.9.3.4.**

Fish. The Enhanced Resource Alternative Protections for the Muddy Creek Corridor/Watershed described in **Section 2.2.3.4** could substantially reduce project impacts to fish. The sources of these reductions would include the following protections:

- For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 0.25 mile of Red Wash, springs, wells, and wetlands. The required avoidance distance would be further increased on perennial streams to 0.5 mile. Exceptions would only be granted by the BLM based on environmental analysis and site-specific engineering and mitigation plans. Only actions within areas that could not be avoided and that would provide protection for the resource identified would be approved. In-channel activities would be restricted to the low-flow period.
- Current monitoring on upper Muddy Creek would be extended to Lower Muddy Creek in the CD-C area. This requirement would bring lower Muddy Creek into conformance with the monitoring being done for upper Muddy Creek and other drainages within the Atlantic Rim project area. If results of the monitoring program showed impacts to sensitive fish habitat, the BLM and an interagency CD-C consultation group would determine whether habitat-improvement projects should be implemented. The projects could include, but would not be limited to, increasing the number of drainage features along roads, increasing in-stream cover for fish, and other measures as applicable.
- A monitoring plan for Bitter Creek watershed will be designed.

The following requirements related to **selenium and salinity** for well locations and operations would also be implemented:

- No surface discharge of produced waters within the Muddy Creek and Bitter Creek watersheds.
- Line all reserve pits in the Muddy Creek and Bitter Creek watersheds.

These protections, however, only apply to BLM land and only about 36 percent of Muddy Creek within the project area is on BLM land, while 51 percent and 13 percent are on private and state land, respectively. An unintentional consequence of these protections being applied only to BLM land could be to increase drilling activities on private and state land. Such development on private and State land along Muddy Creek could completely negate the enhanced resource protections on BLM land along Muddy Creek. To preclude this possibility, the Operators and the state should make a commitment to apply these same enhanced resource alternative protections to private and state land along Muddy Creek. Without this commitment, it is possible that the impacts to fish for this alternative would be the same as for the Proposed Action.

4.8.3.4 Alternative C: Surface Disturbance Cap with High and Low Density Development Areas

This alternative designates parts of the project area for high-density development—those areas that have seen the greatest natural-gas development to date (**Map 2-1**). Within the high-density development areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance allowed at any one time in a section of public land. For the remainder of the project area—the low-density development areas—

the cap would be 30 acres per public land section. Once interim reclamation on the development is determined to be successful, the cap would be increased by the number of acres deemed to have achieved successful *interim* reclamation.

Under Alternative C, the types of impacts to wildlife species and their habitats would be similar to those described for the Proposed Action (**Section 4.8.3.1**). The cap, however, places a limit on the amount of unreclaimed surface disturbance at any one time in a section of federal land. This requirement should encourage the use of directional drilling and enhanced reclamation practices. For this reason, the scope and intensity of impacts on wildlife and their habitat would be less. Maximum surface disturbance for this alternative is estimated to decrease by 4,245 acres in the short term to 42,955 acres, a 9-percent reduction from the Proposed Action. Long-term disturbance would decrease by 1,543 acres, to 17,318 acres.

Because more wells would be drilled from directional well pads under this alternative, fewer well pads overall would be developed—an estimated 5,299 compared to the estimated 6,126 well locations of the Proposed Action, a reduction of about 13 percent. Therefore, fewer access roads would be developed and habitat fragmentation and other adverse impacts would be less extensive than for the Proposed Action. However, disruptive activities are expected to continue and may increase in high-density development areas, accompanied by associated adverse affects on population productivity and survival in localized areas, when compared to the Proposed Action.

Pronghorn. Initially, an additional 3.3 percent of pronghorn CWR within the project area would be directly impacted by development of well pads and access roads under the Proposed Action (**Table 4.8-1**). Assuming successful interim reclamation, approximately 6 percent of pronghorn CWR within the project area would remain disturbed for the life of the project.

Of the estimated 90,310 acres of CWR and associated migratory routes in the project area (**Map 3.8-2**), 30 percent would be in the high-density development area and 70 percent outside. Therefore, no more than 30 acres per section could be unreclaimed at any one time in the majority of pronghorn CWR. In the 30 percent of pronghorn CWR located within the high-density development, no more than 60 acres per section could be unreclaimed at any one time. Due to the surface disturbance cap, more directional wells would be drilled, decreasing habitat fragmentation from that of the Proposed Action and also reducing the acreage of indirect impact to pronghorn, especially in the low-density areas. Since private and state lands would not be subject to the cap, surface disturbance in those sections would not be limited, so the benefits of less fragmentation may not be as prevalent at the landscape level. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2, provided disturbance is limited to 20 acres per square mile (the likely disturbance associated with a single multi-well pad). If that figure were exceeded, the impact could be significant. In addition, disruptive activities are expected to continue and may increase, in high-density areas, accompanied by associated adverse affects on population productivity and survival in localized areas, when compared to the Proposed Action.

Mule Deer. There are 17,849 acres of mule deer CWR within the project area, located in the southeastern portion (**Map 3.8-4**). Of this acreage, approximately 25 percent is within the high-density development area and 75 percent outside. Initially, an additional 4.1 percent of mule deer CWR and associated migratory routes within the project area would be directly impacted by development of well pads and access roads under Alternative C (**Table 4.8-2**). Assuming successful interim reclamation, approximately 6.4 percent of mule deer CWR within the project area would remain disturbed for the life of the project. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2, provided disturbance is limited to 20 acres per square mile (the likely disturbance associated with a single multi-well pad). If that figure were exceeded, the impact could be significant. In addition, disruptive activities are expected to continue and may increase in high-density areas, accompanied by associated adverse affects on population productivity and survival in localized areas when compared to the Proposed Action.

Alternative C is expected to exceed significance Criterion 2 (substantial disruption or irreplaceable loss of vital and high-value habitats) and the WGFD definition of "High Impact" for pronghorn and mule deer CWR and associated migration routes in high-density development areas.

Overlapping Big Game Crucial Winter Range. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2, provided disturbance is limited to 20 acres per square mile (the likely disturbance associated with a single multi-well pad). If that figure were exceeded, the impact could be significant. However, disruptive activities are expected to continue and may increase if high-density development were to occur in CWR.

Raptors, Small Mammals, Upland Game Birds, Neotropical Migratory Birds. In areas of low-density development, impacts to these species should be less than the Proposed Action since the amount of surface disturbance, both initial and long-term, would decrease. In high-density development areas impacts would likely be greater on some species when compared to the Proposed Action. For example, recent research (Gilbert and Chalfoun 2011) found that when natural gas well density reached more than 8 wells per square kilometer (> 20 wells per square mile) the observed numbers of Brewer's sparrow, sage sparrow, and vespers sparrow declined. In the same study, horned lark numbers increased while sage thrashers showed no effect as a result of high-density well development (Gilbert and Chalfoun 2011).

The impact from Alternative C is expected to exceed the significance criteria in high-density areas; however, the application of the RMP general wildlife management action #13 (BLM 2008a, pg. 2-53), "Surface-disturbing activities and disruptive activities will be intensively managed. BMPs (Appendix 14 and 15) will be applied to surface-disturbing and disruptive activities to maintain or enhance upland game bird species, neotropical and other migratory bird species, and their habitats," may serve to reduce these impacts and thus the significance criteria may not be exceeded.

Fish. Within the project area, only a small part of Muddy Creek would be located in the high-density area (**Map 2-1**). Most of Muddy Creek is in the low-density area. In addition, where Muddy Creek is within the high-density areas, it primarily flows through private land. Because surface disturbance would be capped at 30 acres per section in the low-density area and at 60 acres per section in the high-density area, impacts to fish in Muddy Creek derived from surface disturbance should be decreased compared with the Proposed Action. However, without the added types of protections for Muddy Creek discussed in **Section 4.8.3.3** for Alternative B, the types of impacts to fish would be similar to those for the Proposed Action, although the magnitude of impacts should be less.

4.8.3.5 Alternative D: Directional Drilling

Under Alternative D, the types of impacts to wildlife species and their habitats would be similar to those described for the Proposed Action (**Section 4.8.3.1**) though on a more localized level. This alternative requires that all future natural gas wells on federal mineral estate and surface be drilled from multi-well pads. In public land sections that have already had development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes would be permitted in these leases. In sections in which there is no existing development, one new well pad would be permitted for all future development. One road and pipeline corridor on the lease or section would be permitted. The objective of this alternative is to minimize surface disturbance, thereby reducing habitat loss and wildlife disturbance. This alternative also reduces habitat fragmentation. Total surface disturbance for this alternative would decrease by 10,751 acres to 36,499, a reduction of about 23 percent from the Proposed Action. Long-term disturbance is estimated to decrease by 3,908 acres to 14,952 acres, a reduction of about 21 percent from the Proposed Action.

Because more wells would be drilled from directional well pads under this alternative, fewer well pads overall would be developed—an estimated 4,032 compared to the estimated 6,126 well locations of the Proposed Action for a reduction of about 34 percent. Therefore, fewer access roads and pipelines would

be developed and habitat fragmentation and indirect impacts would be less extensive than for the Proposed Action.

Pronghorn. Initially, an additional 3.0 percent of pronghorn CWR and associated migration routes within the project area would be directly impacted by development of well pads and access roads under Alternative D (**Table 4.8-1**). This is a decrease from the 3.6 percent increase in disturbance anticipated under the Proposed Action. As a result of the extended timeframe needed to fully restore the shrub component of the CWR, as much as 5.6 percent of pronghorn CWR within the project area would remain disturbed for the life of the project; however, various seral stages of shrub habitat would be available over the life of the project and would serve as pronghorn forage.

Due to the multi-well pad requirement, fewer well pads would be constructed, decreasing habitat fragmentation as compared to the Proposed Action. Alternative D would also reduce the extent of indirect impacts to pronghorn, especially in the lower-density development areas. Since private and state lands would not be subject to the multi-well pad requirement, surface disturbance in those sections would not be limited, so the benefits of reduced habitat fragmentation may not be as evident at the landscape level. Impacts under this alternative are expected to be less than those of the Proposed Action and sufficient to avoid significance under Criterion 2; provided disturbance is limited to less than 20 acres per square mile, the impact would be classified as "Moderate" per the WGFD definition (WGFD 2010a). The application of mitigation (Timing Stipulations) precluding activity in crucial ranges and associated migration routes during the winter season should serve to minimize impacts to the species from these long-term/long-duration well sites and their noise and enhanced activity levels.

Mule Deer. An additional 3.7 percent of mule deer CWR and associated migration routes within the project area would be directly impacted by development of well pads and access roads under Alternative D (**Table 4.8-2**). Due to the extended timeframe needed to fully restore the shrub component of the CWR, approximately 6.0 percent of mule deer CWR within the project area would remain disturbed for the life of the project; however, various seral stages of shrub habitat would be available over the life of the project and would serve as mule deer forage. The impacts would be similar to those described for pronghorn above. However, a greater percentage of the Mule Deer CWR is outside of the checkerboard, so the landscape-scale benefits of this alternative should be greater for mule deer than for pronghorn. Impacts under this alternative are expected to be less than those of the Proposed Action, and sufficient to avoid significance under Criterion 2; provided disturbance is limited to less than 20 acres per square mile, the impact would be classified as "Moderate" per the WGFD (2010) definition. The application of mitigation (Timing Stipulations) precluding activity in crucial ranges and associated migration routes during the winter season should serve to minimize impacts to the species from these long-term/long-duration well sites and their noise and enhanced activity levels.

Overlapping Big Game Crucial Winter Range. Impacts under this alternative are expected to be less than those of the Proposed Action, and would avoid significance under Criterion 2 and meet the WGFD definition of "Moderate Impact" (WGFD 2010a), provided disturbance is limited to less than 20 acres per square mile.

Raptors, Small Mammals, Upland Game Birds, and Neotropical Migratory Birds. Impacts to these species should be less than for the Proposed Action since the amount of surface disturbance, both initial and long-term, would decrease. Noise from drilling and completion activities occurring at long-duration multi-well pads could represent a localized negative impact to a sub-set of sensitive receptors (i.e. nesting raptors, sage-grouse) due to the increased period of time required for drilling at a single location. Reduced surface disturbance and habitat fragmentation resulting from multi-well pads comes with an increase in decibel level and frequency of that noise, as well as the extended period of time over which large haul-truck activity would occur. However, application of the following RMP general wildlife management action #13 (BLM 2008a, p. 2-53) would also serve to provide habitat protection for small mammal species: "Surface-disturbing activities and disruptive activities will be intensively managed. BMPs

(Appendix 14 and 15) will be applied to surface-disturbing and disruptive activities to maintain or enhance upland game bird species, neotropical and other migratory bird species, and their habitats." With the application of these mitigation measures, the impact from Alternative D is not expected to exceed the significance criteria.

Fish. The types of impacts to fish for this alternative would be similar to those for the Proposed Action. Total surface disturbance for this alternative, however, would be about 23 percent lower than for the Proposed Action; therefore, the magnitude of impacts to fish should be proportionately less.

4.8.3.6 Alternative E: No Action

Under the No Action Alternative, there would be no new surface disturbance and no new impacts on wildlife habitat. Wildlife would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of browse and forage caused by dust.

4.8.4 Impact Summary

The project, as proposed, would disturb and alter approximately 47,200 acres of wildlife habitat over the 15-year project development phase, in addition to the 60,176 acres previously disturbed by natural gas and other development. Reclamation of disturbed areas should recover to grass-dominated habitats in one to several years, depending on precipitation and effectiveness of reclamation efforts. Shrub habitats would not reach pre-disturbance levels during the life of the project; however, a variety of shrub age classes would be available as forage and cover throughout the project area as reclaimed areas mature. Therefore, wildlife dependent on mature shrub habitats would be impacted most by habitat loss. In addition to the physical removal of habitat, disturbance during construction and production can displace or preclude wildlife use during all seasons. Timing restrictions for the critical times of year have been developed for the most sensitive species and are generally implemented during the development phase. During the production phase, the application of BMPs identified in Appendix 15 of the RMP (BLM 2008a) would work to alleviate impacts to the species. This would likely serve to reduce stress and help maintain animal condition and improve winter survival of the animals as they travel farther or are displaced to lower-quality range. Other impacts from natural gas development include habitat fragmentation, reduced availability and palatability of forage due to dust, and mortality from collision between vehicles and wildlife.

The **Proposed Action** is expected to exceed significance under Criterion 2 (substantial disruption or irreplaceable loss of vital and high-value habitats) and the WGFD definition of "High Impact" for pronghorn and mule deer CWR and associated migration routes. Other species (raptors, small mammals, songbirds, and fish) should be protected sufficiently by the COAs, RMP requirements, and BMPs to avoid exceeding the significance level.

Alternative A: 100-percent Vertical Drilling would affect an additional 14,496 acres of habitat compared to the Proposed Action. The impacts described above would be intensified under this alternative; Criterion 2 and the WGFD definition of "Extreme Impact" would likely be exceeded for pronghorn and mule deer CWR, migration routes, and overlapping crucial habitats.

Alternative B: Enhanced Resource Protection was designed to reduce impacts of development on those species or habitats that are most vulnerable to an infill oil and gas project. There would be a slight reduction (1,684 acres, about 3.5 percent) in the amount of habitat disturbed under this alternative compared to the Proposed Action. Anticipated impacts to mule deer and pronghorn CWR and associated migration routes would be reduced compared to the Proposed Action through the application of additional mitigation requirements. That said, impacts to mule deer and pronghorn CWR and migration routes are expected to exceed significance under Criterion 2 and the meet the WGFD definition of "High Impact"

(WGFD 2010a). Other wildlife species would also benefit from this alternative and its additional protection of the Muddy Creek watershed, riparian areas, and playas.

Alternative C: Cap on Surface Disturbance, 60 or 30 Acres per Section seeks to reduce habitat disturbance and reward successful reclamation. This alternative is expected to impact 4,245 fewer acres than the Proposed Action. It should reduce the impacts to all species below those of the Proposed Alternative, but is still expected to exceed the level of significance under Criterion 2 for mule deer and pronghorn CWR. Anticipated impacts would meet the WGFD definition of "High" for both pronghorn and mule deer, as well as "High" for overlapping crucial ranges (WGFD 2010a), primarily in areas of high-density development.

Alternative D: 100 Percent Directional Drilling is expected to reduce surface disturbance by 10,751 acres (about 23 percent) compared to the Proposed Action. Impacts under this alternative are expected to be less than those of the Proposed Action, and sufficient to avoid significance under Criterion 2; provided disturbance is limited to less than 20 acres per square mile, the impact would be classified as "Moderate" per the WGFD (2010) definition.

Alternative E: No Action is assumed to result in no new surface disturbance and no new impacts on wildlife habitat because no further natural gas development would occur within the CD-C project area.

4.8.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

The amount of wildlife habitat would be unavoidably reduced on a short- to long-term basis as a result of the surface disturbance related to construction of well sites and associated facilities on public, state, and private lands within the CD-C project area. The quality and function of habitat would also be reduced due to intermediate- to long-term alterations in the vegetative composition of habitats and the continuing traffic and human presence associated with natural gas production activities. These impacts would be in addition to historical impacts from prior surface disturbance. Proposed and existing habitat alteration together would represent ten percent or more of the CD-C project area. The impacts on mule deer and pronghorn habitat are expected to exceed significance under Criterion 2—management actions that result in substantial disruption or irreplaceable loss of vital and high-value habitats—for the Proposed Action and all action alternatives except Alternative D.

Application of additional mitigation measures such as those listed below, many of them found as elements of Alternative B, could work toward reducing the impacts of the Proposed Action and the action alternatives. In many circumstances the RFO is already requiring these mitigation measures as standard Conditions of Approval (COAs) (M. Read, pers. com., January 2012).

- Minimizing human presence at well sites after they have been put into production by remote monitoring of project facilities and gating of roads;
- Development planning for an entire lease or several leases;
- Noise-reduction technology, such as hospital grade mufflers, sound walls or soundproof buildings, or adding silencers to cooling fans;
- Monitoring of migration corridors to determine which fences restrict movement and fences modified to reduce impacts to migrating big game species;
- Habitat improvement projects such as water developments and vegetation treatments; and
- Training programs for field workers to raise their awareness of activities that cause stress to big game, times of day when collisions are most likely, and other programs as necessary.

4.9 SPECIAL STATUS SPECIES

4.9.1 Introduction

Special-status species are (1) those listed as Threatened or Endangered by the USFWS under the Endangered Species Act (ESA) of 1973 or those that are candidates or have been petitioned for listing and (2) those designated by the BLM State Director as sensitive (BLM 2010). Species are designated as sensitive if their numbers are declining so rapidly that ESA listing might be necessary, or if they have typically small or dispersed populations or inhabit unique habitats.

Eight species listed by the USFWS as threatened, endangered, proposed, or candidate are present, or potentially are present, within or near the CD-C project area (USFWS 2010; **Table 3.9-1**). Two are mammals, and one is a bird. Four of the species are fish found downstream of the project area in the Colorado River system which may be impacted if water depletions occur or if environmental contaminants are increased within the system. One plant listed as USFWS-threatened (Ute ladies'-tresses) may occur within the project area

Twenty-eight species that have been designated as sensitive by BLM are present or potentially present within or near the project area: eight mammals, 10 birds, two amphibians, four fish, and four plants (**Table 3.9-3**).

A Biological Assessment (BA) will not be included in this draft document. Once a Preferred Alternative is selected, the BA will be finalized and sent to the USFWS for a Biological Opinion (BO).

4.9.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) management objectives for special status wildlife and fish species are the same as those presented for wildlife (**Section 4.8.2**). The RMP also defines the following impact significance criteria that are used in this document to assess the impacts associated with the Proposed Action and alternatives (BLM 2008b). Impacts to special status wildlife and fish species would be considered significant if any of the following were to occur:

- Substantial loss of the biological integrity and habitat function of terrestrial and aquatic ecosystems that would make a species eligible for listing under the ESA.
- Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species, or adverse alteration of their critical habitats.
- Substantial loss of habitat function or disruption of life-history requirements of special status species that would preclude improvement of their status. Habitat function means the arrangement of habitat features and the capability of those features to sustain species, populations, and diversity of wildlife over time (WGFD 2010a).

Impacts to special status plant species would be considered significant if any of the following were to occur:

- Any action or event that would remove a community's unique attributes or ability to support other resource values within the planning period, or if corrective actions were beyond the scope of the RMP.
- The viability of protected plant species is jeopardized, with little likelihood of reestablishment after disturbance, or actions result in the need to list a species under ESA.
- Actions that have the potential to remove sensitive plant species or substantially alter the habitat's ability to support the species.

Additionally, the RFO has determined that the following impact significance criterion should be included for this project:

- Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species.

The degree of impact that constitutes "substantial" loss of habitat or disruption of life-history requirements is quantified for some wildlife species in the habitat and population thresholds described in the Enhanced Resource Protection Alternative (Alternative B).

4.9.3 Direct and Indirect Impacts

4.9.3.1 Proposed Action

Habitats directly and indirectly affected by the proposed project are the same as those discussed for general wildlife (**Section 4.8.3**).

Standard environmental protection measures prescribed as Conditions of Approval (COAs) or used as BMPs (**Appendix C**) would be implemented under the Proposed Action and all alternatives. The Wildlife Monitoring and Protection Plan (**Appendix I**) would be followed to detect, prevent, and reduce impacts to wildlife and fish species throughout the life of the project. These protective and mitigative measures would serve to minimize the impacts of development activity on public land managed by the BLM. However, the measures do not apply to private and state lands, which encompass 46 percent of the project area. Therefore, the effectiveness of the mitigation is limited when considering a landscape approach, particularly in the checkerboard section of the project area.

Threatened, Endangered, Proposed or Candidate Wildlife Species

Habitat for **Canada lynx** is not found in the project area and their potential occurrence is described as *Very Unlikely* (**Table 3.9-3**). This species will not be further addressed in this document.

Black-footed ferret. The presence of black-footed ferret in the project area is very unlikely (see **Section 3.9.1.1**). The Proposed Action would likely disturb colonies of white-tailed prairie dogs, which are the black-footed ferret's primary habitat and prey source in this area. Surveys for black-footed ferrets may be required before ground-disturbing activities within mapped prairie-dog colonies located in the Continental Divide, Dad, and Desolation Flats non-block clearance areas. The remaining white-tailed prairie-dog colonies within the CD-C project area are within the USFWS designated block clearance area, where surveys for black-footed ferrets are no longer warranted. The Proposed Action is not expected to exceed the impact significance criteria for black-footed ferret populations.

Greater sage-grouse. The impacts with the potential for the greatest negative effects to greater sage-grouse populations include: loss of nesting or brood-rearing habitat, displacement or additional stress due to increased human activities, excessive noise levels proximal to occupied leks, removal or modification of severe winter habitats, and increased predation due to an increased number of roosting sites for raptors on power poles and other man-made structures.

Approximately 60 percent of the CD-C project area is comprised of sagebrush and other mesic shrub-dominated vegetative classes, which represent identified greater sage-grouse nesting habitat, as defined by the RFO **(Map 3.9-2**). Recovery of shrubs in locations that have been disturbed by development to pre-disturbance levels would not occur during the life of the project. However, younger age classes of sagebrush with grass and forb components may serve as nesting and brood-rearing habitat for grouse. Populations have persisted in many areas where energy development is ongoing, yet research has shown that development can influence declines in lek occupancy, lek attendance, and possibly in population persistence (Braun *et al*. 2002, Aldridge and Boyce 2007, Harju *et al.* 2010, Walker *et al*. 2007). Sage-grouse may repopulate an area following energy development, but may not attain population levels that occurred before development (Braun 1998). Likelihood of abandonment is higher when nests are disturbed early in the incubation period (Remington and Braun 1991).

In the generally accepted body of literature, the following are potential sources of indirect impact to greater sage-grouse and their habitats, all of which could lead to lower productivity and long-term decline in the population of this species in the project area (WGFD 2010a):

- Habitat loss resulting from dust settling on vegetation (**Section 4.6**) and reducing the palatability and production of forbs and shrubs used by grouse.
- Visual intimidation from high-profile structures.
- Potential loss of sagebrush and understory due to over-browsing or grazing by wild ungulates, livestock, and wild horses on ranges shared with grouse, reducing quality and abundance of nesting, brood-rearing and winter habitats, as well as forage.
- In areas of Extreme Impact (more than 3 well pad locations or 60 acres of disturbance per square mile within 2 miles of an occupied lek in non-core population areas; WGFD 2010a), as development becomes more intense, the impact zones surrounding each well pad, production facility, and road corridor begin to overlap, thereby reducing habitat effectiveness over much larger, contiguous areas. Human, equipment, and vehicular activity and noise impacts are also more frequent and intensive (WGFD 2010a).
- Noise levels interfere with bird communication during mating periods resulting in lower bird attendance at leks.
- Disruptive human activities alter normal bird behavior, increase nest abandonment, and may displace birds into less-desirable habitats.
- Construction of facilities and roads creates a long-term loss of grouse habitat and increases fragmentation of remaining habitat.
- Increased predation by raptors and corvids due to facilities such as well houses, compressor stations, and above-ground power lines serving as perches.
- Roads may also serve as travel corridors for some predators.

Refer to **Section 3.9.1.1, Greater sage-grouse,** for a complete discussion of the protective measures in place throughout the project area for the conservation of greater sage-grouse and its seasonal habitats. The conservation strategy for greater sage-grouse continues to evolve and the requirements that would be applied to proposed activities in sage-grouse habitat will change similarly. **Map 3.9-2** shows the core and non-core sage-grouse population areas within and near the project area. Fifty-four of the project area's leks are in non-core areas and 31 are in state-designated core areas.

The Proposed Action and alternatives have been analyzed relative to the requirements of IM WY-2012-019 (BLM 2012c) and the national IM 2012-043 (BLM 2012b) which impose limits for surface-disturbing and disruptive activities in sage-grouse core and non-core areas. The conservation guidelines provided in the WGFD Recommendation for Development of Oil and Gas Resources within Important Wildlife Habitats (WGFD 2010a) were also considered. IM WY-2012-019 (BLM 2012c) calls for consideration and evaluation of greater sage-grouse conservation measures that are the same as or in some cases more stringent than those of the Rawlins RMP. The Rawlins RMP prohibits *surface-disturbing activity* on and within 0.25 mile of the perimeter of an occupied lek year-round in non-core areas and increases the distance to 0.6 of a mile from the perimeter of an occupied lek in designated core. The IM calls for consideration of the same. The RMP has an associated timing limit on *disruptive activities* within 0.25 miles of an occupied lek from 6:00 pm to 9:00 am from March 1 to May 20; IM WY-2012-019 calls for consideration of extending the distance of that timing stipulation to 0.6 mile in core areas. Under the IM, avoidance of surface-disturbing *and/or disruptive activities* within all core area nesting and early brood-rearing habitat (**Map 3.9-2)** from March 1 to July 15 (timing period as found in the RMP) is to be considered. The RMP applies that same level of protection to identified nesting and early brood-rearing habitat, regardless of distance from the lek, in non-core areas from March 1 to July 15 (M. Read,

pers.com. February 2012). BLM is currently working to amend the RMP as it relates to greater sage-grouse conservation (BLM 2010c).

IM WY-2012-019 also includes a density goal for core areas that requires maintenance of sagebrush communities by maintaining or reducing the existing level of density of energy production and/or transmission structures on the landscape, **or** not exceeding one energy production location and/or transmission structure per 640 acres. The one location and cumulative value of existing disturbances in the area would not exceed 5 percent (32 acres) of sagebrush habitat within those same 640 acres.

IM WY-2012-019 provides protection for mapped or modeled winter habitat/concentration areas from surface-disturbing activities from November 15 to March 14. Activities would be allowed outside this period and winter habitat could still be affected or removed by surface disturbance outside the timing limitation. Loss of this habitat could lead to lower productivity and long-term decline in the population of this species. As winter concentration areas are identified and mapped in the CD-C project area BLM would apply seasonal stipulations and habitat protection measures (BLM 2008a and 2012b).

Habitat loss would continue around leks outside the 0.25-mile protected buffer in non-core areas and the 0.6-mile buffer in core areas, including within the buffer zones outside the seasonal protection. In non-core areas, application of the standard for avoidance of potential nesting and brood-rearing habitat as well as the BLM standard COAs, BMPs (**Appendix C**), Timing Limitations, and Mitigation (**Appendix I**) would reduce the impact to sage-grouse but impact to those populations (dust, noise, and continued human presence during the drilling and production phase) would still be anticipated. It is expected that greater than three wells or 60 acres of disturbance per square mile could occur within the 2-mile radius of some non-core leks but not all. In some areas this level of disturbance has already been exceeded; this would be considered an "Extreme Impact" relative to those individual leks (WGFD 2010). In core population areas, habitat disturbance would be limited to less than 5 percent of a 640-acre section or one disruption (i.e. well location) per section (square mile), averaged over the specific sage-grouse impact (i.e. DDCT) analysis area. Provided the protections for greater sage-grouse found in IM WY-2012-019 and the Rawlins RMP are applied, it is not expected that the significance criteria would be exceeded in core areas but localized exceedance of Criteria 1, 2, and 4 could occur in non-core areas. Sage-grouse populations in non-core areas may experience localized substantial loss of habitat, biological integrity or function, decreased viability or increased mortality or substantial disruption of life-history requirements. By definition non-core areas are not "critical habitats;" therefore Criteria 3 would not be exceeded.

Threatened and Endangered Fish Species

Four federally Endangered fish species may occur as downstream residents of the Colorado River system: **Colorado pikeminnow** (*Ptychocheilus lucius*), **bonytail** (*Gila elegans*), **humpback chub** (*Gila cypha*), and **razorback sucker** (*Xyrauchen texanus*) (USFWS 2003). Suitable habitat for these species does exist downstream of the project area in the Little Snake, Yampa, and Green Rivers. Because the Colorado pikeminnow is found in the Little Snake River, it could migrate into Muddy Creek. Muddy Creek, however, is not considered suitable habitat for this species. The action alternatives are not expected to affect this habitat, provided that mitigation measures for water resources and soils outlined in this document are implemented. Although they currently exist only downstream of the project area, water draining from the project area affects the downstream habitat for these species. Under the Proposed Action, the sources of risks to these fish species are water depletions, discharges of produced water, and spills of toxic materials.

Water Depletions. The Upper Colorado River Endangered Fish Recovery Program is a partnership working to recover the endangered fish of the Upper Colorado River Basin. The goal of recovery is to achieve natural, self-sustaining populations of the endangered fish so that they no longer require protection under the ESA. Under the Recovery and Implementation Program (RIP) for Endangered Fish Species in the Upper Colorado River Basin, "any water depletions from tributary waters within the

Colorado River drainage are considered as jeopardizing the continued existence of these fish." Tributary water is defined as water that contributes to instream flow habitat. Depletion is defined as water which would contribute to the river flow if not intercepted and removed from the system.

The FWS has determined that progress made under the RIP has been sufficient to merit a waiver of the depletion fee, which helps fund the RIP, for depletions of 100 acre-feet per year or less (Memorandum dated March 9, 1995 to Assistant Regional Director, Ecological Services, Region 6, from Regional Director 6, "Intra-Service Section 7 Consultation for Elimination of Fees for Water Depletions of 100 acre-feet or Less from the Upper Colorado River Basin"). The Proposed Action, however, may deplete an average of 510 acre-feet of water per year (**Section 4.4.4.1**) and therefore a one-time depletion fee of approximately $20 per acre foot may be required. The figure of 510 acre-feet is the amount of water estimated to be withdrawn from aquifers in the Wasatch formation that may have contact with and contribute to the Little Snake River and its tributaries, including Muddy Creek. The extent to which the groundwater withdrawals constitute a depletion and any depletion fee will be determined in consultation between BLM and FWS before the Final CD-C EIS.

Discharges of Produced Water and Spills of Toxic Chemicals. Produced water from the project area would not be discharged to Muddy Creek within the Little Snake River drainage; therefore, produced-water discharges will not pose a risk to these species. Accidental releases (e.g., spills) of toxic chemicals also could occur. However, accidental releases of toxic chemicals should become highly diluted before they would reach any downstream waters where these species occur; consequently, the risks from such occurrences are negligible (BLM 2007). For any future proposals involving CBNG, the proposed treatment and disposal of produced water will be analyzed in a separate NEPA document.

Threatened and Endangered Plant Species

The USFWS (2002) determined that the threatened Ute ladies'-tresses (*Spiranthes diluvialis*) may be present within the CD-C project area. However, because extensive surveys failed to document the presence of Ute ladies'-tresses within the project area, impacts to this plant are not anticipated. The possible presence of this federally listed plant species on public lands would be determined by the presence of appropriate riparian habitat. The application of the COA requiring avoidance of riparian areas by 500 feet serves to protect this species. In the unlikely event that the species is found within the project area, potential impacts to the species on public land would be addressed through consultation with the USFWS. In particular, those sites would be avoided to prevent any impacts. Therefore, decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate plant species or adverse alteration of their critical habitats, if identified, on public lands within the project area would not occur with implementation of the Proposed Action. Because the likely presence of this species on private or state lands is low, the likelihood of direct impacts on those lands is also low.

Sensitive Wildlife Species

The following sensitive wildlife species have not been found within the project area and would likely not be impacted by the project: black-tailed prairie dog, fringed myotis, long-eared myotis, spotted bat, Townsend's big-eared bat, Baird's sparrow, Columbian sharp-tailed grouse, northern goshawk, peregrine falcon, and boreal toad. These species will not be discussed further. Nevertheless, should populations be found, mitigation would be applied to avoid disruption of habitat function or of life history requirements. Species that may be affected by the Proposed Action are discussed below.

Sensitive Mammal Species

Fringed myotis, long-eared myotis, spotted bat, and Townsend's big-eared bat have the potential to occur in the project area even though their preferred roosting and hibernation habitats are not found in the project area; however, equipment stack caps would be required as a mitigation for these species in an

effort to preclude incidental roosting. No other adverse effects are anticipated at this time, and Criterion 2 would not be exceeded.

Pygmy rabbits are patchily distributed throughout the project area (WYNDD 2007, HWA unpublished data). The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance of some portions of pygmy rabbit habitat and burrow systems. The RFO has a survey and avoidance policy for pygmy rabbit burrow systems. Therefore, direct impacts to pygmy rabbits, in the form of lost burrows and foraging habitat, are not expected to exceed the impact significance criteria.

Swift foxes have been documented within the project area in the past; however, sightings in the area have not occurred in recent years. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance to some suitable foraging habitat. Should populations be found, mitigation would be developed to protect them. Therefore, impacts are not expected to exceed the impact significance criteria.

White-tailed prairie-dog colonies covering approximately 8,818 acres have been mapped within the project area to date (BLM unpublished data, HWA unpublished data). The Rawlins RMP requires that development avoid prairie-dog colonies whenever possible. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance to some portions of these prairie-dog colonies. Direct impacts to prairie dogs, in the form of lost burrows and foraging habitat, are not expected to exceed the impact significance criteria.

Wyoming pocket gophers are found within the project area. This was established by trapping efforts in 2008–2010 (WYNDD unpublished data, HWA unpublished data). Based on those trapping efforts, the availability of suitable habitat, and the known distribution of the species, Wyoming pocket gophers are likely to be found in additional areas of suitable habitat within the project area. The BLM requires site-specific surveys to determine if a project proposal should be relocated in an effort to avoid Wyoming pocket gopher mounds whenever possible. Therefore, impacts are not expected to exceed the impact significance criteria.

Sensitive Bird Species

Bald eagles have been observed within the project area primarily from November through March (WGFD 2006, HWA unpublished data). No bald eagle nests or nesting habitat occur within the area, and the nearest potential nesting habitat is found along the Little Snake River, approximately 9 miles south of the project area. Bald eagles may forage within the project area during the winter months because of carrion associated with pronghorn, mule deer, and elk winter ranges. The potential for vehicle-animal collisions would increase as a result of greater vehicle traffic associated with the project. Because bald eagles commonly feed on carrion, particularly during the winter months, the presence of road-killed wildlife on and adjacent to the access roads is an attractant. Eagles feeding on these carcasses are in danger of being struck by moving vehicles. However, such occurrences would be rare and effects on the population are not expected to exceed the impact significance criteria.

Brewer's sparrow, loggerhead shrike, sage sparrow, and **sage thrasher** are the predominant shrub-dependent songbirds that occur within the project area (WGFD 2006, WYNDD 2007, HWA unpublished data). In addition to the removal of habitat, activities under the Proposed Action may displace birds to lower-quality habitats, which could lead to a reduction in reproduction rates or an increase in predation. Recent research (Gilbert and Chalfoun 2011) found that when natural gas well density reached more than eight wells per square kilometer (more than 20 wells per square mile) the observed numbers of Brewer's sparrow, sage sparrow, and vespers sparrow declined. In the same study horned lark numbers increased while sage thrashers showed no effect as a result of high-density well development (Gilbert and Chalfoun 2011).

Burrowing owls are found throughout the project area (WGFD 2006, WYNDD 2007, BLM unpublished data). Surveys for this species should be conducted before construction in prairie-dog colonies during the owl breeding/nesting season. If nesting owls are found, the same measures used for protection of other raptor species (**Appendix I**) will be applied. Given these precautionary measures, the Proposed Action is not expected to exceed the impact significance criteria for this species population.

Ferruginous hawks are the most abundant raptor species nesting within the project area (BLM unpublished data). The primary impact to ferruginous hawks from project activities is disturbance during nesting, which could result in reproductive failure. This impact would be mitigated by implementing measures in **Appendix C,** such as no surface occupancy (i.e. well locations, roads, ancillary facilities, or other surface structures) year-round within 1,200 feet of a ferruginous hawk nest and a seasonal restriction on surface disturbing and other disruptive activity from March 1 to July 31 within 1 mile of a ferruginous hawk nest. Nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone for nesting/foraging ferruginous hawks. It is difficult to determine if this would exceed Criterion 4 in this case because other factors such as topography could decrease the size of the needed buffer around nests, but the impacts are not expected to exceed the criterion.

Long-billed curlew is an uncommon summer resident, but may be locally common in suitable habitat (WGFD 2004a). The long-billed curlew has been recorded once within the project area (WGFD 2007) and is not expected to nest within the area due to lack of habitat. No significant impacts to this species are expected with implementation of the Proposed Action.

Mountain plover. The impacts with the potential for the greatest effects to mountain plover populations include: loss of nesting habitat, displacement or additional stress due to increased human activities, and increased potential for vehicular collisions due to higher traffic levels on existing and new roads. Mountain plover breed in suitable habitat throughout the project area (WGFD 2007, BLM unpublished data, HWA unpublished data). Approximately 342,393 acres of occupied or potential mountain plover nesting habitat have been mapped, comprising approximately 32 percent of the project area (**Map 3.9-4**; HWA unpublished data). A substantial portion of this nesting habitat would be disturbed with implementation of the Proposed Action. Impacts of displacement or additional stress from increased human activities should be minimized by avoiding construction activities in potential plover nesting habitat during the nesting period from April 10 to July 10, unless surveys show that no birds were found.

Mountain plovers tend to use the same nesting areas from year to year (Dinsmore 2003), but the exact nest locations change. They often nest near roads and well sites (Manning and White 2001), feed on or near roads, and use roads as travel corridors (USFWS 1999), all of which make them susceptible to being struck by vehicles. In occupied habitat, BLM guidelines call for speed and traffic volume controls during the brood-rearing period. This may modify work schedules and shift changes during the most likely time for plovers to be on the road (Appendix 16 to the RMP). Following drilling and well-completion operations, noise levels, vehicle traffic, and human activity would be reduced. As a result, plovers might acclimate to the well pad production facilities and use habitats immediately adjacent to such sites. With the COAs and BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan (**Appendix I**), the impact of the Proposed Action on mountain plover populations would likely not exceed the impact significance criteria.

Trumpeter swans and **white-faced ibis** are uncommon in the project area and are always associated with wetland habitats. Both species have been observed within the project area during migration on only a few occasions (WGFD 2006, WYNDD 2007). Except for a few areas along Muddy Creek, wetlands are very limited within the project area. The Proposed Action is not expected to exceed the impact significance criteria because development would not occur within 500 feet of riparian and wetland habitats.

Sensitive Amphibian Species

Great Basin spadefoot have been documented within the project area (WGFD 2006, WYNDD 2007) and occur within sagebrush communities. The intensity of development associated with implementation of the Proposed Action would likely result in direct disturbance to suitable breeding habitat. Development would not be permitted within 500 feet of riparian and wetland habitats; however, and with this protection, significant impacts are not expected.

Northern leopard frog sightings have been documented in all counties of Wyoming and this species has been documented in the project area. Provided that measures are taken to avoid disturbance and contamination of perennial water sources (**Section 4.4**), impacts from the Proposed Action are not expected to exceed the impact significance criteria because development would not occur within 500 feet of riparian and wetland habitats.

Sensitive Fish Species

Sources of risks to sensitive fish species are (1) increases in suspended sediments and sedimentation, (2) produced-water discharges, and (3) spills of toxic materials. For any future proposals involving CBNG, the proposed treatment and disposal of produced water will be analyzed in a separate NEPA document.

Increases in Suspended Sediments and Sedimentation. Research conducted during the summer and fall of 2003 and 2004 within the upper Muddy Creek watershed, including the project area, found the two most consistent habitat associations among sub-adult and adult roundtail chubs, bluehead suckers, and flannelmouth suckers to be positive associations with both rock substrates and deep pools (**Figures 4.9-1 and 4.9-2**; Bower 2005). Under the Proposed Action, the primary impacts to these two habitat features are (1) sedimentation from new construction and project-related land disturbance resulting in decreased availability of rock substrates, and (2) alteration of local hydrologic conditions by new road construction that could lead to sedimentation and channel adjustments resulting in a loss of deep pool habitats. Additionally, fragmentation of aquatic habitats, if any project-related road crossings of Muddy Creek are constructed, could limit access to required habitats or block fish migration.

The impact of new roads and other facilities on fish habitats can be divided into three categories: construction, presence, and urbanization (Angermeyer *et al.* 2004). During the construction phase, prior to interim reclamation, erosion of soils exposed during earth-moving activities accelerates fine-sediment loading in stream channels. Though the biological effects of sedimentation include a variety of ecological interactions (Waters 1995), sedimentation can act to shift habitat structure such as channel depth, pool-to-riffle ratio, percent fines in substrates, and cover availability (Angermeyer *et al.* 2004). This sediment can extend miles downstream of the construction site and persist in stream channels for years (Angermeyer *et al.* 2004).

During the presence phase, impacts are primarily associated with the interception of shallow groundwater flow paths by roads. Water is frequently diverted along the roadway and routed to surface-water drainage networks at drainage crossings. This can, in turn, alter the timing, routing, and magnitude of runoff, triggering geomorphic adjustments through erosion by channel incision, new gully or channel-head formation, or slumping and debris flows (**Figure 4.9-1**; see review in Trombulak and Frissel 2000). Channel incision occurs when the base elevation of the stream channel adjusts to account for an alteration of geomorphic parameters such as sediment supply, flow volume, or channel roughness (e.g., riparian vegetation). Channel incision has been shown to simplify channel geometry and result in the loss of pool habitat (Shields *et al.* 1994). Project-related crossings of Muddy Creek would be required to pass fish and would be mitigated as outlined in the Rawlins RMP. The RMP requires that any road crossing of a stream that may potentially support fish for a portion of the year must be constructed to allow fish passage.

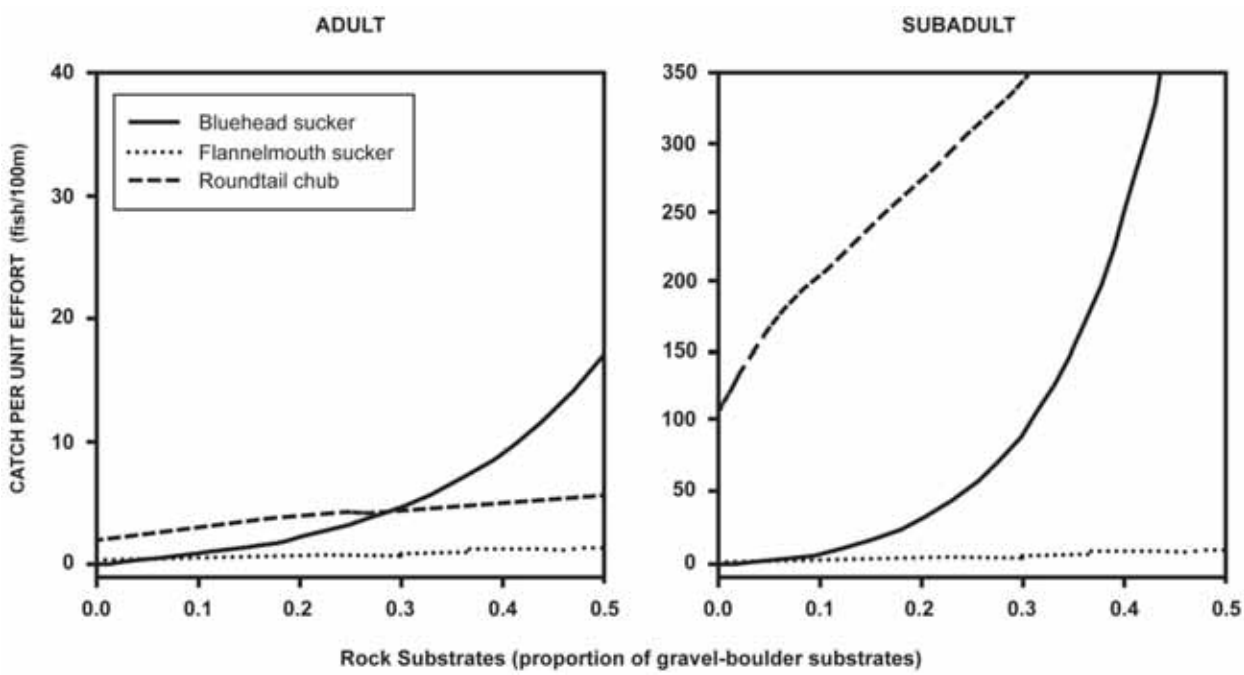


Figure 4.9-1. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of the prevalence of rock substrates at the reach scale from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species.

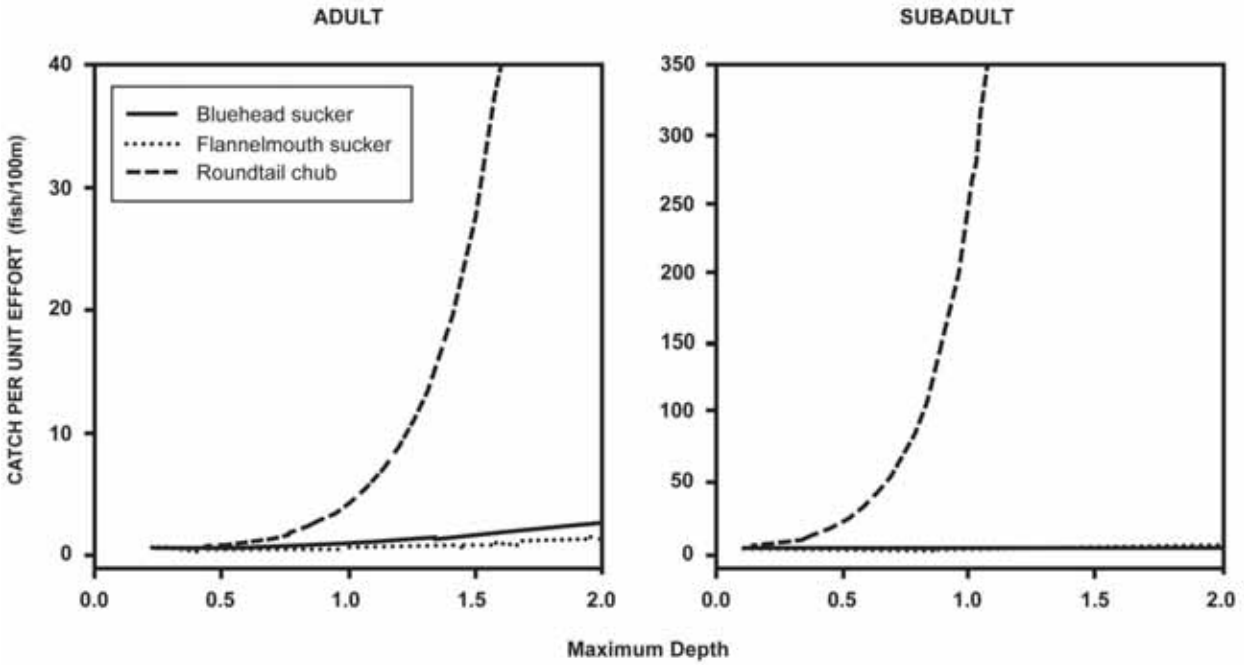


Figure 4.9-2. Relative abundance of two length groups of three species within the upper Muddy Creek watershed as a function of maximum channel unit depth from Bower (2005). Plots were generated using the averaged multi-model linear-regression function for both length groups of the three species above minimum depth thresholds.

Figure 4.9-3. Example of erosion resulting from concentration of surface runoff at drainage crossings

In the case of the Proposed Action, the effects of urbanization are thought to include the detrimental effects of exotic species introduction and increased human presence within the project area. Roads provide dispersal mechanisms for a variety of exotic upland and riparian plant species. Of particular concern is the spread of tamarisk (*Tamarix* spp., also known as salt cedar) within the upper Muddy Creek watershed. This exotic species has been shown to displace native riparian vegetation while consuming a greater volume of water, resulting in reduced water tables and suitability of aquatic habitats (Graf 1978). Tamarisk is currently known to exist in portions of the project area and its spread is likely a result of dispersal via roadways. Increased human uses of the area are also likely to increase the probability of unsanctioned, illegal, and unintentional introductions of exotic fishes and other aquatic organisms. These introductions have been cited as one of the major threats to fresh-water biodiversity (Allan and Flecker 1993) and warrant careful consideration given the detrimental effects of exotic fishes on native Colorado River Basin fishes present within the upper Muddy Creek watershed.

Stream fishes require habitats for spawning, feeding, rearing, and refuge. The spatial heterogeneity and connectivity of the stream system can necessitate the movement of fishes among these habitats in order to complete their life-cycles (Schlosser 1995). Interruption of movement among required habitats by road crossings can have demographic effects, decreasing population viability (Trombulak and Frissel 2000, Gibson *et al.* 2005). The distributions of the three target species during the summer and fall of 2003 suggest several implications of habitat fragmentation with regard to access to refuge habitats and subsequent ability to recolonize adjacent reaches (Bower 2005). Additionally, movements of the three species observed during 2005 suggests that required habitats exist in spatially distinct portions of the watershed, thus requiring movement of individuals in order to complete their life history requirements (Compton 2007). Eighty-acre spacing of well locations, typical in the high-development parts of the project area, could result in a road density of up to 2.5 mi/mi^2 within the portion of the project along Muddy Creek, including new road construction. Additionally, crossings of Muddy Creek may occur as a result of the Proposed Action, although the number and specific locations of these crossings have not yet been determined. Eighty-acre spacing would result in significance based on Criterion 2.

Research within the Little Robbers Gulch drainage has demonstrated the effects of roads, natural gas drill pads, and pipelines on sediment production and runoff (Wollmer 1994). This work examined the effect of road densities of 2 mi/mi^2, including associated well pad and pipeline facilities, on local sediment production and runoff. A net increase of 1 percent in local sediment production and 0.3 percent in local runoff was found when compared to unaltered rangeland sites. Although this work helps to identify the potentially limited extent of local erosion caused by roads, the study did not address the effects of flow interception which can lead to altered runoff timing, routes, and magnitudes. It is these hydrologic alterations that are most likely to result in geomorphic adjustments through erosion, causing sedimentation or loss of habitat features such as deep pools.

Increased sediment delivery to stream-bottoms can embed gravels and reduce spawning success via decreased embryo survival fill in rearing pools, and reduce complexity of the habitat in stream channels

(Magee *et al.* 1996). Deposition of sediment can also decrease populations and species composition of aquatic macroinvertebrates that are highly dependent on interstitial spaces for different life stages. These community changes can be detrimental to fisheries that depend on macroinvertebrates as primary food supplies and can change the abundance and diversity of the fish population. Loss of these stream attributes would threaten the persistence of BLM sensitive fish species.

In addition to project activities that cause surface disturbance, a major source of sediment input to streams in the project area is wind erosion. Much of the area along Muddy Creek within the project area has a moderate to high wind-erosion potential (**Map 3.3-2**). A moderate potential for wind erosion exists for 80 percent of the total project area or 859,633 acres (**Table 3.3-1**).

Discharges of Produced Water. Produced water from the project area would not be discharged to Muddy Creek within the Little Snake River drainage; therefore, produced-water discharges would not pose a risk to these species

Spills of Toxic Materials. Accidental releases of toxic materials to Muddy Creek would pose a risk to sensitive fish populations. The probability of spills occurring is unknown, but their consequences could be significant if spills occurred. One spill could kill most of the fish in lower Muddy Creek.

Because of the limited distribution in Wyoming and other states of the three sensitive fish species found in the project area—the roundtail chub, the bluehead sucker, and the flannelmouth sucker—the effects of the Proposed Action are considered to be significant. The disturbance created by new roads and facilities would increase suspended sediments and sedimentation, altering habitat features found to be important to the fishes and fragmenting that habitat. These effects would be exacerbated by any accidental discharge of produced water or spills of toxic materials into the watershed. The significant impact on the habitat of the species within the project area may preclude improvement of their status as prescribed in the *Range-wide Conservation Agreement for Bluehead Suckers, Flannelmouth Suckers, and Roundtail Chubs*. This would be contrary to Criterion 4. Eighty-acre spacing of wells would result in significance based on Criterion 2.

Sensitive Plant Species

The presence of sensitive plant species on public lands would be determined by soil surveys or rare-plant surveys prior to site development. Avoidance and best management practices identified on a case-by-case basis would then be applied to proposed surface-disturbing activities to protect or enhance sensitive plant species and their habitats (BLM 2008a, p. 2-47). Therefore, decreased viability or increased mortality of the Cedar Rim thistle, Gibben's beardtongue, Meadow milkvetch, and persistent sepal yellowcress—or adverse alteration of their critical habitats—would not occur on public lands within the CD-C project area with implementation of the Proposed Action. Meadow milkvetch and persistent sepal yellowcress would be further protected on public lands because development would not be permitted within 500 feet of riparian and wetland habitats (BLM 2008a). Cedar Rim thistle and Gibben's beardtongue could be impacted if their habitats are disturbed by development activity. BLM-designated sensitive plant species are likely to occur on private and state lands within the project area; however, surveys to determine their presence or to locate their habitat would not be required nor would avoidance or other mitigating activity. The impact on private and state lands is thus not known.

Indirect impacts to special status plants and/or their habitats could occur as a result of several natural gas development activities. New invasive weed infestations near well pad locations and other surface disturbances could spread into occupied special status plant species habitat. The effects of fugitive dust created by new access roads and increased vehicle activity could have a detrimental effect on the vigor and survival of special status plant species. Unauthorized off-road vehicle use could negatively impact special status plant species, either by direct destruction or by alteration of their habitats. Indirect impacts to BLM-designated sensitive plants on public lands are anticipated to be either minimal or none due to the required 500-foot setback from riparian areas and the use of soil survey information to locate potential

sensitive species habitats. In addition, the RFO staff has information that identifies potential habitats by soil type and known populations of these species.

4.9.3.2 Alternative A: 100-Percent Vertical Drilling

Threatened, Endangered, Proposed, or Candidate Wildlife Species

Under Alternative A, the types of impacts to special status species and their habitats would be similar to those described for the Proposed Action. For this alternative, the scope and intensity of the impacts would be more widespread because of the increased surface disturbance associated with construction of more well pads, roads, and pipelines required for 100-percent vertical drilling. The total number of well pads and access roads would be 8,950, compared to the estimated 6,126 well pads estimated for the Proposed Action. Estimated surface disturbance for this alternative would be 31 percent greater (14,496 acres) than the Proposed Action. Combined with previous surface disturbance, more than 11 percent of the project area would be disturbed at one time or another. After successful reclamation, the project-related acreage that would remain in a non-vegetated state would be 28 percent greater (5,272 acres) than the Proposed Action. Shrub-dominated habitat would not recover during the life of the project. Habitat loss and fragmentation would be comparably more extensive than under the Proposed Action. Impacts to species already likely to exceed significance criteria such as sage-grouse in non-core areas would be increased and are expected to exceed Criteria 2 and 3. Additionally, in the checkerboard portion of the project area, the RMP limitations do not apply to private and state lands, so it is possible that impacts to species with large indirect impact zones, such as nesting/foraging ferruginous hawks, could reduce the effectiveness of the mitigation on BLM land, possibly leading to exceeding impact significance Criterion 4. Although this increase of surface disturbance would increase the impact to shrub dependent bird species such as Brewer's sparrow, loggerhead shrike, sage sparrow, and sage thrasher, it should not reach the level of significance under Criterion 4.

The BLM will seek to apply conservation measures for **greater sage-grouse** in state-designated core population areas consistent with IM WY-2012-019 (BLM 2012c), pending the amendment of the Rawlins RMP. In non-core areas, leks would be protected by the application of the 0.25-mile lek NSO as well as the Rawlins RMP requirement to avoid identified nesting and early brood-rearing habitat, regardless of distance from a lek, from March 1 to July 15. Timing Limitations would provide additional seasonal protection to wintering sage-grouse in non-core areas. It is expected that greater than three wells or 60 acres of disturbance per square mile could occur within the 2-mile radius of some non-core leks but not all; this would be considered an "Extreme Impact" relative to those individual leks (WGFD 2010a).

As discussed in the Proposed Action, **ferruginous hawk** nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone. It is difficult to determine if this would exceed Criterion 4 in this case because other factors such as topography could decrease the size of the needed buffer around nests, but the impacts are not expected to exceed the criterion.

Other sensitive species including **mountain plover** and **white-tailed prairie dog** would be provided protections for nest and habitat avoidance, as appropriate, on BLM-managed lands but not on private and state-managed lands. Given the increased acreage anticipated to be disturbed under this Alternative it is expected that Criterion 4 may be exceeded for these species.

Although the increase of surface disturbance anticipated under this alternative would increase the impact to shrub-dependent bird species such as Brewer's sparrow, loggerhead shrike, sage sparrow, and vespers sparrow, it is not likely to reach the level of significance under Criterion 4.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

The types of impacts to sensitive fish species would be the same as for the Proposed Action, but because of the larger surface area affected, the magnitude of the impacts would be proportionally greater.

Special Status Plants

Although the amount of surface disturbance would be greatly increased under Alternative A, the measures to avoid and protect special status plants that would be implemented make it unlikely that special status plants would be more affected by implementation of Alternative A than by the Proposed Action.

4.9.3.3 Alternative B: Enhanced Resource Protection

Threatened, Endangered, Proposed, or Candidate Wildlife Species

The ERP alternative was developedin part to prevent significant impacts to wildlife resources of concern by implementing additional protections and mitigations, when necessary, beyond those normally applied (e.g. BMPs, COAs, Wildlife Monitoring and Protection Plan). The ERP alternative also recognizes that development may be more intensive than currently expected and may result in impacts to wildlife habitats and populations faster than anticipated. This alternative would combine prescriptive and adaptive management approaches, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis. The enhanced resource protections would go into effect immediately and be applied to all future APDs and other project-related activities. Should surface disturbance or population thresholds be reached, additional protection measures would also be implemented, specific to each affected species. See **Section 2.23** for a detailed description of this alternative.

The additional restrictions under this alternative are likely to encourage the use of directional drilling and enhanced reclamation practices. For this reason, the scope and intensity of impacts on special status species and their habitat would be less. Maximum initial surface disturbance for this alternative is estimated to decrease by 1,684 acres to 45,516 acres, a 3.6 percent reduction from the Proposed Action. Long-term disturbance would decrease by 611 acres, to 18,249 acres.

Because more wells would likely be drilled directionally from multi-well pads under this alternative, fewer well pads overall would be constructed—an estimated 5,798 compared to the estimated 6,126 well locations of the Proposed Action, a reduction of 5.4 percent. Therefore, fewer access roads would be developed and habitat fragmentation would be less extensive than for the Proposed Action.

The special status species/habitat that would receive enhanced protections under this alternative include greater sage-grouse leks, nesting/brood-rearing habitat, and winter concentration areas, and ferruginous hawk nest habitat. Enhanced protections afforded these species and their habitats would benefit numerous other species. The following additional mitigation measures, along with many others more specific to special status species, are included in this alternative:

- Minimize human presence at well sites after they have been put into production by installing remote monitoring devices on project facilities and gating roads;
- Utilize noise-reduction techniques;
- Timely reclaim well pads, pipelines, and rights-of-way to reduce displacement of wildlife from the well field;
- Provide training programs for field workers to raise awareness of activities that cause stress to wildlife, times of day when collisions are most likely, and other programs as necessary;
- Install devices to preclude raptor-perching near prairie-dog towns and pygmy rabbit burrows; and
- Bury new power lines near sage-grouse leks.

Greater sage-grouse. The enhanced protections for greater sage-grouse would decrease the degree of impact, especially in non-core areas, as compared to the Proposed Action. These enhanced protections would be in addition to protections normally applied (e.g. BMPs, COAs, Wildlife Monitoring and Protection Plan) and protections described in IM WY-2012-019 for sage-grouse core areas. Applications for Permit to Drill (APDs) within greater sage-grouse lek, nesting/brood-rearing habitat, and winter concentration areas would be submitted as part of an overall development plan for an entire lease or several leases. The plan is described previously in the general requirements portion of the alternative.

In addition, the following requirements would be implemented throughout sage-grouse habitat:

- Burying new power lines and using low-profile facilities within 1 mile of an occupied lek or in winter concentration areas;
- Use of noise-reduction technology so that noise would not exceed 49 decibels measured at 30 feet from the source at all drilling, production and compressor sites; and
- No more than one oil and gas or mining location per 640 acres and no more than 5 percent habitat disturbance (related to all programs or applicable sources of disturbance).

Additionally, surface-disturbance and population thresholds have been developed as part of this alternative to maintain sage-grouse habitat and populations in the face of increasing development pressure.

Surface-disturbance thresholds would reduce the risk of impacts of habitat removal and modification in sage-grouse habitats. The surface-disturbance thresholds seek to reduce the amount of habitat disturbed and to mitigate disturbance with reclamation. If surface disturbance for natural gas roads, pipelines, well pads or other facilities has exceeded 5 percent or one oil and gas or mining location per 640 acres within **core areas**, the BLM would:

- Require remote well-monitoring at all well pads;
- Evaluate reclamation success in the section and request from the Operator a revised reclamation plan to address any failed reclamation. The calculated percentage disturbance would be adjusted downward for successful interim reclamation.
- Conduct an assessment of the disturbance and determine if enhancement of sage-grouse habitat is needed at that time. If so, begin implementation.

If surface disturbance were to reach 10 percent or 2 oil and gas or mining locations per 640 acres of **non-core** sage-grouse lek, nesting/early brood-rearing habitat, or winter concentration areas in a lease, habitat improvement projects would be required. Projects could include, but would not be limited to:

- Vegetation treatments such as fertilization, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs, and establishment of food plots; and
- Water developments.

Population-level thresholds are intended to maintain sage-grouse population levels within the project area. If WGFD were to express formal written concern that the population of sage-grouse is declining at an accelerated rate, all Operators on public lands within sage-grouse lek, nesting/early brood-rearing habitat or winter concentration areas would implement a mitigation package identified by BLM that would include, but would not be limited to:

- Evaluation of reclamation success in the lease or right-of-way and a request to the Operator to provide a revised reclamation plan to address any failed reclamation.
- Vegetation treatments such as fertilization, seeding, prescribed burning, cutting/chopping for regeneration, planting shrubs, and establishment of food plots (the BLM may also coordinate habitat improvement projects among multiple Operators); and
- Timing and Distance Restrictions (Non-core areas to conform with core areas):

  - When the threshold is reached, surface-disturbing activity or surface occupancy would be prohibited or restricted on or within a 0.6 mile of the perimeter of occupied sage-grouse leks. In addition, disruptive activities within 0.6 mile of the perimeter of occupied sage-grouse leks are restricted from 6:00 pm to 9:00 am from March 1 – May 15.
  - Avoid surface-disturbing and disruptive activities in suitable greater sage-grouse nesting and early brood rearing habitat within 2.5 miles of the perimeter of an occupied lek from March 15 – June 30.
  - Prohibition of surface-disturbing and disruptive activities within 0.5 mile of non-core sage-grouse winter concentration areas from November 15 – March 14.
- Density Restrictions:
  - Core area APDs would be limited to the density disturbance calculation tool thresholds (see density restrictions in IM 2012-019). When thresholds are exceeded, the BLM would work to colocate or minimize disturbance for valid and existing rights.
  - When the population threshold is reached in non-core areas, strive to maintain <3 pads per square mile within 2 miles of the perimeter of occupied sage-grouse leks

If the population status of the species changes in the future, additional data would be collected and additional protection measures would be developed.

Standard density restrictions in defined core population areas would limit the density of disruptions on the landscape to 1 well pad per 640 acres or the cumulative area of disturbance to less than 5 percent of the suitable sagebrush habitat within the same 640 acres (IM WY-2012-019). In non-core areas the Rawlins RMP provides timing stipulation protection to identified nesting and early brood-rearing habitat regardless of the distance from a lek. With these protection measures, habitat in sage-grouse lek, nesting/early brood-rearing habitat, or winter concentration areas should be maintained. The risk of a significant population decrease resulting from gas development is expected to decrease under this alternative. Impacts to sage-grouse in both core and non-core areas should not reach the level of significance under this alternative provided the Core Population Area mitigation measures found in the IM, the RMP, and the State Executive Order are applied and the 5 percent surface disturbance trigger is effective at predicting habitat impact issues in advance of Criterion 4 being exceeded.

Ferruginous Hawk Nesting Habitat. Under this alternative, the basic RMP requirements and standard site-specific requirements would apply. Currently, there are 84 known ferruginous hawk territories within the project area. No additional protections would apply to ferruginous hawk nesting habitat unless one of the two following thresholds were reached—a surface disturbance threshold and a population threshold:

In the event that surface disturbance within 1 mile of a ferruginous hawk nest exceeds 10 percent, Operators in all leases within the 1 mile nest radius of would be required to participate in a development/mitigation plan before additional APDs would be issued.

If WGFD were to express formal written concern about the ferruginous hawk population, the following mitigation measures would be implemented immediately:

- All existing development features and facilities (pads, pipelines, roads, holding yards, compressor stations, and other associated infrastructure) within the nesting territories would be inspected to determine reclamation success. If reclamation has been unsuccessful, measures would be taken to improve the reclamation of the facilities.

- Ten man-made[19] nests would be built outside of existing monitoring territories on natural substrates, and farther than 1,200 feet from existing disturbances, prior to January 10th of the year following receipt of WGFD's letter of concern.
  - The farther the nest is constructed from existing disturbances the better.
  - These nests would be incorporated into the annual monitoring efforts.
  - Controlled Surface Use and Timing Limitation stipulations would be applied to any nests that become occupied by raptors.
- Two artificial nesting structures [20] would be placed outside of existing monitoring territories, and farther than 1,200 feet from existing disturbances, prior to January 10th of the year following receipt of WGFD's letter of concern.
  - Priority for placement of these nests would be determined based on information regarding extant nests located on man-made infrastructure, or where there is known repeated attempts at nesting on man-made infrastructure.
  - These nests would be incorporated into the annual monitoring efforts.
  - Controlled Surface Use and Timing Limitation stipulations would be applied to any nests that become occupied by raptors.

If the species population continues to decline, additional data would be collected and additional protection measures would be developed.

With these protection measures, nesting habitat and fledgling production should be maintained, even in the checkerboard area. The risk of population decrease resulting from gas development is expected to decrease from the Proposed Action and would not be expected to exceed the impact significance criteria.

Under the Enhanced Resource Protection Alternative, other special status species discussed in the Proposed Action (e.g. pygmy rabbit, mountain plover, white-tailed prairie dog, swift fox, long-billed curlew, Great Basin spadefoot, northern leopard frog, etc.) would have no additional specific species protections beyond those required by the RMP (timing and surface stipulations), BMPs (**Appendix C**) and the Wildlife Monitoring and Protection Plan. However, by implementing the ERP alternative, many of these species would benefit from the additional protections. For example, riparian species and northern leopard frogs would benefit from the enhanced protections of the Muddy Creek corridor/watershed, Chain Lakes wetlands, and playas.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

The Enhanced Resource Alternative Protections for the Muddy Creek and Bitter Creek Corridors/Watersheds described in **Section 2.2.3.4** could significantly reduce project impacts to sensitive fish species. The sources of these reductions would include the following protections:

- For protection of amphibians and their habitats, avoidance of surface-disturbing and disruptive activities within 0.25 mile of Red Wash, springs, wells, and wetlands would be required. The required avoidance distance would be further increased on perennial streams to 0.5 mile. Exceptions would only be granted by the BLM based on environmental analysis and site-specific engineering and mitigation plans. Only actions within areas that could not be avoided and that would provide

[19] Man-made nests are nests that are built in appropriate habitat and are intended to attract ferruginous hawks.

[20] Artificial nesting structures are built to attract hawks that would build their own nest on the structure.

protection for the resource identified would be approved. In-channel activities would be restricted to the low-flow period.

- Current monitoring on upper Muddy Creek would be extended to lower Muddy Creek in the CD-C project area. This requirement would bring lower Muddy Creek into conformance with the monitoring being done for upper Muddy Creek and other drainages within the Atlantic Rim project area. If results of the monitoring program showed impacts to sensitive fish habitat, the BLM and an interagency CD-C consultation group would determine whether habitat-improvement projects should be implemented. The projects could include, but would not be limited to, increasing the number of drainage features along roads, increasing in-stream cover for fish, and other measures as necessary.
- A monitoring plan for the Bitter Creek watershed will be designed.

The following requirements related to **selenium and salinity** for well locations and operations would also be implemented:

- No surface discharge of produced waters within the Muddy Creek and Bitter Creek watersheds.
- Line all reserve pits in the Muddy Creek and Bitter Creek watersheds.

These protections, however, would only apply to BLM land (an estimated 48 percent of the total area). An unintentional consequence of these protections could be to increase drilling activities on private land and state land. Such development on private and state land along Muddy Creek could completely negate the enhanced resource protections on BLM land along Muddy Creek. To preclude this possibility, the Operators and the state should make a commitment to apply these same enhanced resource protections to private and state land along Muddy Creek. Without this commitment, it is likely that the impacts to sensitive fish species for this alternative would be the same as for the Proposed Action alternative.

Sensitive Plant Species

Special-status plants would receive no added protection under Alternative B. The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that special status plants would not be affected by implementation of Alternative B any more than they would under the Proposed Action.

4.9.3.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

Threatened, Endangered, Proposed, or Candidate Wildlife Species

This alternative differentiates between existing high-density development areas—those areas that have seen the greatest natural-gas development to date—and low-density development areas (**Map 2-1**), placing a higher cap on disturbance in areas that have already undergone considerable development. Within the high-density development areas, a 60-acre cap would be placed on the amount of unreclaimed surface disturbance allowed at any one time in a section of public land. For the remainder of the project area—the low-density development areas—the cap would be 30 acres per section. All prior surface disturbance committed to long-term use for roads or on-pad production facilities and all disturbance that had not been successfully reclaimed would count against the cap. Acreage that had successfully undergone interim reclamation would not count against the cap. In general, adverse impacts in both areas should be reduced compared to the Proposed Action.

Under Alternative C, the types of impacts to special status wildlife species and their habitats would be similar to those described for the Proposed Action. The cap, however, would place a limit on the amount of unreclaimed surface disturbance at any one time in a section of public land. This requirement should encourage the use of directional drilling and enhanced reclamation practices. For this reason, the scope and intensity of impacts on special status species and their habitat would be less. Maximum surface

disturbance for this alternative is estimated to decrease by 4,245 acres in the short term to 42,955 acres, a 9 percent reduction from the Proposed Action. Long-term disturbance would decrease by 1,543 acres, to 17,318 acres.

Because more wells would be drilled from directional well pads under this alternative, fewer well pads overall would be developed—an estimated 5,299 compared to the estimated 6,126 well locations of the Proposed Action, a reduction of 13.5 percent. Therefore, fewer access roads would be developed, fewer pipelines would be installed, fewer haul-truck miles would be logged, and habitat fragmentation would be less extensive than for the Proposed Action.

Greater sage-grouse should benefit from fewer wells and disturbance. In the core areas, restrictions found in IM WY-2012-019 and the Greater Sage-grouse Core Area Protection program (SGEO) (SWED 2011) would apply in many instances, so impacts may not exceed the impact significance criteria. In non-core areas, application of RMP and IM timing stipulations in potential nesting and brood-rearing habitat as well as the BLM standard COAs, BMPs, and mitigation would reduce the potential impact to sage-grouse although some impact to those populations would still be anticipated over the long term. The protections found in the SGEO would apply in non-core areas on non-federal lands. Impacts to sage-grouse in both core and non-core areas should not reach the level of significance under this alternative provided the Core Population Area mitigation measures found in the IM, RMP, and SGEO are applied. As discussed in the Proposed Action alternative, ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone. It is difficult to determine if this would exceed Criterion 4 in this case because other factors such as topography could decrease the size of the needed buffer around nests. Impacts to white-tailed prairie dog and mountain plover are not expected to exceed Criterion 4 as the protection measures found in the RMP would be applied.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

Within the project area, about 59 percent of the Muddy Creek watershed is located in the high-density area and about 41 percent is in the low-density area (**Map 2-1**). Because surface disturbance would be capped at 30 acres per section in the low-density area and at 60 acres per section in the high-density area, impacts to fish in Muddy Creek as a result of surface disturbance should be less under this alternative compared with the Proposed Action. Without the added types of protections for Muddy Creek discussed in **Section 4.8.3.3** for Alternative B, however, the impacts to sensitive fish species could be similar to those for the Proposed Action.

Sensitive Plant Species

The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that special status plants would be as little affected by implementation of Alternative C as by the Proposed Action. To the extent that surface disturbance decreases and the number of disturbance sites is reduced, the likelihood of adverse impacts is diminished further.

4.9.3.5 Alternative D: Directional Drilling

Threatened, Endangered, Proposed, or Candidate Wildlife Species

Under Alternative D, the types of impacts to special status species and their habitats would be similar to those described for the Proposed Action. This alternative requires that all future natural gas wells on federal mineral estate and surface be drilled from multi-well pads. In sections that have already undergone

development, the enlargement of one existing well pad would be permitted as the multi-well pad for all future drilling in that section. No new roads or pipeline routes would be permitted in these leases. In sections that have not been developed, one new well pad would be permitted for all future development. One road and pipeline corridor on the lease would be permitted. The objective of this alternative is to minimize surface disturbance and to reduce habitat loss and wildlife disturbance. It would also reduce fragmentation of habitat. Total surface disturbance for this alternative would decrease by 10,751 acres to 36,449, a reduction of about 23 percent from the Proposed Action. Long-term disturbance is estimated to decrease by 3,908 acres to 14,952 acres, a reduction of about 21 percent.

Most wells would be drilled from directional well pads under this alternative and fewer well pads overall would be developed—an estimated 4,032 compared to the estimated 6,126 for the Proposed Action, for a reduction of about 34 percent. Therefore, fewer access roads would be constructed and fewer pipelines installed, and habitat fragmentation would be less extensive than for the Proposed Action. However, noise from drilling and completion activities occurring at long-duration multi-well pads could represent a localized negative impact to a sub-set of sensitive receptors (i.e. nesting raptors, lekking or brooding sage-grouse) due to the increased period of time required for drilling and well completion activity at a single location. Reduced surface disturbance and habitat fragmentation resulting from multi-well pads comes with an increase in decibel level and frequency of that noise, as well as the extended period of time over which large haul-truck activity would occur.

Because this alternative reduces the number of active well locations to be drilled along with associated roads and pipelines, impacts to most species would be reduced under this alternative compared to the Proposed Action. Impacts to the habitats of those species that depend on shrubs (sage-grouse and the shrub-dependent songbirds) would be significantly less than the Proposed Action due to the decrease in impacted habitat.

In addition to the reduced surface disturbance and fragmentation resulting from Alternative D, implementation of the BLM IM and State Executive Order sage-grouse protections would reduce impacts to greater sage-grouse in core areas. Mitigations and restrictions applied for protection of sage-grouse in non-core areas (BLM 2012c and WSEO 2010) would apply on all remaining sage-grouse habitat in the project area, regardless of ownership, as appropriate.

As discussed in the Proposed Action, ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone; however, the reduced number of well locations on BLM-administered lands should further decrease risks to the species. It is not expected that Criterion 4 would be exceeded as other factors such as topography could decrease the size of the needed buffer around nests.

Threatened and Endangered Fish Species

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action.

Sensitive Fish Species

Total surface disturbance for this alternative would be about 23 percent lower than for the Proposed Action; therefore, impacts to sensitive fish species should be proportionally less.

Sensitive Plant Species

The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that special status plants would be as little affected by implementation of Alternative D as by the Proposed Action. To the extent that surface disturbance decreases and the number of disturbance sites are reduced, the likelihood of adverse impact would be diminished even further.

4.9.3.6 Alternative E: No Action

Under the No Action Alternative it is assumed that no further natural gas development would occur within the CD-C project area. There would consequently be no new surface disturbance and no new impacts on special status species or their habitat. These species would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of browse and forage caused by dust.

The Rawlins RMP (BLM 2008b) prescribes the following management objectives associated with wildlife and fisheries resources (including Special Status Species):

- Maintain, restore, or enhance wildlife habitat in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements. A full range of mitigation options will be considered when developing mitigation for project-level activities for wildlife and Special Status Species habitats.
- Maintain, restore, or enhance T&E species habitat, in coordination and consultation with the USFWS and other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance designated BLM State Sensitive Species habitat to prevent listing under the ESA, in coordination and consultation with other local, state, and federal agencies and consistent with other agency plans, policies, and agreements.
- Maintain, restore, or enhance habitat function in crucial winter range.

The RMP also defines the following impact significance criteria that are used in this document to assess the impacts associated with the Proposed Action and alternatives (BLM 2008b). Impacts to special status wildlife and fish species would be considered significant if any of the following were to occur:

1. Substantial loss of the biological integrity and habitat function of terrestrial and aquatic ecosystems that would make a species eligible for listing under the ESA.
2. Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species, or adverse alteration of their critical habitats.
3. Substantial loss of habitat function or disruption of life-history requirements of special status species that would preclude improvement of their status. Habitat function means the arrangement of habitat features and the capability of those features to sustain species, populations, and diversity of wildlife over time (WGFD 2010a).
4. Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species. (Not in the RMP but added by RFO staff to this list.)

Impacts to special status plant species would be considered significant if any of the following were to occur:

1. Any action or event that would remove a community's unique attributes or ability to support other resource values within the planning period, or if corrective actions were beyond the scope of the RMP.
2. The viability of protected plant species is jeopardized, with little likelihood of reestablishment after disturbance, or actions result in the need to list a species under ESA.
3. Actions that have the potential to remove sensitive plant species or substantially alter the habitat's ability to support the species.
4. Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species. (Not in the RMP but added by RFO staff to this list.)

4.9.4 Impact Summary

The project, as proposed, would disturb and alter approximately 47,200 acres of wildlife habitat over the next 15 years, in addition to the 60,176 acres already disturbed by natural-gas and other development. Reclamation of disturbed areas should recover grass-dominated habitats in one to several years, depending on precipitation and effectiveness of reclamation efforts. Shrub habitats would not reach pre-disturbance levels during the life of the project. Therefore, shrub-dependent special status species would be impacted most by habitat loss.

In addition to the physical removal of habitat, disturbance during construction and production can displace or preclude wildlife use during all seasons. Timing restrictions for the critical times of year have been developed for the most sensitive species and are generally implemented during the development phase, but no restrictions would be in place during the production phase. Other impacts from natural-gas development include habitat fragmentation, reduced availability and palatability of forage due to dust, and mortality from collision between vehicles and wildlife. The measures aimed at avoiding and protecting special status plants that would be implemented under the Proposed Action and all alternatives would ensure that potential impacts to special status plants would be minimized or eliminated.

Proposed Action. It is expected that for the Proposed Action, Criteria 2 and 3 (*Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species, or adverse alteration of their critical habitats.* and *Substantial loss of habitat function or disruption of life-history requirements of special status species that would preclude improvement of their status.*) could be exceeded for sage-grouse outside the core area. Additionally, ferruginous hawk nests located near private or state surface in the checkerboard would not benefit from the entire 1-mile seasonal buffer zone but it is not expected that Criterion 4 would be exceeded as other factors, such as topography, could decrease the size of the needed buffer around nests. Other special status species should be protected sufficiently by the COAs, RMP requirements, and BMPs to avoid exceeding the significance level.

The primary source of potential risks to fish species from land disturbance from project activities would be increases in suspended sediments and sedimentation. The intensity of these impacts may decrease with the completion of the construction phase and with the onset of reclamation efforts on disturbed areas.

None of the Threatened and Endangered fish species found downstream of the project area within the Colorado River system are known to occur in the project area; therefore, there would be no direct impacts to these species. Implementation of all mitigation measures for water and soils would help reduce other potential impacts. Accidental releases of produced waters or other materials also could occur. However, these materials would become highly diluted before they would reach any downstream waters where these species occur; consequently, the potential risks from such occurrences would be negligible.

With the implementation of the Proposed Action, direct loss of habitat for sensitive fish species would result from sedimentation associated with the construction of well sites and related access roads and pipelines. Accidental releases of produced waters or other materials could occur. Alteration of sensitive fish habitat suitability from sedimentation would result in significant impacts to sensitive fishes (Criteria 3 and 4).

Alternative A: 100-percent Vertical Drilling would affect an additional 14,496 acres of wildlife habitat (a 30.7-percent increase). The impacts described above would be greatly intensified under this alternative and Criteria 2 and 3 would likely be exceeded for sage-grouse outside the core area. Criterion 4 (*Actions that preclude attainment of conservation goals, as stated in conservation plans and strategies for special status species.*) would not be exceeded for ferruginous hawks.

Impacts to threatened and endangered fish species would be the same as for the Proposed Action. Overall, the types of impacts to sensitive fish species would be similar to those described for the Proposed Action; however, the level of impacts would be greater due to increased surface disturbance. Accidental releases of produced waters or other materials also could occur with significant consequences. Alteration of fish

habitat suitability from sedimentation would result in significant impacts to sensitive fish species (Criteria 3 and 4).

Alternative B: Enhanced Resource Protection was designed to reduce impacts of development on those species or habitats that are most vulnerable to an infill oil and gas project. There would be a slight reduction (1,684 acres, about 3.5 percent) in the amount of wildlife habitat disturbed under this alternative compared to the Proposed Action, but because of the additional mitigation requirements, impacts to sage-grouse outside core areas and ferruginous hawks should be reduced to a level below significance. Other special status species (white tailed prairie dogs, Wyoming pocket gopher, pygmy rabbits, mountain plovers and neotropical birds) would also benefit from this alternative. The additional protection of the Muddy Creek watershed, riparian areas, and playas would also benefit a number of special status species.

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action. The Enhanced Resource Protections for the Muddy Creek Corridor/Watershed described in **Section 4.2.3.9** could significantly reduce project impacts to sensitive fish species if they were applied to both BLM and private land within the project area. Without the application of these protections to private land, however, the benefits of these enhanced resource protections could be negated by increased drilling activities on private land. Accidental releases of produced waters or other materials also could occur. Without this commitment, alteration of fish habitat suitability from sedimentation could result in significant impacts to sensitive fish species (Criteria 3 and 4). With such a commitment, the project area and other human activities within the Muddy Creek and Great Basin watersheds should not have significant cumulative impacts on the status of their populations within Wyoming.

Alternative C: Surface Disturbance Cap – High and Low Density Development Areas seeks to reduce habitat disturbance and reward successful reclamation. It is expected to impact 4,245 fewer acres than the Proposed Action. It should reduce the impacts to all species below that of the Proposed Alternative, but impacts would still be expected to exceed the significance level for sage-grouse in non-core areas. While fewer wells should help nesting ferruginous hawks, it is still possible the significance level would be reached in the checkerboard area.

Impacts to Threatened and Endangered fish species would be the same as for the Proposed Action. Because only a small proportion of Muddy Creek is on BLM land in high-density development areas, impacts to sensitive fish species would be less than under the Proposed Action. Alteration of fish habitat suitability from sedimentation, however, still would result in significant impacts to sensitive fish species (Criteria 3 and 4). Accidental releases of produced waters or other materials also could occur with significant consequences.

Alternative D: Directional Drilling would be expected to reduce surface-disturbance acreage by approximately 23 percent, when compared to the Proposed Action; anticipated impacts to special status species in the project area would be below the point of significance. Impacts to threatened and endangered fish species would be the same as for the Proposed Action. Because the amount of land disturbed under this alternative would be less than for the Proposed Action, impacts to fish should be proportionally less. Accidental releases of produced water or other materials also could occur with significant consequences. Alteration of fish habitat suitability from sedimentation would result in significant impacts to sensitive fish species (Criteria 3 and 4).

Alternative E: No Action is assumed to result in no new surface disturbance and no new impacts on special status species or their habitat because no further natural gas development would occur within the CD-C project area on federal, state, or fee mineral estate.

4.9.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Criterion 1—*Substantial loss of the biological integrity and habitat function that would make a species eligible for listing under the ESA*— is not expected to be exceeded under the Proposed Action or any of

the alternatives for any species. Criterion 2— *Decreased viability or increased mortality of Threatened, Endangered, Proposed, and/or Candidate species*—would be exceeded for greater sage-grouse in non-core areas under the Proposed Action and all action alternatives except Alternative B. Criterion 2—*Substantial loss of habitat function or disruption of life-history requirements*—would be exceeded for greater sage-grouse in non-core areas under The Proposed Action and all action alternatives except Alternative B. It would also be exceeded for sensitive fish species. Criterion 4—*Actions that preclude attainment of conservation goals*—may be exceeded for ferruginous hawks under Alternative A and would be exceeded for sensitive fish species under the Proposed Action and all action alternatives. The measures aimed at avoiding and protecting special status plants under the Proposed Action and all alternatives would insure that potential impacts to special status plants would not be exceeded under the Proposed Action or any action alternatives.

The exceedances of Criteria 2 and 3 for greater sage-grouse in non-core areas could be avoided by application of the protections and mitigations for greater sage-grouse found in Alternative B, including:

- Burying new power lines and using low-profile facilities within 1 mile of an occupied lek or in winter concentration areas;
- Use of noise-reduction technology so that noise would not exceed 49 dBa measured at 30 feet from the source at all drilling, production and compressor sites; and
- Enhance timing, distance, and density restrictions within high value habitats.

The exceedances of Criteria 3 and 4 for sensitive fish species under the Proposed Action and all action alternatives could be avoided by application of the increased set-back distances found in the Muddy Creek watershed in Alternative B to private and state lands as well as public lands. Those increased distances are from 500 feet to 0.25 mile of Red Wash, springs, wells, and wetlands and to 0.5 mile from perennial streams.

Additional mitigation measures whose general application would benefit numerous special status species include the following:

- Minimizing human presence at well sites after they have been put into production by remote monitoring of project facilities and gating of roads;
- Development of travel management plans;
- Utilization of noise-reduction techniques;
- Training programs for field workers to raise their awareness of activities that cause stress to wildlife, times of day when collisions are most likely; and
- Installation of devices to preclude raptor-perching near prairie-dog towns and pygmy rabbit burrows.

These additional mitigation measures, along with others more specific to special status species, are included in Alternative B, Enhanced Resource Protection.

4.10 WILD HORSES

4.10.1 Introduction

Surface-disturbing activities associated with the construction of well pads, reserve pits, and roads could adversely affect wild horses. Land-clearing and grading activities necessary for construction remove vegetation, resulting in loss of forage, and create disturbance through increased human activity. Assuming successful reclamation, BLM standards for reclamation of disturbed sites such as linear road and pipeline rights-of-way and well pad sites would be adequate to mitigate any potential adverse effect on wild horses because of forage loss.

Prevention and containment of invasive plant species establishment and spread would have a positive impact to wild horses, wildlife, and livestock by reducing competition with native plants, consequently maximizing forage production.

4.10.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives for wild horses:

1. Maintain wild horse populations within the appropriate management levels (AML) of the HMA.
2. Manage wild horses to meet the Wyoming Standards for Healthy Rangelands.
3. Identify existing genotypes and phenotypes through recognized means of genetic evaluation and maintain genetic integrity.
4. Maintain habitat for existing AMLs.
5. Conduct all activities in compliance with relevant court orders and agreements, including the Consent Decree (August 2003).

Impacts to the wild horse resource would be considered significant if any of the following were to occur:

- Resource management actions resulting in greater than a 10-percent permanent reduction in animal unit months (AUMs) available for livestock grazing within a given allotment. In the case of the Lost Creek HMA, this would apply only to the Cyclone Rim allotment as it is the only grazing allotment within the HMA boundary in the CD-C project area (**Map 3.10-1**). The Adobe Town HMA occupies a very small portion of the project area (5,826 acres), primarily located in the Continental, Red Creek, South Flat Top and Willow Creek allotments.
- Available forage, water, or other habitat components are not sufficient to achieve or maintain the appropriate management level (AML) in a given HMA.
- Viability of wild horse populations cannot be maintained.
- The wild, free-roaming character of a wild horse herd in an HMA is lost.
- Wyoming BLM Standards for Healthy Rangelands are not met.
- Vegetation significance criteria are not met (**Section 4.6.2**).
- Non-compliance with any provision of the Free-Roaming Wild Horse and Burro Act of 1971.

4.10.3 Direct and Indirect Impacts

The wild horse resource would be directly impacted by the intensity and timing of development within the affected herd management area (HMA) and indirectly by any quantitative or qualitative changes to the vegetation resource. The primary impact to wild horses would be initial loss of available forage as a result of construction and production-related disturbances. Available forage would be reduced during drilling and field-development and reclaimed as soon as feasible under direction of the current BLM reclamation guidelines and recommendations (**Section 4.6.3.1**). A long-term loss of forage would occur under all alternatives by construction of roads, drill pads, and ancillary facilities that remain in-use during the life of the project. Wild horse management concerns with development of gas resources on public lands in the CD-C project area include control of invasive, non-native weed species, reclamation success, rangeland improvement functionality, and dust from roads. In the past, reclamation efforts within the project area have been hampered by inadequate reclamation techniques and extended drought conditions.

Indirect impacts of natural gas development on wild horses would include increased vehicle activity that could increase the potential for horse/vehicle collisions. If the Operators advise project personnel regarding appropriate speed limits on designated access roads, and these instructions are complied with, the likelihood of horse/vehicle collisions would be minimized. The level of risk for displacement of wild horses from the CD-C project area to areas outside HMA boundaries is unknown at the present time. There is some potential for wild horse conflict with wildlife/livestock.

4.10.3.1 Proposed Action

Under the Proposed Action **(Section 2.2.1**), construction of 8,950 new natural gas wells and required ancillary facilities would be anticipated over the course of the 15 year development phase within the CD-C project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. The Proposed Action is estimated to initially disturb a total of 47,200 surface acres (**Table 4.0-1**), which represents about 4.4 percent of the total land surface of the project area. Within this total, the initial disturbance acres for the Cyclone Rim allotment in the CD-C project area portion of the Lost Creek HMA is projected to be up to about 2,336 acres. Following successful reclamation, the long-term disturbance would be about 592 acres, representing a forage loss equivalent to approximately 69 AUMs (based on an average stocking ratio of 8.6 acres per AUM), less than 0.2 percent of the total forage in the allotment).

The Proposed Action would also have a small effect on the Adobe Town HMA as the initial disturbed acres for the four allotments within the HMA would total an estimated 385 acres as follows: Continental, 2 acres; Red Creek, 82 acres; South Flat Top, 301 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 101 acres, with an associated forage loss equivalent to 11.7 AUMs, less than 0.1 percent of the total AUMs in the allotments. Because the relative loss of forage is so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

The level of risk for displacement of wild horses from the CD-C project area to areas outside the HMA boundaries is unknown at the present time. The opportunity for the public to view wild horses would not be affected.

4.10.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the vegetation resource resulting from implementation of Alternative A would be similar to the Proposed Action with the exception that the total amount of initial disturbed acres would increase from a total of 47,200 acres (Proposed Action) to 61,696 acres (Alternative A). Within this total, the initial disturbance acres for the Cyclone Rim (Lost Creek HMA) allotment is projected to be about 3,037 acres. Following successful reclamation, the long-term disturbance would be about 770 acres, with an associated forage loss equivalent to approximately 90.0 AUMs, less than 0.2 percent of the total forage in the allotment.

Alternative A would have a small effect on the Adobe Town HMA as the initial disturbed acres for the four allotments within the CD-C portion of the HMA would total an estimated 503 acres as follows: Continental, 3 acres; Red Creek, 107 acres; South Flat Top, 393 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 107 acres, with an associated forage loss equivalent to 12.4 AUMs, less than 0.1 percent of the total AUMs in the allotments. Because the relative loss of forage is so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

4.10.3.3 Alternative B: Enhanced Resource Protection

Alternative B was developed to avoid and/or mitigate significant impacts to specified resource values described in **Section 2.2.3** by implementing additional protections and mitigations beyond those normally applied. The wild horse resource is not identified as one that would receive enhanced protection directly. However, the wild horse resource may indirectly benefit because livestock forage would be afforded enhanced protective measures to avoid reaching the significance criteria. These include mitigation of adverse impacts on water features, thorough power-washing of field vehicles to reduce the spread of invasive weeds, and control of fugitive dust from roads and production facilities, along with surface disturbance thresholds which trigger review of reclamation efforts and potentially range improvement projects.

Impacts to wild horses resulting from implementation of Alternative B (**Section 2.2.3)** would be slightly less than the Proposed Action, decreasing from a total initial disturbance of 47,200 acres (Proposed

Action) to 45,516 acres (Alternative B). Within this total, the initial disturbance acres for the Cyclone Rim (Lost Creek HMA) allotment is projected to be about 2,253 acres. Following successful reclamation the long-term disturbance would be about 571 acres, with an associated forage loss equivalent to approximately 66.0 AUMs, less than 0.2 percent of the total forage in the allotment.

Alternative B would have small effect on the Adobe Town HMA as the initial disturbance for the four allotments within the CD-C portion of the HMA would total an estimated 371 acres as follows: Continental, 2 acres; Red Creek, 79 acres; South Flat Top, 290 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 107 acres, with an associated forage loss equivalent to 12.4 AUMs. Because the relative loss of forage would be so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

4.10.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), the types of impacts to the wild horse resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the scope and intensity of the impacts would be less because of the surface cap restrictions. Total surface disturbance would be reduced from 47,200 acres (Proposed Action) to 42,955 acres (Alternative C), a 9-percent reduction.

Within this total, the initial disturbance acres for the Cyclone Rim (Lost Creek HMA) allotment is projected to be about 2,126 acres. Following successful reclamation, the long-term disturbance would be about 539 acres, with an associated forage loss equivalent to approximately 63.0 AUMs, less than 0.2 percent of the total forage in the allotment.

Alternative C would have a small effect on the Adobe Town HMA as the initial disturbance for the four allotments within the CD-C portion of the HMA would total an estimated 351 acres as follows: Continental, 2 acres; Red Creek, 75 acres; South Flat Top, 274 acres; and Willow, 0 acres. Long-term surface disturbance is estimated at 92 acres, with an associated forage loss equivalent to 10.7 AUMs. Because the relative loss of forage would be so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

4.10.3.5 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), the types of impacts to the wild horse resource would be similar to those described for the Proposed Action (**Section 4.6.3.1**) but the scope and intensity of the impacts would be less widespread because of the expected reduction in surface disturbance. Estimated project-wide, initial surface disturbance for this alternative would be approximately 36,449 acres, a decrease of 10,751 acres (23 percent) from the Proposed Action. The initial forage lost under this alternative is estimated to be 1,131 AUMs less than the Proposed Action. The estimated 14,952 acres of long-term disturbance is estimated to be 3,908 acres less than the Proposed Action, representing about 411 fewer AUMs lost than the Proposed Action.

Although it is not known at the present time where future multi-well pads would be located in the Cyclone Rim allotment in the CD-C project area portion of the Lost Creek HMA, the estimated maximum initial disturbance within the Cyclone Rim allotment would be approximately 164 acres, which represents the equivalent of about a 19 AUM loss for the allotment. Following successful reclamation, the long-term disturbance would be about 80 acres, representing a forage loss equivalent to approximately 9 AUMs (based on an average stocking ratio of 8.6 acres per AUM).

It may also be assumed that with fewer well pads developed, there would be similar reductions in the number of access roads and road miles within the allotment which would decrease the potential for wild horse/vehicle collision hazards, as well as reduced human presence and reduced fugitive dust generation.

Alternative D would have a small effect (if any) on the Adobe Town HMA because of the small amount of acreage involved (see **4.10.3.1**). Because the relative loss of forage is so small, none of the four

allotments in the Adobe Town HMA or the Lost Creek HMA within the Cyclone Rim allotment would undergo a reduction in the amount of AUMs allocated.

4.10.3.6 Alternative E: No Action

Under the No Action Alternative it is assumed that no further natural gas development would occur within the CD-C project area and there would be no new disturbance except where APDs have been approved by the BLM for previously authorized activities.

4.10.4 Impacts Summary

Impacts to wild horses associated with the action alternatives would include disturbed land and associated loss of available forage. Implementation of the Proposed Action would result in an initial loss of forage equivalent to approximately 69 AUMs within the project-area portion of the Lost Creek HMA, less than 0.2 percent of the total forage in the allotment. The Proposed Action would also have only a small effect on the Adobe Town HMA as the forage loss would be equivalent to 11.4 AUMs, less than 0.1 percent of the total AUMs in the allotments. Because the relative loss of forage would be so small, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated.

The alternatives to the Proposed Action would generally affect wild horses to a greater or lesser degree than the Proposed Action according to the increase or decrease in surface disturbance that would result from the alternative. However, because the relative loss of forage would be so small in each case, none of the allotments in either HMA would undergo a reduction in the amount of AUMs allocated. The No Action Alternative would have the least impact upon wild horses because virtually none of the land in either HMA would be developed.

Incentives for successful reclamation, which are featured components of Alternative C, would be a positive impact to wild horses because it rewards timely reclamation, which can prevent and contain invasive species, thus reducing competition with native plants and consequently maximizing forage production.

Under Alternative D, it may be assumed that with the fewer well pads developed, there would be similar reductions in the number of access roads and road miles within the affected allotments which would decrease the potential of wild horse/vehicle collision hazards, as well as reduced human presence and reduced fugitive-dust generation, all of which would benefit the wild horse resource.

None of the alternatives would affect the opportunity for the public to view wild horses.

The risk of displacement of wild horses from the CD-C project area to areas outside the HMA boundaries is unknown at the present time.

Wild horse conflict with wildlife and livestock would be minimized provided the current AMLs for both HMAs are closely monitored and regulated by periodic gather-and-removal cycles.

4.10.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

No measurable unavoidable adverse impacts on the area's wild horse herds are expected under the Proposed Action or the other alternatives. However, one additional mitigation measure may further minimize the likelihood of impact on the herds. The Operators could enhance wild horse welfare by addressing the importance of the Wild Free-Roaming Horse and Burro Act of 1971 (Public Law 92-195) at all new-employee orientations. Such orientations would stress the fact that wild horses are federally protected and it is a violation of the Act to harass, injure, or destroy them, and that violations may result in citations being issued as appropriate. In addition, a violation of the Act would be considered a **significant** project impact by the BLM (**Section 4.10.3**). Overall avoidance of wild horses is the best policy to prevent unnecessary displacement and agitation of the horses and potential separation of small foals from their mares during the foaling season.

■ HUMAN ENVIRONMENT

4.11 VISUAL RESOURCES

4.11.1 Introduction

As described in **Chapter 3, Affected Environment**, the BLM manages approximately 60 percent of the CD-C project area as Visual Resource Management (VRM) Class III and approximately 40 percent as VRM Class IV. Chapter 3 identified the management objectives for the VRM class designations found in the project area as the following:

Class III. The objective of Class III is to partially retain the existing character of the landscape. The level of change to the landscape should be moderate. Management activities may attract the attention of the casual observer but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV. The objective of Class IV is to provide for management activities that require major modifications to the existing character of the landscape. The level of change to the landscape can be high. The management activities may dominate the view and may be the major focus of viewer attention. Every attempt should be made to minimize the impact of these activities through careful location, minimal disturbance, and repetition of the basic visual elements of form, line, color, and texture.

In other words, Class III and IV areas are intended for surface-disturbing activities that respectively cause moderate and high levels of landscape alteration. This summarizes the management guidance for VRM that appears in Appendix 25 of the ROD for the Rawlins RMP (BLM 2008b).

4.11.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives for visual resources:

1. Establish VRM classes for the RMPPA.
2. Maintain the overall integrity of visual resource classes while allowing for development of existing and future uses.

Impacts to visual resources would be considered significant if the RFO is unable to meet the management objective for VRM established in the approved RMP, namely to "maintain the overall integrity of visual resource classes while allowing for development of existing and future uses" (Record of Decision and Approved Rawlins RMP, p. 2-48). This means that for the BLM to allow oil and gas development and production facilities within VRM Class III, the landscape change introduced by development must be moderate or reduced to moderate by mitigation in the form of BMPs as conditions of approval (Rawlins RMP FEIS, 4-393). Within VRM Class IV, the BLM permits oil and gas development and production facilities without additional mitigation because VRM Class IV allows for major modification of the existing landscape. However, the BLM does review individual permit applications in VRM Class IV and can ask oil and gas operators to voluntarily use the basic visual impact mitigation methods of adjustment in the siting of facilities, painting of facilities to reduce contrast with the natural landscape, and minimizing the amount of surface disturbance caused by construction and operations.

The impact analysis is based on interdisciplinary team knowledge of resources and the project area, review of existing BLM documents, and information provided by other agencies. **Map 3.11-1** presents VRM classes for the project area, and **Table 3.11-1** presents acreages for each VRM class. To compare the alternatives in terms of impact severity, the analysis uses the amount of initial and long-term surface disturbance presented in **Table 2.4-1** as a direct indicator.

4.11.3 Direct and Indirect Impacts

4.11.3.1 Proposed Action

Under the Proposed Action, the RFO would be able to meet its management objective for VRM within the project area. This is based upon the RFO's experience with development that has occurred in the project area to date.

The Proposed Action would create initial surface disturbance of 47,200 acres, or 4.4 percent of the project area. Most of the initial disturbance would be for well pads, structures, and roads. Interim reclamation would reduce surface disturbance to 18,861 acres, or 1.8 percent of the project area, which would remain as open disturbance for the life of the project, after which facilities would be removed and final reclamation would begin.

The RFO approach to mitigating the effects of oil and gas development to visual resources is to first enforce operator commitments to particular BMPs. Additional BMPs may be added as Conditions of Approval (COAs) on a site-specific basis in VRM Class III (**Section 2.2.1.7 Operator-Committed Practices**). This would mitigate the impact to the landscape and keep landscape modification at a moderate level.

As noted in **Appendix C**, BLM may require BMPs as COAs for APDs and other site-specific permits. Requirements or requests for site-specific mitigation occur during the review and NEPA analysis of APDs, right-of-way applications, and other individual permit applications.

As described in **Section 4.11.2**, oil and gas development and production facilities would be compatible with VRM Class III management objectives when the development, including adequate mitigation, yields a moderate level of landscape modification. **Figure 4.11.1** illustrates the moderate contrast introduced by development of a single natural gas production site, viewed in the foreground from a public road. The structures remain below the horizon line and are all painted in one suitable color, and the site and related roads have been reduced to the minimum adequate and safe size.

Figure 4.11.1. Example of existing site in the project area

In its analysis of the RMPPA, BLM anticipated that meeting VRM objectives would affect the placement of facilities associated with minerals exploration and development. This would exert a definite influence on finding acceptable locations where development might occur as well as the size and coloration of facilities depending on the visual class and location (Minerals, Rawlins RMP FEIS p. 4-87).

Since the project is an infill development in an existing natural gas field, new road construction would not be extensive. The primary access to the project area is I-80. Existing arterial roads, including WY 789 and several Sweetwater and Carbon county roads, provide access within the project area. New road construction would primarily be short sections of road from the existing road network to the individual new well sites and support facilities. Some existing access roads may need to be improved to accommodate increased traffic. At the project scale, incremental road development would be low for a project of this size, which means a relatively low level of surface disturbance.

At the site-specific level within VRM Class III, individual facilities may modify the visual character of a view from a given "key observation point" (KOP) such that BMPs other than those explicitly committed to by the Operator may be needed for adequate mitigation (see **Appendix C** for the full list of BMPs). BLM may impose additional BMPs as COAs to site-specific permits. However, some BMPs that involve facility siting, road alignment, and the scale or configuration of equipment would have to be evaluated in each case for consistency with prior terms of valid minerals leases.

Despite operator-committed practices, oil and gas development under the Proposed Action would unavoidably affect the visual resources of the project area by modifying the landscape (**Figure 4.11.1**). Development removes existing vegetation, replacing it with bare ground, graveled roads and pads, and structures related to drilling and production. The "built" forms, lines, colors, and textures contrast with natural landscape elements, though mitigation can reduce the level of contrast.

In addition, as described in **Section 4.11.3,** oil and gas development is compatible *per se* with VRM Class IV management objectives because a designation of VRM Class IV determines that major modification of the existing character of the landscape would be permitted. At the level of a large-scale development such as that proposed for the project area, this is a categorical determination. In effect, the designation of areas as VRM Class III or VRM Class IV reflects a planning level (RMP) decision to allow oil and gas development to affect visual resources, subject to more individualized and site-specific conditions of approval in VRM Class III that can only be determined once site-specific permitting begins.

Operator implementation of BMPs would lower the visual impact of site-specific development even in the VRM Class IV part of the project area. Committed BMPs include interim reclamation of well locations and access roads, painting new facilities with a suitable environmental color, and building new roads to a "no higher than necessary" standard which reduces surface disturbance. Despite the application of committed BMPs, a high level of change could occur under the Proposed Action in the parts of the project area that are in VRM Class IV but are still relatively natural. In such areas, oil and gas facilities could dominate the view of even the casual observer and perhaps discourage or displace activities for which a setting with natural character is desired.

Section 3.11.3 described how, in parts of the project area where public and private land-ownership is intermingled in a "checkerboard" pattern, much of the private land may not be subject to BLM administration. The BLM's authority over visual resources extends only to where BLM owns the surface or the oil and gas beneath the surface. In the checkerboard specifically and wherever non-BLM in-holdings exist, the BLM would mitigate the visual impact of development on the BLM-administered surface as best it can and would encourage oil and gas developers to apply comparable mitigation to adjacent privately owned surface. Development not managed by the BLM that occurs on non-BLM sections in the checkerboard or other in-holdings may not attain BLM standards and so may indirectly degrade the appearance of the landscape on the BLM land.

Oil and gas development would be quite apparent from the road network in the project area. The road network of the project area is extensive, so any development visible from an established road would be in the foreground to middle ground of the view from (i.e., within 5 miles of) the road (BLM 2011a).

The site-specific analysis called for in permitting APDs and other individual development proposals contained within the Proposed Action would require the selection of KOPs. A KOP is a proxy for the

location of a casual viewer sensitive to scenic quality. All KOPs in the project area are likely to be on the state, county, and BLM roads used by hunters, sightseers, and wildlife watchers. **Table 4.11-1** lists the roads in the project area that access Class III areas in the northern and southern part of the project area. BLM would consider the view of a well site, road, or other facility from identifiable KOPs during the site-specific analysis of the application for a permit.

Table 4.11-1. Roads accessing VRM Class III in the CD-C project area where users would likely see oil and gas facilities under the action alternatives

Northern part of project area		Southern part of project area	
Road	**Common Name**	**Road**	**Common Name**
CR 20	Luman Road	WY 789	Baggs–Creston Junction Highway
CR 23N	Wamsutter–Crooks Gap Road	BLM 3216	Robbers Gulch Road
CR 67	Tipton (North) Road	BLM 3321	Little Robbers Gulch Reservoir Road
BLM 3207	Red Desert Road	--	--

Notes:
1. All county roads are in Sweetwater County.
2. All roads would likely access foreground to middle-ground views of facilities within 3 to 5 miles or less of the viewer.

Given successful final reclamation, impacts to visual resources are not irretrievable. However, they are long term. During the process of final reclamation of the Proposed Action, reclaimed land would potentially present evidence of disturbance that would have a residual effect on scenic quality until vegetative treatments mature. The road network would contribute the most to this type of impact; even reclaimed roads may present obviously intrusive linear features on the project area landscape lasting long after the life of the project.

4.11.3.2 Alternative A: 100-Percent Vertical Drilling

Allowing 100-percent vertical drilling (one well per pad) would increase the visual impacts of development. In the short term, Alternative A would disturb 61,696 acres, or 5.8 percent of the project area. This is 31 percent more initial disturbance than would be caused by the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 24,133 acres, or 2.3 percent of the project area, which would remain open for the life of the project under Alternative A, after which facilities would be removed and final reclamation would begin. Alternative A would cause about 28 percent more long-term disturbance than the Proposed Action. The likelihood of casual observers encountering visual impacts to views within the project area would be higher roughly in proportion to the greater amount of disturbance.

The compatibility of Alternative A with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and COAs would allow oil and gas development to be compatible with VRM Class III, which allows up to moderate change to existing landscape character. Oil and gas development is compatible *per se* with VRM Class IV, which allows for major modification to existing landscape character.

4.11.3.3 Alternative B: Enhanced Resource Protection

Alternative B would slightly decrease the potential for visual impacts of development compared to the Proposed Action. In the short term, Alternative B would disturb 45,516 acres, or 4.3 percent of the project area. This is 4 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 18,249 acres, or 1.7 percent of the project area, that would remain open for the life of the project under Alternative B, after which facilities would be removed and final reclamation would begin. Alternative B would cause about 3.0 percent less long-term disturbance than the Proposed Action. The likelihood of casual observers encountering visual impacts to views within the project area would be roughly the same for Alternative B as for the Proposed Action.

The compatibility of Alternative B with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and COAs would allow oil and gas development to be compatible with VRM Class III, which allows for moderate change to existing landscape character. Oil and gas development is compatible per se with VRM Class IV, which allows for major modification to existing landscape character.

Under Alternative B, enhanced protection measures for biological resources would reduce impacts to visual resources because of their broad aim to reduce surface disturbance. Measures to minimize biological disturbance of the Chain Lakes Alkaline Wetlands and Other Playas would particularly benefit scenic quality because these features characterize the natural landscape of the northern part of the project area (BLM 2011a).

4.11.3.4 Alternative C: Surface Disturbance Cap, High and Low Density Development Areas

Alternative C would modestly decrease the potential for visual impacts of development, compared to the Proposed Action. In the short term, Alternative C would disturb 42,955 acres, or 4.0 percent of the project area. This is 9.0 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation under Alternative C would reduce surface disturbance to 17,318 acres, or 1.6 percent of the project area, which would remain open for the life of the project, after which facilities would be removed and final reclamation would begin. Alternative C would cause about 8.0 percent less long-term disturbance than the Proposed Action. The likelihood of casual observers encountering visual impacts to views within the project area would be slightly less for Alternative C than for the Proposed Action.

The compatibility of Alternative C with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and conditions of approval would allow oil and gas development to be compatible with VRM Class III, which allows up to moderate change to existing landscape character. Oil and gas development is compatible per se with VRM Class IV, which allows for major modification to existing landscape character.

The surface-disturbance caps under Alternative C would put an upper limit on the impact to scenic quality that would occur at points in time during the life of the project.

4.11.3.5 Alternative D: Directional Drilling

Alternative D would decrease the the potential for visual impacts of development, compared to the Proposed Action. In the short term, Alternative D would disturb 36,449 acres, or 3.4 percent of the project area. This is 23 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 14,952 acres, or 1.4 percent of the project area, that would remain open for the life of the project under Alternative D, after which facilities would be removed and final reclamation would begin. Alternative D would cause about 21 percent less long-term disturbance than the Proposed Action.

The compatibility of Alternative D with BLM's VRM objectives would be the same as for the Proposed Action. Adequate visual mitigation in the form of BMPs and conditions of approval would allow oil and gas development to be compatible with VRM Class III, which allows up to moderate change to existing

landscape character. Oil and gas development is compatible *per se* with VRM Class IV, which allows for major modifications to existing landscape character.

The likelihood of casual observers encountering visual impacts to views within the project area would be less for Alternative D than for the Proposed Action. In addition, if Alternative D achieves fewer and less densely distributed well pads and fewer associated roads, pipelines, and other facilities, a casual viewer observing from points along the interior road network of the project area may encounter oil and gas related disturbance somewhat less frequently because of the wider distribution of pads and related development.

This would benefit parts of the CD-C project area, especially those located in VRM Class III. When combined with less surface disturbance overall, the probability that a more compact pattern of development would be seen somewhat less often as a visitor moves through the landscape could lead casual viewers to be more accepting of modification to the existing character of the landscape. Thus, development under Alternative D could be more consistent with the management objective of landscape retention in areas now rated VRM Class III.

4.11.3.6 Alternative E: No Action

Under Alternative E, none of the impacts to visual resources described under the Proposed Action or under Alternative A through Alternative D would occur. The key assumption for the analysis of Alternative E is that no further oil and gas development would occur in the project area and there would be no further change to the existing character of the landscape as a result of new oil and gas development. In addition, as oil and gas facilities gradually become obsolete over time, much of the project area now affected by oil and gas development would gradually return to a more natural-appearing scenic quality, assuming the success of past reclamation planning and its implementation in the future.

The likelihood of casual observers encountering visual impacts to views within the project area because of oil and gas development would, over time, gradually become less than today for Alternative E and much less in the long term than for the Proposed Action, because it is assumed that Alternative E would lead to no new oil and gas development and that existing oil and gas facilities would eventually become obsolete and be reclaimed.

4.11.4 Impact Summary

Compared to the Proposed Action,less degradation of landscape quality would occur under Alternatives B, C, and D and more would occur under Alternative A. Under Alternative E, no new oil and gas development would occur, and there would be no further change to the existing character of the landscape because of new development.

The character of the surface disturbance and the character of the impacts to visual resources would be similar under all action alternatives because they would consist in all cases of drill sites and equipment, production pads and facilities, access roads, and utilities. The level of impact to landscape quality would vary roughly in proportion to the difference among the alternatives in terms of the level of development and the resulting amount of initial and long-term surface disturbance. Under Alternative E, No Action, much of the project area now affected by existing oil and gas development would gradually return to a more natural-appearing scenic quality, assuming reclamation success over time.

4.11.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

The Proposed Action and alternatives would create contrasting lines, forms, colors, and textures in the landscape through the removal of existing vegetation and the introduction of drilling and production facilities and access roads. Visual resources would be unavoidably adversely impacted for the life of the project and beyond until the surface has returned to a condition that is comparable to the surrounding

natural area. The level of contrast would be more evident in areas with little or no current energy development.

Approximately 60 percent of the project area is managed as VRM Class III, where the level of change must be moderate or reduced to moderate using mitigation measures, operator-committed measures, and BMPs applied at the discretion of the RFO as conditions of approval for site-specific APDs. The remaining 40 percent of the project area is managed as VRM Class IV, where major modifications of the landscape are allowed. Because both VRM Class III and Class IV allow for modification of the landscape, no additional visual mitigation measures would be necessary for the CD-C project.

4.11.6 Effect of the VRM Amendment to the Resource Management Plan

As noted in **Section 3.11.4**, the RFO must use the existing 1990 VRM classifications to manage visual resources in the CD-C project area. However, the BLM has begun the VRM-RMP amendment process and intends to finalize the VRM amendment to the RMP by the end of 2013 (**Section 3.11.5**). A VRM amendment may lead to changes in the classification of land within the CD-C project area, based on the findings of the 2011 visual resource inventory (**Section 3.11.3**).

Changes to the classification of land within the CD-C project area could affect the analysis of impacts to visual resources in terms of how many acres of land are governed by the management objectives of VRM Class III or VRM Class IV. In its decision on the CD-C project, the BLM would seek to attain the management objectives for each VRM class that is in effect.

4.12 RECREATION

4.12.1 Introduction

This section presents impacts to recreation from the Proposed Action and alternatives. Recreational uses on public lands administered by the BLM within the project area include hunting, off-highway vehicle (OHV) use, wildlife viewing, and pleasure driving on public roads. The affected environment for recreation resources is described in **Section 3.12, Recreation**, with recreation features of the project area illustrated in **Map 3.12.1.**

4.12.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) lists the following management objectives for recreation resources:

1. Provide for the health and safety of visitors.
2. Prevent or mitigate resource damage resulting from recreation uses.
3. Coordinate with other programs to minimize conflicts and adverse impacts on recreational opportunities.
4. In the Western Extensive Recreation Management Area (ERMA), consider the above recreation objectives during development involving surface-disturbing or disruptive activity. Consider the Adobe Town Dispersed Recreation Management Area desired future condition during development involving surface-disturbing or disruptive activity.
5. In the Eastern ERMA (RMP Map 2-17), retain the quality of dispersed recreation opportunities and settings (with the exception of isolated development areas, such as coal mines or wind generation facilities) while meeting the above recreation objectives.
6. Provide public education regarding appropriate use of BLM lands.
7. Provide opportunities for public use, interpretation, education, and appreciation of natural and cultural resources.

Impacts to recreation would be considered significant if any of the following were to occur:

1. Management actions result in long-term elimination or reduction of recreation use in any area or compromise public health and safety.
2. Intensity of development is incompatible with the stated objectives of Special Recreation Management Areas (SRMAs).
3. Increases in recreational activity create substantial risks to public health and safety or resource damage.

4.12.3 Direct and Indirect Impacts

4.12.3.1 Proposed Action

Under the Proposed Action, the RFO would be able to meet its management objectives for recreation within the project area. This is because the Operators have incorporated IM WY-2004-194, Integration of Best Management Practices into Application for Permit to Drill Approvals and Associated Rights-of-Way. The Operators cite this IM as prompting their commitment to considering several BMPs in nearly all circumstances during development. Several of the cited BMPs would have the effect of lowering surface disturbance (**Section 2.2.1.7 Operator-Committed Practices**). Lowering surface disturbance would lower impacts to big-game wildlife (see **Section 4.8 Wildlife**), and lower impacts to big game would in turn indirectly lower impacts to hunting, the main recreation activity that currently exists in the project area.

Pursuant to a general agreement with the WGFD, the Approved RMP directs the BLM to intensively manage surface-disturbing and disruptive activities to reduce impacts to wildlife (Rawlins RMP 2-33). Interactions with the WGFD over management of development's impacts to wildlife under the Proposed Action would also indirectly lower impacts to hunting recreation.

In addition, BMPs that lower surface disturbance would reduce impacts to visual resources. Lower impacts to visual resources would indirectly reduce impacts to recreation settings, which in turn would indirectly reduce impacts to hunting and to non-consumptive, dispersed recreation in the project area such as wildlife observation, OHV recreation, and driving for pleasure.

The level of impact to recreation from the Proposed Action would correlate with measures of surface disturbance. The Proposed Action would create initial surface disturbance of 47,200 acres, or 4.4 percent of the project area. Most of the initial disturbance would be for well pads, structures, and roads. Interim reclamation would reduce surface disturbance to 18,861 acres, or 1.8 percent of the project area, which would remain as open disturbance for the life of the project, after which facilities would be removed and final reclamation would begin.

Despite Operator-committed practices, oil and gas development under the Proposed Action would unavoidably affect recreation resources of the project area by modifying supplemental values important for recreation quality. As part of the natural gas development process, new roads could create access to areas that previously were not used for recreation. However, the industrial character associated with oil and gas activity introduces contrasting elements affecting scenic quality, which would displace some recreationists to other areas. Supplemental values and resources such as scenic quality, solitude, and wildlife would be degraded and would interfere with recreationists' goals and experiences. Eventually, successful final reclamation would rehabilitate the recreation settings to be found in the project area. However, the time needed to accomplish this would potentially span more than one generation of recreatoinists.

Overall, the intensity of impacts to recreation under the Proposed Action would vary roughly in proportion to the change in the density of well development. In addition, impact intensity would vary within the project area depending on the extent of new well development as compared to the density of existing development.

Thus, the intensity of impacts to recreation would be highest in the northern part of the project area, where natural gas development is less dense to date and where the Chain Lakes WHMA and the large block of public land northwest of the WHMA are a resource for big game hunting and other wildlife-based recreation. Similarly, impacts to the WGFD Carbon County Walk-In Area #1 would be relatively high because less development has occurred to date in this part of the project area.

Natural gas development raises health and safety issues for the BLM because of conflict that may arise between industrial traffic and recreational traffic. The hazard associated with road use would potentially rise in proportion to the amount of gas development, plus the trend in recreational use.

At Little Robbers Gulch Reservoir in the southern part of the project area, unrestricted surface-disturbing activity nearby would degrade the setting of the undeveloped recreation site. However, low water levels in the agricultural reservoir have already degraded the site's appeal as a fishing hole and group campsite during hunting season, meaning that further degradation of the setting at the reservoir may have less importance to recreationists because of the already declining usage for other reasons.

Recreation use displaced from the project area could find substitute opportunities elsewhere within the RFO or in adjoining BLM field offices. This applies equally to hunting, wildlife viewing, and pleasure driving. However, these resources would likely be farther away for recreationists who now use the CD-C project area; additionally, resources elsewhere may themselves be under increasing pressure from fluid minerals development and development of other resources potentially conflicting with recreation.

4.12.3.2 Alternative A: 100-Percent Vertical Drilling

With 100-percent vertical drilling (one well per pad) there would be no reduction of surface disturbance as there would be from using directional drilling and pads with multiple wells. Alternative A would disturb 61,696 acres in the short term, which is 5.8 percent of the project area. This is 31 percent more initial disturbance than would be caused by the Proposed Action.

Interim reclamation would reduce un-revegetated surface disturbance to 24,133 acres (2.3 percent of the project area); this would remain open for the life of the project under Alternative A, after which facilities would be removed and final reclamation would begin. Alternative A would cause about 28 percent more long-term disturbance than the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

The relative intensity of impacts to recreation would be highest in the parts of the project area where previous well density has been no more than one or two wells per section. The likelihood of impacts to recreation would be higher roughly in proportion to the greater amount of disturbance and rise in well density.

4.12.3.3 Alternative B: Enhanced Resource Protection

Alternative B Enhanced Resource Protection would slightly decrease the potential for impacts to recreation compared to the Proposed Action. In the short term, Alternative B would disturb 45,516 acres, or 4.3 percent of the project area. This is 4 percent less initial disturbance than for the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation under Alternative B would reduce surface disturbance to 18,249 acres (1.7 percent of the project area); this would remain open for the life of the project, after which facilities would be removed and final reclamation would begin. Alternative B would cause about 3 percent less long-term disturbance than the Proposed Action.

Under Alternative B, impacts would be more apparent in the parts of the project area where previous well density has been no more than one or two wells per section. The likelihood of impacts to recreation would be roughly the same for Alternative B as for the Proposed Action. However, specific measures to benefit

big game wildlife habitat that are among the enhanced protections included in Alternative B may provide some additional mitigation of impacts to wildlife and in turn reduce impacts to the hunting-based recreation that predominates in the project area.

4.12.3.4 Alternative C: Surface Disturbance Cap, High and Low Density Development Areas

Alternative C would modestly decrease the potential for recreation impacts from development, compared to the Proposed Action. In the short term, Alternative C would disturb 42,955 acres, or 4 percent of the project area. This is 9 percent less initial disturbance than for the Proposed Action. The types of facilities causing impacts and the qualitative character of impacts would be the same as described for the Proposed Action.

Interim reclamation under Alternative C would reduce surface disturbance to 17,318 acres, or 1.6 percent of the project area, which would remain open for the life of the project, after which facilities would be removed and final reclamation would begin. Alternative C would cause about 8 percent less long-term disturbance than the Proposed Action.

The likelihood of impacts to recreation would be higher roughly in proportion to the greater amount of disturbance. However, the surface disturbance caps under Alternative C would put an upper limit on the impact to recreation that would occur at points in time during the life of the project.

4.12.3.5 Alternative D: Directional Drilling

Alternative D would decrease the potential for recreation impacts, compared to the Proposed Action. In the short term, Alternative D would disturb 36,449 acres, or 3.4 percent of the project area. This is 23 percent less initial disturbance than for the Proposed Action. The kinds of facilities causing impacts and the qualitative character of impacts would be as described for the Proposed Action.

Interim reclamation would reduce surface disturbance to 14,952 acres, or 1.4 percent of the project area; this would remain open for the life of the project under Alternative D, after which facilities would be removed and final reclamation would begin. Alternative D would cause about 21 percent less long-term disturbance than the Proposed Action.

The likelihood of impacts to recreation within the project area would be somewhat less for Alternative D than for the Proposed Action. Alternative D further lowers surface disturbance and therefore lowers the direct loss of habitat, improving the chance of retaining herd sizes in the CD-C project area. A more compact pattern of development under Alternative D would also benefit big game wildlife management long term by lowering habitat fragmentation and disturbance from human activity because fewer well pad access roads would be constructed. The benefit to big game wildlife management under Alternative D would lower the impact to hunting recreation during the life of the project.

4.12.3.6 Alternative E: No Action

Under Alternative E, none of the impacts to recreation described under the Proposed Action and Alternatives A through D would occur, so there would be no further change to recreation resources in the CD-C project area because of new oil and gas development. In addition, as existing oil and gas facilities gradually become obsolete over time, those parts of the project area now affected by oil and gas development could gradually return to a reclaimed condition that is intended to attain a more natural-functioning character. The effect of reclaiming obsolete oil and gas facilities could be positive for the recreation resource if the current trend toward habitat loss, degradation of recreation settings, and growth in human intrusion is stabilized for a number of years or perhaps reversed to some degree.

4.12.4 Impact Summary

Under the Proposed Action, the RFO would be able to meet its management objective for recreation within the project area because the project area is within the RFO's Western ERMA, where restriction or avoidance of surface-disturbing and disruptive activities to protect recreation is not required by the Rawlins RMP. Consistent with the RMP's management prescription for the Western ERMA, the Operators have incorporated BLM IM 2004-194, Integration of Best Management Practices into Application for Permit to Drill Approvals and Associated Rights-of-Way. Operator-committed practices noted in **Section 2.2.1.7 Operator-Committed Practices** would lower surface disturbance, impacts to big game, and indirectly the impacts to hunting, the main recreation activity in the project area.

The intensity of impacts to recreation from the Proposed Action and other action alternatives would correlate to the variation in long-term surface disturbance by alternative:

- Proposed Action—18,861 acres (1.8 percent of the project area)
- Alternative A: 100-Percent Vertical Drilling—24,133 acres (2.3 percent of the project area)
- Alternative B: Enhanced Resource Protection—18,249 acres (1.7 percent of the project area)
- Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section —17,318 acres (1.6 percent of the project area)
- Alternative D: Directional Drilling—14,952 acres (1.4 percent of the project area)

Under Alternative E, none of the impacts to recreation described under the Proposed Action and Alternatives A through D would occur. Thus, there would be no further change to recreation resources in the CD-C project area because of new oil and gas development. As existing oil and gas facilities gradually become obsolete over time and are reclaimed, the effect could be positive for the quality of the recreation resource.

4.12.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

The Proposed Action and alternatives may result in a reduction or long-term elimination of recreation—most notably hunting—within portions of the project area that are directly affected by short-term or long-term surface disturbance. Impacts to big game as a result of the Proposed Action and alternatives may also indirectly impact hunting and wildlife viewing. However, because the project area lies entirely within the RFO's Western ERMA, the Rawlins RMP does not require restrictions or avoidance of surface-disturbing or disruptive activities to protect recreation. No additional mitigation would be required beyond Operator-committed measures and BMPs.

4.13 LANDS WITH WILDERNESS CHARACTERISTICS

No Lands with Wilderness Characteristics (LWCs) are located within the boundaries of the CD-C project area. Therefore, the Proposed Action and alternatives are in compliance with the RMP, which provides for oil and gas development on multiple-use lands within the RFO, subject to BLM approval and permitting.

As directed by BLM Manual Sections 6310 and 6320 (BLM 2012f, 2012g),[21] and in compliance with FLPMA Sections 201 and 202, the RFO will maintain the inventory of LWCs on a continuing basis and

[21] Instruction Memorandum (IM) No. 2011-154 , dated July 25, 2011, and transmitted July 26,2011, directs offices to continue to conduct and maintain inventories regarding the presence or absence of wilderness characteristics, and to consider identified lands with wilderness characteristics in land use plans and when analyzing projects under NEPA. The IM places BLM Manuals 6301, 6302, and 6303, dated February 25, 2011, into abeyance until further notice. The policy expressed in the IM was developed by the Division of the National Landscape Conservation System and the Division of Decision Support, Planning and NEPA of the BLM.

rely on its inventory of LWCs in the development and revision of land use plans and when making subsequent project level-decisions.

4.14 CULTURAL AND HISTORICAL RESOURCES

4.14.1 Introduction

Cultural resources on public lands, including archaeological sites and historic properties, are protected by various laws and regulations, for example the National Historic Preservation Act of 1966 (NHPA), Governing Regulations, and 36 CFR Part 800. The specific directives can be found in "Archaeology and Historic Preservation: Secretary of the Interior's Standards and Guidelines" (Federal Register 1983). Laws and regulations concerning cultural resources stipulate that the proposed undertaking take into consideration the effects of the action to significant cultural resources. This requires that cultural resources within the proposed area of potential effect (APE) be identified and evaluated. Measures must be taken to mitigate or minimize any adverse effects to those historic properties included in, or eligible for, the National Register of Historic Places (NRHP). The Wyoming Cultural Records Office documents 4,860 sites in the project area, as summarized in **Section 3.14.3**. **Appendix J, Cultural Resources Management**, describes how the BLM applies cultural laws and regulations to the inventory, classification, protection, and mitigation of cultural resources located on public lands.

Many of the historic and prehistoric sites within the project area are located in eolian sand deposits with increased site density near playa lakes and springs. An extensive sand dune complex is located within the CD-C project area which has been designated Site 48CR5784. This area differs from other eolian sand dunes in the project area in that the eolian deposits are relatively stable and continuous for a nine-square-mile area. Very little development has occurred in this sand dune complex and the integrity of any cultural deposits has not been assessed. Soils mapping and a site-specific treatment plan were completed for the EIS.

The BLM has designated a quarter-mile buffer surrounding the contributing segments of the historic trails and associated sites as highly sensitive. These eligible linear resources include the Overland and Cherokee Trails, the 1868 Union Pacific Railroad Grade, and the Lincoln Highway. All but the Cherokee Trail are located in the checkerboard land pattern; however, for the basis of this analysis, the calculations include both the public and private land. For management purposes, the BLM has established a two-mile analysis area around the trails for consideration of the elements of setting, defined as those elements of integrity of location, feeling, and association that contribute to the eligibility of the trails or associated sites. Although 2 miles is the standard distance for consideration of setting, it does not preclude the consideration of a larger area, depending on the circumstances.

4.14.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management goals associated with cultural resources:

1. Develop management plans for special areas or cultural resources (e.g., Aimee Eaton site, Powder Wash, Robbers Gulch, and Muddy Creek site complex) in areas of high risk for development or at high risk for adverse effects.
2. Maintain setting for those contributing portions of historic properties where setting is an aspect of integrity by utilizing viewshed management tools (e.g., sacred sites, Lincoln Highway, Union Pacific Railroad [UPRR], and associated sites).
3. Monitor the condition of historic properties that are known to be under threat from development or vandalism.

4. Identify cultural resources in the RMPPA by defining priority geographic areas for new field inventory, based on probability for unrecorded significant cultural resources.
5. Develop a public outreach and education program to instill a conservation ethic in the public regarding cultural resources.
6. Develop and maintain interpretation of cultural resources in areas of high public interest and access.
7. Consult proactively with Native American tribes as appropriate to identify resource types or places that may be affected by BLM authorizations or actions.
8. Seek opportunities for cooperation with tribal governments for management of cultural resources and public education.
9. Maintain an inventory and evaluate historic transportation routes for contributing or noncontributing status (Appendix 5).

The RMP also prescribes the following management goals for Historic Trails (Cherokee, Overland, Rawlins to Baggs, etc):

1. Develop management plans for historic trails or segments of historic trails in areas of high risk for development or at high risk for adverse effects.
2. Maintain setting for those contributing portions of historic trails where setting is an important aspect of integrity by utilizing viewshed management tools.
3. Monitor the condition of contributing portions of historic trails that are known to be under threat from development.
4. Maintain an inventory and evaluate trail segments and associated sites for contributing or noncontributing status.
5. Provide educational opportunities and public outreach programs.
6. Develop and maintain interpretation of historic trails in areas of high public interest and access.
7. Manage historic trails and other resources for long-term heritage, recreational, and educational values.

Impacts would be considered significant if management actions result in adverse effects to properties listed or determined eligible for listing on the NRHP or considered important to Native American groups as measured by:

- Destruction or alteration of all or part of a property.
- Isolation of a cultural resource from, or alteration of, its surrounding environment.
- Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting.
- Neglect and subsequent deterioration.

The criteria for evaluating cultural resource significance are described in the Code of Federal Regulations (36 CFR 60.4):

> "The quality of significance in American history, architecture, archaeology, engineering, and culture present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and:
>
> 1. that are associated with events that have made a significant contribution to the broad patterns of our history; or
> 2. that are associated with the lives of persons significant in our past; or
> 3. that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or

4. that have yielded, or may be likely to yield, information important in prehistory or history."

For cultural sites, both prehistoric and historic, significance is primarily judged either by the site's ability or potential to yield information important in prehistory or history (Criterion D) or the site's association with events that have made a significant contribution to the broad patterns of our history (Criterion A). Each site's importance, however, is determined individually, so the existence of sites eligible under Criteria B or C must not be discounted.

The BLM meets its responsibilities under Section 106 of the NHPA through implementation of a national Programmatic Agreement among the BLM, the Advisory Council on Historic Preservation (ACHP), the National Conference of State Historic Preservation Officers, and a state protocol with the Wyoming State Historic Preservation Office (SHPO) rather than by following the procedures set forth in the ACHP's regulations (36 CFR Part 800).

The preferred strategy of cultural resource management is avoidance of effect to those elements that contribute to the eligibility of a historic property. If this strategy cannot be implemented, mitigation of effects by project redesign, data recovery, project cancellation, or numerous other mitigation options should be implemented.

4.14.3 Direct and Indirect impacts

4.14.3.1 Proposed Action

Eleven percent of the project area has been subject to Class III cultural resource inventory as a result of previous development. These inventories indicated a cultural site density of 0.04 sites per acre. Of the total sites within the project area, 23 percent on average could be expected to be eligible for the NRHP. These calculations assume that the area-wide site density is equal across the project area and that the 11 percent of the area inventoried is a valid sample. With an estimated surface disturbance of 47,200 acres, the Proposed Action could affect an estimated 1,888 sites. Of these, 434 could be eligible for nomination to the NRHP.

Gauging the effect of any impact depends on the level of information available for that particular property provided by inventory and/or testing data. In compliance with Section 106 of the NHPA, a Class III cultural resource inventory would be conducted for the proposed area of disturbance associated with each APD or other proposed project activity. The inventory would identify cultural resources either eligible or ineligible for inclusion on the NRHP and whether any of the NRHP-eligible sites would be adversely affected. The values that render a cultural resource eligible for the NRHP would dictate what type and kind of impacts are of concern. If a cultural resource is not listed on the NRHP or is determined by the BLM and SHPO as not eligible for listing on the NRHP, it is not a historic property for purposes of the NHPA and does not need to be considered under Section 106.

For NRHP-eligible sites located in proposed disturbance areas, site avoidance is the preferred method of mitigation. However, when avoidance is not feasible, if any cultural resources listed on or eligible to the NRHP would be adversely affected by the Proposed Action, adverse effects would be appropriately mitigated as directed in Section 106. The Operator, in consultation with the BLM and the SHPO and with input from other interested parties per 36 CFR Part 800.6 and the Statewide Protocol Section VII, shall develop a mitigation plan designed to eliminate the adverse effects. These additional mitigation measures would be developed in accordance with BMPs and COAs outlined in **Appendix C**. Construction would not proceed until the terms of the mitigation plan were satisfied. Impacts to historic properties from projects occurring in the absence of a federal undertaking (federal authorization) would be beyond federal control. Data recovery (i.e., archaeological excavation), photo-documentation, additional archival research, or any other form of mitigation would be identified as part of the APD process and implemented prior to ground-disturbing activities associated with the Proposed Action. Implementation of appropriate mitigation measures would eliminate or minimize project-related adverse effects, and required additional

mitigation measures would meet or exceed these criteria. Data derived through mitigation could provide beneficial information on prehistoric and historic use in the CD-C project area, as well as contribute to the regional database for cultural resources.

Direct impacts would primarily take the form of alteration or disturbance of previously unidentified sites. Physical disturbance of eligible sites could result from construction activities and associated operations and could adversely affect undiscovered archaeological sites. Cultural resource inventories may not locate all significant sites. Buried sites—in particular, burials—may be missed in the course of field investigations. If construction or other project personnel discover what may be human remains, funerary objects, or items of cultural patrimony on federal land, construction would cease within the vicinity of the discovery, and the Authorized Officer (AO) would be notified of the find. The AO would notify the appropriate County Sheriff and state medical examiner. Any discovered Native American human remains, funerary objects, or items of cultural patrimony found on federal land would be handled in accordance with the Native American Graves Repatriation Act. Non-Native American human remains would be handled in accordance with Wyoming law. Construction would not resume in the area of the discovery until the AO has issued a notice to proceed.

Iincreased indirect impacts to archaeological sites could result from increased access within the project area, as well as increases in both surface activities and number of workers during construction associated with the Proposed Action. Potential indirect effects would include changes in erosion patterns due to construction, soil compaction, or vegetation removal; fugitive dust; off-road vehicle traffic associated with construction or maintenance activities; and increased vandalism, including illegal artifact collection, due to increased access. Where the setting of historic trails and associated sites contributes to NRHP eligibility, actions resulting in the introduction of visual elements that diminish the integrity of the property's significant historic features must be mitigated. Best management practices to reduce visual impacts such as consolidation of facilities, low-profile tanks, and paint that blends with terrain would be implemented.

4.14.3.2 Alternative A: 100-Percent Vertical Drilling

Impacts to prehistoric and historic properties under Alternative A would be the greatest. With an estimated surface disturbance of 61,696 acres, an estimated 2,467 sites could be affected, of which 568 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.3 Alternative B: Enhanced Resource Protection

Under Alternative B, with an estimated surface disturbance of 45,516 acres, an estimated 1,821 sites could be affected, of which 418 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.4 Alternative C: Surface Disturbance Cap with High and Low Density Development Areas

Under Alternative C, with an estimated surface disturbance of 42,955 acres, an estimated 1,718 sites could be affected, of which 395 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.5 Alternative D: Directional Drilling

Under Alternative D, with an estimated surface disturbance of 36,449 acres, an estimated 1,458 sites could be affected, of which 335 could be eligible for nomination to the NRHP. Avoidance of significant cultural properties is the preferred management strategy. If avoidance is not possible, mitigation measures would be implemented on a case-by-case basis as outlined in **Section 4.14.6**.

4.14.3.6 Alternative E: No Action

Under Alternative E, because there would be no new natural gas development and no new surface disturbance, no sites would be affected and no cultural studies would be required as a result of this project. Impacts to historic properties from activities occurring in the absence of federal authorization would be beyond the oversight of the BLM.

4.14.5 Impact Summary

Impacts to cultural resources are assumed to be proportional to the amount of new surface disturbance for each alternative (i.e., increased disturbance would result in a proportionately increased potential for adverse impacts to prehistoric and historic resources). Impacts under Alternative A would be the greatest, with an estimated 2,467 sites that could be affected. Impacts would decrease proportionately for the Proposed Action (1,888 potentially affected sites), followed by Alternatives B (1,821 potentially affected sites), C (1,718 potentially affected sites), and D (1,458 potentially affected sites). No impacts would occur under Alternative E, No Action, because there would be no new natural gas development and no new surface disturbance. Avoidance and mitigation would remove the potential for significant impacts on public lands for all alternatives.

4.14.6 Unavoidable Adverse Impacts and Additional Mitigation Measures

Cultural resource inventories may not locate all significant sites—especially burials or other buried sites—resulting in unintentional destruction, alteration, or disturbance of artifacts or sites during construction and associated operations. Cultural resources may also become isolated from their surroundings if they are not discovered prior to project development, and/or the character or physical components of their settings may be altered by the introduction of visual, audible, or atmospheric elements. **Appendix C** describes mitigation measures for the inventory and protection of cultural sites discovered during project operations. No additional mitigation measures would reduce or eliminate impacts to undiscovered sites.

Mitigation measures that would affect Historic Properties for which setting is an Aspect of Integrity, including visual, auditory, and atmospheric impacts, are described in **Appendix C**. The following additional mitigation measures would apply to all development activities under all alternatives that would affect those elements of a setting:

- Begin reclamation at the time most optimal to regenerate the native species.
- Replace native shrubs to decrease visibility.
- Construct roads in minimally visible areas.
- Relocate project or hide disturbance.
- Use matting on rights-of-way during construction to minimize surface disturbance and visibility.
- Allow no surface disturbance within a quarter-mile or the visual horizon, whichever is closer, of contributing segments of historic trails or trail-associated sites.
- Limit trail crossings to existing disturbance corridors or non-contributing segments, unless otherwise determined by BLM in consultation with the SHPO.

An additional mitigation measure that may serve to minimize visual impacts to the setting of Historic Properties is the use of low-profile tanks.

Direct impacts to other cultural resources would be further minimized by any mitigation measures that reduce the amount of surface disturbance using modified construction techniques.

4.15 SOCIOECONOMICS

This section provides an assessment of social and economic effects of the Proposed Action and Alternatives.

4.15.1 Planning Documents and Regulations

4.15.1.1 Rawlins RMP

The Rawlins RMP (BLM 2008a) provides the following management goals and objectives for socioeconomics.

Management Goals

1. Provide opportunities to develop national energy resources on BLM-administered lands within the RMP project area.
2. Provide opportunities to develop resources other than those related to energy (e.g., grazing, recreation, wildlife, fisheries, and tourism) on BLM-administered lands within the RMP project area.
3. Provide opportunities to sustain the cultural, social, and economic viability of local and regional communities by using decision review processes that include considerations of various potential impacts of BLM decisions, including: housing, employment, population, fiscal impacts, social services, cultural character, and municipal utilities.

Management Objectives

1. Work cooperatively with private and community groups and local government to provide for customary uses consistent with other resource objectives and to sustain or improve local, regional, and national economies.
2. Maintain and promote the cultural, economic, ecological, and social health within the RMP project area.

4.15.1.2 County Land Use Plans

Carbon County

The Carbon County Land Use Plan (CCLUP) (Carbon County Board of Commissioners and Carbon County Planning Commission 2010) was adopted in November of 2010. Although the CCLUP does not outline goals and objectives for natural resources development, it does specify recommended areas for oil and gas industry expansion and for an oil and gas industry processing and transportation corridor. The CD-C project area lies within the CCLUP's recommended area for oil and gas exploration and production.

The CCLUP contains the following goals, strategies and actions relative to energy development:

Goal 1. Achieve a sustainable balance between energy development, agriculture, and the environment.

Strategies and Actions:

Encourage a steady, paced development of the gas and oilfields.

- Participate in comment periods of the federal environmental impact statement process.
- Attend meetings and hearings of the Industrial Siting Council.

Enhance the County government's capacity to monitor, comment on, and influence state and federal decisions on energy development projects.

- Conduct regular meetings between Board of County Commissioners, BLM, DEQ, USDA Forest Service, and other governmental bodies to share information about pending energy projects.
- Participate in comment periods for environmental impact statements.

Limit residential development-related impacts on resource extraction, irrigated lands, and agriculture in general.

- Create zoning incentives that encourage residential development in areas not suited for irrigation, agriculture, or resource extraction.

Support mitigation of impacts created by energy industries where available science supports mitigation.

- Maintain dialog with energy industries by regular meetings to keep communication current.
- Identify issues that need mitigation and develop solutions for resolution with industry leaders.
- If available science indicates a proposed energy project cannot mitigate its impacts, Carbon County should either not approve the project or else recommend that it be located in a more suitable location (Ibid, pps. 89–90).

Sweetwater County

Sweetwater County adopted the Sweetwater County Comprehensive Plan (SCCP) (Sweetwater County Board of Commissioners and Sweetwater County Planning Commission 2002) in the fall of 2002. The SCCP contains the following goals and objectives relevant to this assessment.

Sensitive Areas and Resources

Coordinate and cooperate with the appropriate federal, state, and local organizations, governments, and agencies to:

- Identify and protect the county's natural environment and resources.
- Recognize and protect the county's unique cultural, recreational, environmental, and historical resources.
- Identify areas suitable/desirable for open space preservation. (These areas may include stream corridors, recreation areas, and wildlife habitat.) Explore alternative preservation strategies (Ibid, p. 2.6).

Planning Coordination/Cooperation with Other Entities

- Support and participate in federal and state land-use planning activities.

Natural Resources

- Encourage and support environmentally responsible resource exploration/development within the region. This includes encouraging associated industries and businesses to locate within Sweetwater County communities.
- Anticipate and plan for resource development impacts. Proactively address associated infrastructure, housing, and service needs.

- Encourage a balance between resource development and environmental protection.
- Evaluate natural resource development proposals (and the associated land uses) for their effects on air, water, and environmental quality.
- Encourage/support public land uses consistent with orderly development and efficient use of renewable and non-renewable resources.
- Encourage the location of associated worker housing within existing communities where services are/can be provided.
- Work with resource managers to ensure adequate access to natural resources.
- Work with property owners and lessees to preserve adequate public access.

Public Lands and Resources

- Encourage/support proactive county participation in relevant public land and resource planning and decision-making processes.
- Encourage/support cooperative interaction between local, state, and federal agencies and private land owners.
- Promote agency awareness of county issues and interests. These include, but are not limited to: natural resource exploration and development, multiple-use land and resource management practices, agriculture/ranching and recreation, and adequate public access to and across public lands.
- Continue county support for resource-based industries including mineral exploration/development and ranching.
- Promote local (private) concerns and interests as an integral part of public land management decisions. County officials and plans will provide the foundation to address/protect to private interests related to public lands and resources.
- Support, where appropriate, the transfer of suitable federal lands and resources to private interests.
- Encourage/support public land uses consistent with orderly development and efficient use of renewable and non-renewable resources.
- Prepare county policy positions for relevant federal and state land and resource issues.
- Conduct county plan "consistency and coordination" reviews for/on all relevant public land management agency plans and decisions.
- Develop/implement appropriate county/agency Memoranda of Understanding (MOUs) and agreements.
- Coordinate with public land management agencies to exchange resource and mapping information/expertise.

4.15.1.3 Impact Significance Criteria

The following criteria are used to assess the significance of the anticipated socioeconomic impacts of the Proposed Action and Alternatives and the No Action Alternative:

- An increase in a county's or community's resident and temporary populations that would substantially strain the ability of affected communities to provide housing and public services or otherwise adapt to growth-related social and economic changes
- An aggregate change in public revenue and expenditure flows likely to result in an inability on the part of affected units of government to maintain public services and facilities at acceptable or pre-established service levels
- Permanent displacement of residents or users of affected areas resulting from project-related changes in or conflicts with existing uses or ways of life

- Disproportionately high and adverse environmental or human health impacts to an identified minority or low-income population, which appreciably exceed those to the general population in and around the project area

4.15.2 Direct and Indirect Impacts

Three key considerations shape this assessment:

- **Ongoing Development in the CD-C project area—** Oil and gas drilling, field development, and production activities have occurred within the project area for over 50 years and the pace of drilling has accelerated over the last decade. An average of 289 wells per year have been drilled in the project area over the last five years and at the beginning of 2011 there were an estimated 3,738 producing wells within the project area.

  For all action alternatives, this assessment considers the effects of increased drilling, field development, and production activities. Thus, while the Proposed Action assumes annual drilling of an average of approximately 600 wells, the socioeconomic assessment considers the incremental socioeconomic impacts associated with the Proposed Action to be those associated with the drilling of roughly 300 additional new wells per year, along with subsequent completions and production. This approach acknowledges that the industrial and community infrastructure associated with the historic development of approximately 300 wells per year is already in place and local communities have addressed many of the socioeconomic effects associated with that pace of development. At the same time, the recent economic recession triggered a slowdown in pace of development that in turn resulted in an outmigration of non-resident oil and gas workers from the region. Consequently, the initiation of drilling at levels assumed for all action alternatives would result in a substantial influx of workers. Conversely, the No Action alternative would result in further outmigration of oil and gas workers from the region.

- **Uncertainty**—The socioeconomic assessment assumes a sustained, relatively high level of new well development over time. However, the actual pace of natural gas drilling has been and will continue to be variable and unpredictable because development decisions are dependent on a variety of factors including natural gas demand, pricing, regulatory approvals, rig and manpower availability, transmission pipeline capacity, weather, and the overall investment and development strategies of individual energy companies. For example, during the assessment period for this EIS, global energy demand and prices rose to historic levels and then declined precipitously. This decline was accompanied by a concurrent crisis affecting the availability of development capital, which hampered expansion and operations for some Operators and service companies. Although less affected than many other areas of the country, Carbon and Sweetwater counties each experienced economic slowdowns in the 2008 through 2010 period.

  To acknowledge this uncertainty, the assessment provides a discussion of the effects of higher and lower annual rates of drilling for certain social and economic conditions.

- **Regional Context**—Cumulative effects are analyzed in a separate section of this document, but for socioeconomics, cumulative influences must be considered in the assessment of impacts for the Proposed Action and alternatives. The natural gas reserves in the project area are part of a regional natural gas resource. Consequently, periods of expansion and decline in the project area would generally occur in the context of regional energy development expansion and decline in southwest Wyoming and indeed throughout much of the Rocky Mountain west. This means that extended periods of elevated demand for natural gas and resultant high gas sales prices would generate not only periods of accelerated activity in the project area but in other natural gas fields in Carbon, Sweetwater, and adjacent counties. Conversely, extended periods of lower natural gas demand would result in regional slowdowns in development activity.

4.15.2.1 Impacts Common to the Action Alternatives

Natural gas development can have a variety of effects on social and economic conditions. These effects can be both beneficial and adverse and can include:

- **Employment**—effects on direct employment in the natural gas industry, induced employment in businesses that support the natural gas industry, and indirect effects on other sectors of the economy, including those sectors affected by changes in industry and employee spending and sectors that could be directly affected by development including outdoor recreation and ranching. Natural gas development can also affect community and regional economic diversity.
- **Income**—effects on income of direct, indirect, and induced businesses and their employees; on other sectors of the economy such as tourism, recreation, and ranching; and effects on landowners, mineral owners, and royalty interests.
- **Population**—effects on resident and temporary populations in nearby communities.
- **Housing**—demand for temporary and long-term housing.
- **Infrastructure and services**—demands on a variety of government and quasi-public and private facilities and services.
- **Fiscal conditions**—changes in local and state tax and federal mineral royalty revenues and government expenditures.
- **Social conditions**—effects on community stability and cohesion, quality of life, attitudes, opinions, lifestyles, and changes in crime and other social indicators.
- **Environmental Justice**—beneficial or disproportionately high and adverse effects on minority and low-income populations.

Each alternative considered in this EIS, including the No Action Alternative, has the potential to affect the social and economic conditions previously described in **Section 3.15**. All action alternatives would result in increased employment and income in certain sectors of the local economy and population growth with resultant increased demand for housing and community infrastructure and services. After all authorized wells are drilled, each alternative would result in decreased employment and income for certain sectors of the economy, and result in further outmigration of employees and households should the cessation of drilling coincide with a period of economic stability or decline in other regional economic activity. Each of the alternatives has the potential to affect other sectors of the economy, such as ranching and outdoor recreation, that are also closely linked to land use and access in the project area. Beneficial and adverse effects on community infrastructure, local government services, and community social conditions would also likely occur under all alternatives.

Economic Effects

Each action alternative would generate additional direct employment and income in the natural gas industry, indirect employment and income in businesses that support the natural gas industry, and induced effects on other sectors of the economy affected by changes in industry and employee spending. Each alternative would also affect other economic activities including outdoor recreation and ranching and could potentially affect regional economic diversity.

Under the No Action Alternative, it is assumed that drilling and field-development employment would cease, resulting in a substantial decline in direct, indirect, and induced employment in the study area. Production-related employment would continue but diminish as production from existing wells declines and the wells eventually become uneconomical and production ceases.

Under all action alternatives, employment and income associated with drilling and field development is assumed to occur over 15 years and then cease; production-related employment would continue at

substantially higher levels than under the No Action Alternative after Year 6, but again diminish as production decreases and previously drilled wells cease production.

Induced and indirect employment associated with drilling, field-development, and production activities would parallel the advances and declines in direct employment for each alternative.

Cyclical Economic Expansion and Contractions

The economic expansion associated with each action alternative would likely be followed by a period of economic contraction.[22] For the No Action Alternative, the contraction phase is assumed to begin upon the issuance of a ROD for the EIS and economic activity and employment would diminish as production decreases and eventually ceases. For all action alternatives, the current level of natural gas development would expand and extend drilling within the project area for approximately 15 years. The contraction phase would then begin as drilling and field-development employment ceases and production employment begins to decrease.

The expansion phase would be characterized by substantial increases in direct employment and income in the natural gas industry and increases in indirect and induced employment and income. For the action alternatives, the 15-year drilling and field-development phase would be accompanied by increases in both temporary and long-term population as well as temporary and long-term housing demand, and demand for community infrastructure and local government services. For the No Action Alternative, these expansionary effects would not occur. To the contrary, No Action would precipitate further economic contraction.

Federal, state, and local governments would receive additional tax and royalty revenues from all alternatives. Such revenues, particularly federal mineral royalties, would be substantially higher under the action alternatives when contrasted to the revenues associated with the No Action Alternative.

The economic contraction phase would likely result in substantial reductions in employment, out-migration of workers and families, and reductions in demand for housing, community infrastructure, and local government services. The contraction phase would also be characterized by reductions in annual federal, state, and local government tax and royalty revenues. The severity of these effects would depend on other economic activities occurring at the time and the success of interim economic development initiatives. Under the No Action alternative, the contractions would follow the issuance of the ROD for this EIS.

The foregoing discussion assumes the pace of development outlined for the Proposed Action and alternatives. Historically, natural gas development and expansion cycles have been more frequent and shorter in duration than the 15-year cycle assumed for all action alternatives in this EIS.

Effects on Other Uses in the Project Area (Recreation and Ranching/Grazing)

All alternatives have the potential to displace some other uses and users of the project area, temporarily in some instances and for longer periods in others. The current level of existing development and ongoing drilling and field-development activity has already altered the recreational setting in portions of the project area, displacing some recreation use (primarily hunting). The intensification of development would result in a more dense level of development in already-developed parts of the project area and perhaps introduce development in currently undeveloped areas. The effect of doubling the average annual level of drilling and field-development activity under the action alternatives would increase the potential for conflict with recreation activities and for displacement of recreation use of the area. Over time, as development and production activities cease and reclamation occurs, recreation users may return to the

[22] This characterization of effects is a function of the assumption of the steady pace of new well development. In fact some variability would be expected over time. Such variability would likely temper both the expansions and contractions described here.

project area. Shifts in the geographic distribution of hunting and other recreation activity could have corresponding economic implications as well.

Grazing patterns and practices in the project area have already been affected by natural gas development activity. The boundaries of some grazing allotments extend beyond the project area, but the portions of these allotments in some areas adjacent to the project area are also affected by natural gas development. The high level of development activity, disturbance, infestation of invasive plant species and resultant reductions in available forage have resulted in reductions in use of certain allotments and require grazing permittees to more actively monitor and more frequently move livestock, resulting in higher labor and fuel costs and reductions in livestock weight gain. These effects—together with damage to fences, cattle guards, and other grazing improvements; increased livestock mortality from vehicle/livestock collisions; an extended period of drought; volatile livestock sales prices; difficulty obtaining capital; high fuel costs; and labor shortages—have resulted in higher cost, lower production, and reduced profitability for grazing permittees and temporarily displaced some permittees from allotments within the project area. Some grazing permittees interviewed for this assessment tied these effects to actual or anticipated reductions in herd size, complete sell-off of herds, and serious consideration of relinquishing their BLM grazing leases. Permanent displacement of grazing permittees along with a substantial reduction in overall levels of grazing use could trigger the significance threshold established for this assessment.

Under the No Action Alternative, the adverse effects on grazing permittees associated with high levels of drilling and field-development activity and traffic would diminish as drilling and field-development and associated traffic ceases, and temporary disturbances are reclaimed. Under all of the action alternatives, the levels of drilling and field-development and associated traffic could potentially double over recent levels and the amount of temporary and long-term disturbance would increase substantially, likely resulting in displacement of grazing operators from portions of allotments that are undergoing intensive development. Adverse effects on portions of grazing allotments, coupled with the aforementioned other factors (drought, high labor costs, volatile livestock sales prices, and scarcity of operating capital) could have detrimental effects on the economic viability of some affected ranches.

Effects on Environmental Amenity Values

As noted in **Section 3.15.7.1**, environmental amenities including air and water quality, wildlife and wildlife habitat, scenic vistas, cultural and historical features, and areas that provide opportunities for solitude are highly valued by many local residents and non-residents alike. These amenities add to the quality of life for residents, provide value by promoting local tourism and recreation, and are some of the factors that can attract new residents and businesses to an area. Many people value these amenities for their very existence and desire their continued availability for future generations.

Much of the project area has already been affected by development, adversely affecting some outdoor amenities including wildlife and wildlife habitat, scenic vistas, and areas that provide opportunities for solitude. All alternatives would continue to affect these amenities, although the No Action Alternative would result in no incremental effect. The action alternatives would intensify development in many currently developed areas of the project area and perhaps result in development in currently undeveloped areas.

In addition to the effects of development, disturbance, and activity on environmental amenities, the proliferation of litter along roads and increases in poaching that have accompanied development activity adversely affect scenic and wildlife amenities. These effects would continue under all alternatives but would likely intensify under the action alternatives given the increase in activity and extended duration of the drilling and field-development phase.

Economic Diversity

Energy development has the potential to enhance economic diversity in rural communities by expanding commercial and community infrastructure and by providing funding which can be used for economic development, community revitalization, and tourism promotion efforts. Energy development also has the potential to limit economic diversity in rural communities by raising housing costs and limiting housing availability, contributing to workforce shortages, and adversely affecting environmental amenities. Potential dampening effects of natural gas development in the project area on the growth and maintenance of economic diversity in certain communities within the study area would diminish sooner under the No Action Alternative as labor competition and high housing costs decline, the perceived effects on amenity values diminish as drilling and field-development cease, and long-term reclamation proceeds. Potential dampening effects on economic diversity would intensify under all action alternatives as the pace and duration of drilling would increase substantially and housing demand and cost and labor shortages would likely increase. The potential dampening effects on economic diversity should be viewed in the context of the cumulative development within the study area as high levels of drilling in the project area would likely be accompanied by high levels of drilling elsewhere in the study area. Potential economic diversity-enhancing effects could ultimately be associated with all action alternatives as well as with cumulative development. Energy development in the region has expanded the inventory of housing, tourism and recreation infrastructure (motels and restaurants), other commercial infrastructure, and increased the resident workforce in communities in the study area, all of which would be resources for economic development as natural gas development subsides.

4.15.2.2 Proposed Action

Oil and natural gas exploration and production have been important but volatile elements of the Carbon and Sweetwater County economies for well over 30 years. According to the Wyoming Oil and Gas Conservation Commission (WOGCC), there were 1,791 producing wells in Carbon County in 2010, with another 3,234 producing wells in Sweetwater County, although natural gas production in the two counties declined by 4 percent in 2010.

Up to 8,950 additional wells would be drilled in the project area over the course of 15 years under the Proposed Action; an average of almost 600 new wells drilled annually. Information provided by the Operators indicates that a range of 213 to 738 new wells per year (**Figure 4.15-1**) would be drilled. The pace and timing of natural gas development are two key variables affecting socioeconomic conditions in communities near development. The actual pace and timing of development in the project area would be dependent on a variety of factors including natural gas demand, pricing, regulatory approvals, rig and manpower availability, weather, and corporate strategies. Given the cyclical nature of natural gas development and the regional nature of the natural gas development industry discussed in **Section 4.15.2.1**, the assessment also considers the socioeconomic effects of surges and declines in development that might result in higher or lower levels of drilling than those contemplated by this assessment.

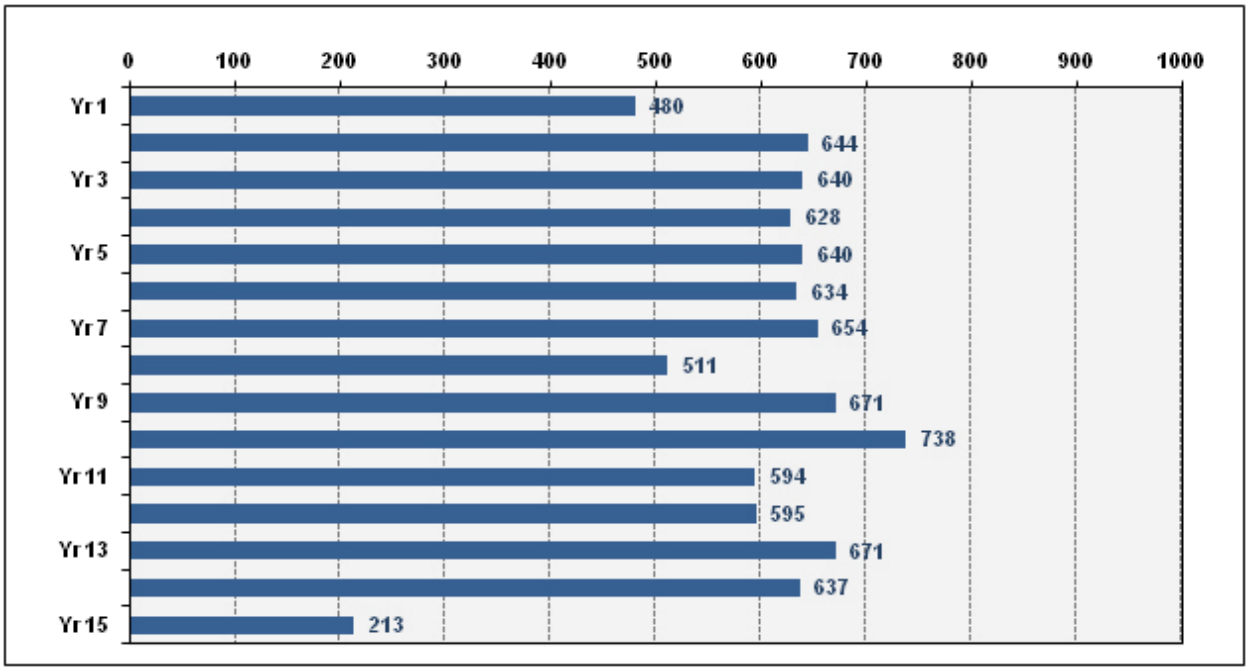


Figure 4.15-1. Number of new wells drilled in the project area, Proposed Action

Source: CD-C Operators.

Implementation of the proposed drilling program would result in consistently increasing production over the first 13 years of drilling, with projected annual production peaking at more than 670 MMcf and 9.4 million bbls of liquid condensates. Production would then begin an extended period of decline (see **Figure 4.15-2**).

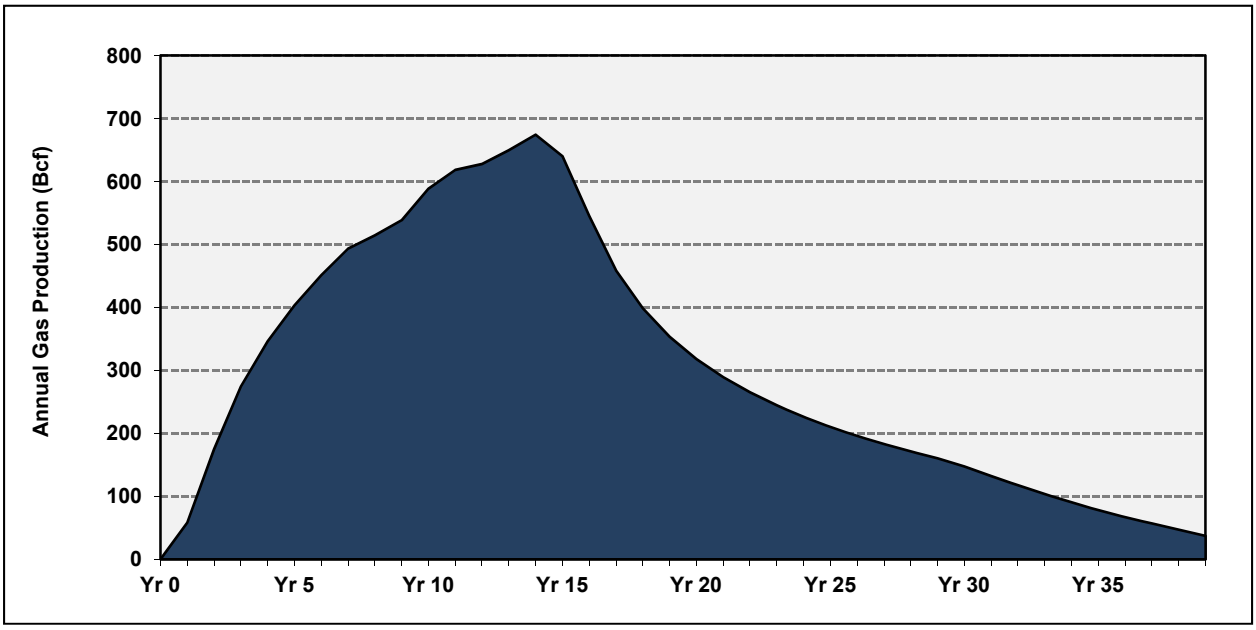


Figure 4.15-2. Estimated incremental annual gas production, Proposed Action

Source: BLM RMG estimates, BCLLC/SDLLC calculations.

Estimated total production for the Proposed Action over the life of the field is 12.02 trillion cubic feet (Tcf) of gas and 167.3 million bbls of liquid condensates.

Employment

A key driver of the socioeconomic impacts of the Proposed Action and alternatives is the estimated direct employment associated with the proposed natural gas development, extending from pre-development approval and permitting through drilling, completion, production, and reclamation. The direct development and operations jobs would in turn support additional indirect and induced jobs in the local economies, all of which would create demands on the local labor force, promote economic migration and population growth, increase demands on housing and public facilities and services, and affect local social conditions.

The labor-intensive drilling and completion phase for new wells is of initial concern for assessing short-term effects on migration, population, housing demand, and public facilities and services. Over time, the level of Proposed Action-related field operations and production employment would rise due to the need to service additional wells and haul increased volumes of produced water and condensate.

Project-related direct employment estimates were developed based on information obtained from the Operators, the U.S. Bureau of Labor Statistics, U.S. Bureau of Economic Analysis, Wyoming Department of Employment, and other sources. Projected direct employment estimates were then used as the primary input into the REMI[23] economic-demographic model, calibrated for a six-county region of southwest Wyoming, which in turn yields projections of the total employment, income, population, and other economic and demographic changes over time.

It is important to note that the employment projections described in this section are based on current natural gas development and production employment experience in the CD-C project area. In recent years, the Operators have been successful in refining development and production technologies and processes, which has reduced labor force requirements on a per well basis. It is reasonable to assume that further technology and process refinements will further reduce workforce requirements, particularly in the later years of this period used for this assessment.

<u>Estimated Direct Jobs</u>

Information supplied by the Operators indicates that development of a typical well in the project area, from access road and pad construction through drilling, completion, installation of surface production facilities and gathering lines and interim reclamation, requires approximately 30 days. Direct onsite employment at an individual well site varies over time, ranging from a single field biologist doing pre-development site clearance to 25 or more drilling and well-service employees during actual drilling and completion operations. Some development activities and events are of relatively short duration (a matter of hours); others continue for days on a round-the-clock basis. Interim reclamation would also occur at each site, employing a small number of workers for several days. Additionally, project engineers and managers, state and federal regulatory and resource management staff, and others occasionally visit an

[23] The Economic Profile System – Human Dimensions Tool (EPS-HDT), created by Headwaters Economics, Inc. and supported by the U.S. Bureau of Land Management, is a valuable tool for characterizing and describing historic economic and demographic trends in a region. It was also used to inform this assessment. EPS–HDT does not offer a forecasting or projection capability to assess changes in employment and income stemming from new economic stimulus. Many assessments rely on economic input-output (I-O) models to estimate the indirect and induced effects of natural resource development initiatives. The use of such I-O models has received criticism. Such criticism is one factor that led to the use of the REMI model in this assessment.

REMI is a dynamic, econometric economic and demographic model developed by Regional Economic Models, Inc. that has gained broad professional recognition and acceptance. Versions of the core model are calibrated for specific geographic regions. The specific application of the REMI to this project was completed by Sammons/Dutton LLC (SDLLC) and Blankenship Consulting, LLC (BCLLC). The REMI model is used because its capabilities address many of the more common criticisms associated with the use of economic input-output (I-O) models, including the static nature of the economic relationships and lack of a demographic component.

individual well site, but are not included in the Operator's summary of onsite employees. Allowances for these workers were captured in adjustments for off-site direct employees and estimated induced employment.

The Operators provided information regarding the timing/phasing of development activities, duration of activities, and approximate numbers of employees, including both company and contractor employees, for a typical well in the project area. Separate development profiles were provided for single-bore vertical wells and for multiple-bore directional wells from a single location. These profiles are the basis for estimating direct onsite employment during field development, based on the concept of work teams or crews, with a work team or crew responsible for each of the major development activities. Individual members of a crew may work together or independently, may be company employees or contractors, and may complete some of their work off-site. Given the varying durations of the key activities, it is estimated that completion of an average of almost 600 new wells per year under the Proposed Action could involve as many as 100 separate work crews within the field on any given day, of which approximately 25 would be drilling crews directly associated with operating rigs. **Table 4.15-1** summarizes the estimated numbers of crews and average crew size associated with the Proposed Action.

Table 4.15-1. Overview of direct onsite labor effort to implement the Proposed Action, CD-C project area[1]

Activity	Approximate Number of Crews	Workers / Crew	Typical Activity Duration
Pre-approval / permitting	6	6	3 days
Location construction	10	5	6 / 14 days (single well / multi-well) [2]
Rig mobilization / de-mobilization	10	11	3 / 5 days (single well / multi-well)[2]
Drilling	25[24]	18	10 / 42 days (single well / multi-well) [2]
Completion	17	11	5 / 8 days (single well / multi-well)[2]
Well service	7	22	3 days
Tank battery setup	9	6	4 days
Gas-gathering system	2	15	1 day
Electrical system	3	8	1 / 2 days

[1] *Assumes 60 percent are single-bore vertical wells and 40 percent are directional bores with an average of four completed bores per multi-well location.*
[2] *Average per well bore.*

Sources: CD-C Operators, BCLLC, and SDLLC.

Factors including the numerous tasks involved in drilling, completing, and bringing a well into production; the specialized nature of crews involved in completing those tasks; the different number of individuals associated with the various crews and varying durations for distinct tasks; and the fact that the work schedules of different crews vary (some 5-day/40-hour weeks, some round-the-clock for extended periods of time) results in fluctuating levels of onsite employment within the project area over time. Over a typical eight-week period, onsite employment within the project area would range from just over 500 jobs to more than 970 jobs, with an average of approximately 765 jobs.

The round-the-clock drilling and sequential nature of some activities results in a considerable level of activity on weekends and requires additional employees to sustain work crews during scheduled times off,

[24] The Operators have estimated that between 20 and 40 rigs could be on location within the project area at any one time. Some rigs contracted to major Operators would be working on a continuous year-round basis, while others contracted to small independent Operators would drill one or two wells in any one year. An average of 25 rigs was used for this assessment.

illness, injury, or labor market inefficiencies. A 15-percent allowance above the average onsite employment is used for this analysis, raising the total direct onsite jobs supported by the Proposed Action to 881 employees. The breakdown of those jobs by major activity is presented in **Table 4.15-2** below.

Table 4.15-2. Average onsite and total direct employment during the development phase, Proposed Action

Industry/Activity	Onsite Direct	Total Direct
Drilling / rig services	443	532
Completion / field services	311	373
Construction	92	110
Engineering / environmental services	35	42
Total	**881**	**1,057**

Source: BCLLC and SDLLC

The direct workforce estimates for the development phase include one further adjustment; that being an allowance for administrative, management, maintenance, clerical, and other support employees working locally for the company and contractors to support the workers actually working onsite. An example of such direct-support jobs would be the mechanics based in Rock Springs who maintain and service the drilling rigs and gas-field service trucks. This analysis includes a 20-percent allowance for such jobs, based on data from the U.S. Bureau of Labor Statistics and economic censuses of industry. The adjustments for administrative and support personnel raise the total direct employment associated with the Proposed Action to 1,057 (**Table 4.15-2**).

Direct onsite employment was also estimated in conjunction with ongoing production and field operations. The primary activities associated with operations would be the ongoing monitoring, maintenance, and servicing of the wells, occasional well workovers, and the hauling of produced water and condensate.[25] The numbers of jobs in all three categories would climb over time as the cumulative number of producing wells increases. The annual numbers of well service employees are estimated from information provided by the Operators and the numbers of transportation workers are a function of the estimated water and oil condensate production. Estimates of the number of production and transportation workers account for the diminishing levels of production from the existing wells over time. As with the development employment, the estimates of operations employment include allowances to account for 7-day-per-week staffing and for management and support employees. Estimated direct employment for operations derived using these assumptions climbs steadily over time, eventually peaking at 2,494 employees in Year 13 of the project (see **Figure 4.15-3**). The peak coincides with a year of high new development (671 new wells) combined with high levels of water and condensate production.

[25] Some producers may develop piping systems to handle produced water. Such systems would reduce the number of employees required. However, the extent of such systems is currently unknown. Consequently, the current analysis assumes an all truck haul cenario in order to portray a “worst case” scenario with respect to both transportation and socioeconomics.

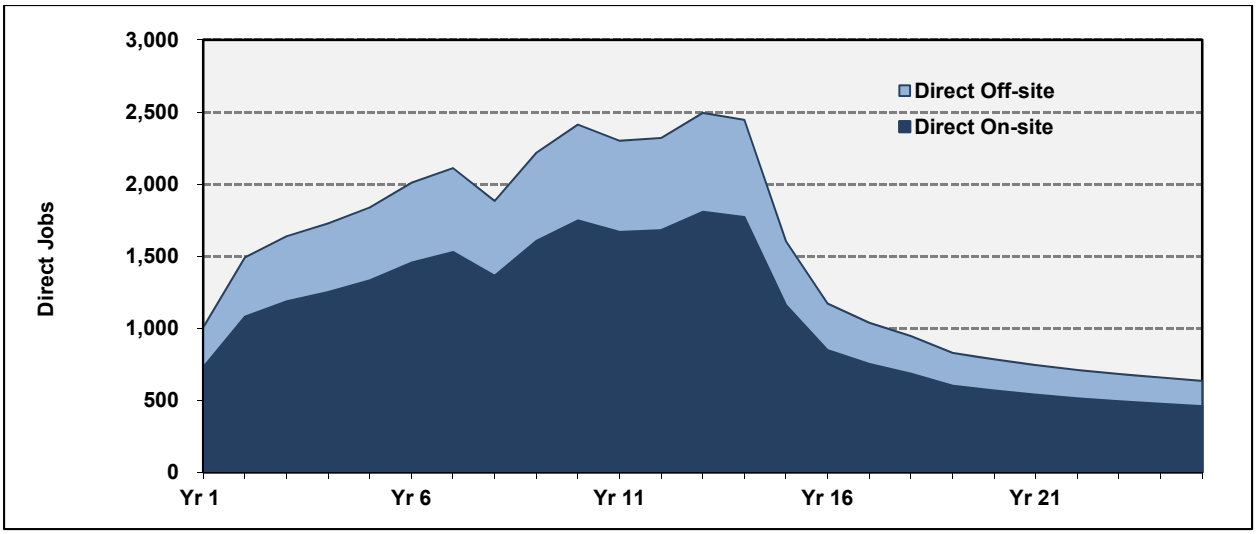


Figure 4.15-3. Direct employment, onsite and off-site, Proposed Action

The current assessment addresses the incremental increase in employment due to the Proposed Action. Such increases would be above and beyond the employment already working in the project area due to the ongoing drilling and production activity by the CD-C Operators, which is estimated at about 522 at present. The resulting incremental direct employment estimates, shown in **Table 4.15-3** and **Figure 4.15-4**, would increase to a peak of 1,600 total direct jobs in Year 13. Direct employment would decline sharply following the completion of new well development, shedding nearly 1,200 total direct jobs by Year 20.

Table 4.15-3 Incremental direct employment during field operations and production, Proposed Action[1]

Year	Total Direct	Incremental Direct Due to the PA
Year 5	1,838	1,128
Year 10	2,413	1,585
Year 15	1,602	666
Year 20	784	475
Year 25	634	431

[1] *Incremental is relative to the estimated direct* CD-C*-related employment in 2007.*
Source: SDLLC and BCLLC.

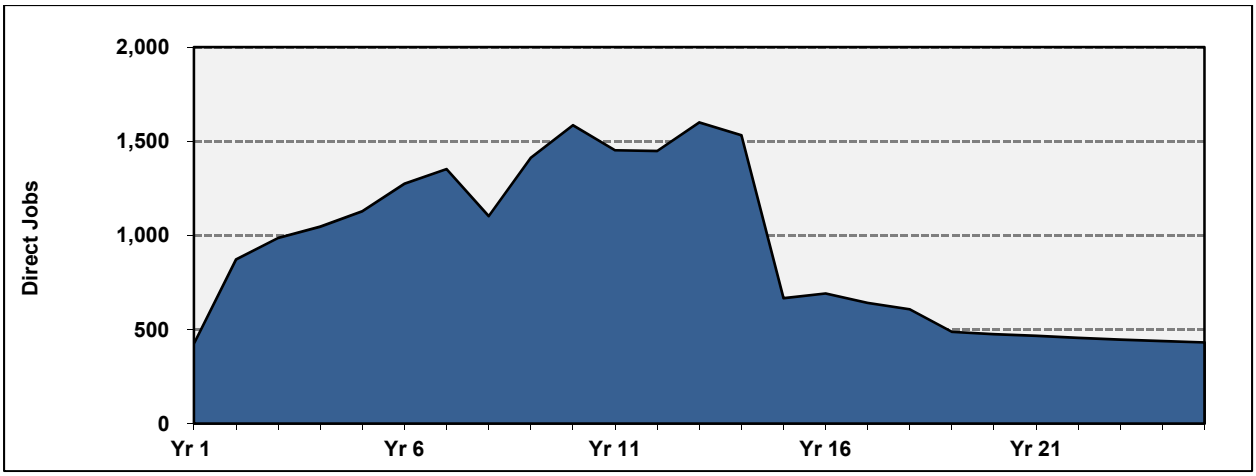


Figure 4.15-4. Incremental direct employment, Proposed Action

Estimated total direct employment over time, by major industrial sector, is the primary input driving the economic and demographic forecasts associated with the Proposed Action. Features in the REMI model were used to increase the likelihood that much of the growth in labor demand from the Proposed Action would be satisfied by non-residents who would work in the region on a temporary basis while maintaining their permanent residence elsewhere, and also that migrating workers would be more predominantly male than the general population. Both of these characteristics have been observed in the local labor force in conjunction with recent and ongoing energy resource development in southwest Wyoming.

In addition to the employment associated with drilling, field development, and production, Proposed Action-related employment would occur in conjunction with the construction of ancillary facilities including up to ten field compression facilities, a central pipeline compression facility, one or two central processing/stabilization plants, and up to 45 miles of high-pressure pipeline. The timing, location, and ultimate configuration of these facilities are not currently known, but their development would result in additional short-term construction and secondary employment during the period in which they were constructed. Most of these facilities would be constructed over a matter of months using a mix of local and non-local construction workers. The central processing/ stabilization plants could require a year or more to construct, with a workforce ranging to several hundred workers at peak.

Effects on Total Employment

Economic activity associated with the Proposed Action would result in additional economic growth in the two-county region. The incremental employment growth would increase over time as production increases the demands for operations and water and condensate transportation.

Projected employment gains of 890 jobs in the region would result from the Proposed Action in the first full year of expanded drilling. The total includes an estimated 428 direct jobs and 432 additional indirect and induced jobs supported by the increased economic stimulus associated with new well development, purchases by the Operators, suppliers and vendors, the consumer purchases of employees, and increased expenditures by local public entities. The net employment increment associated with the increased development activity in Sweetwater and Carbon counties would climb to 3,951 jobs in Year 13 (**Figure 4.15-5**). That total includes the 1,865 direct jobs and 2,086 indirect and induced jobs supported by the Proposed Action. Over the 15-year period of project development, each direct job is estimated to support approximately 1.14 additional induced and indirect jobs.

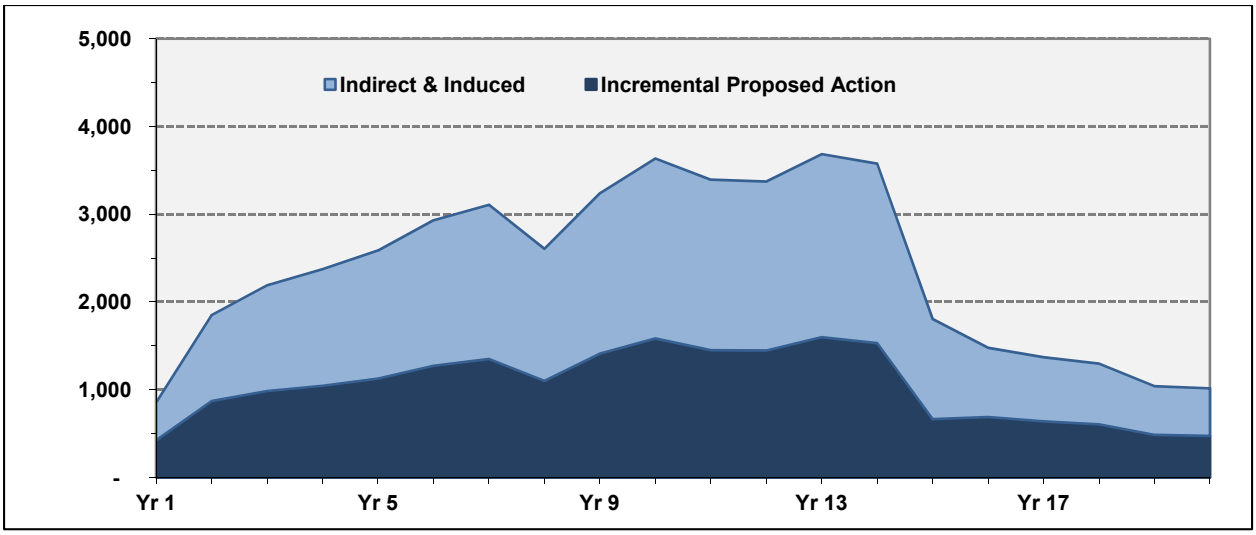


Figure 4.15-5. Direct, indirect, and induced employment effects from the Proposed Action in Sweetwater and Carbon Counties

All sectors of the local economies would be expected to see job gains as a result of the Proposed Action. Beyond the direct impacts in mining (including the oil and gas industry) and transportation, the largest gains in private sector jobs would occur in retail and wholesale trade, construction, and accommodations and food service. Local government employment, including public education, would also increase given implementation of the Proposed Action. The distribution of the net job gains in the peak year, by selected major industrial sector, is presented in **Table 4.15-4.**

Table 4.15-4. Incremental numbers of jobs by industrial sector, Year 13

Industrial Sector	Jobs	Share
Mining *(including oil and gas drilling, production and services)*	1,699	43%
Construction	619	16%
Retail & Wholesale Trade	348	9%
Accommodations and Food Services	238	6%
Local Government	198	5%
Real Estate, Rental, Leasing	173	4%
Transportation and Warehousing	164	4%
Health Care and Social Assistance	168	4%
Administrative and Waste Services	98	3%
Professional Technical Services	77	2%
State Government	29	<1%
All other combined	140	4%
Total	**3,951***	**100.0%**

* *Other includes: manufacturing, information services, other services, management of other companies, educational services, forestry, and fisheries.*

** *The total includes projected indirect and induced jobs in Uinta, Lincoln, Fremont, and Sublette counties.*

The majority of the new jobs, including not only direct jobs but also indirect and induced jobs, would be based in Sweetwater County, although substantial job gains are projected to occur in Carbon County. Net gains in Sweetwater County are projected to be nearly 600 jobs in the first year of development, increasing to more than 2,800 jobs at the peak. The corresponding range of job gains in Carbon County is from 197 jobs in Year 1 to 966 jobs at the peak (**Figure 4.15-6)**. New well development under the Proposed Action is also projected to result in up to 170 incremental indirect and induced jobs elsewhere

in southwestern Wyoming due to increases in local income and spending associated with commuters who live in one county and work in either Sweetwater or Carbon counties.

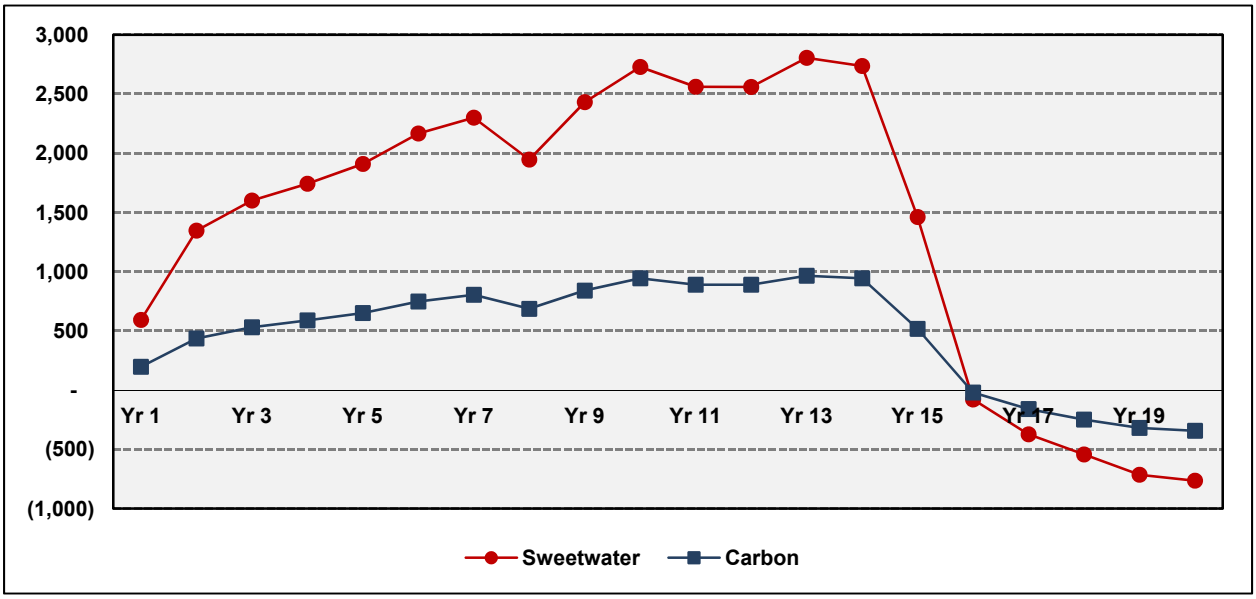


Figure 4.15-6. Total employment effects in Sweetwater and Carbon Counties from the Proposed Action

Completion of field-development operations would trigger substantial reductions in employment. Net reductions of more than 4,300 jobs (approximately 3,100 in Sweetwater County) are projected in the two counties within two years of field development completion. Further declines would be expected over the following three years such that the net change in total employment, as compared to the outset of the project, would become negative even though more than 475 direct employees would be involved in continuing production and transportation. This seeming paradoxical result would occur because of the loss of drilling and development jobs previously associated with ongoing development activity in the CD-C project area that would be sustained by the approval of the Proposed Action.

At the peak, the Proposed Action would increase the combined total local employment in Sweetwater and Carbon counties by about 9 percent as compared to total current (2009) employment. The net increase in local employment attributable to the Proposed Action would also be comparable to the increase in combined employment anticipated from all other economic activity in Sweetwater and Carbon counties.

Year-to-year variability in the pace of drilling would likely result in some corresponding fluctuations in the number of drilling and field-development jobs; higher rates translating into more employees and lower rates of drilling requiring fewer employees. Levels of off-site direct employment would likely be slightly less sensitive to fluctuations in drilling employment, but sustained differences in the annual number of wells drilled would eventually be accompanied by commensurate changes in off-site employment. Differences in the annual rate of drilling and development would translate into slight differences in the number of incremental operations and production employees hired, but such employment tends to be more responsive to the long-term levels of production than to current drilling rates.

Other Economic Effects

At the time of the original assessment (2007), labor-market conditions in the project area were tight due to past and ongoing energy and mineral resource development. Unemployment rates were low, labor-force participation among residents was high, and temporary, non-resident workers filled many jobs. Estimates generated by the REMI model suggested that as many as one in five jobs added prior to the recession had

been filled by temporary or commuting non-resident workers. As the economic recession persisted, triggering layoffs, labor-market conditions eased, increasing worker availability and out-migration of some non-resident workers. The higher rate of development associated with the Proposed Action would likely result in a return to pre-recession conditions, including lower unemployment as available local labor is absorbed and an influx of workers, many of whom would be single-status. Labor-market conditions would again change once project development is completed and labor demand weakened relative to available supply. Local unemployment would increase, labor-force participation would decline, and labor-force out-migration would likely occur.

Per-Capita Personal Income

Total and average per-capita personal income would increase under the Proposed Action. Total personal income would rise due to increases in the number of jobs, particularly in the relatively higher-paying energy-sector jobs. More energy-sector related jobs would contribute to rising per-capita incomes, which would also receive a boost from the upward pressure on all wages and salaries from the tight labor markets. Some of the gains in personal income would likely be offset by higher consumer prices. The positive project-related effects on income would moderate and eventually diminish, particularly following the completion of the well-development phase.

Population Growth

Implementation of the Proposed Action would provide a long-term economic stimulus to the local economies of Sweetwater and Carbon counties. Local labor availability to fill the jobs supported by the economic expansion is limited due to recent and ongoing economic expansions in the region. Past expansion also triggered substantial labor immigration to the area. Future expansion with the Proposed Action would trigger additional migration and population growth for the region.

Under the Proposed Action, substantial net labor migration would occur during the first several years of implementation, peaking at over 600 in Year 2. Projected annual net migration attributable to the Proposed Action would fluctuate in response to the variation in the pace of drilling, averaging about 275 people per year through the completion of development. Substantial net out-migration of more than 800 residents per year would occur for several years after the cessation of drilling (**Figure 4.15-7**). The rate of net out-migration would be less pronounced than the initial immigration due to the continuing operations and transportation employment associated with the Proposed Action.

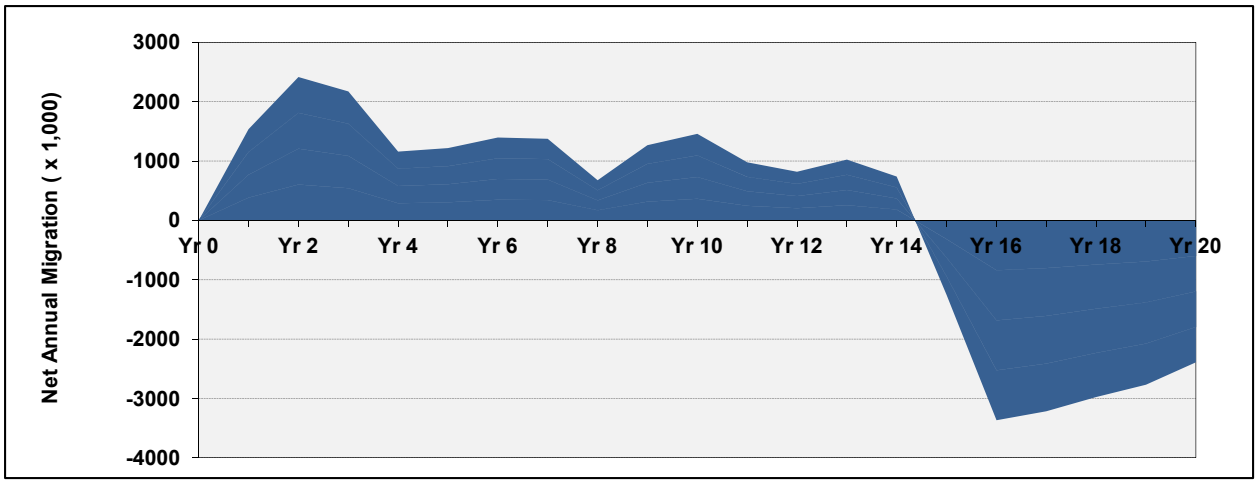


Figure 4.15-7. Projected net migration into the study area

Driven by migration, population growth due to the Proposed Action is projected to increase over time to almost 4,936 residents in Year 14. Approximately 3,100 additional residents are projected to reside in Sweetwater County, with 1,050 additional residents in Carbon County (**Table 4.15-5** and **Figure 4.15-8**). The majority of the project-related incremental population in Sweetwater County would be expected to reside in Rock Springs and Wamsutter. In Carbon County, most of the incremental population would be anticipated to live in Rawlins and Baggs/LSRV. The net increase in population is comparable to the net increase in employment, reflecting a combination of a high level of single-status workers, two-worker households, and workers holding multiple jobs among the immigrating households, and an increasing number of temporary non-resident and commuting workers.

Table 4.15-5. Summary of incremental population impacts from the Proposed Action

	Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater County	236	1,349	2,399	2,990	1,033
Carbon County	69	410	793	1,028	311
Combined Increment	305	1,759	3,192	4,018	1,344

Source: SDLLC and BCLLC, using the REMI model.

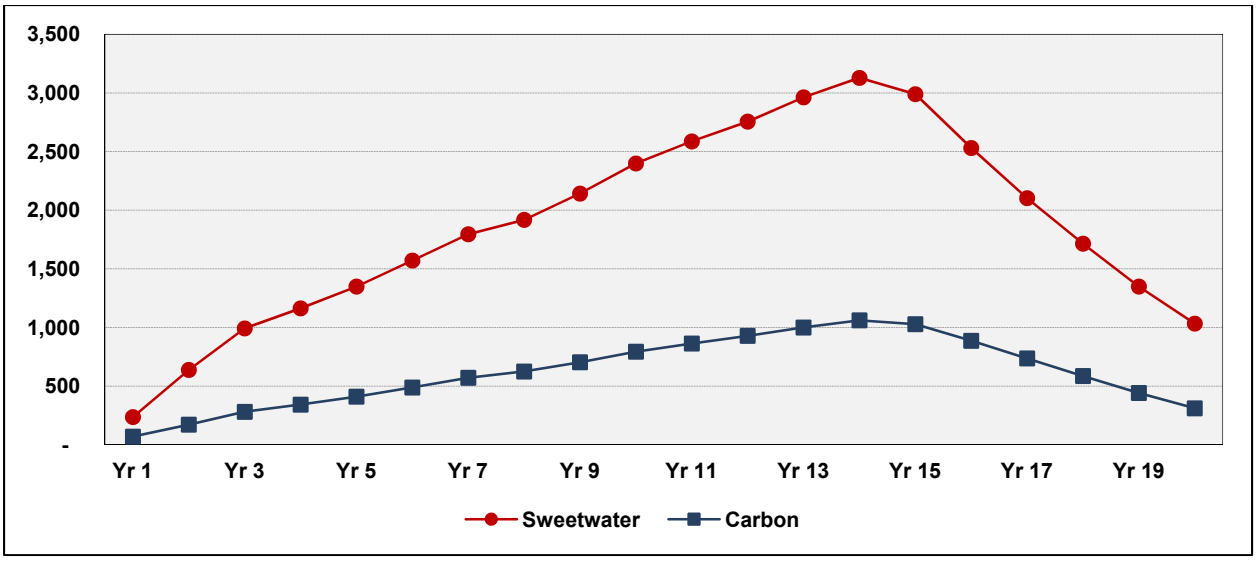


Figure 4.15-8. Forecast population increments due to the Proposed Action

The effects of the Proposed Action would contribute to growth during the development period, with population peaking in about Year 14 or 15 and then declining in the wake of the economic contractions associated with the completion of drilling. At the peak, the incremental population impacts associated with the Proposed Action would represent about 8 percent of the combined 2010 resident populations of Sweetwater and Carbon counties.

The estimated population impacts presented above may overstate the actual change in resident population by the extent to which jobs are filled by unaccompanied temporary non-resident and commuting workers. While these workers would place demands on local facilities and services, increase market demand for private-sector businesses, and generate public-sector revenues, they have fewer indirect demands on facilities, services, and conventional housing than do migrating households.

Results of the model indicate that the number of non-resident workers would increase over time to meet the labor demands associated with production and transportation operations. Following the completion of new well development, the number of non-resident workers would decline substantially.

Short-term surges in temporary population would accompany the construction of the ancillary facilities described in the preceding employment section. The operations workforce associated with these facilities would be relatively small and result in small long-term changes in population within the study area.

Population Distribution in Sweetwater and Carbon Counties

The incremental population growth and additional non-local workers residing in the region would create demands on housing, private-sector businesses, and public facilities and services, with the incidence of demands on various providers being determined largely on the residency patterns of the new residents and workers. In turn, three important factors affect residency patterns: housing availability, the base of operations/location of the jobs, and proximity to community facilities and services. Among those factors, job location and housing availability, including temporary living facilities, tend to be more influential for the temporary workers. Housing availability and proximity to community facilities and services are typically more influential for those production and transportation workers who establish long-term residence in the area, and even moreso for those filling the indirect and induced jobs supported by the Proposed Action.

Residency assumptions for the temporary and permanent populations were established considering the size of communities, their distances from the project area, informed judgment regarding housing

availability (including the potential development of construction-worker housing in the area) and historic residency patterns of natural gas workers. Applying the assumed residency patterns to the incremental project-related population shows an increasing population over time, peaking at more than 2,100 residents and 128 temporary workers in Rock Springs in Year 15, with a corresponding peak in excess of 758 residents and 52 temporary workers in Rawlins in that year (**Table 4.15-6**). The peak influx of temporary workers actually happens several years earlier. It is important to note that these estimates are in addition to the population associated with ongoing development and production operations in the project area.

Table 4.15-6. Incremental resident population and non-resident workers by community

		Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater County						
Rock Springs	Long-term	25	646	1,310	2,136	644
	Temporary	81	217	304	128	-
	Total	106	863	1,614	2,264	644
Wamsutter	Long-term	3	81	164	267	81
	Temporary	122	325	457	192	-
	Total	125	406	621	459	81
Green River	Long-term	2	65	131	214	64
	Temporary	-	-	-	-	-
	Total	2	65	131	214	64
Other & Unincorporated	Long-term	1	15	33	53	16
	Temporary	-	-	-	-	-
	Total	1	15	33	53	16
County Total	Long-term	31	807	1,638	2,670	805
	Temporary	203	542	761	320	-
	Total	**234**	**1,349**	**2,399**	**2,990**	**805**
Carbon County						
Rawlins	Long-term	14	220	482	758	203
	Temporary	33	88	124	52	-
	Total	47	308	606	810	203
Baggs/LSRV	Long-term	3	50	109	171	46
	Temporary	8	20	29	12	-
	Total	11	70	138	183	46
Unincorporated, including man camps and Other	Long-term	1	5	12	19	5
	Temporary	10	27	37	16	-
	Total	11	32	49	35	5
County total	Long-term	18	275	603	948	254
	Temporary	51	135	190	80	0
	Total	**69**	**410**	**793**	**1,028**	**254**
Total assigned "population"	Long-term	49	1,082	2,241	3,618	1,059
	Temporary	254	677	951	400	-
	Total	**303**	**1,759**	**3,192**	**4,018**	**1,059**

Source: SDLLC and BCLLC, using the REMI model.

The most notable effect on local population would be expected to occur in Wamsutter. The town is located at the I-80 interchange that serves as the major access point into the project area. BP has established a field operations center in Wamsutter and a number of oil and gas service firms have established offices and yards in the town. Furthermore, some new permanent housing has been developed in Wamsutter, and temporary living facilities have been located in Wamsutter during past periods of high

drilling activity. An initial impact of 125 residents and non-local workers is projected in Year 1, increasing to over 400 within the next two years. Provided adequate housing is available, the net population growth increment is projected to increase to over 600 residents and temporary workers in Year 10.

In summary, implementation of the Proposed Action would result in substantial incremental employment and population growth in Sweetwater and Carbon counties, with the net increments increasing over time until peaking in Year 14 of the project. Thereafter the impacts would diminish although ongoing production would sustain ongoing operations and transportation employment for more than 40 years. The peak employment impacts are estimated at 3,951 jobs, including 1,863 direct jobs and 2,088 indirect and induced jobs. A peak population impact of nearly 3,700 permanent residents is projected. At the peak, the incremental population attributable to the Proposed Action would represent about 8 percent of the total population of the respective counties. Following the completion of new well development, the incremental employment and population impacts would decline to levels sustained by the ongoing production and transportation. At that time, substantial out-migration of Proposed Action-related population would be anticipated to occur, in the absence of other major economic activities.

Fluctuations in annual drilling rates would result in substantial increases or decreases in temporary workers. Corresponding effects on indirect and induced workers would be less pronounced, but would have relatively larger effects on community population, as most of these workers are assumed to be community residents.

Housing

Direct, indirect, and induced workers associated with the Proposed Action would require both temporary and longer-term housing resources. A portion of the drilling and field-development workforce, including ancillary facility construction workers whose work assignments would be temporary, would be likely to seek temporary housing resources while working in the project area. Such resources include dormitory units in mobile home and RV parks in Wamsutter, as well as motels, mobile home parks and RV Parks in Rawlins, Rock Springs, Wamsutter, and Baggs. Other resources have included a 250-bed complex in Wamsutter, now closed and relocated, and two smaller temporary-living facilities located on WY 789 near Dad.

Most production workers and a portion of drilling, completion, and gas-field service workers and indirect and induced employees would likely seek long-term housing resources in communities near the project area. For this assessment, long-term housing includes conventional single-family and multi-family housing and mobile homes, both on lots and in mobile home parks.

Table 4.15-7 displays estimated Proposed Action-related demand for temporary and longer-term housing in communities near the study area for five periods: the first year of development and Years 5, 10, 15 (following completion of drilling), and 20. Demand estimates for long-term housing are expressed in terms of units; demand for temporary housing is expressed in terms of beds. Temporary demand could be accommodated by motels and RV pads, which typically accommodate more than one bed per unit or by worker camps/temporary living facilities, which can house one or multiple beds per unit.

In all communities, demand for both long-term and temporary housing increases sharply over the first 10 years of activity of the Proposed Action. Demand for temporary housing eases while demand for long-term housing continues to increase for several more years, after which demand for housing is projected to decline dramatically.[26]

[26] Note that vendors and certain types of contractors will require short-term temporary housing, primarily motels throughout the production phase of the project. These short-term requirements have not been estimated.

Table 4.15-7. Proposed Action-related temporary and long-term housing demand

Housing Demand	Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater County					
Rock Springs					
Long-term (units)	104	501	819	958	150
Temporary (beds)	81	217	304	128	91
Wamsutter					
Long-term (units)	13	63	102	120	19
Temporary (beds)	122	325	456	192	137
Green River					
Long-term (units)	10	50	82	96	15
Temporary (beds)	0	0	0	0	0
Sweetwater County Other					
Long-term (units)	3	13	20	24	4
Temporary (beds)	0	0	0	0	0
Sweetwater County total					
Long-term (units)	**130**	**627**	**1,024**	**1,197**	**187**
Temporary (beds)	**203**	**542**	**761**	**320**	**228**
Carbon County					
Rawlins					
Long-term (units)	31	219	371	422	66
Temporary (beds)	33	88	124	52	37
Baggs/LSRV					
Long-term (units)	7	49	83	95	15
Temporary (beds)	8	20	29	12	9
Carbon County Other					
Long-term (units)	1	5	9	11	64
Temporary (beds)	10	27	38	16	11
Carbon County total					
Long-term (units)	**39**	**274**	**463**	**528**	**83**
Temporary (beds)	**51**	**135**	**190**	**80**	**57**

Source: SDLLC and BCLLC, using the REMI model.

Several communities, including Rawlins, Rock Springs, and Wamsutter, have developed housing and/or infrastructure improvement plans that, if realized, would accommodate the long-term housing demand associated with the Proposed Action and other energy development. At present no communities have the existing available housing to accommodate the anticipated long-term demand.

During late 2008 and early 2009 there was an increase in available long-term housing units throughout the study area as a result of the national economic slowdown and in Carbon County, due to substantial completion of Sinclair Refinery expansion construction. Still, most of the long-term housing required to fill the Proposed Action-related housing demand would need to be added through new construction, given that the Proposed Action would likely occur in the context of substantial regional natural gas development.

Although there are adequate regional temporary housing resources to accommodate temporary housing demand associated with the Proposed Action, there would be localized shortages of temporary housing, particularly in Wamsutter. The closure of the BP Wamsutter base camp, which had 250 beds and was permitted for an additional 250 beds, has substantially reduced the availability of temporary housing resources within that community. If the pace of development within the project area accelerates, as

contemplated by the Proposed Action, additional worker housing would be required in Wamsutter. There could also be substantial competition for temporary housing from demand associated with the regional natural gas development projects and other planned and proposed energy development described in **Table 5.0-1**. Development and expansion of temporary living facilities and potential expansions of motels, mobile homes and RV parks throughout the study area would be required to accommodate Proposed Action-related temporary housing demand if the Proposed Action occurred concurrently with other development.

Project-related demand for housing would also be subject to variability in response to the anticipated year-to-year variances in the pace of development. Variations in drilling levels would primarily affect the number of temporary workers, which would correspondingly result in higher or lower demand for and occupancy of temporary housing resources.

The substantial decrease in demand for long-term housing resources in communities following the 15-year drilling and field-development phase of the Proposed Action could result in substantial shocks to community housing markets, including vacancies and a decrease in housing value, depending on other economic activities occurring in the area at that time.

Community Infrastructure and Services

The Proposed Action would affect community infrastructure and services in several ways. The increases in industrial activity within the project area and increases in traffic to and within the project area would result in demand for additional law enforcement, emergency management and response, and road maintenance services for Carbon and Sweetwater Counties and the volunteer emergency response agencies that serve these areas. The Proposed Action-related population increase in affected communities including Rawlins, Baggs/LSRV, Wamsutter, Rock Springs and Green River would experience increased demand for a wide range of community infrastructure and local government services. The increase in temporary and transient population would likely generate higher levels of demand for certain services including law enforcement and emergency medical treatment. County and municipal governments would receive revenues from the Proposed Action (assessed in the following section), which could help offset the costs of the additional services required to meet the demand, although municipal revenues generated directly by the project would be limited to sales and use tax revenues. Incremental revenues from development would typically lag development-related demand by months or in some cases, years.

<u>Community Infrastructure</u>

Expanding and improving community infrastructure to accommodate growth requires substantial lead-time and capital. With the possible exception of Wamsutter, demand for public facilities during the assessment period will result from a number of other projects and factors in addition to the project area. Consequently, while project area-related demand for public facilities may not by itself trigger a need for community infrastructure expansion, cumulative demand from the project area in combination with other natural gas and energy projects and other sources could trigger additional infrastructure needs.

Because energy-related population growth occurred within the study area for several years prior to the current slow-down and additional growth was anticipated, most local governments expanded and improved some community facilities including water and wastewater systems, solid-waste disposal facilities, detention facilities, and a range of other facilities. For some local governments, further improvements in specific systems are planned.

Solid Waste Disposal Facilities. Most communities and solid-waste management districts within the study area have implemented solid waste management plans and in some cases, expanded landfill capacities. The Carbon County communities within the study area (Rawlins and Baggs) are transporting their municipal solid waste to the Casper Regional Landfill. The City of Casper is permitted to operate the CRL on a 1,750 acre site; Phase I includes 88 acres and has an estimated capacity of 11,920,000 cubic

yards and a lifespan of 50 years. Five future cells also have estimated life spans of 50 years (Inberg-Miller Engineers 2009).

The Sweetwater County communities in the study area (Wamsutter, Green River and Rock Springs) plan to transport their municipal solid waste to the Rock Springs Regional landfill. Much of the gas-field solid waste within the project area is also transported to the Rock Springs landfill. The Rock Springs Landfill, which will become the I-80 Solid Waste Management Planning Area landfill, has capacity for about 30 years at current fill rates. The District has an additional 300 acres that may be used after the current facility reaches capacity.

Through their participation in the solid-waste management districts, all communities within the study area should have capacity to accommodate the increase in solid-waste-disposal demand generated by the Proposed Action and alternatives, although some operating improvements will likely be required to accommodate the increased volumes associated with the Proposed Action, with associated increases in operating costs. Increased levels of drilling and development in the project area would likely be accompanied by increases in drilling and development in other natural gas fields in the study area. Implementation of the Proposed Action would increase fill rates at both regional and municipal landfills, hastening the date when expansion of existing landfills or development of new landfills would be required.

Water. Water systems within the study area are operated by municipalities. All communities have adequate water rights and treatment and storage capacity or are in the process of improving their systems to provide adequate capacity to accommodate additional population.

Although the main components of municipal water systems, with planned improvements, would be adequate to accommodate the growth associated with the Proposed Action, each municipality could encounter the need to expand or improve its water-distribution system to accommodate areas within the community that would develop housing to accommodate growth. Additionally, elevated levels of drilling and development in all gas fields in and near the project area could result in the need to expand water systems to serve new housing developments in each municipality, resulting in additional water system expenditures.

Wastewater. Rawlins, Rock Springs, and Green River all have adequate wastewater treatment capacity to accommodate the population increment associated with the Proposed Action and other foreseen growth. Baggs and Wamsutter are currently in the planning stages of developing additional wastewater treatment capacity to accommodate foreseen growth. All municipalities have the potential to encounter costs to develop wastewater collection mains to serve areas of their communities that would accommodate new housing development and to expand or improve wastewater treatment systems to meet evolving regulatory standards.

Criminal Detention Facilities. Carbon and Sweetwater counties each have relatively new criminal-detention facilities. The 78-bed Carbon County detention facility has been in operation since 2004. During the summer of 2009 the facility's design capacity was exceeded several times; suggesting a shorter than expected 10- to 15-year design life for the facility. The Proposed Action would contribute to the potential need to expand the Carbon County Detention Facility during the 15-year development phase of the project.

The Sweetwater County Detention Facility has a design capacity of 208 inmates. Recent occupancy has averaged about 110 inmates, or 53 percent of capacity. The facility was designed to allow for expansion on the same site while maximizing use of existing administrative facilities. The Sweetwater County Detention Facility should be adequate to accommodate the population increment associated with the Proposed Action.

Hospitals. Major health-care institutions within the study area include the Memorial Hospital of Carbon County, which is undergoing major renovations, and Memorial Hospital of Sweetwater County, which

recently completed a major improvement and expansion project. In general, the expanded physical hospital facilities should be adequate to accommodate the population increment associated with the Proposed Action. Both hospitals would experience increased use of emergency rooms and staff to treat patients, including gas-field development workers who do not have local primary-care physicians. Consequently the Proposed Action, in concert with other energy-development activities, could result in strains on emergency-room facilities and staff. On the other hand, recent development and expansion of urgent care facilities in Rawlins and Rock Springs could reduce this impact.

Both hospitals experienced substantial increases in uncollected debt attributed to increasing numbers of patients without health-care insurance and indigent patients during periods of expanded energy development. Uncollected debt would likely increase under the Proposed Action and increases in other energy development.

Physician and health-care professional recruitment and retention has also been a problem in the past. The Proposed Action and other energy development would increase demand for physicians and likely contribute to increases in housing costs, which could contribute to difficulties in physician and health-care professional recruitment.

Other Municipal Infrastructure. As discussed below, each of the counties and communities within the study area will require additional employees and equipment to accommodate demand from the incremental population growth associated with the Proposed Action and other energy development. New employees will require office space and new equipment will require storage space in buildings or storage yards. Recreational facilities such as parks, libraries, and recreation centers will receive additional demand and may require expansion, improvement, or increases in staffing. It is likely that counties and municipalities would be required to develop new facilities and expand and improve existing facilities to accommodate the additional demand associated with the Proposed Action and other energy development.

Community Services

Demand associated with the incremental population associated with the Proposed Action would result in additional demand for community services, which, in turn, would require additional staff, equipment, and operating expenditures.

County sheriff's departments and local emergency-management and response agencies would be required to increase resources to maintain the current level of services (LOS) they provide to the project area and on highways and roads that provide access to the area. County road and bridge departments would experience demands for additional road maintenance for county roads within the project area. County governments would experience pressure to expand all essential services to accommodate the additional population, housing, commercial, and community infrastructure associated with the Proposed Action and other energy development. As discussed in the following section on fiscal effects, counties would receive ad valorem property taxes on certain natural gas facilities and production and sales and use tax revenues to help offset the cost of increased service demand.

Affected communities and certain special districts within the study area would also experience increased demand for services associated with the Proposed Action. For municipalities, this demand would generally be driven by the incremental population associated with the Proposed Action, although the specific demographics of the temporary and transient, single-status, working-age male population would likely result in higher demand for law enforcement and emergency medical services.

Communities are much more limited than counties in their ability to fund the needed increases in municipal services. As is discussed in the fiscal section, direct revenues generated by the Proposed Action to communities would accrue primarily in the form of sales and use tax revenues, although the Proposed Action could indirectly result in additional ad valorem tax revenues on commercial and residential development and from relatively larger distributions from various shared revenues for which the allocation formulas are population based. To assist local communities affected by energy development,

the Wyoming Office of State Lands and Investments administers a number of grants and loans funded out of mineral revenues that local governments can use to fund infrastructure improvements, and a number of energy companies have provided funds to local governments to develop facilities to accommodate energy-related growth, particularly in Wamsutter.

Public Education

Three school districts would be affected by the Proposed Action, Sweetwater County School Districts 1 and 2 and Carbon County School District 1. **Table 4.15-8** below summarizes the projected increases in student enrollments in these school districts for the first 20 years of the Proposed Action.

Table 4.15-8. Projected Proposed Action-related school enrollment: Years 1 through 20

District/(Location)/Grades	Year 1	Year 5	Year 10	Year 15	Year 20
Sweetwater #1 (Rock Springs)					
Elementary: K–4 (ages 5–9)	16	16	125	211	170
Elementary: 5 & 6 (ages 10 & 11)	6	6	11	69	69
Junior High: 7 & 8 (ages 12 & 13)	5	5	10	45	66
High School: 9–12 (ages 14–17)	11	11	22	29	129
Rock Springs Subtotal	***38***	***38***	***168***	***354***	***434***
Sweetwater # 1 (Wamsutter)					
Wamsutter Elem/Middle (K–8)	6	6	37	81	76
Sweetwater #1 Total	***44***	***44***	***205***	***435***	***510***
Sweetwater #2 (Green River)					
Elementary: K–4 (ages 5–9)	2	2	14	23	19
Elementary: 5 & 6 (ages 10 & 11)	1	1	1	7	8
Junior High: 7 & 8 (ages 12 & 13)	1	1	1	5	7
High School: 9–12 (ages 14–17)	1	1	2	3	11
Sweetwater #2 Total	***5***	***5***	***18***	***38***	***45***
Carbon District #1 (Rawlins)					
Elementary: K–5 (ages 5–10)	6	6	46	90	77
Middle: 6–8 (ages 11–13)	2	2	6	26	35
High School: 9–12	3	3	7	10	34
Rawlins Total	***11***	***11***	***59***	***126***	***146***
Carbon District #1 (Baggs/LSRV)					
LSRV K–12	4	4	15	32	36
Carbon #1 Total	***15***	***15***	***74***	***158***	***182***

Source: SDLLC and BCLLC, using the REMI model.

Proposed Action-related increases in school enrollment would follow the trends in resident population increase, climbing over time as long-term employment increases, but then declining as drilling activity is completed and the production levels begin to fall (see **Figure 4.15-9)**.

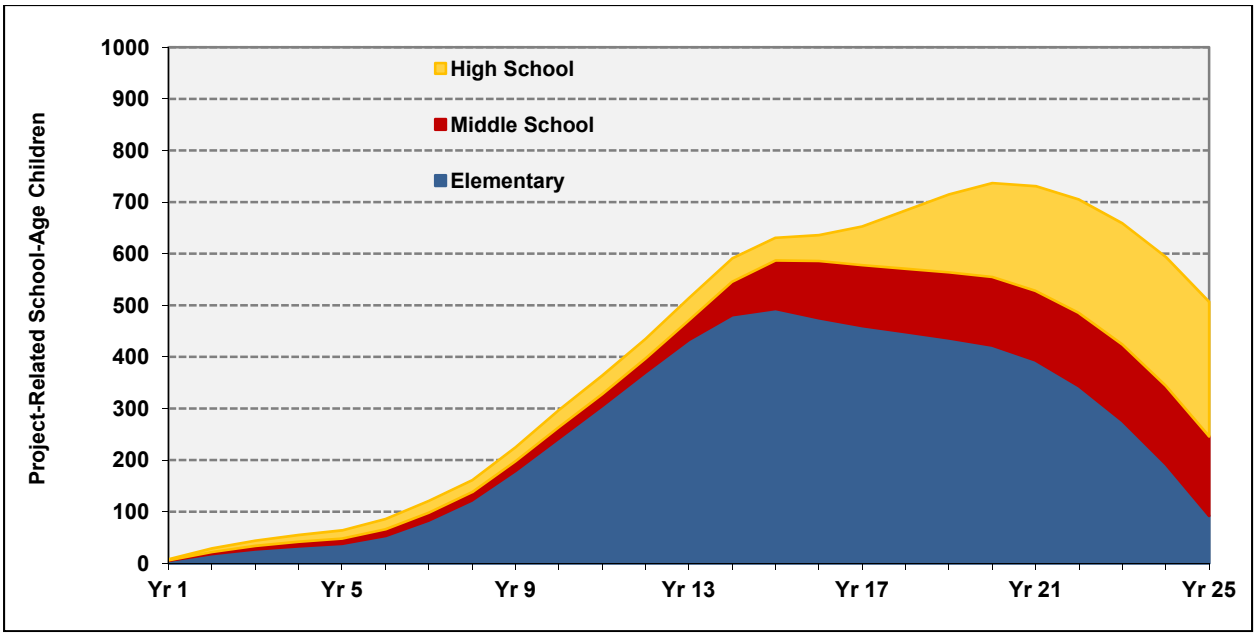


Figure 4.15-9. Increases in school-age children due to the Proposed Action

Source: SDLLC and BCLLC, using the REMI model.

Proposed Action-related enrollment in SCSD #1 schools in Rock Springs would increase from an estimated 38 students in Year 1 to 434 in Year 20. Based on recent enrollment trends, the incremental increases in student enrollment would initially be more heavily concentrated in kindergarten and the lower grades, but shifting into the middle and high school grades over time. Considering cumulative increases in enrollment for other energy development, the Proposed Action-related enrollment would exceed the capacity of the current schools during the 15-year field-development period, depending on other concurrent levels of energy development in the region. If SCSD #1 is able to anticipate the increase in demand in a timely fashion and seek and obtain approval from the Wyoming School Facilities Commission for new school facilities, the demand could likely be accommodated without long periods of overcrowding. Depending on the date of approval, the length of time required to construct such facilities and the concurrent level of energy development, modular classrooms could be required to accommodate some Proposed Action-related students in the interim.

Proposed Action-related enrollment in the SCSD #1 K–8 school in Wamsutter would increase from an estimated six students in Year 1 to 81 in Year 15, decreasing thereafter. The current school facility in Wamsutter would require expansion to accommodate this increase in enrollment.

SCSD #2, based in Green River, would experience much lower impacts on student enrollments than would SCSD #1. Proposed Action-related enrollment in the SCSD #2 in Green River would increase from an estimated five students in Year 1 to 45 in Year 20. SCSD #2 could accommodate the anticipated increase in enrollment with current school facilities, depending on the level of other energy development concurrent with the Proposed Action.

Proposed Action-related enrollment in CCSD #1 in Rawlins would increase from an estimated 15 students in Year 1 to 182 in Year 20. The school-age enrollments would begin declining thereafter. CCSD #1 schools in Rawlins could nominally accommodate the Proposed Action-related increases in enrollment, but given that increases in drilling and field development in the project area are likely to be accompanied by increases in drilling and development in other fields in the study area, the capacities of Rawlins schools are likely to be exceeded during the 15-year drilling period. The available capacities of the newly completed Rawlins Elementary School and the 500-student-capacity high school authorized by

the Wyoming School Facilities Commission would be nearly exceeded by the projected Proposed Action-related increase in enrollment alone, not considering increases in enrollment related to other energy development.

The LSRV K–12 schools in Baggs could accommodate the projected Proposed Action-related increase in enrollment, but would absorb most available capacity such that enrollment associated with other nearby energy development could result in enrollment increases beyond available capacities, particularly toward the end of the 15-year drilling phase and the subsequent five years of project operations.

As discussed in Section 1.7.4 of the Socioeconomic Technical Report, the Wyoming School Foundation Program provides a guaranteed level of funding to every school district in the state, with funding based on numbers of students, classrooms, and other factors such as adjustments for small schools, transportation, special programs, and the cost of living. Consequently, the school districts affected by Proposed Action-related increases in enrollment should have the financial resources to fund the required increases in teachers and operating costs, although the districts would experience increased costs to provide for special needs of incoming students, including programs for transient students and additional teachers to serve English-language learners. Wyoming teacher salaries are relatively high, but districts may have to provide housing to recruit the required number of teachers. Districts may also have trouble recruiting and retaining custodians and school-bus drivers if the area experiences another surge in energy development, given the wage competition during energy booms.

Fiscal Effects

Projections of future natural gas and condensate production provide the foundation for projecting the Proposed Action-related mineral development revenue.[27] Projected production was derived using typical well-production data provided by the BLM Wyoming's Reservoir Management Group (RMG) and the projected numbers of new wells associated with the Proposed Action.

Estimated total production for the Proposed Action (and Alternative A) over the life of the field is 12.02 Tcf of gas and 167.3 million bbls of liquid condensate. The estimated market value of that production, based on assumed future commodity prices of $4.00 per thousand cubic feet (Mcf) of gas[28] and $40.00 per bbl of liquid condensates is $52.0 billion ($2010); $45.6 billion for gas and $6.4 billion for condensate.[29]

The value of gas and condensate sales under the Proposed Action would reflect the trends in annual production, increasing over time as long as the anticipated level of new development occurs, but declining steadily once new development ceases. At the level of development associated with the Proposed Action, the incremental annual sales would exceed $1 billion within three to four years and remain above that mark for approximately 20 years. Projected annual sales value would peak at approximately $2.92 billion for the Proposed Action (**Figure 4.15-10)**. Sales of natural gas would account for nearly 90 percent of the total, $2.6 billion. In 2007, a total value of $1.37 billion in natural gas and $441 million in crude oil and condensate was produced in Carbon and Sweetwater counties. Despite substantial increases in natural gas production, the corresponding production values in 2009 were $949 million and $330 million, respectively.

[27] The gas and condensate volumes associated with the Proposed Action would be in addition to gas and condensate produced from wells already developed and allowed under previous NEPA actions.

[28] The $4.00/mcf commodity price for natural gas is net of an assumed $0.50/mcf gas processing allowance.

[29] Projected market value of sales assumes 95 percent of projected production is sold.

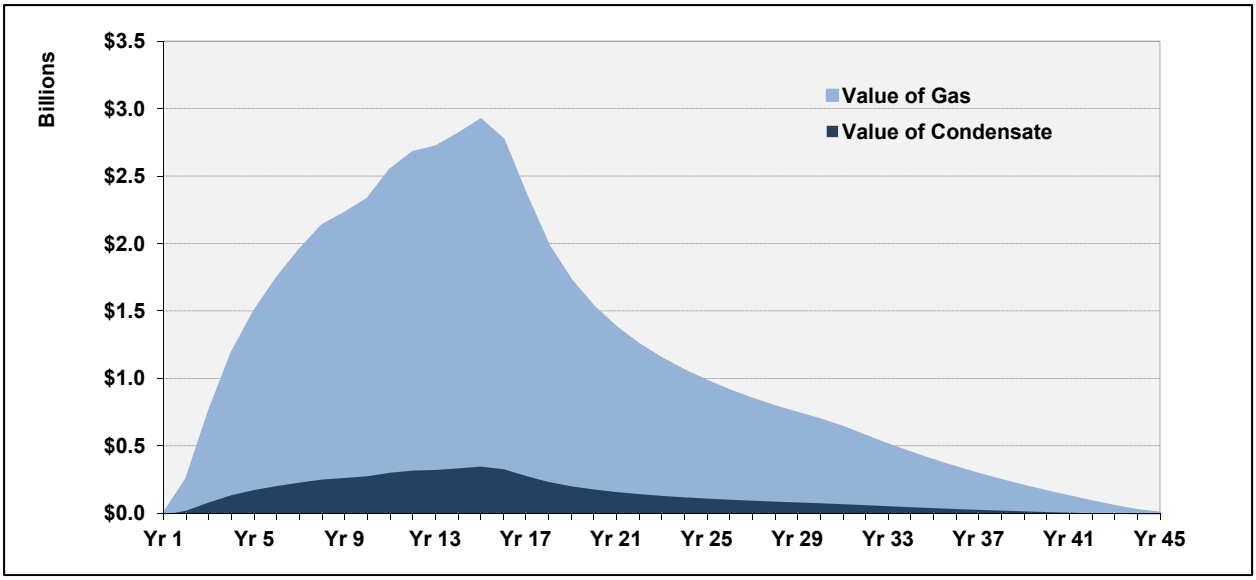


Figure 4.15-10. Projected value, annual natural gas and liquid condensate production, Proposed Action

Source: SDLLC and BCLLC

Production and the value of sales would decline rapidly after full-field development occurs (Year 15), decreasing by approximately 65 percent in the subsequent decade.

Severance Taxes

The State of Wyoming levies a severance tax on all minerals produced in the state. Current severance tax rates are 6.0 percent on condensate and natural gas. Severance tax rates are applied to the taxable value at the point where the production process is complete, before processing and transportation. Because processing adds value to the raw gas, the effective tax rate relative to market value is less than the nominal rate. In 2007, the Wyoming Legislative Services Office estimated the effective rates at 5.46 percent for condensate and 4.86 percent for natural gas. Applying these rates to the project values for the Proposed Action yields severance taxes of $818 million in the first decade as development continues and production climbs; $1.13 billion in the second decade during which peak production occurs; and a total of nearly $2.6 billion over the life of the field (**Figure 4.15-10** and **Table 4.15-9**).

Table 4.15-9. Projected state severance tax revenues and initial allocations, Proposed Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Permanent Wyoming Mineral Trust Fund, 41.7%	$ 341,020,000	$ 468,900,000	$ 185,770,000	$ 1,066,450,000
General Fund, 19.4%	159,700,000	219,580,000	86,990,000	499,410,000
Budget Reserve, 38.6%	317,730,000	436,880,000	173,080,000	993,620,000
Total state severance taxes	**$ 818,450,000**	**$ 1,125,360,000**	**$ 445,840,000**	**$ 2,559,480,000**

Source: SDLLC and BCLLC

Severance tax receipts collected by the state are allocated to the Permanent Wyoming Mineral Trust Fund (PWMTF) and to the Severance Tax Distribution Account; further distributions to numerous other funds are made from the latter. Those subsequent distributions are subject to a legislatively established aggregate cap of $155 million on annual revenue deposits. Revenue in excess of the annual cap is

distributed one-third to the state's general fund and two-thirds to the budget reserve account.[30] The high levels of mineral production and prices over the past decade have consistently generated sufficient severance taxes for such distributions to the general fund and budget reserve account. Under the assumed allocations, the Proposed Action would generate nearly $1.1 billion to the PWMTF, nearly $500 million to the state's General Fund, and more than $993 million to the Budget Reserve Account.

Federal Mineral Royalties

Federal mineral royalties (FMR), based on a rate of 12.5 percent, would be derived on the value of production from the federal mineral estate. The federal mineral estate encompasses about 59 percent of the total oil and gas mineral estate in the project area. Total projected FMR of $3.8 billion would be generated from the Proposed Action over the life of the field.[31] Of that total, nearly $1.96 billion would accrue to the Federal Treasury, with $1.88 billion in disbursements to the State of Wyoming (**Table 4.15-10**).

Table 4.15-10. Projected federal mineral royalties and distribution ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Federal Treasury (51%)	$ 625,690,000	$ 860,330,000	$ 340,830,000	$ 1,956,680,000
State of Wyoming (49%)	601,150,000	826,590,000	327,470,000	1,879,950,000
Total FMR	**$1,226,840,000**	**$1,686,920,000**	**$ 668,300,000**	**$ 3,836,630,000**

Source: SDLLC and BCLLC

As with the state's severance taxes, the state's share of FMR is allocated according to a tiered allocation formula. The state first deducts 1 percent for administration. Thereafter, the next $200 million in annual receipts is distributed among seven different funds, e.g., a county highways fund and school capital construction account. FMR in excess of $200 million are distributed as follows: one-third to the School Foundation Program and two-thirds to the state Budget Reserve Account. The $200 million annual cap has been exceeded consistently for more than a decade, such that incremental revenues flow to the education and budget reserve accounts. In recent years, a portion of the School Foundation Program distributions has been diverted to two special education accounts: the Hathaway and Higher Education endowments. The Hathaway endowment provides scholarships for high-school graduates entering college and the Higher Education endowment allows the University of Wyoming (UW) to fund a number of endowed faculty positions and acquire materials and resources to support those chairs. Projected allocations of the $1.88 billion in FMR accruing to the state are $626 million for education and $1.25 billion to the state's Budget Reserve Account (**Table 4.15-11**).

[30] The high levels of mineral production and commodity prices have consistently generated sufficient severance tax revenue to exceed the cap, such that additional revenues flow to the general fund and budget reserve account. The resulting distribution, which is used in this analysis, is 41.7 percent to the PWMTF, 19.4 percent to the General Fund and 38.9 percent to the Budget Reserve Account.

[31] A "temporary" change in the distribution of FMR was recently enacted by Congress and the President. Under the new formula, 51 percent of the revenue accrues to the federal government and 49 percent to the state, rather than the prior 50/50 split net of a 1 percent administrative processing fee. The forecasts reflect the current allocation formula.

Table 4.15-11. Projected allocation of Wyoming's share of federal mineral royalties, Proposed Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Wyoming School Foundation	$ 200,180,000	$ 275,250,000	$ 109,050,000	$ 626,020,000
State budget reserve	400,970,000	551,340,000	218,420,000	1,253,930,000
Total state share of FMR	**$ 601,150,000**	**$ 826,590,000**	**$ 327,470,000**	**$1,879,950,000**

Source: SDLLC and BCLLC

State Royalties

Like the federal government, the State of Wyoming collects mineral royalties on production from the state's mineral estate. The state's interest in the project area oil and gas estate is estimated at 2 percent, yielding an estimated $169 million ($2010) in royalties over the life of the field, assuming a 12.5-percent royalty rate. State mineral royalties accrue to the Wyoming Office of State Lands and Investments. Those revenues are in turn used to benefit public education and other designated state institutions, such as the Wyoming State Hospital.

Gross Products and Local Ad Valorem Taxes

The gross products tax is based on the value of the minerals produced in the previous year. The taxable value is determined by the state, but the tax is levied and collected by local taxing jurisdictions based on the applicable tax levy. Consequently, the tax is akin to local ad valorem property taxes. Based on the location of the wells and mineral resources, the taxing districts most directly affected by the Proposed Action include Sweetwater County, Carbon County, SCSD #1 and CCSD #1. A mandatory statewide mill levy to support public education via the Wyoming School Foundation program would be collected by the two counties, with the proceeds being transferred to the state. Projected gross products tax revenue from the Proposed Action, assuming current mill levies over the life of the project, would total $3.11 billion (**Table 4.15-12**). Of that total, 13.8 percent would accrue to Sweetwater County, 7.4 percent to Carbon County, 43.2 percent to SCSD #1, 25.0 percent to CCSD #1, and 10.6 percent to the Wyoming School Foundation Program.[32]

[32] The allocation to school districts assumes that the two local districts retain all of the additional tax revenue to meet increases in operating costs associated with changes in enrollment, rather than being subject to the "recapture" provisions under the Wyoming School Finance Act. Under those provisions, locally generated tax revenues in excess of the amount a district is authorized to expend under the financing equalization program are transferred to the state to help support statewide education. As a result, school districts realize little significant fiscal benefits from high levels of mineral development within their boundaries. Both SCSD #1 and CCSD #2 have been subject to the recapture provisions, CCSD # 1 as recently as 2010. In 2010, CCSD #1 contributed $15.8 million of its ad valorem tax collections to the School Foundation Program.

Table 4.15-12. Projected gross products and ad valorem taxes to local counties and school districts, Proposed Action ($2008)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project (40+ years)
Sweetwater County	$ 94,360,000	$ 162,330,000	$ 68,150,000	$ 354,130,000
Carbon County	50,810,000	87,410,000	36,700,000	190,680,000
Sweetwater County School District #1[1]	296,470,000	510,000,000	214,120,000	1,112,560,000
Carbon County School District #1 [1]	171,490,000	295,010,000	123,860,000	643,560,000
Wyoming School Foundation Program **	72,580,000	124,860,000	52,420,000	272,380,000
Combined totals	**$685,710,000**	**$1,179,610,000**	**$495,250,000**	**$2,573,310,000**

[1] These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act. Both SCSD #1 and CCSD #2 have been subject to the recapture provisions, CCSD # 1 as recently as 2010. In 2010, CCSD #1 contributed $15.8 million of its ad valorem tax collections to the School Foundation Program.

Source: SDLLC and BCLLC

In addition to the gross products tax on production, the counties, school districts, and some local taxing districts (special service districts and communities) would levy ad valorem taxes on the production equipment, pipelines, and other real improvements associated with the project, as well as residential, commercial, and industrial development generated by the project. Local communities would realize additional ad valorem tax revenues from new real-estate development supported by the project and the effects of demand on values of existing real estate. The affected local taxing districts include: Sweetwater County Conservation District; Sweetwater County Solid Waste District #2; Sweetwater County Weed and Pest District; Western Wyoming Community College; the Baggs Cemetery and Solid Waste Disposal districts; the Little Snake River Conservation, Museum, and Rural Mental Health districts; Carbon County Weed and Pest District; the cities of Rock Springs, Green River, and Rawlins, and the towns of Wamsutter and Baggs. Project-related ad valorem tax revenues accruing to these districts are not estimated in this analysis.

Sales and Use Taxes

Future expenditures for materials, supplies, and equipment associated with new well development and subject to sales and use tax are projected to exceed $2.8 billion under the Proposed Action. That total excludes taxable capital expenditures associated with any new centralized gas-processing facilities or transmission pipelines. Based on the locations of the wells and the concentration of well drilling and oil and gas service firms in Rock Springs, approximately two-thirds of that total, $1.9 billion, would occur in Sweetwater County. Taxable expenditures of $340 million by the Operators are assumed to occur in Carbon County, and $626 million are assumed to occur elsewhere in Wyoming or out of state.[33] The latter would be subject to use tax when brought into the state.[34]

The state imposes a 4.0-percent general sales and use tax on such purchases. Sweetwater County's tax rate is 2.0 percent (1.0 percent general purpose and 1.0 percent specific-purpose option). Carbon County historically levied only the 1.0-percent general purpose tax, but added a 1.0-percent specific purpose tax effective April 2009. Those tax rates, assumed to remain constant, would yield nearly $161 million in

[33] These estimates are based on information provided by the Operators to SDLLC and BCLLC and the development of 8,950 new wells.

[34] Additional taxable purchases would be made in conjunction with ongoing production and field operations. However, data to estimate such purchases was not available at the time of the analysis.

sales and use taxes; $115.8 million from the state's 4.0-percent rate, $38.2 million in locally imposed taxes in Sweetwater County and $6.7 million on sales in Carbon County.[35]

Projected distributions of the state's sales and use tax receipts, based on the current statutorily established allocations, would include $80.3 million to the general fund and $35.5 million to local governments. The distributions to local governments, which are primarily a function of population distribution in the 2000 Census, would include: $4.2 million to Sweetwater County, $1.3 million to Carbon County, and $30.0 million to other local governments.[36] Each county retains a portion of its distribution from the state; the remainder is distributed to cities and towns in the respective counties. Combining the locally generated sales and use tax and distributions from the state yields totals of $42.4 million in Sweetwater County and $8.1 million in Carbon County; more than $2.8 million in Sweetwater County and $534,000 in Carbon County on an annual basis.

The Proposed Action would stimulate higher consumer expenditures in the regional economy and Sweetwater and Carbon counties and local municipalities would benefit from sales and use tax receipts derived from the consumer expenditures. All sectors of the economy would benefit from the boost in consumer sales, with the most pronounced effects on the retail trade, food and beverage, and lodging and entertainment sectors. Incremental consumer expenditures would increase over time, as production and transportation employment increases, augmenting the incremental expenditures associated with the development phase. The incremental expenditures would drop sharply after the development phase is completed.

Revenue Summary

The combined total public-sector revenues from the identified sources are projected to exceed $9.3 billion over the life of the field. FMR totaling $3.8 billion would account for the single largest share of the total, 41.0 percent (**Table 4.15-13** and **Figure 4.15-11)** though nearly one-half of that total would be distributed to the State of Wyoming. The state would garner another $2.7 billion in severance taxes and state mineral royalties. Sweetwater and Carbon Counties would realize a combined total of $544 million in gross products and ad valorem taxes and the two school districts and Wyoming State Foundation program would collectively receive nearly $2.0 billion in tax revenues.

[35] The total assumes all non-local purchases are made out of state. If purchases are made elsewhere in Wyoming, additional sales taxes could be generated for that county, but the revenues accruing to Sweetwater and Carbon counties would be unaffected.

[36] The resident populations of Sweetwater and Carbon county, expressed as a percentage of Wyoming's total population, increased slightly between 2000 and 2010. Consequently, assuming no changes in the allocation formula by the Wyoming Legislature, the shares of local distributions from the state's receipts may increase slightly in the future.

Table 4.15-13. Projected public-sector taxes and royalties on gas and condensate production, Proposed Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Severance tax	$ 818,450,000	$ 1,125,360,000	$ 445,840,000	$ 2,559,480,000
Federal Mineral Royalties	1,226,840,000	1,686,920,000	668,300,000	3,836,630,000
State Mineral Royalties	54,030,000	74,300,000	29,430,000	168,960,000
Gross products / ad valorem, Counties [1]	145,170,000	249,740,000	104,850,000	544,810,000
Gross products / ad valorem, Schools [1]	540,540,000	929,870,000	390,400,000	2,028,500,000
Sales and use taxes, development-related	156,610,000	66,660,000	n/a	223,270,000
Total combined	**$2,941,640,000**	**$4,132,850,000**	**$1,638,820,000**	**$9,361,650,000**

[1] *These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act.*

Source: SDLLC and BCLLC

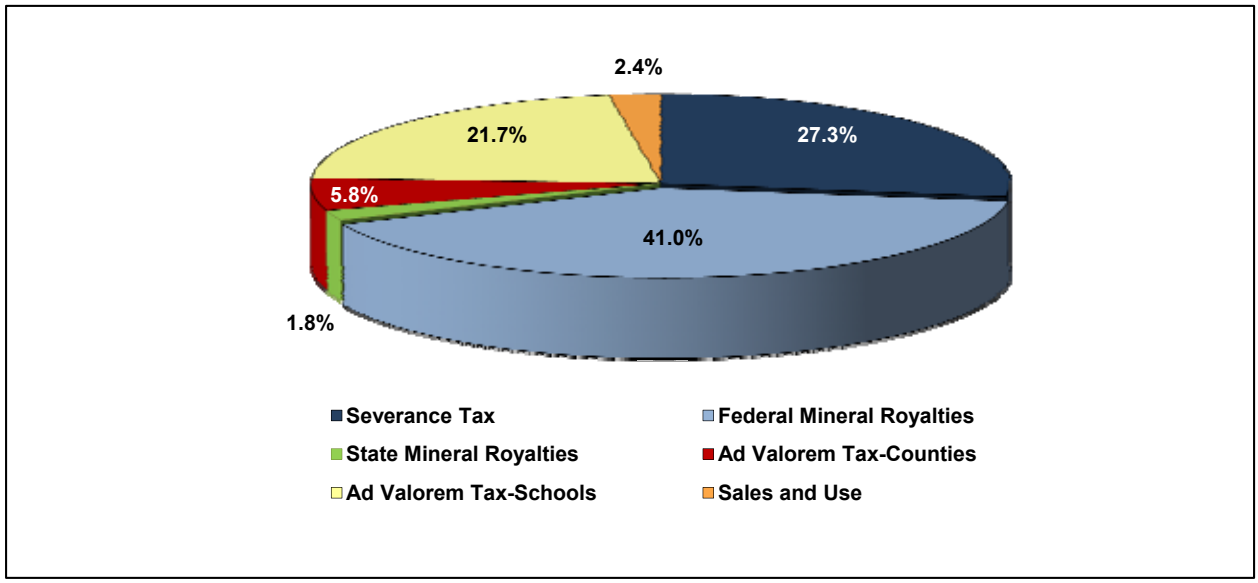


Figure 4.15-11. Distribution of public-sector taxes and royalties, Proposed Action

Source: SDLLC and BCLLC

Local Public Sector Expenditures

Although the revenues generated to the public sector by the Proposed Action would be substantial over time, local and state governments would correspondingly be required to make substantial expenditures to respond to demand from development activities and from the population associated with the Proposed Action. Many of the required infrastructure and service expenditures were identified and discussed conceptually in the preceding Community Infrastructure and Services section. The amount and timing of expenditures that local governments might make in response to development are not known and would depend in part on the concurrent level of development throughout the study area.

In the past, local governments have often had to respond to service demand from energy development prior to receiving substantial revenues from that development. In the case of major infrastructure investments, local governments assume substantial risk that the development will continue and generate adequate revenue to pay for the investment. This phenomenon has been called the "tax lead-time

problem" (Governors Committee on Oil Shale Environmental Problems 1974), but might be more appropriately called the "tax lag-time problem," in that the receipt of adequate tax revenues lag the point in time at which local governments incur cost to serve development and growth.

Another issue alluded to elsewhere in this assessment is the "jurisdictional mismatch problem," in which development-related tax revenues do not accrue in sufficient amounts to the local governments affected by development-related impacts. In Wyoming, ad valorem taxes on natural gas production and facilities typically do not accrue to municipalities, where most of the population-related impacts occur. Municipalities must rely on development-related sales and use taxes, which are often inadequate to fund expenditures to serve development and can diminish relatively rapidly when development slows.

These are historical problems that have accompanied energy and other forms of natural-resource development in Wyoming and much of the west. The magnitude of these problems in relation to the Proposed Action will depend in part on the magnitude of concurrent energy development in the study area. As previously noted, most local governments in the study area have expanded infrastructure during past periods of energy development, so there is some capacity for growth in infrastructure in the affected communities. Additionally, production-related revenues from existing wells within the project area will provide revenue streams for counties, school districts, the Wyoming School Foundation Fund and some special districts as future development occurs.

Social Effects

Many of the social effects of the last natural gas boom discussed in **Section 3.15.7** could occur under the Proposed Action, particularly if substantial concurrent development were to occur in other parts of the study area. The availability of a relatively large number of high-paying jobs and corresponding low regional unemployment would again be seen as positive aspects of development. Many of the current residents of Carbon and Sweetwater counties are associated with energy industries and residents of all affected communities are familiar with energy development. But as the population in affected communities would grow as a result of the Proposed Action and other energy development, the proportion of newcomers and the numbers of temporary and transient persons in affected communities would increase. This trend has been associated with decreased community cohesion and increases in certain types of crime including those involving drugs, alcohol, and minor disturbances and assaults (see **Section 3.15.4.1**).

Conversely, as more families relocate to communities, more commercial and community infrastructure would be available for newcomers and long-time residents alike. Community infrastructure and services would likely be strained and commercial establishments would experience some crowding in some communities during the early part of the development period, particularly if increases in development in the project area coincided with development elsewhere in the study area.

Each of the communities within the CD-C study area would be affected differently by population growth associated with the Proposed Action. Rawlins and Rock Springs have embarked on housing and infrastructure development and community revitalization efforts. Both of these communities have initiated programs to preserve and redevelop portions of their historic downtown areas and have instituted and expanded cultural and recreational events that offer venues for newcomers and long-time residents to socialize. Wamsutter has an extensive program to develop and expand both physical and commercial infrastructure and housing resources and has enlisted participation by natural gas companies and the State of Wyoming in their efforts. Baggs is expanding and improving infrastructure to accommodate growth and the social effects of growth on this relatively close-knit ranching and outdoor recreation community will present unique challenges. However, the relatively modest level of growth associated with the Proposed Action and the community's experience with prior and ongoing energy development will likely soften these effects. Green River would receive proportionately the smallest amount of growth from the

Proposed Action and is likely to host few temporary workers, so adverse social effects of the Proposed Action would likely be minimal in that community.

Although the value of environmental amenities and outdoor recreation for residents of the study area is relatively well-documented, social effects of the change in environmental amenities associated with the Proposed Action are likely to be minimal. The fact that much of the project area is already developed and industrialized would diminish concern for further changes in most environmental amenities. The exceptions would be areas that are considered sensitive such as the sage-grouse lek complex southeast of Creston, the small portion of the Red Lake Dunes Citizens' Proposed Wilderness that extends into the northwestern part of the project area, and the Chain Lakes Wildlife Habitat Management Area.

The displacement of grazing permittees from the most intensively developed areas of the CD-C project area would be a substantial social impact, particularly if the ranching families who hold the allotments exit the ranching business. Ranching is an important element of the culture in the study area and further reductions in the ranching community would be of concern for many residents.

Environmental Justice

No environmental justice populations have been identified within or in areas immediately adjacent to the project area. Although some communities in this area have concentrations of racial and ethnic minority populations slightly higher than the statewide averages, the percentages are not meaningfully higher with the exception of Rawlins and that minority population is in large part attributable to the racial composition of the inmate population at the Wyoming State Penitentiary. Rawlins is 25 miles from the eastern boundary of the project area; consequently, the inmate population is unlikely to be affected by human health or environmental effects of the Proposed Action.

The percentage of persons in poverty within and immediately adjacent to the project area is lower than the statewide average. The percentage of persons in poverty in Carbon County is slightly higher than the statewide average as a result of the population associated with the Wyoming State Penitentiary, but again, that population is unlikely to be affected by the activities associated with the Proposed Action.

Based on the foregoing, no disproportionately high and adverse human health or environmental effects on minority or low-income populations are anticipated under the Proposed Action.

4.15.2.3 Alternative A: 100-Percent Vertical Drilling

Employment

Like the Proposed Action, Alternative A assumes a total of 8,950 new wells would be drilled over a 15-year period. Alternative A assumes that all wells would be drilled vertically from single-well pads. The shift to all single-well pads would require more rigs to drill the same number of wells each year compared to the Proposed Action. Projected long-term gas, condensate, and water production would be the same as under the Proposed Action. Applying the work-crew concept developed for the Proposed Action to Alternative A yields an increase of 15 to 20 percent in the number of direct onsite jobs (about 150) and 200 to 210 total direct jobs as compared to the Proposed Action. Estimated long-term production and transportation employment would be slightly higher than for the Proposed Action due to the reduced efficiencies of servicing the higher number of single-well pads.

The additional direct employment would support more indirect and induced employment, as well as triggering additional population growth. Total peak incremental employment under Alternative A would average about 400 more jobs than under the Proposed Action during the 15-year development phase (**Figure 4.15-12**). The majority of the added jobs would be based in Sweetwater County.

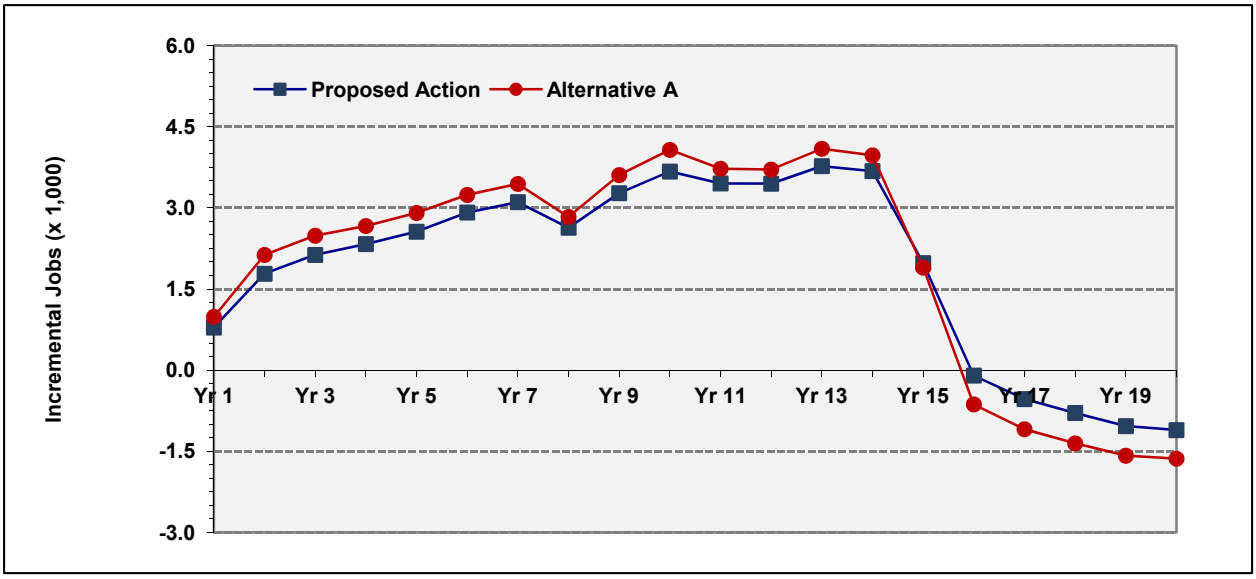


Figure 4.15-12. Total incremental employment, Alternative A compared with the Proposed Action

Sources: SDLLC & BCLLC based on CD-C Operators employment estimates and REMI model output

Following the completion of new well development, incremental employment under Alternative A would be comparable to that under the Proposed Action, because Alternative A would have similar long-term direct production and transportation employment requirements.

Population

Projected population growth under Alternative A would mirror employment impacts, with the peak incremental population eventually reaching 4,464 residents, approximately 450 higher than under the Proposed Action (**Table 4.15-14**). The majority of the higher population would likely reside in Sweetwater County, particularly in Rock Springs. Alternative A would also result in higher net in-migration and an influx of temporary non-resident workers during the initial years of implementation, but also higher out-migration following the completion of new well development.

Table 4.15-14. Incremental resident population impacts from Alternative A

	Year 1	Year 5	Year 10	Year 15	Year 20
Alternative A	353	2,054	3,664	4,464	1,028
Proposed Action	303	1,759	3,192	4,018	1,059
Difference	50	295	472	446	-31

Source: SDLLC and BCLLC, using the REMI model

Most of the difference in population change would occur in Rock Springs and Rawlins, although the magnitudes of those differences would be limited in comparison to either the current population or the incremental growth associated with the Proposed Action.

Other Socioeconomic Effects

The relatively minor differences in community population between Alternative A and the Proposed Action would result in minor differences in housing demand, demand for community infrastructure and local government services, and increases in public-school enrollment. Rock Springs and Rawlins would likely experience a small increase in temporary workers resulting in a corresponding increase for services associated with the predominantly working-age-male demographics of that workforce.

Fiscal Effects

Alternative A includes the same number of wells as the Proposed Action, both in total and on an annual basis. However, all of the wells would be drilled from single-bore pads. The projected production is also equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (**Table 4.15-15**).

Table 4.15-15. Summary of projected public-sector taxes and royalties on gas and condensate production, Alternative A ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Severance tax	$ 818,450,000	$1,125,360,000	$ 445,840,000	$ 2,559,480,000
Federal mineral royalties	1,226,840,000	1,686,920,000	668,300,000	3,836,630,000
State mineral royalties	54,030,000	74,300,000	29,430,000	168,960,000
Gross production / ad valorem tax, counties **	145,170,000	249,740,000	104,850,000	544,810,000
Gross production / ad valorem tax, schools **	540,540,000	929,870,000	390,400,000	2,028,500,000
Sales and use taxes -	156,610,000	66,660,000	n/a	223,270,000
Total combined	**$2,941,640,000**	**$4,132,850,000**	**$1,638,820,000**	**$9,361,650,000**

*** These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act.*

Source: SDLLC and BCLLC

Sales and use tax revenues derived from the direct expenditures by the Operators under Alternative A would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be slightly higher under Alternative A than under the Proposed Action, due to the higher level of employment during the development phase; however, estimates of the differences were not prepared for this analysis.

Social Effects

Social effects of Alternative A would be comparable to those associated with the Proposed Action.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under Alternative A.

4.15.2.4 Alternative B: Enhanced Resource Protection

Employment

Like the Proposed Action, Alternative B assumes a total of 8,950 wells drilled over a 15-year period, but assumes a 20 percent increase in the number of directionally drilled wells located on federal lands. For purposes of this assessment the shifts in projected long-term gas, condensate and water production would be the same as under the Proposed Action. Total direct employment under Alternative B, including long-term production and transportation employment, would be slightly lower than for the Proposed Action. However, the differences would not be of such a magnitude as to materially alter the direct, indirect, and induced employment and income effects from those anticipated under the Proposed Action. Consequently, the profile of employment growth and subsequent declines shown for the Proposed Action in **Figure 4.15-6** reasonably characterizes the impacts on local employment of Alternative B.

Population

Projected population growth under Alternative B, like the foreseeable effects on employment and income, would be similar but slightly lower than those under the Proposed Action. The majority of the project-related incremental population in Sweetwater County would be expected to reside in Rock Springs and Wamsutter. In Carbon County, most of the incremental population would be anticipated to live in Rawlins and Baggs/LSRV. Any difference in population in communities would likely be negligible and not reflective of any specific feature of Alternative B.

Other Socioeconomic Effects

Project-related demands on temporary and long-term housing resources, community infrastructure and local government services, and public-school enrollment under Alternative B would be comparable to those under the Proposed Action.

Fiscal Effects

Alternative B includes the same number of wells as the Proposed Action, both in total and on an annual basis, but more of the wells on federal lands would be drilled on multi-well pads. The projected production is also equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (see **Table 4.15-13** above**)**.

Sales and use tax revenues derived from the direct expenditures by the Operators under Alternative B would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be slightly lower under Alternative B than under the Proposed Action, due to the lower level of employment during the development phase; however, these differences would be minimal and estimates of the differences were not prepared for this analysis.

Social Effects

Generally, social effects of Alternative B would be comparable to those associated with the Proposed Action. However, the additional protections afforded by Alternative B for areas that are considered sensitive such as the sage-grouse lek complex southeast of Creston, the small portion of the Red Lake Dunes Citizens' Proposed Wilderness that extends into the northwestern part of the project area, and the Chain Lakes WHMA would reduce concern for the environmental effects on those areas.

Similarly, the additional resource protections provided by Alternative B (**Section 2.2.3**) would result in a reduction of impacts to forage and grazing activities and correspondingly reduce impacts to ranchers and grazing permittees as compared to the Proposed Action.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under Alternative B.

4.15.2.5 Alternative C: Surface Disturbance Cap

Employment

Like the Proposed Action, Alternative C assumes a total of 8,950 wells drilled over a 15-year period, but assumes a 50-percent increase in directional drilling of wells located on federal lands. Projected long-term gas, condensate, and water production would be the same as under the Proposed Action. Total direct

employment under Alternative C, including long-term production and transportation employment, would be lower than for the Proposed Action. However, the differences would not materially alter the direct, indirect, and induced employment and income effects from those anticipated under the Proposed Action. Consequently, the profile of employment growth and subsequent declines shown for the Proposed Action in **Figure 4.15-6** reasonably characterizes the impacts on local employment of Alternative C.

Population

Projected population growth under Alternative C, like the foreseeable effects on employment and income, would be similar to but somewhat lower than those anticipated under the Proposed Action.

Other Socioeconomic Effects

Project-related demands on temporary and long-term housing resources, community infrastructure and local government services, and public-school enrollment under Alternative C would be comparable to but somewhat lower than those under the Proposed Action.

Fiscal Effects

Alternative C includes the same number of wells as the Proposed Action, both in total and on an annual basis, but more of the wells on federal lands would be drilled on multi-well pads. The projected production would also be equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (see **Table 4.15-13** above**)**.

Sales and use tax revenues derived from direct expenditures by the Operators under Alternative C would be comparable to those under the Proposed Action, totaling about $223.3 million during the development phase. Sales and use tax revenues derived from consumer expenditures would be somewhat lower under Alternative C than under the Proposed Action, due to the lower level of employment during the development phase; however, the difference is anticipated to be small and estimates of the differences were not prepared for this analysis.

Social Effects

Social effects of Alternative C would be comparable to those associated with the Proposed Action.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under Alternative C.

4.15.2.6 Alternative D: Directional Drilling

Employment

Like the Proposed Action, Alternative D assumes a total of 8,950 new wells drilled but with all future natural gas wells on federal mineral estate to be drilled directionally from multi-well pads. Projected annual and long-term gas, condensate, and water production would be the same as under the Proposed Action (see **Figure 4.15-3**). Based on differences in the lower average overall labor requirements between vertical wells on single wells pads and those for directionally drilled wells on multi-well pads, on a per well basis, total direct employment under Alternative D, including long-term production and transportation employment, would be 5 to 10 percent lower than for the Proposed Action. However, the differences would not materially alter the direct, indirect and induced employment and income effects from those anticipated under the Proposed Action. Consequently, the profile of employment growth and

subsequent declines shown for the Proposed Action in **Figure 4.15-6** reasonably characterizes the impacts on local employment of Alternative D.

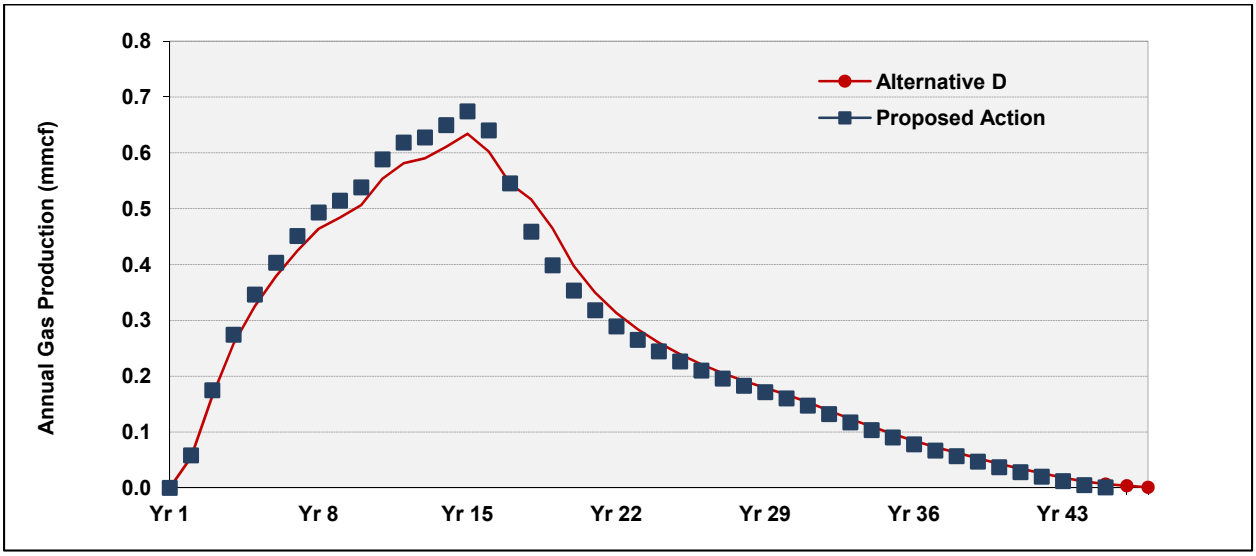


Figure 4.15-13. Projected annual natural gas production (MMcf), Alternative D and Proposed Action

Population

Projected population growth under Alternative D, like the foreseeable effects on employment and income, would mirror those under the Proposed Action—but with about 300 fewer residents at the peak. The majority of the project-related incremental population in Sweetwater County would be expected to reside in Rock Springs and Wamsutter. In Carbon County, most of the incremental population would be anticipated to live in Rawlins and Baggs/the Little Snake River Valley. Any difference in population in communities would likely be negligible and not reflective of any specific feature of Alternative D. Alternative D would also result in lower initial influx of temporary non-resident workers during the initial years of implementation but also lower out-migration following the completion of new well development.

Other Socioeconomic Effects

The relatively minor differences in community population between Alternative D and the Proposed Action would result in minor differences in housing demand, demand for community infrastructure and local government services, and increases in public-school enrollment. Rock Springs and Rawlins would likely experience a somewhat smaller influx of temporary workers than under the Proposed Action, the difference resulting in a corresponding lesser decrease for services associated with the predominantly working-age-male demographics of that workforce.

Fiscal Effects

Alternative D includes the same number of wells as the Proposed Action, both in total and on an annual basis, but more of the wells on federal lands would be drilled on multi-well pads. The projected production is also equivalent to that under the Proposed Action. Consequently, projected revenues from state severance taxes, FMR, state mineral royalties, and gross products/ad valorem taxes under Alternative D would be comparable to those under the Proposed Action: approximately $9.4 billion over the life of the field (see **Table 4.15-13** above**)**.

Sales and use tax revenues derived from the direct expenditures by the Operators under Alternative D would be comparable to those under the Proposed Action, totaling about $223.3 million during the

development phase. Sales and use tax revenues derived from consumer expenditures would be slightly lower under Alternative D than under the Proposed Action, due to the lower level of temporary employment during the development phase; however, estimates of the differences were not prepared for this analysis.

4.15.2.7 Alternative E: No Action

At year-end 2010 there were an estimated 3,486 producing wells in the project area. For this analysis, the No Action Alternative assumes that no additional wells would be drilled in the project area beyond those drilled before the issuance of the ROD for the EIS. Assuming the cessation of drilling in 2012, production would peak at approximately 270 Bcf per year, less than 40 percent of the peak under the Proposed Action, and then begin an extended period of decline (see **Figure 4.15-14**). Total remaining production from producing wells under No Action is estimated at about 3.2 Tcf of gas and 43 million barrels of oil condensates.

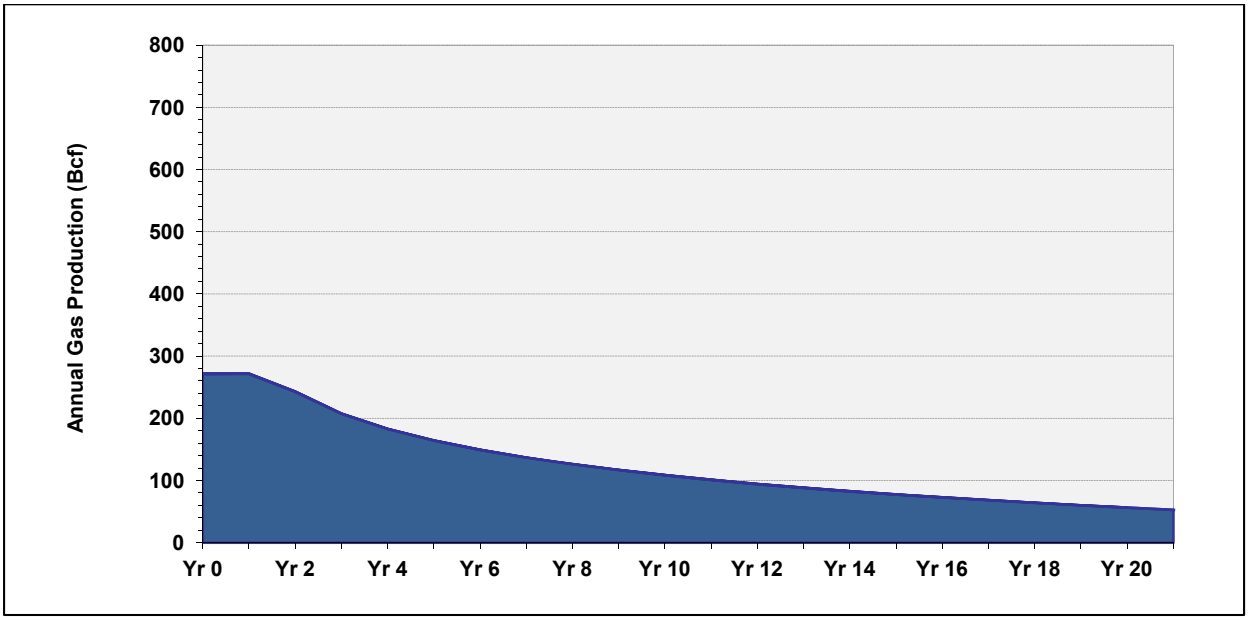


Figure 4.15-14. Projected annual natural gas production under the No Action Alternative

Sources: SDLLC & BCLLC based on USBLM Wyoming RMG production estimates

Employment

Implementation of the No Action alternative would reduce an important source of economic stimulus in the regional economy as drilling and field development in the CD-C area would come to a halt in 2012. Thereafter, drilling-and-completion-related employment would rapidly decline (**Figure 4.15-15**). Long-term production and transportation employment would also be lower under the No Action as compared to the Proposed Action, due to the lower volumes of gas, condensate, and water production.[37] The loss of direct onsite and off-site drilling and field-development employment, along with the lower production and transportation jobs relative to the Proposed Action, would ripple through the economy, reducing the number of indirect and induced jobs supported by activity in the project area. The magnitude of the eventual job losses would grow over time.

[37] Current levels of direct onsite and off-site development employment associated with development are assumed to cease at the same time as the completion of drilling under the No Action.

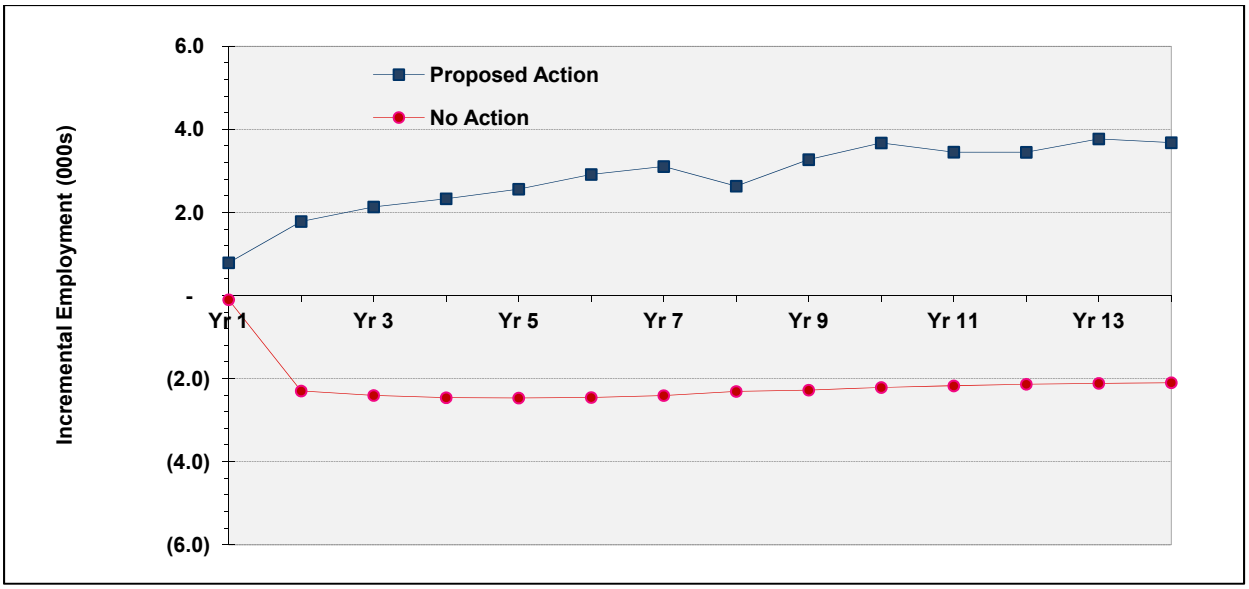


Figure 4.15-15. Incremental employment in Sweetwater and Carbon Counties, No Action and Proposed Action

SDLLC & BCLLC based on CD-C Operators' employment estimates and REMI model output.

Projected population change under No Action would initially show a modest decline as temporary residents would account for most of the outflow. Over time, population declines would mount as the losses in temporary and long-term induced and production-related jobs and slower growth in population-related consumer demand affected resident households. Net population declines in the region would exceed an estimated 2,000 residents within 5 years and eventually total approximately 4,000 fewer residents (see **Figure 4.15-16**), assuming the absence of other economic activity that would provide employment for the displaced workers. The largest declines in resident and temporary populations would occur in Rock Springs, with the largest relative difference occurring in Wamsutter.

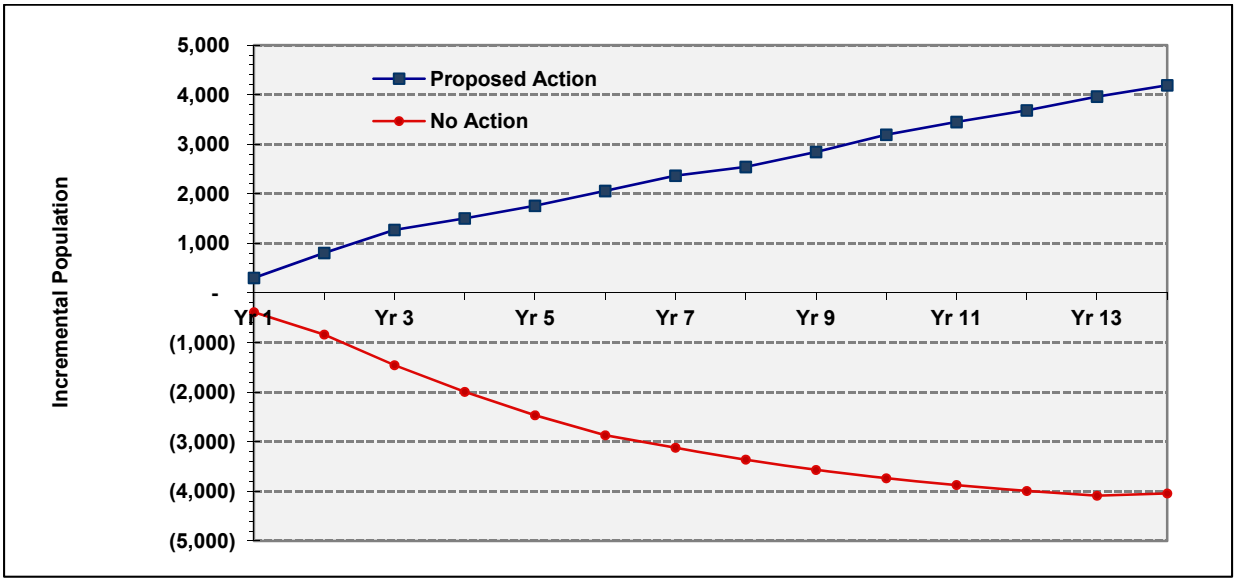


Figure 4.15-16. Incremental population change, No Action and Proposed Action

SDLLC & BCLLC based on CD-C Operators' employment estimates and REMI model output.

Housing, Community Infrastructure and Services

Implementation of the No Action Alternative would result in substantially lower demand for long-term and temporary housing resources in communities near the project area. Following the completion of development, and depending on other energy-development activities occurring at the time, communities near the CD-C project area could see substantial increases in vacancies and lower real estate values and rental costs in both long-term and temporary housing under the No Action Alternative.

Communities near the project area would experience moderating demand for most community facilities and services following implementation of the No Action Alternative. Some workforce and social service organizations may see temporary increases in the need to assist individuals and families affected by loss of employment. Over time, the trends in population change could result in excess capacity in some communities depending on the level of other energy-development activity. Future reductions in service demand would be relatively greatest in Wamsutter and Baggs/LSRV but would also extend to Rawlins and Rock Springs.

Fiscal Effects

The No Action Alternative assumes a halt to new oil and gas development in the project area following a ROD for the EIS. Cessation of activity would be followed by a steady decline in production volumes, with corresponding effects on sales of product and the associated public sector tax revenues. Total estimated incremental sales value of production from existing wells under the No Action is projected at $15.0 billion, approximately 29 percent of the $52.0 billion in aggregate sales value under the Proposed Action. Under No Action, peak annual market value of sales is projected at $1.38 billion in 2012. The rapidity of both the growth and decline of annual sales volume under the No Action Alternative contrasts markedly to that for the Proposed Action (**Figures 4.15-2** above and **4.15-17** below).

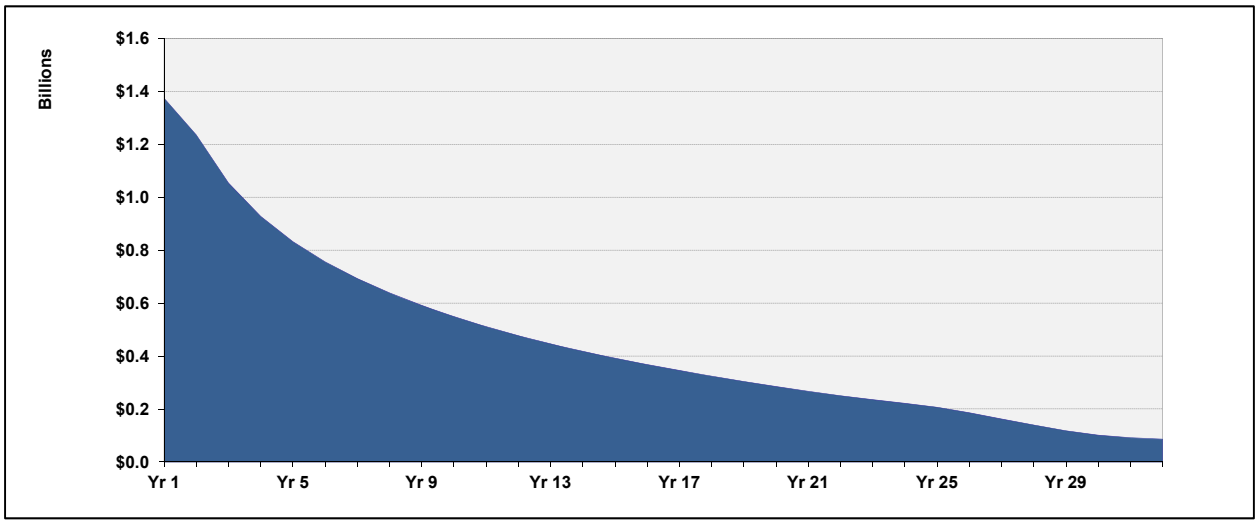


Figure 4.15-17. Projected annual value of gas and condensate production, No Action

Source: SDLLC and BCLLC

The lower total production under No Action, relative to the Proposed Action, would result in correspondingly lower royalty and tax generation. Total projected revenues from the defined sources are $2.5 billion (**Table 4.15-16**), nearly 73 percent lower than under the Proposed Action. Similar relative reductions characterize the differences in the other major public sector revenues as well. The differences reflect not just the lower projected production, but also the absence of FMR resulting from the lack of additional new wells on federal lands under the No Action Alternative. State mineral royalties from new wells and production on state lands would, however, be the same as under the Proposed Action.

Table 4.15-16. Summary of projected taxes and public-sector royalties on gas and condensate production, No Action ($2010)

	Year 1–10 Subtotal	Year 11–20 Subtotal	Year 21–30 Subtotal	Life of Project Total (40+ yrs)
Severance tax	$624,280,000	$274,610,000	$131,910,000	$1,049,850,000
Federal mineral royalties	0	0	0	0
State mineral royalties	92,800,000	48,870,000	22,780,000	168,960,000
Ad valorem tax, counties [1]	120,840,000	64,940,000	31,330,000	223,670,000
Ad valorem tax, schools [1]	448,550,000	241,040,000	116,280,000	830,190,000
Sales and use taxes	156,610,000	66,660,000	n/a	223,270,000
Total combined sources	**$1,443,080,000**	**$696,120,000**	**$302,300,000**	**$2,495,940,000**

[1] *These allocations assume the locally generated taxes are retained by the school districts and not subject to transfer to the state under the "recapture" provisions of the Wyoming School Finance Act.*

Source: SDLLC and BCLLC.

The lower total production under No Action, relative to the Proposed Action, would result in correspondingly lower royalty and tax generation, including FMR and state mineral royalties due to the lack of new wells completed on public lands. Not only would less revenue accrue to the Wyoming State Foundation program from distributions of the FMR, but the program would also receive less revenue from the statewide mandatory levy on gross products and the taxable real property associated with oil and gas development.

Sales and use taxes would also be substantially lower under No Action than under the Proposed Action due to the lower value of taxable purchases by the Operators and lower consumer expenditures by workers and businesses supported indirectly by new development.

Social Effects

Social effects of the No Action Alternative would include increases in unemployment and reductions in income that would result 15 years sooner under the No Action than the Proposed Action. Widespread unemployment would trigger out-migration and some disruption of the social fabric in communities.

Local residents who have benefited economically from continued development of the project area would likely be dissatisfied with the forgone opportunities.

As development within the project area ceases and interim reclamation occurs, many of the adverse impacts to grazing permittees would begin to diminish. Over time, the use of grazing allotments in the most intensely developed portions of the project area could increase, benefiting ranchers in the region. Similarly, as development activities cease and interim reclamation occurs, some recreation users of public lands within the project area might return to the area.

Environmental Justice

No disproportionately high and adverse human health or environmental effects on minority or low-income populations would be anticipated under the No Action Alternative.

4.15.3 Impact Summary

Each of the alternatives assessed in this EIS would result in substantial social and economic effects within the study area. Under the parameters and assumptions used for this assessment, the five action alternatives would generate similar effects with minor differences. Alternative A – 100 Percent Vertical Drilling would have slightly higher levels of employment, population, sales and use tax generation, and housing and public infrastructure and services demand than the Proposed Action; Alternative B – Enhanced Resource Protection, Alternative C – Surface Disturbance Cap, and Alternative D – Directional Drilling

would each have increasingly fewer effects on socioeconomic conditions. However, for broad assessment purposes the effects of the five action alternatives would be similar and are summarized together.

The beneficial economic, social, and fiscal effects of the action alternatives would be foregone under the No Action Alternative. Instead, the added economic stimulus associated with drilling, development, and production would be replaced by increased unemployment, workforce outmigration, and a decline in public-sector revenues. Moreover, these effects would begin occurring soon after the issuance of the ROD, 15 years sooner than under the action alternatives.

Each of the five action alternatives would generate over 1,000 incremental total onsite and off-site direct jobs during the fifth year of field development and about 1,400 and 1,600 total direct jobs in Years 10 and 15, respectively. Direct employment would decline sharply following the completion of new well development, shedding nearly 1,200 total direct jobs by Year 20. At that time, five years after drilling and field development is scheduled to cease, total direct jobs would decrease to below 500.

For the five action alternatives, total employment including direct, indirect, and induced jobs, would climb to a peak of around 4,000 jobs in Year 14 of development. It is important to note that these would be in addition to the existing level of project-area employment associated with average annual drilling of almost 300 wells and production of over 3,700 wells. Once drilling/field development is completed, regional employment would decrease by over 4,300 jobs, which would include not only the incremental jobs associated with drilling/field development under the Proposed Action but the currently existing drilling/field development-related jobs as well, hence the total job loss would be larger than the total incremental job gain associated with the action alternatives, even though a substantial number of production-related jobs would remain after drilling/field development ceases.

Population increases and losses for all alternatives would closely follow employment gains and losses. Incremental population associated with the five action alternatives would increase over time to a peak of about 3,700 new residents and almost 1,000 temporary workers during Year 15 of development. Project-related population would fall to about 700 residents by Year 20, five years after drilling/field development ceases.

Project-related population under No Action would decline rapidly upon issuance of the ROD resulting in population outmigration in both Sweetwater and Carbon counties and the affected communities.

The population associated with the five action alternatives would generate demand for additional long-term and temporary housing resources, increasing to an estimated total demand of over 1,500 long-term units and almost 1,000 temporary beds in Year 15 of development, and decreasing to about 250 long-term units and no temporary units during Year 20. Again, this substantial reduction in housing demand would be associated not only with the decrease in incremental demand associated with the action alternatives, but the decrease in demand from the population associated with current development and production employment in the project area as well.

Implementation of the No Action Alternative would result in a substantial decrease in area housing demand compared to existing conditions. Depending on other energy-development activities occurring at the time of the issuance of the ROD, communities near the CD-C project area could see substantial vacancies in both long-term and temporary housing under the No Action Alternative.

The substantial increase in population associated with the five action alternatives would generate corresponding demand for community infrastructure and services. Most communities within the study area have anticipated energy-related growth and have improved or are planning to improve major community infrastructure such as water, wastewater, solid-waste disposal systems, criminal detention facilities, and schools. Current or planned facilities should be adequate to accommodate the population associated with the action alternatives in the near term but may require expansion during the latter part of the 15-year drilling and field-development cycle, depending on the cumulative level of energy

development occurring at the time. Demand for community facilities would substantially diminish after the 15-year drilling/field-development cycle is completed.

Many community-service providers would be required to add staff, equipment, and perhaps facilities to accommodate the population associated with the five action alternatives, particularly in the context of cumulative regional energy development.

Under the No Action Alternative, current infrastructure and service demand associated with development in the CD-C project area would diminish substantially, perhaps resulting in excess capacity in some infrastructure and services, depending on the level of other energy development activity occurring at the time of the issuance of a ROD. Future reductions in service demand would be relatively greatest in Wamsutter and Baggs/LSRV but would also extend to Rawlins and Rock Springs.

Substantial federal, state, and local government revenues would be generated by the natural gas and liquids production associated with each of the five action alternatives and by the capital investment associated with drilling/field development. Under the production and pricing assumptions used for this assessment, the action alternatives would generate about $3.8 billion ($2008) in FMR over the 40-year life of the project, and about $1.8 billion of that amount would accrue to the state. An estimated $530 million in state mineral royalties would be generated by the action alternatives, and $3.1 billion in ad valorem and gross products taxes to various counties, special districts, school districts, and the Wyoming School Foundation Fund. Sales and use taxes associated with project-related investments would yield nearly $161 million in sales and use taxes at current rates: $115.8 million from the state's 4.0 percent rate, $38.2 million in locally imposed taxes in Sweetwater County, and $6.7 million on sales in Carbon County. Projected distributions of the state's sales and use tax receipts, based on the current statutorily established allocations would include $80.3 million to the general fund and $35.5 million to local governments. As noted above, sales and use tax revenues would be somewhat higher under Alternative A and somewhat lower under Alternatives B, C, and D.

Oil and gas-related tax revenues would be much lower under the No Action Alternative than under any of the action alternatives, both in terms of annual receipts and total receipts over the life of the field.

The lower total production under No Action relative to the action alternatives would result in correspondingly lower royalty and tax generation. Total projected revenues from the defined sources would be nearly 77 percent lower than under the Proposed Action. Similar relative reductions characterize the differences in the other major public-sector revenues as well.

Not only would less revenue accrue to the Wyoming State Foundation program from distributions of the FMR, but the program would also receive less revenue from the statewide mandatory levy on gross products and the taxable real property associated with oil and gas development.

Sales and use taxes would also be substantially lower under No Action than under the action alternatives due to the lower value of taxable purchases by the Operators and lower consumer expenditures by workers and businesses supported indirectly by new development.

Social effects of the action alternatives would generally be similar to current effects in communities within the study area, which are both beneficial and adverse. Increases in certain types of crime and social problems and decreases in community cohesion could be associated with rapid population growth and large numbers of temporary workers in communities, depending on the concurrent level of energy development in the area. Conversely, increased employment opportunities, a generally robust economy, and increases in commercial and community infrastructure would be seen as beneficial to many residents.

The fact that much of the project area is already developed and industrialized would diminish concern for further changes in most environmental amenities under the action alternatives. Given that substantial change in the recreation setting has already occurred, the relative change in recreation use associated with any further development would be small. The concern for development-related effects on areas that are

considered sensitive would also occur under all action alternatives, but would not occur under the No Action Alternative.

The displacement of grazing permittees from the most intensively developed areas of the project area could occur under all alternatives; the risk of additional displacement would not occur under the No Action Alternative.

No disproportionately high and adverse human-health or environmental effects on minority or low-income populations would be anticipated under any of the action alternatives or the No Action Alternative.

4.15.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Most unavoidable adverse socioeconomic impacts of the Proposed Action and alternatives are associated with: the rapid and/or temporary influx of new workers, the need to provide housing and community services and facilities for the additional workforce and their families, and the decline in public revenues that would occur at the end of the project or with the implementation of the No Action alternative. The following mitigation measures should be implemented to reduce adverse socioeconomic effects and enhance the beneficial effects:

- To the extent practicable, the Operators should attempt to hire and train local workers from Carbon and Sweetwater counties.
- The Operators should acquire and require their contractors to acquire Carbon and Sweetwater County sales and use tax licenses and purchase all materials, equipment, and supplies to be used within the project area under these licenses so that proper attribution of sales and use tax payments can occur.
- The Operators and their major contractors should ensure that adequate temporary housing resources are available to accommodate their temporary drilling, field-development, and ancillary facility construction workforces.

In order to allow local governments to effectively plan for the needed infrastructure and services to accommodate the workforce and population associated with this major development initiative, the Operators should meet annually with the BLM and representatives of local and state governments to discuss near-term and mid-term development plans. If events that would substantially accelerate or retard development in the project area become evident, the Operators should meet with the BLM and representatives of local and state governments to discuss the potential effects of such events.

4.16 TRANSPORTATION

This section assesses effects of the Proposed Action and other alternatives on the transportation system providing access to and within the CD-C project area, including federal and state highways, Carbon and Sweetwater county roads, BLM roads, and private roads. Environmental effects of new and improved roads within the project area are described in sections **3.3 Soils; 3.7 Invasive, Non-native Species; 3.8 Wildlife; 3.11 Visual; 3.12 Recreation;** and **4.18 Range Resources**.

4.16.1 Planning Documents and Criteria

4.16.1.1 Rawlins RMP

The Rawlins RMP (BLM 2008a) prescribes the following goal and objectives for transportation and access management:

Management Goal

1. Develop and maintain a transportation management system to accommodate public demand for legal access through and across public land and to meet resource management needs and objectives (e.g., wildlife objectives).

Management Objectives

1. Maintain or expand, as determined necessary, existing access, including the right of access by a non-federal-land in-holder.
2. Abandon or close redundant or unnecessary access roads; reclaim after consultation with local government and interested parties.
3. Conduct transportation planning to manage existing and new access in a manner that ensures compatibility with resource values and management objectives.
4. Incorporate existing state and county road systems into BLM transportation system to accurately show existing access. Coordinate access issues with state and local governments.

4.16.1.2 Transportation Plan

As noted in **Section 3.16 Transportation and Access**, an MOU between the BLM, WYDOT, Carbon and Sweetwater Counties and a number of the CD-C Operators established a transportation plan (TP) and transportation planning committee (TPC) for the Continental Divide portion of the project area. Upon the issuance of a ROD, the Creston portion of the project area will be brought into the TP and the Creston Operators will join the TPC as part of the federal permitting process.

4.16.1.3 Impact Significance Criteria

The following criteria are used to determine whether transportation impacts would be significant and represent a balance between public access and transportation safety:

1. Substantial limitation on public access to travel within the project area.
2. Substantial reduction in opportunity for acquisition of access easements and road development.
3. Increases in traffic levels on the local public transportation system that would cause the level of service on the system to fall below acceptable levels, as defined by the responsible government agency.

4.16.2 Direct and Indirect Impacts

Section 3.16 Transortation and Access describes the highway network providing access to the project area and the county, the BLM, and the private road network providing access within the project area. The CD-C project is an infill project; consequently, under all alternatives new roads would primarily be resource roads connecting the existing road network with new well pads, and ancillary facilities (e.g. gathering systems, compressor stations, and other associated infrastructure).

The principal measure of transportation effects related to the alternatives would be changes in the number of vehicle trips required. Vehicle trips would be generated by drilling, completion, and ancillary facility construction; by production activities, including routine monitoring and maintenance; by hauling of produced water and liquids; and by periodic well workovers. Interim and final reclamation activities would also generate vehicle trips.

For all alternatives, vehicle trips would originate from a variety of locations including Rock Springs, Rawlins, Wamsutter, Baggs, and locations outside the study area. Drilling rigs and some gas-field service and construction equipment would be transported to the project area and remain there for the duration of a particular contract or task. For the major Operators, drilling rigs would work on a year-round basis; in these cases, trips involving major pieces of equipment, such as rig moves, would occur primarily within

the project area. Similarly, most produced-water and liquids-collection trips are likely to occur entirely within the project area as produced-water disposal and liquids-transportation sites will be located within the project area.

Many gas-field service firms serving the project area are presently located in Rock Springs, although some are located in Rawlins and a few are located in Baggs and the Little Snake River Valley (LSRV) area. BP has a major field-operations center just north of Wamsutter and several companies have established field offices and equipment lay-down and support yards in Wamsutter, which also houses many gas-field workers on both a temporary and longer-term basis. Devon Energy has a field office in Baggs to serve the Creston/Blue Gap field. There are two temporary living facilities located adjacent to WY 789 in the Dad area, and many gas-field workers reside in Rock Springs, Rawlins, and Baggs.

Tables 4.16-1 and **4.16-2** display estimated per-well round-trips associated with typical drilling and production activities in the project area. Trip estimates were developed from information provided by the Operators, estimates from similar projects, and from information concerning anticipated per-well volumes of produced liquids and water provided by the BLM Wyoming's Reservoir Management Group. The trip estimates are based on drilling and completion activities for typical wells, construction of gathering systems and well-site production facilities, performance of routine field operations and maintenance activities, and consideration of vendor and miscellaneous visits.

Table 4.16-1. Per-well round-trip estimates: drilling and completion

Activity	Vertical Wells		Multi-Well Pad (4 wells)	
	Total	Trucks[1]	Total	Trucks
Pad/access road construction	35	21	45	28
Mobilization / demobilization	107	73	161	97
Drilling	251	174	980	704
Completion	256	175	602	403
Construction of production facilities, electrical and gathering lines	29	17	33	21
Interim reclamation	10	6	15	9
Total Drilling	**688**	**466**	**1,836**	**1,262**

[1] For this assessment, a "truck" is defined as any vehicle other than a passenger vehicle such as a pick-up, car, or van.
Sources: CD-C Operators; BCLLC

Table 4.16-1 displays trip estimates for single wells drilled vertically from an individual well pad and for directional wells drilled from multi-well pads, which are assumed to average four bores/pad. Directional wells drilled from multi-well pads generate reduced drilling, completion, and field-development traffic, on a per well basis, as compared to vertical wells on single-well pads. The reductions are principally in trips associated with well pad and access road construction, rig moves, completion, gathering and electrical system construction, and interim reclamation activities.

Table 4.16-2. Estimated production traffic (round-trips)

Activity	All Wells
Pumpers (pick-ups)	Each well visited daily; each pumper can visit 15 wells/day
Produced water & liquids haul trucks	Trips are based on a BLM Reservoir Management Group decline curve for produced water and liquids assuming an average of 6,900 gallon haul trucks
Workovers	Each well every 15 years; 6 light truck and 8 heavy truck trips/well

Sources: CD-C Operators; BCLLC

Tables 4.16-1 and **4.16-2** display traffic estimates in terms of round trips. The principal measure of traffic used elsewhere in the assessment is average annual daily traffic (AADT). In contrast to round trips, AADT represents one-way trips, i.e. AADT would count a round trip as two trips.

Not all drilling and production trips would originate outside the project area. For each drilling and production activity, a certain number of trips would originate within the project area, including trips associated with some rig moves and other heavy equipment that would move from well pad to well pad without leaving the project area, commuting trips for some drilling and completion crews who reside in Wamsutter in motels and mobile-home/RV parks, and some trips associated with gas-field service companies whose offices and yards are located in Wamsutter.

Under all action alternatives, construction and operations of additional compressor sites, a central pipeline compression facility, central gas-processing/stabilization facilities and high-pressure gas line would be required. Because the same number of wells would be developed under all action alternatives, the overall volume of traffic generated by these facilities is assumed to be the same, although the location of individual facilities and the timing of construction could differ based on the alternative. For Alternative E: No Action, no additional facilities are assumed to be required.

4.16.2.1 Proposed Action

This analysis assumes a total of 8,950 additional wells would be drilled over 15 years under the Proposed Action; an average of about 600 wells per year. The transportation assessment is based on the drilling schedule outlined in **Section 3.5, Air Quality**. Of the total wells, 42 percent are assumed to be directional wells drilled from multi-well pads averaging four bores/pad. The remaining 58 percent are assumed to be drilled vertically from single-well pads.

Drilling and production in the project area during 2009 generated an estimated AADT of 1,525. Of that total, an estimated 1,060 trips traveled on highways providing access to the project area and on county, BLM, and private roads to a worksite within the project area. An estimated 465 trips were internal, both originating and terminating within the project area, traveling entirely on county, BLM, and private roads to reach a worksite.

Figure 4.16-1 displays estimated Proposed Action-related AADT, including both internal and external trips by year through the 15-year drilling period and the first 15 years of full-field operations, based on the drilling schedule provided by the Operators. Transportation effects of drilling and production activities associated with the Proposed Action would build from an estimated 1,682 AADT in Year 1 to a peak of over 3,900 AADT in Years 13 and 14 of drilling. This would be in addition to the trips associated with ongoing production activities from existing wells, which are described under the No Action alternative (**Section 4.16.2.6**). This volume would diminish during the last year of drilling and for the remainder of the productive life of the project, as produced-water and liquids volumes decrease as the wells age. By Year 30 of the Proposed Action, an estimated 1,360 AADT would be generated daily within the project area. **Table 4.16-1** provides estimates of per-well round trips for drilling and completion activities. Drilling-related trips could be higher or lower during any given year, depending on the actual number of wells drilled. Actual future drilling levels would vary in response to natural-gas demand and prices, drill rig and workforce availability, gas transmission pipeline capacity, weather, regulatory approvals, individual company development strategies, and other factors. Actual production-related trips would depend on the cumulative number of wells in production.

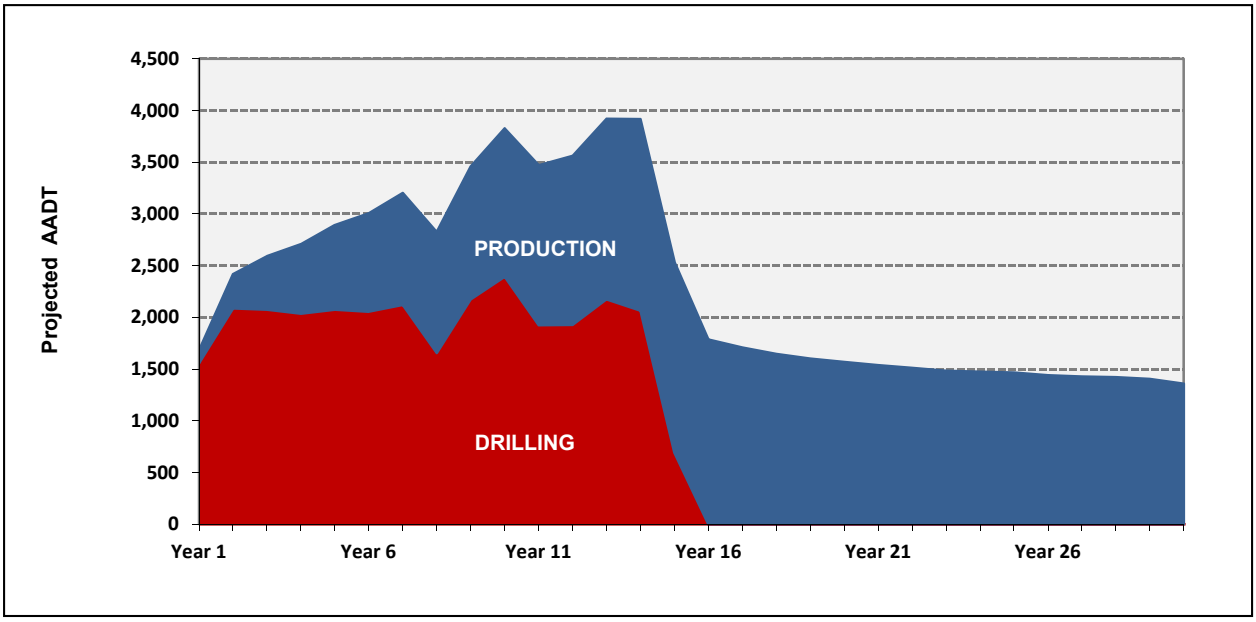


Figure 4.16-1. Drilling/field development AADT, Proposed Action

Source: CD-C Operators, BCLLC

Tables 4.16-3, 4.16-4, and 4.16-5 display estimated incremental highway AADT associated with Year 1, Year 10, and Year 20 of the Proposed Action. Year 1 AADT is contrasted with WYDOT 2009 AADT estimates for segments of highways providing access to the project area. It is important to note that WYDOT 2009 AADT estimates include traffic associated with the drilling of 244 new wells and production services for 3,783 wells within the project area during that year.

Estimates of drilling-related traffic for Year 1 and Year 10 of the Proposed Action represent the increment over the 2009 drilling level, which are included in the WYDOT 2009 AADT and the forecast 2020 AADT. Note that in Year 20 of the Proposed Action, project area-related traffic would be entirely operations related, as all drilling would have been completed under the assumptions used for this assessment.

Project area drilling and production-related AADT were assigned to highway segments based on a combination of development-area access and likely locations of Operator offices and yards, natural gas field-service companies and vendor offices and yards, and temporary and long-term employee housing. Based on these origin and destination factors and a review of each drilling and production-related activity, it is assumed that about 40 percent of all project area-related trips would originate internally, from Wamsutter or elsewhere within the project area during the initial years of drilling. That percentage would decrease over time as production-related traffic increases. Beginning in Year 16, following the completion of drilling, an estimated 24 percent of all trips would be strictly internal, traveling exclusively on county, BLM and private roads. Internal trips would diminish to about seven percent by Year 30, due to reductions in produced water and liquids over time.

Of trips that originate or terminate externally, 55 percent are assumed to be to or from Rock Springs; 25 percent to/from Rawlins, 10 percent from Baggs/LSRV or at points along WY 789 and 10 percent from Wamsutter.[38] Of the total trips traveling from Rawlins, 15 percent are assumed to originate at points to the

[38] Although Wamsutter is within the CD-C project area, external trips originating from Wamsutter are assumed to travel on I-80 to other destinations within the project area.

north and travel US 287 through Rawlins during Year 1, 8 percent during Year 10, and 2 percent during Year 20 following the completion of drilling.

Table 4.16-3. Projected AADT, highways providing access to the CD-C project area: Year 1, Proposed Action

Highway Segment	2009 WYDOT Estimated AADT		Proposed Action Year 1 AADT		% Increase over 2009	
	All Vehicles	Trucks	All Vehicles	Trucks	All Vehicles	Trucks
I-80						
• Rawlins W. Urban Limits	13,078	6,495	158	75	1%	1%
• Creston Junction	12,225	6,368	203	96	2%	2%
• Continental Divide Int.	11,973	6,443	209	99	2%	2%
• Wamsutter	12,014	6,458	503	238	4%	4%
• Red Desert	11,563	6,332	413	195	4%	3%
• Tipton	11,493	6,287	356	169	3%	3%
• Table Rock	11,693	6,314	354	167	3%	3%
• Rock Springs E. Urban Limits	1 1,678	6,498	348	165	3%	3%
WY 789						
• Creston Junction	1,265	316	28	13	2%	1%
• Jct CCR 700 West	1,801	427	28	13	2%	2%
US 287						
• Rawlins N. Urban Limits (Bypass)	5,241	786	24	11	<1%	2%
• Jct Rte 46 (Lamont/Bairoil)	2,303	620	24	11	1%	2%

Jct = junction
Source: WYDOT 2009 VMB and 2020 and 2030 AADT projections; BCLLC calculations

Under the assumptions used for this assessment, the highest concentration of project area-related traffic on I-80 would be at Wamsutter. As shown in **Table 4.16-3**, during Year 1 of the Proposed Action, when a total of 440 wells are assumed to be drilled, both total AADT and truck AADT on I-80 at Wamsutter would be an estimated 4 percent of 2009 WYDOT estimates for that location. Total AADT and truck AADT on WY 789 would be 1 to 2 percent of 2009 AADT. Total AADT would be less than 1 percent of 2009 AADT at the bypass north of Rawlins; total and truck AADT would be 1 to 2 percent of 2009 AADT elsewhere on US 287 during Year 1 of the Proposed Action.

Table 4.16-4. Projected AADT, highways providing access to the CD-C project area: Year 10, Proposed Action

Highway Segment	2020 WYDOT Projected AADT		Proposed Action Year 10 AADT		% Increase over 2020	
	All Vehicles	Trucks	All Vehicles	Trucks	All Vehicles	Trucks
I-80						
• Rawlins W. Urban Limits	15,342	8,992	748	339	5%	4%
• Creston Junction	14,915	8,740	960	436	6%	5%
• Continental Divide Int.	14,880	8,750	985	447	7%	5%
• Wamsutter	14,938	8,747	2,375	1,078	16%	12%
• Red Desert	14,806	8,722	1949	885	13%	10%
• Tipton	14,858	8,640	1683	764	11%	9%
• Table Rock	15,054	8,782	1672	759	11%	9%
• Rock Springs E. Urban Limits	16,715	9,374	1642	745	10%	8%
WY 789						
• Creston Junction	1,501	377	132	60	9%	16%
• Jct CCR 700 West	1,874	411	132	60	7%	15%
US 287						
• Rawlins N. Urban Limits (bypass)	4,419	962	60	27	1%	3%
• Jct Rte 46 (Lamont/Bairoil)	2,722	862	60	27	2%	3%

Jct = junction
Source: WYDOT 2009 VMB and 2020 and 2030 AADT projections, BCLLC calculations.

During Year 10 of the Proposed Action (**Table 4.16-4**), a total of 738 wells are assumed to be drilled and 6,240 Proposed Action-related wells would require production activities. Highway traffic estimates during Year 10 of the Proposed Action are contrasted with WYDOT forecasts of 2020 traffic on affected highways. Proposed Action-related AADT for all traffic on I-80 at Wamsutter would be a 16 percent increase over forecast 2020 AADT at that location and Proposed Action-related truck AADT would be 12 percent. Total AADT on WY 789 at Creston Junction would be 9 percent of forecast 2020 AADT and truck AADT would be 16 percent. Proposed Action-related total AADT on US 287 would be 1 to 2 percent of forecast 2020 AADT and truck AADT would be about 3 percent.

Table 4.16-5. Projected AADT, highways providing access to the CD-C project area: Year 20, Proposed Action

Highway Segment	2030 WYDOT Projected AADT		Proposed Action Year 20 AADT		% Increase over 2030	
	All Vehicles	Trucks	All Vehicles	Trucks	All Vehicles	Trucks
I-80						
• Rawlins W. Urban Limits	17,539	10,627	334	75	2%	1%
• Creston Junction	17,142	10,320	429	98	3%	1%
• Continental Divide Int.	17,130	10,354	440	99	3%	1%
• Wamsutter	17,211	10,354	1,061	239	6%	2%
• Red Desert	17,063	10,325	870	196	5%	2%
• Tipton	17,132	10,224	752	170	4%	2%
• Table Rock	17,365	10,43	747	168	4%	2%
• Rock Springs E. Urban Limits	18,949	11,059	733	165	4%	1%
WY 789						
• Creston Junction	1,731	426	59	13	3%	13%
• Jct CCR 700 West	2,174	472	59	13	3%	3%
US 287						
• Rawlins N. Urban Limits (bypass)	5,046	1,098	7	2	<1%	<1%
• Jct Rte 46 (Lamont/Bairoil)	3,000	978	7	2	<1%	<1%

During Year 20 of the Proposed Action, no new drilling would occur but 8,950 wells would require production-related activities. Highway traffic estimates during Year 20 of the Proposed Action are contrasted with WYDOT forecasts of 2030 traffic Proposed Action-related total AADT on I-80 at Wamsutter would be six percent of WYDOT projected 2030 AADT at that location and truck traffic would be two percent. Total AADT on WY 789 at Creston Junction would be 3 percent of forecast 2030 AADT and Proposed Action-related truck AADT would be 13 percent. Both total and truck AADT on US 287 would be less than 1 percent of forecast WYDOT 2030 AADT on that highway.

Traffic associated with the Proposed Action would be unlikely to result in a deterioration of the LOS on I-80, except to perhaps accelerate the decrease from LOS A to LOS B at the Creston Junction intersection, given the relatively high forecasts for Proposed Action-related traffic at that intersection during drilling and field development. Similarly, the level of Proposed Action-related traffic on WY 789 from Creston Junction south to Baggs would be unlikely to result in a substantial deterioration in LOS but would certainly contribute to the LOS rating of C at the intersection with Carbon County Road 700 West during the drilling and field development period. The Proposed Action-related traffic on US 287/WY 220 north to Casper will contribute to the decrease in LOS from B to the forecast LOS C, but the relatively minor level of project-related traffic will play a small role in that decrease in LOS.

In addition to the drilling and production-related traffic shown in the preceding table, a number of ancillary facilities would be required under the Proposed Action. Such facilities could include up to 10 field compression facilities, a central pipeline compression facility, one central processing/stabilization plant, and up to 45 miles of high-pressure pipeline. Trip estimates for these facilities were not available from the Operators; consequently, estimates of similar facilities in other natural gas development areas were used to provide order-of-magnitude estimates for assessment purposes. **Table 4.16.6** below summarizes the construction trip traffic associated with each of these facilities.

Table 4.16-6. Projected traffic effects on highways associated with ancillary facilities: Proposed Action

Facility Type	Duration of construction	Light-duty vehicle trips	Truck trips	Total trips	Approximate AADT
Field compressors (up to 10 required)	Several weeks per compressor	152 / compressor facility	24 / compressor facility	176 / compressor facility	< 1.0
Pipeline compressors (1)	Several months	760	120	880	5
Central processing facility (1)	Up to two years	27,200	12,700	39,900	110
High-pressure pipeline (45 miles)	--	1,305	1,951	3,256	18

Source: BCLLC.

These facilities would be constructed at different locations and at different times during the drilling and field-development period; therefore, the construction trips would also occur during different periods. In addition to the construction traffic estimates contained in **Table 4.16-6**, these facilities would generate a low level of traffic during operations and most of those trips would involve light-duty vehicles.

Because AADT is calculated on a 365-day/year basis, construction of each of these facilities, except the central gas-processing/stabilization facility, would result in minor increases in AADT. However, traffic on the specific access road to each facility and at intersections of highways and access roads could be substantial during the construction period, particularly during shift changes for construction workers. During these brief periods, the level of service ratings for these intersections could drop below current levels. As noted, once constructed, these facilities would generate relatively low volumes of daily traffic.

The increases in traffic volumes associated with the Proposed Action could result in additional maintenance requirements on affected highway segments, particularly on WY 789 and on I-80 around the Wamsutter interchange during peak drilling years. The volume of over-height/over-width loads using I-80 underpasses (described in **Section 3.16.2**) would continue to increase under the Proposed Action, requiring more frequent Wyoming Highway Patrol traffic-safety services, unless and until modifications in underpasses are completed. Given the substantial percentage increase in AADT associated with the Proposed Action, higher accident rates could be possible on the segments of highways providing access to the project area, especially during peak drilling years.

County roads providing access within the project area would see substantial increases in use, particularly SCR 23S (Wamsutter-to-Crooks Gap Road South), CCR 701 (Wamsutter-to-Dad Road), and SCR 23N (Wamsutter-to-Crooks Gap Road North), which would provide access to the most densely developed portion of the project area. CCR 701 currently has the highest traffic volume of any road or highway in Carbon County, with the exception of I-80, and SCR 23 (north and south) is among the highest traffic-volume roads in Sweetwater County. The vast majority of traffic on these roads is industrial and is associated with project area gas-field activities. The Proposed Action would result in substantially accelerated maintenance requirements on these roads and likely require additional improvements to accommodate the increased volume of industrial traffic.

Certain BLM and private roads providing access within the project area would also experience substantial increases in traffic associated with the development phase of the Proposed Action. Typically the Operators improve and maintain these roads through agreements with the BLM and private surface owners. Operators would also be required to secure right-of-way agreements with private landowners for use of private roads and BLM roads without right-of-way agreements.

Based on the above, the state of Wyoming, Sweetwater and Carbon counties, and the BLM would all experience substantially higher road-improvement and maintenance requirements associated with the Proposed Action. Each of these entities would also receive substantial additional revenues from severance

taxes (in the case of the state), federal mineral royalties (in the case of the BLM, the state, and the counties) and from ad valorem property taxes (in the case of the counties[39]), on natural gas production associated with the Proposed Action, which could be used to help fund Proposed Action-related improvements and maintenance requirements.

Continued implementation of the CD-C TP and TPC process would result in a coordinated approach to road use, development, maintenance, and reclamation; to the extent possible considering the high level of development and associated traffic, it would also reduce transportation effects.

4.16.2.2 Alternative A: 100-Percent Vertical Drilling

Alternative A assumes the same overall drilling schedule as the Proposed Action, but assumes all wells would be drilled vertically from single-well pads. The trip-generation factors used for Alternative A are the same factors used for vertical wells in the Proposed Action (see Vertical Wells columns in **Table 4.16-1**).

Figure 4.16-2 compares total AADT for the Proposed Action and Alternative A. Alternative A would result in an estimated total AADT of 1,935 during Year 1, 15 percent higher than the estimated total AADT for the Proposed Action during Year 1. During Year 10, Alternative A would generate an estimated AADT of 4,217, 10 percent greater than the Proposed Action. The smaller percentage is the result of the larger proportion of operations-related traffic to total traffic in that year (the level of operations traffic would be the same under either alternative). After Year 15, when drilling is assumed to be completed under both alternatives, the estimated average number of round trips would be the same.

The higher level of traffic associated with Alternative A would generate correspondingly higher levels of traffic on federal and state highways providing access to the project area. However, incremental AADT associated with Alternative A would generate no more than 1 to 2 percent increases in AADT on any highway segment during the first 15 years as compared to the Proposed Action.

Under Alternative A, the increases in AADT on highways providing access to the project area associated with construction and operations of additional compressor sites, a central pipeline compression facility, two or more central gas processing/stabilization facilities and 45 miles of high-pressure gas line would be the same as under the Proposed Action.

The higher traffic volumes associated with Alternative A would result in correspondingly higher maintenance requirements on affected highway segments as compared to the Proposed Action and generate the potential for higher accident rates on the segments of highways providing access to the project area.

County roads providing access within the project area would experience higher levels of traffic under the drilling and field-development phase of Alternative A compared to the Proposed Action and correspondingly higher maintenance requirements.

BLM and private roads providing access within the project area would also experience higher increases in traffic associated with the Proposed Action. As with the Proposed Action, the Operators would improve and maintain these roads through agreements with the BLM and private surface owners.

Although WYDOT and Sweetwater and Carbon counties would experience higher road maintenance costs under Alternative A compared to the Proposed Action, natural gas production would likely be the same under both alternatives; consequently, the state and counties would receive the same revenues under both alternatives but be required to fund somewhat higher highway and road maintenance costs under Alternative A than under the Proposed Action.

[39] Sweetwater County has a dedicated mill levy for road and bridge funding; Carbon County does not.

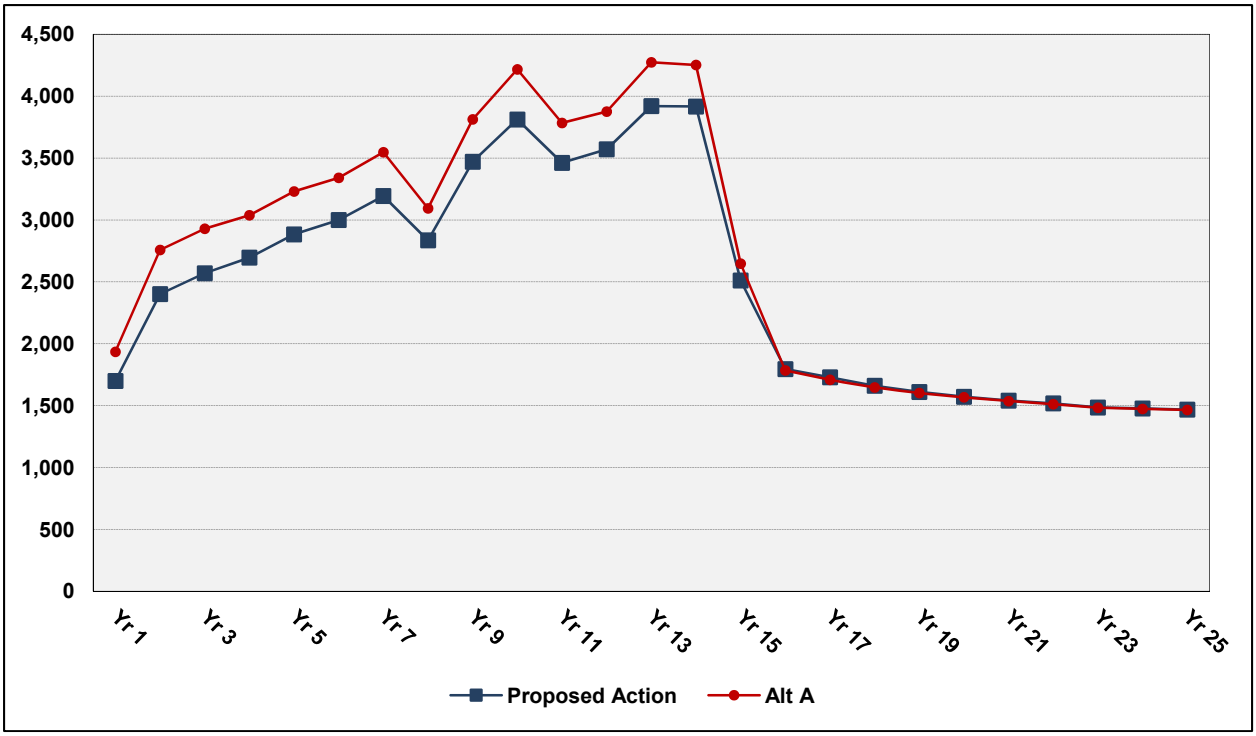


Figure 4.16-2. Total project-related AADT: Alternative A and Proposed Action

As with the Proposed Action, continued implementation of the CD-C TP and TPC process would result in a coordinated approach to road use, development, maintenance and reclamation and, to the extent possible considering the high level of development and associated traffic, reduce potential transportation effects.

4.16.2.3 Alternative B: Enhanced Resource Protection Alternative

Implementation of Alternative B would result in the same drilling schedule and number of wells as the Proposed Action. For the purposes of this assessment, it is assumed that implementation of the enhanced resource protection measures described in **Section 2.2.3** would result in a 20 percent increase in directional drilling from multi-well pads on federal lands compared to the Proposed Action. This would result in 53 percent of all wells within the project area being drilled vertically from single well pads (compared to 58 percent for the Proposed Action) and 47 percent of all wells being drilled directionally from multi-well pads (compared to 42 percent for the Proposed Action).

Figure 4.16-3 provides a comparison of total AADT for the Proposed Action and Alternative B. Alternative B would result in an overall reduction of 1 to 2 percent in total AADT during the 15-year drilling period compared to the Proposed Action. However, at a site-specific level, drilling four directional wells on a multi-well pad would require approximately 33 percent fewer trips than drilling four vertical wells on individual pads. Consequently, reductions in traffic at specific well-site locations could be substantial under Alternative B as compared to the Proposed Action.

After drilling is completed, Alternative B and Proposed Action AADT would be the same because the same number of wells would require production-related activities. Traffic associated with construction of ancillary facilities under Alternative B would be similar to that associated with the Proposed Action.

Highway and road maintenance and improvement requirements would be similar for both alternatives, as would the potential for increases in accidents. Similar levels of tax and royalty revenues would accrue to state and local governments under both alternatives.

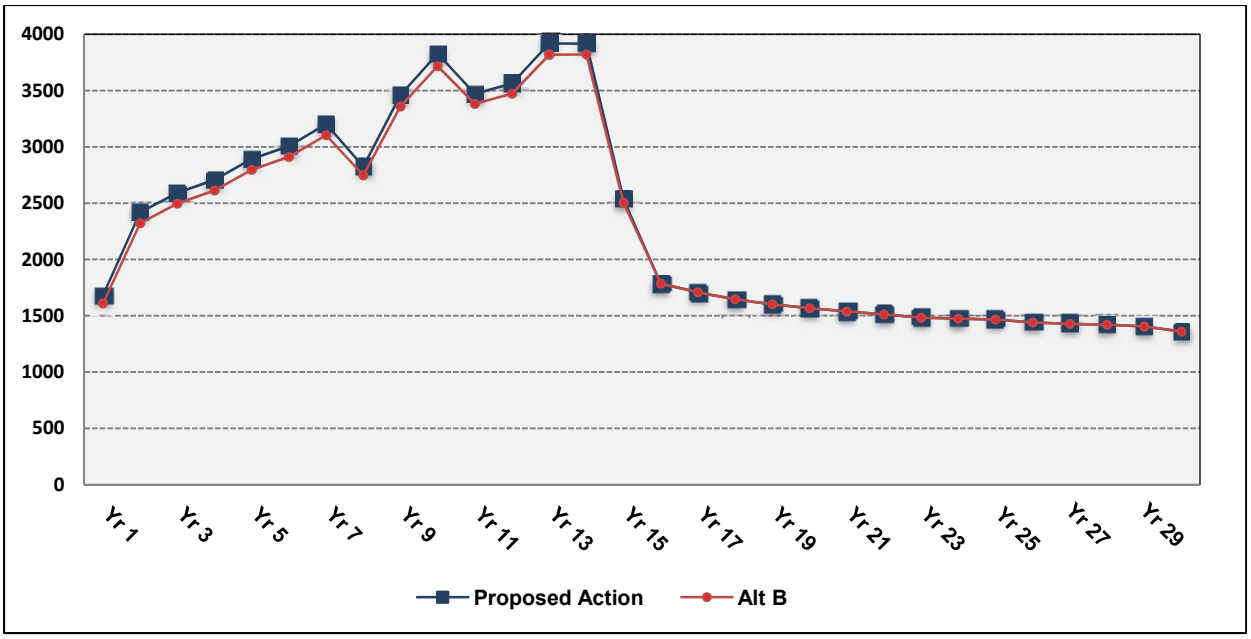


Figure 4.16-3. Total project-related AADT: Alternative B and Proposed Action

4.16.2.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

Implementation of Alternative C would result in the same drilling schedule and number of wells as the Proposed Action. For the purposes of this assessment, it is assumed that implementation of the 60-acre surface disturbance cap in high-density natural gas development areas and the 30-acre disturbance cap elsewhere in the project area would result in a 50-percent increase in directional drilling from multi-well pads on federal lands. This would result in 46 percent of all wells within the project area being drilled vertically from single well pads (compared to 58 percent for the Proposed Action) and 54 percent of all wells being drilled directionally from multi-well pads (compared to 42 percent for the Proposed Action).

Figure 4.16-4 compares total AADT for the Proposed Action and Alternative C. Implementation of Alternative C would result in a reduction of 3 to 4 percent in total AADT during Years 1 through 13 of the 15-year drilling period compared to the Proposed Action; AADT would be the same for the two alternatives after drilling is completed. As with all alternatives, at a site-specific level, drilling four directional wells on a multi-well pad would require an estimated 33 percent fewer trips than drilling four vertical wells on individual pads.

After drilling is completed, Alternative C and Proposed Action AADT would be the same because the same number of wells would require production-related activities. Traffic associated with construction of ancillary facilities under Alternative C would be similar to that associated with the Proposed Action.

Highway and road maintenance and improvement requirements would be similar for both alternatives, as would the potential for increases in accidents. Similar levels of tax and royalty revenues would accrue to state and local governments under both alternatives.

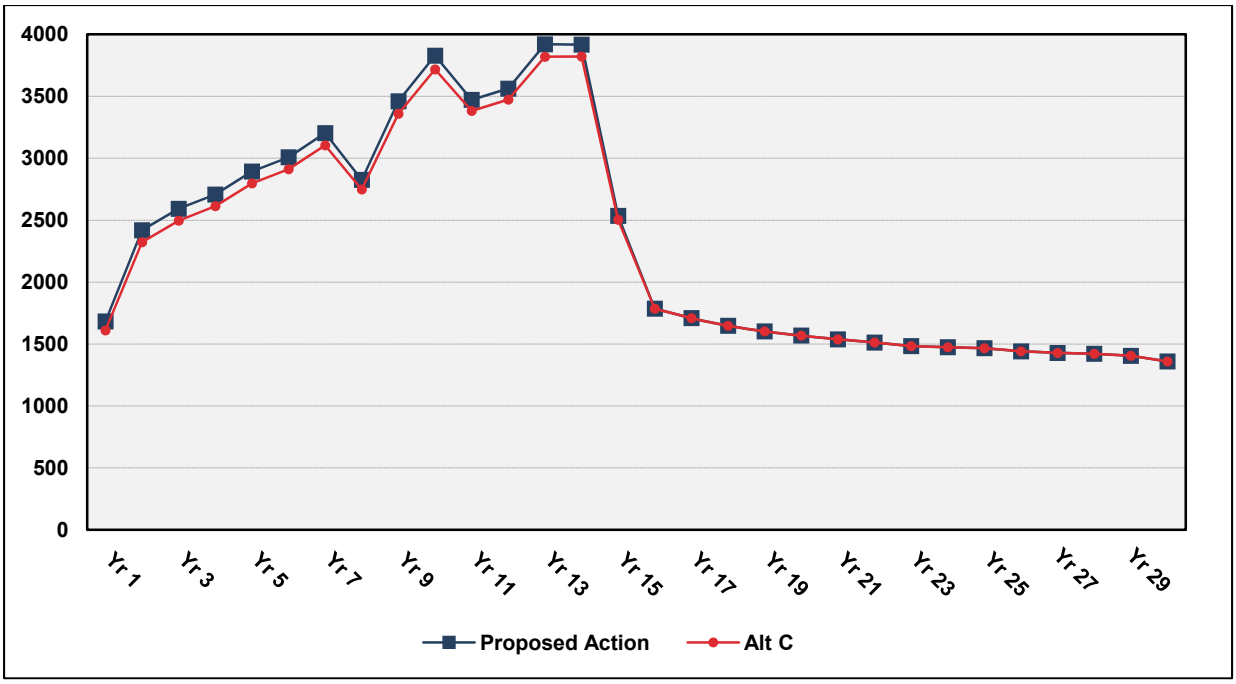


Figure 4.16-4. Total project-related AADT: Alternative C and Proposed Action

4.16.2.5 Alternative D: Directional Drilling

For the purpose of this assessment, it is assumed that requiring all wells on federal lands to be drilled on multi-well pads would result in a 74-percent increase in directional drilling from multi-well pads on federal lands. This would result in a total of 27 percent of all wells within the project area being drilled vertically from single well pads (compared to 58 percent for the Proposed Action) and 74 percent of all wells being drilled directionally from multi-well pads (compared to 42 percent for the Proposed Action).

Figure 4.16-5 provides a comparison of total AADT for the Proposed Action and Alternative D. Implementation of Alternative D would result in a reduction of 3 to 11 percent in total AADT during the 15-year drilling period compared to the Proposed Action. These reductions would result from the reduced number of trips required for location construction, rig mobilization and demobilization, and other drilling and completion activities that could be performed for multiple wells on one well pad. During project operations, AADT would be about the same as that associated with the Proposed Action.

After drilling is completed, Alternative D and Proposed Action AADT would be similar because the same number of wells would require production-related activities. Traffic associated with construction of ancillary facilities under Alternative D would be similar to that associated with the Proposed Action although the timing and location of facilities construction could differ.

Highway and road maintenance and improvement requirements would be similar for both alternatives, as would the potential for increases in accidents. Similar levels of tax and royalty revenues would accrue to state and local governments under both alternatives.

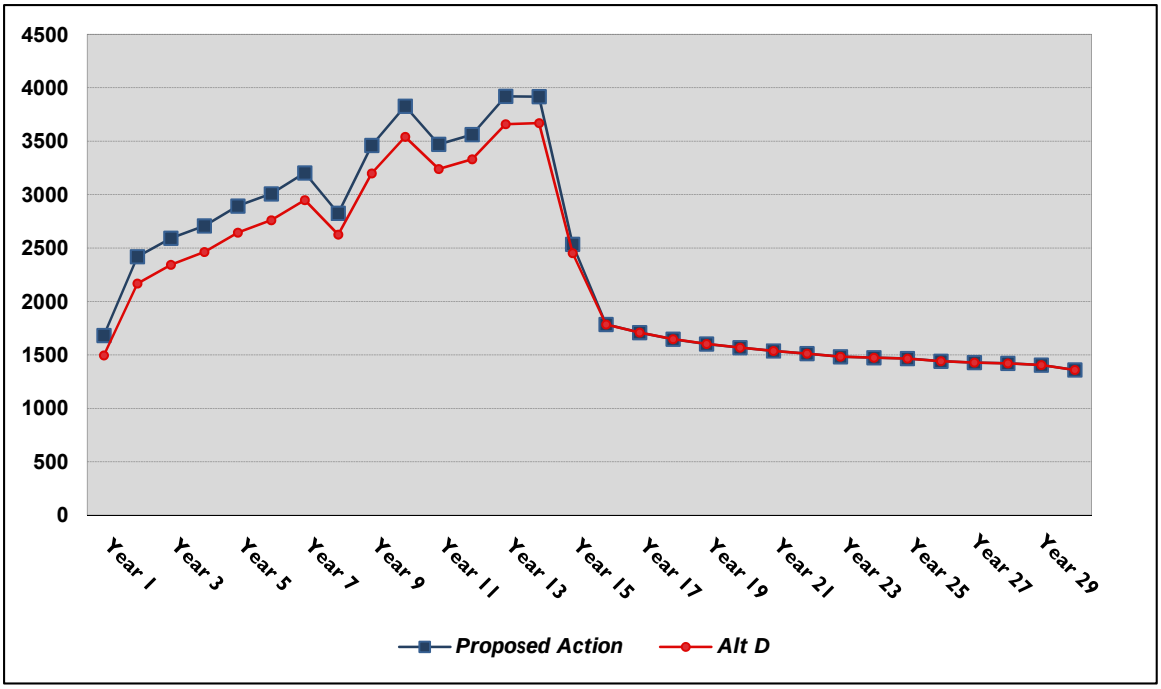


Figure 4.16-5. Total project-related AADT: Alternative D and Proposed Action

4.16.2.6 Alternative E: No Action

Under the No Action alternative it is assumed that drilling activities would cease upon issuance of a ROD for the EIS. The termination of drilling within the CD-C project area would result in a reduction of traffic on area highways and roadways; during 2009 an estimated AADT of 726 was associated with drilling and completion activities within the project area. Production activities for existing wells would continue under the No Action alternative; it is estimated that an AADT of 798 was associated with production activities within the project area during 2009. Production-related AADT would be somewhat higher initially to account for additional wells drilled prior to the issuance of a ROD, but begin to decline thereafter as produced water and liquids volumes decline and wells come off-line as the field matures.

The reduction in traffic associated with the No Action alternative would result in substantially lower wear and tear on area highways and on county, BLM, and private roads as compared to any of the action alternatives. Conversely, state and county governments would receive substantially fewer revenues to perform road maintenance activities. Given the substantially lower volumes of traffic, the potential for project-related accidents would be substantially lower under the No Action alterative.

4.16.3 Impact Summary

Figure 4.16-6 contrasts estimated total AADT for the Proposed Action with each of the four action alternatives.

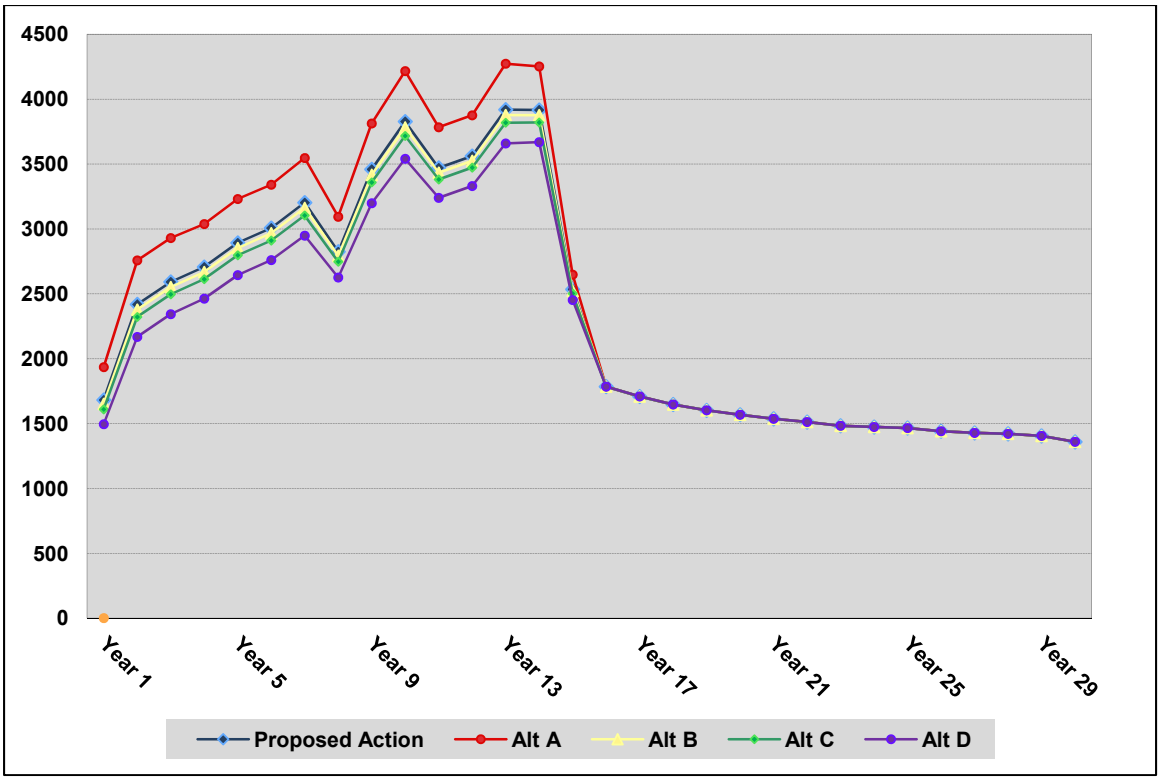


Figure 4.16-6. AADT, all action alternatives

Each action alternative would result in increases in traffic associated with drilling and production activities. Based on the assumptions associated with each alternative, the pattern of traffic increases would be similar for all alternatives. Differences in the magnitude of traffic increases on affected highways and roads would result from differences in the ratio of directional wells drilled on multi-well pads to wells drilled horizontally on single-well pads. Additionally, the pace of drilling would be a factor under Alternative D.

In addition to the traffic associated with drilling and production, each action alternative would result in similar temporary increases in AADT on federal and state highways resulting from construction of ancillary facilities such as compressor sites, a central pipeline compression facility, two or more central gas-processing/stabilization facilities, and a high-pressure gas line.

All action alternatives would accelerate highway maintenance requirements on county, BLM, and private roads. The timing and level of improvements and maintenance requirements would be driven by the magnitude of traffic increases on specific highways and roads.

All action alternatives would generate similar amounts of revenue that could be used to fund highway and road-maintenance needs.

Highway and road-maintenance requirements would be substantially less under the No Action alternative than under any action alternative. The amount of production-related tax and royalty revenues to fund maintenance requirements would correspondingly decrease as production diminishes and wells cease production at a more rapid pace than under the action alternatives.

4.16.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Most unavoidable adverse transportation impacts of the Proposed Action and alternatives are associated with increases in the number of vehicle trips on the network of roads and highways in the project area and

the consequent need to manage and maintain that network. An important component for reduction of those impacts for all action alternatives would be continued active participation in the CD-C TP and TPC process. For all alternatives, the substantial increase in industrial traffic would require a sustained and coordinated transportation-planning and road-maintenance effort. For Alternative E, No Action, road-abandonment and reclamation planning would be required sooner than under the action alternatives.

4.17 NOISE

4.17.1 Introduction

Noise anticipated from the Proposed Action and all alternatives would include that which currently occurs within the CD-C project area as a result of gas-compression stations, livestock grazing operations, wind, well-workover operations, and traffic along area access roads, state highways, and I-80. Additional noise would be generated by well site and access road construction, drilling and completion, pipeline construction, and surface-disturbing reclamation operations. Frequent strong winds would add to ambient noise levels. The EPA guideline of 55 decibels (dBA) represents a level at which an activity would have no effect on receptors in the environment; the sounds would not be noticeable to the human ear. Emerging research relative to the impact of noise on wildlife, specifically greater sage-grouse and mountain plover, indicates this level of noise or the 49-dBA level (10 dBA over background) commonly found in BLM documents may not be sufficiently protective (Blickley and Patricelli undated, Blickley and Patricelli 2010). The Rawlins RMP does not contain specific noise limitations or reduction/mitigation requirements; rather, the RMP manages noise impacts through performance-based project design or mitigation. In Appendix 15 to the RMP (Best Management Practices) there is a general statement requesting consideration of "noise reduction techniques and designs" to benefit wildlife in general and the greater sage-grouse in particular.

Blickley and Patricelli (2010) express concern that, "Other acute impacts of noise, such as masking and behavioral disruption, occur over a much larger area. Masking occurs when the perception of a sound is affected by the presence of background noise, with high levels of background noise decreasing the perception of a sound. One possible consequence of masking is a decrease in the efficacy of acoustic communication. Many animals use acoustic signals to attract and retain mates, settle territorial disputes, promote social bonding, and alert other individuals to predators. Disruption of communication can, therefore, have dramatic impacts on survival and reproduction," and "In addition to the acute effects of noise, animals may suffer chronic effects, including elevated stress levels and associated physiological responses. Over the short term, chronic stress can result in elevated heart rate. Longer-term stress can be associated with the ability to resist disease, survive, and successfully reproduce."

Appendix 16 of the Rawlins RMP (Mountain Plover Guidelines) provides for operations setbacks from identified nesting habitat, as follows: "To protect the identified mountain plover-occupied habitat, the proposed facility will be moved one-half mile from the identified occupied habitat." Blickley and Patricelli (2010) found through their research of selected compressor stations in the Powder River Basin that "stipulations limiting the development of compressor stations within ½ mile of nesting sites are likely to prevent masking of the mountain plover vocalizations analyzed."

Refer to Wildlife (**Section 4.8**) and Special Status Species (**Section 4.9**) for evaluations of the performance standards and their effectiveness relative to the project area.

4.17.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) does not provide management objectives specific to noise. The following criterion was used to assess the significance of noise impacts related to this project:

1. Long-term activities that would exceed the federal 55-dBA maximum guideline for noise at either human- or animal-sensitive locations.

Impact significance criteria for noise relative to wildlife and special status species can be found in **Sections 4.8** and **4.9**, respectively.

4.17.3 Direct and Indirect Impacts

4.17.3.1 Proposed Action

Direct impacts of the Proposed Action would include increased noise levels from the drilling, completion, and production of an additional 8,950 wells, of which 500 may be CBNG. Operators anticipate drilling up to 600 wells per year with up to 25 rigs running at any one time for up to 15 years; 42 percent of the wells could be directionally drilled. Related activities would include construction of associated infrastructure including access roads, power lines, and gas/water/condensate pipelines, as well as the reclamation of disturbed areas.

Construction and drilling operations would take place at each well site resulting in an increase in noise when compared to the natural background condition of 30 to 50 dBA. Construction, drilling, and completion activities related to the drilling of conventional wells may last from 30 to 60 days. Wells drilled directionally may take slightly longer to drill and complete compared to vertical conventional wells. Directional wells may also require a larger rig with larger engines. Directional pad drilling usually involves several wells drilled from the same location, lengthening the period of disturbance per location. If 3,760 wells were drilled directionally, the greater number of days needed for drilling and completion activities would increase well-development noise/activity substantially, compared to vertical drilling. However, directional drilling would result in fewer well pads and access roads being built in the project area and would require a reduced number of rigs to accomplish the development within the estimated 10- to 15-year period. Fewer semi-truck loads of equipment would be brought to each site, resulting in reduced overall traffic noise. The shallower CBNG wells are expected to take up to 20 days for drilling and completion.

Equipment and operational noise would be generated during these activities from a variety of sources including engines, equipment impact, and well-flaring. The large rigs used for drilling conventional wells are significantly louder than the lower-horsepower (hp) rated small drilling rigs used for developing CBNG. It has been determined that drilling and flaring operations produce the loudest project-related noise. In the Jonah field, noise from drilling operations was measured as 77.5 dBA onsite and 50.1 dBA at 0.25 miles (BLM 2006b). Based on this information, drilling operations should not exceed the significance threshold for impacting sage-grouse leks—a sensitive receptor—as long as the lek and nest protection buffers are observed. This is consistent with the findings of the 2009 PAPA Noise Study (KC Harvey 2009) which evaluated noise at various lek sites within the natural gas field. Flaring operations at the Jonah field were measured at 97.9 dBA on site and 66.3 dBA at 0.25 miles. The use of flowback separators decreased flaring noise to 63.7 dBA on site. Holloran (2005) suggests that heavily traveled main haul-roads located within 3 miles of greater sage-grouse leks may negatively impact male lek attendance. While Holloran (2005) does not provide information regarding the vehicle type(s), anecdotal information (Holloran pers. com. 2003) indicated a steady stream of large diesel semi-rigs such as water and fuel tankers, completion equipment haul trucks, and drilling equipment as the traffic generating noise and disturbance impacts to sage-grouse. Directional pad drilling would result in locally more intense noise generation but would result in fewer well pads and access roads being built in the project area. In addition, directional pad drilling would result in fewer total semi-truck loads of equipment going into the field over the life of the project.

During the production phase of field operations, noise sources are generally less intense or of very short duration. These activities include occasional well workovers, routine site visitation by company personnel ("pumpers" and technicians) and road-maintenance equipment. Produced-water and condensate hauling,

compressor stations, and well-site compression are generally louder and frequent or continual sources of noise.

Vehicle traffic associated with production is typically limited to pickup trucks and occasional workover rigs. Wells producing water and condensate are regularly visited by haul tanker trucks, which transport these fluids to disposal facilities and sales points unless connected to gathering pipeline systems. In the absence of gathering systems, the greater the volume of fluid produced, the more frequent the tanker visits.

Noise resulting from compressor stations or well-site compression would continue for as long as gas production, gathering, and transmission occur within the field or from a particular well. The number, size, and location of field compressors would change over the life of the field depending on the volume of gas produced, the size of the lines, and the volume and pressure of gas within the major transmission lines. Project Operators anticipate the need for 10 additional compressor stations in the project area including one large central pipeline compression facility. Operators also anticipate the need to enlarge some of the existing compression infrastructure.

The need for well-site compression is dependent on the characteristics of the specific well and gas-line pressures. An unknown number of wells would likely require well-site compression for some period of time during the life of the project. Well-site compression typically uses 125- to 200-hp two-stage compressors.

Two or more central gas-processing/stabilization plants would also be required within the project area. The specifics of these anticipated facilities have not been determined and would be evaluated on a case-by-case basis by the BLM.

Existing operations within the project area generate noise levels as indicated in **Table 4.17-1**. Operations that may result from the Proposed Action are expected to generate noise at the same level at a larger number of sources for the life of the project.

Table 4.17-1. Typical noise measurements from common energy development-related sources in the CD-C project area[1]

Description	HP	dBA	dBC
Two (2) Cat 3516 with noise wall	1,000	45	--
Two (2) Cat 3516 without noise wall	1,000	50	--
Two (2) Waukesha H24 and F18 compressor engines	--	75	--
Two (2) electric-driven compressors	--	65	--
One (1) Ajax Cooper 2802	250	51	--
One (1) Ajax Cooper 2803 compressor engine	400	52	--
Cat or Waukesha compressor engine	1,200	75	--
Cat or Waukesha with high-performance intake and exhaust silencers	1,200	70	--
One (1) Waukesha 5794LG compressor engine; fan end	1,000	91	95
One Cat 3516 compressor engine; fan end, quiet fan	1,000	63	
One (1) Dehyd boiler	15	52	--
One (1) Cummins electric generator skid unit	1,000	69	--
Cat 3608 compressor engine w/ 2 heat exchangers	--	79	--
Disposal well pump building with electric motors inside	--	53	--
Cat 3608 compressor engine	1,000	58	--
Drill rig (Jonah Field)	--	69	
One (1) Ajax/Cooper compressor engine with weather cover	4,000	--	76
One (1) Champlin 242J-12 Ajax wellhead compressor	--	71	86

[1]*Noise emission data – Levels at 100 ft. collected by Engineering Dynamics Incorporated.*

Relative to the production life of a well, the construction, drilling, and completion phases of operations are short-term events lasting up to 60 days. However, when considered over the life of the Proposed Action, the increased noise levels resulting from drilling and completion activities at multiple sites within the project area would continue for up to 15 years, until the resource is fully developed. In addition to the noise related to field-development activities, noise could be expected from the continued production and maintenance of existing wells within the project area. Noise levels in the project area would also continue to be influenced as they are now by weather, occasional vehicle traffic, and aircraft overflights.

At various times and at specific locations within the project area, noise levels associated with drilling, field-development, and operations activities would temporarily exceed the EPA-established baseline noise levels of 39 dBA for a "Farm in Valley" and the EPA-established threshold of 55 dBA, averaged over 24 hours. Noise generated from these activities can be of an intensity and frequency that causes harm to human receptors. Field-development and production-related noise impacts would affect site workers who are subject to state and federal Occupational Health and Safety (OSHA) standards. OSHA mitigation standards for noise limits exposure as follows: an 8-hour time-weighted average of 85 dBA or a dose of 50 percent are referred to as OSHA action levels [29 CFR 1910.95(c)(2)]. Occupational exposure to noise levels in excess of 85 dBA requires monitoring and mitigation, preferably by engineering means, to protect workers. Offsite worker impacts would be limited due to the lack of residential occupation and concentrated recreational activity within the development area. The small towns within the project area are generally located along I-80 and would continue to be impacted by the general noise of human activity, the vehicle and traffic noise generated along the interstate, and train movement along the railroad. Scattered, transitory activities such as livestock operations and recreation including hunting may be exposed to noise as they move past development activities and operating equipment. Temporary worker housing (man camps) located within the project area may be affected by noise generated by field-development activities but these impacts would generally be associated with specific operations and of limited duration. Noise can also modify animal behavior and habitat-use patterns such as the use of critical winter habitats or sage-grouse leks.

Operational noise would be lessened with the implementation of remote telemetry, which can significantly reduce the number of site visits needed by operations personnel. A survey conducted in the Moxa field area (BLM 2007e) found that the use of telemetry (remote monitoring of wells) could reduce field visits by 50 percent. The use of electricity or natural gas as a fuel for onsite power generation, as opposed to the use of diesel fuel, also reduces noise levels. There would be situations when noise-mitigation opportunities are limited by operational and engineering constraints. For example, CBNG production might be operated using diesel generators until water is removed and gas volumes are adequate to power pumping equipment. Natural gas wells may require artificial lift systems to facilitate production resulting in the need to use gas-lift, plunger-lift, down-hole pump, or other technology. This could include rod pumps or other noise-generating mechanisms. Depending on the fluid volumes produced, the installation of produced-water and condensate-gathering systems to transport these fluids to centralized facilities for disposal or sale could substantially reduce production-related noise compared to tanker-truck transportation.

Noise from field-development and production activities can also be dampened or reduced with the use of mechanical muffler systems; the use of vegetative, constructed, or topographic screening; distance; and consideration of the direction of the noise source from the receptor. These methods serve to lessen the impact of noise on workers, residences, and sensitive wildlife species. Noise is also affected by environmental factors such as humidity, wind direction and speed, and air density. Consideration of the prevailing wind direction when siting noise-generating operations also serves to lessen the impact of noise on sensitive receptors.

Indirect impacts of the Proposed Action include the continued production of the existing federal, fee, and state wells in the project area and the continuation of compression required to transport the gas produced in the field. Noise-control devices already in place would continue to provide mitigation. Directional

drilling of 3,760 wells would require an increase in the number of rigs needed to complete development within the proposed 10- to 15-year period due to the additional number of days needed for drilling and completion activities per well; alternatively, the time needed for completion of the project would be extended appreciably.

4.17.3.2 Alternative A—100-Percent Vertical Drilling

Overall noise generated as a result of drilling 100 percent of the project wells vertically, as opposed to the Proposed Action, which includes drilling 42 percent or 3,760 of the wells directionally, would not change the analysis of impacts when compared to the Proposed Action. The number of days needed for drilling and completion of individual wells may be slightly less for vertical wells when compared to directional wells and result in an overall reduction in the number of days of drilling and completion noise generated during development of the project.

Construction, drilling, and completion activities related to the drilling of vertical conventional wells may last from 30 to 60 days. If it takes an additional week (7 days) to drill a well directionally, then the total number of days affected by drilling and completion noise would decline substantially under this alternative. However, 100-percent vertical wells would also require 42 percent more rig moves and the associated noise from rig moves within the field, when compared to the Proposed Action. In addition, the number of well completion semi-truck trips may also increase as a result of this alternative.

Directional wells may also require a larger rig with larger engines, which may operate at higher decibel and frequency levels when compared to the rigs needed to drill vertically. The noise level, frequency of noise generation, or distance from which noise from larger engines is perceived may decline under Alternative A.

4.17.3.3 Alternative B: Enhanced Resource Protection

Design features of Alternative B, as detailed in Chapter 2, would serve to reduce noise in sensitive environments. For example, (1) clustered development would concentrate noisy activities rather than having noise sources dispersed across the project area, (2) use of noise-reduction technology would prevent noise exceeding 49 dBA measured at 30 feet from the source at all drilling, production, and compressor sites, (3) pipeline transportation of produced liquids would reduce semi/haul truck traffic and associated noise, and (4) remote well-monitoring would also reduce daily traffic near sage-grouse leks and in crucial big game habitats. Enhanced seasonal restrictions on surface-disturbing or disruptive activities within buffers associated with sage-grouse leks, mountain plover nesting habitat, and ferruginous hawk nests would reduce noise impacts on these sensitive species.

4.17.3.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

Implementation of Alternative C could result in areas with concentrated development activity as well as areas of more dispersed operations. It is likely that development noise levels within the high-density areas would be greater than those found in the low-density development areas. The Surface Disturbance Cap approach could slow the pace of development, especially in the high-density development areas, to the point that elevated development noise levels were extended in time compared to the Proposed Action.

4.17.3.5 Alternative D: Directional Drilling

Alternative D would likely result in an extension of the period of time over which a sensitive receptor is impacted by drilling noise. The engine size required for directional drilling would be larger and may result in a higher, or more noticeable, level of noise impacting a sensitive receptor. Noise resulting from completion activities and flaring would also be extended over a longer period of time at any one drilling site. These extended and possibly enhanced noise levels could result in a greater frequency of displacement by sensitive receptors.

4.17.3.6 Alternative E: No Action

Under the No Action alternative the noise generated by currently authorized and approved development and production operations would continue. No new noise sources would be produced.

4.17.4 Impact Summary

The Proposed Action (8,950 wells, of which an estimated 3,760 could be directional) may result in an increase in the number of rigs running annually in order to accomplish the goal of completion of resource development in 15 years when compared to Alternative A, 100-Percent Vertical Drilling. Noise impacts would differ somewhat among the alternatives with noise sources potentially being more dispersed across the landscape under the disturbance cap alternative (Alternative C) or extended over time.

The duration of noise-generating activity and dispersal of noise-generating equipment across the project area would be greatest under the Proposed Action. Directional wells are considered in the Proposed Action and Alternatives B, C, and D. Directional drilling may require a larger rig with larger engines, which may operate at higher decibel and lower frequency levels when compared to the rigs needed to drill vertically. The noise level, frequency of noise generation, or distance from which noise from larger engines is perceived may decline under Alternative A. Alternative D (Directional Drilling), while these rigs are a more intensive noise source, would result in an overall reduction in well pads and roads built and provide only localized areas of noise.

Alternative A, 100-Percent Vertical Drilling, would result in the greatest number of generation sources. The number of days needed for drilling and completion of individual wells may be slightly less for vertical wells when compared to directional wells and result in an overall reduction in the days of drilling and completion noise generated in the development of the project. The time savings realized from vertical drilling could be negated by the amount of time it takes for a rig move; furthermore, the noise reductions realized from Alternative B could be negated by the noise of semi/haul trucks moving drilling rigs. The greatest difference between the Proposed Action and Alternative A could possibly be reduction in the low-frequency noise generated by the bigger engines on directional rigs.

Design features of Alternative B, as detailed in Chapter 2, would serve to reduce noise in sensitive environments.

4.17.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Under the Proposed Action and all alternatives, construction, drilling, and flaring activities would generate onsite noise levels exceeding the EPA-established maximum of 55 dBA. In addition, haul trucks and other construction traffic would generate transitory noise exceeding the federal maximum. In general, these would be short-term events lasting up to 20 days for directional wells and up to 60 days for conventional wells. However, when considered over the life of the Proposed Action, the increased noise levels resulting from drilling and completion activities at multiple sites within the project area would continue for up to 15 years, until the resource is fully developed. Over the life of the project, compressor stations and well-site compression would generally be louder and frequent or continual sources of noise. However, full and successful implementation of the required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs (**Appendix C**) would ensure that the significance criterion is not exceeded.

In Appendix 15 of the RMP (Best Management Practices) there is a general statement requesting consideration of "noise reduction techniques and designs" to benefit wildlife in general and the greater sage-grouse in particular. Implementation of mitigation measures should be considered on a site-specific basis. The following additional mitigation measures would also be considered:

- Dampen or reduce noise from field-development and production activities with the use of mechanical mufflers, vegetative or constructed screening, and direction from receptor, topography,

or distance. Noise is also affected by environmental factors such as humidity, wind direction and speed, and air density.

- Consider the prevailing wind direction when siting noise-generating operations to lessen the impact of noise on sensitive receptors.
- Use flowback separators within 0.25 mile of sensitive receptors.
- Reduce semi/haul truck traffic with the installation of gathering pipelines for produced water and condensate.
- Install remote well-site monitoring to reduce light-truck traffic.
- Modify or enclose compressors to minimize or eliminate loud, continuous noise during greater sage-grouse strutting periods from March 1 through May 20 each year within 0.25 mile of strutting grounds.
- Avoid noise-generating activities from 6 p.m. to 9 a.m. within 2 miles of strutting grounds.

■ MANAGEMENT ENVIRONMENT

4.18 RANGE RESOURCES

4.18.1 Introduction

The CD-C project area includes lands that are located within 47 grazing allotments (described in **Section 3.18**). In many cases, the boundaries of these allotments extend beyond the boundaries of the CD-C project area. Under all alternatives, cattle and sheep grazing would continue throughout the duration of the project. Impacts to rangeland resources would result with implementation of all alternatives. Impacts would be the greatest during the natural gas project development phase but would occur throughout the life of the project, due to vegetation and soil disturbance associated with construction activities, reclamation, weed-control, and road construction and use (e.g., fugitive dust and animal collisions).

4.18.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) includes the following management objectives for livestock grazing:

1. Maintain, restore, and enhance livestock grazing to meet Wyoming Standards for Healthy Rangelands (RMP Appendix 8) and achieve allotment objectives.
2. Encourage grazing permittees and the interested public to participate with BLM to monitor and evaluate rangeland health to determine appropriate management actions.
3. Utilize livestock grazing management techniques (RMP Appendix 19) to maintain vegetation communities and ecosystem functions, in consultation and coordination with the grazing permittees and with participation by the interested public. Utilize data collected from scientifically based inventory and monitoring techniques to support decisions that authorize livestock grazing levels and management.
4. When feasible and providing Wyoming Standards for Healthy Rangelands are met, maintain and/or increase animal unit month (AUM) levels in the RMP project area for livestock grazing.
5. Identify opportunities and implement range and vegetation improvement projects to sustain and enhance livestock grazing and meet Wyoming Standards for Healthy Rangelands in cooperation, consultation, and coordination with the grazing permittees and the interested public (Appendix 19).
6. Mitigate direct, indirect, and cumulative livestock forage losses and impacts to livestock grazing (including impacts on livestock grazing operational capabilities and production performance) where opportunities exist.

Impacts to rangeland resources would be considered significant if:

1. Resource management actions result in greater than 10 percent permanent reduction in AUMs available for livestock grazing within a given allotment,
2. Resource management actions reduce or eliminate the opportunity to run the livestock of choice,
3. Wyoming BLM Standards for Healthy Rangelands are not met, or
4. Vegetation significance criteria are exceeded (**Section 4.6.2**).

4.18.3 Direct and Indirect Impacts

Impacts to livestock and grazing resources would occur under the Proposed Action and all action alternatives on all lands in the project area, as well as on private and state lands under the No Action Alternative. The impacts would include those caused by a reduction of total available forage, road construction and maintenance, well pad construction, pipeline construction, improperly fenced open pits,

vehicle traffic, fugitive dust creation, accidental spills of hazardous or other materials, and creation of habitats conducive to invasive weed infestations.

The primary impact to grazing resources would be loss of available forage as a result of construction and production-related disturbances. Available forage would be reduced during drilling and field development and would be partially reclaimed as soon as feasible under direction of the current BLM reclamation guidelines and recommendations (**Appendix E**). A long-term loss of forage would occur under all alternatives by construction of roads, drill pads, and ancillary facilities that remain in place throughout the life of the project. In addition, in areas where vegetation resources have been enhanced, disturbance would not only reduce quality and quantity of diverse vegetation but would also result in wasted investments by the BLM and permittees (for example, tebuthiuron [Spike 20P™] treatments).

While new roads, pipelines, and well pad construction produce adverse impacts such as removing available forage, the construction of new roads could provide beneficial impacts for livestock permittees from improved access to remote facilities and grazing areas. However, increased access could produce an increased disturbance to livestock, an increased number of undesignated roads/trails, and increased distribution problems associated with unclosed cattle gates and/or cut fences. Vehicles would also present a potential collision hazard to livestock, especially during the calving/lambing season and at night.

For all of the alternatives, fugitive dust caused by vehicles traveling along proposed new roads, existing roads, and other areas of surface disturbance could settle on vegetation used as forage, especially alongside roadway corridors with heavy traffic. This dust would affect the quality and regenerative capacity of roadside grasses and forbs as well as decrease the palatability of the forage for livestock/wildlife use and potentially increase operating costs through increased livestock medical expenses (see **Section 3.6.3**). The graveling of roads reduces dust in the short term, but the scoria commonly used breaks down faster than other gravels and, in the long term, fugitive scoria dust covers the vegetation. Livestock forage would also be impacted should any spills of fuels, solvents, or drilling fluids occur.

Areas of disturbed soil would lead to the spread of invasive plant species. These species would reduce rangeland and forage values by replacing preferred forage species, leading to a reduction in grazing capacity. Without proper management and control, invasive plant species may become established and cause wide-spread infestations. Additionally, some invasive species such as halogeton, black henbane, and houndstongue are poisonous to livestock and can kill or impair them if ingested.

Livestock management concerns with development of natural gas resources on public lands in the CD-C project area include reclamation success, rangeland improvement functionality, dust from roads, and livestock losses. In general, adequate reclamation efforts within the project area have been hampered by inadequate reclamation techniques and extended drought conditions. Invasive weed control has been sporadic and random in implementation, which results in a threat to maintaining Wyoming BLM Standards for Healthy Rangelands and watershed health.

Cattle guards and gates are often damaged by overweight/over-width loads, leading to added maintenance and unwanted mixing of livestock. Numerous instances of gates being left open or fences cut for pipelines that have not been closed or repaired adequately have been recorded. This has led to mixing of livestock and additional time for herding. In large allotments, this may involve up to a week of additional time and expense for the livestock operator.

Improving roads leads people to drive faster, which has increased the incidences of young lambs, calves, and even full-grown animals being hit and killed or maimed.

4.18.3.1 Proposed Action

Under the Proposed Action (**Section 2.2.1**), approximately 8,950 new natural gas wells and the construction of required ancillary facilities would be anticipated over the course of the 15-year

development phase within the CD-C project area. It is assumed that 42 percent of the wells (3,765) would be drilled from directional drilling pads. Over the development phase, the Proposed Action is estimated to initially disturb a total of 47,200 surface acres (**Table 4.0-1).** This total represents an initial forage loss equivalent to approximately 5,488 AUMs, based upon an allotment-wide average of about 8.6 acres per AUM stocking ratio. During the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to about 18,861 acres resulting in a long-term forage loss equivalent to about 2,193 AUMs.

In addition to the 47,200 acres initially disturbed by implementation of the Proposed Action, an estimated initial total of 60,176 historic disturbance acres already exist within the project area (**Table 4.0-1**). The existence of 60,176 initial historic disturbance acres added to Proposed Action disturbance acreage would result in a grand total of 107,376 initial disturbance acres or about 10 percent of the total land surface of the project area. During the projected 45- to 55-year life of the project, the overall disturbance would be reduced to about 36,524 acres, or about 3.4 percent of the total land surface in the project area with successful reclamation on all disturbed acres. The driving factors for attaining pre-disturbance conditions would mainly depend upon time to achieve successful reclamation, future land uses, and future climatic conditions. This would hold true for the reclamation of herbaceous species, but not for native shrub establishment, especially in the more xeric portions of the project area where Wyoming big sagebrush and Gardner's saltbush are the primary land cover types on approximately 590,272 acres, which represents about 55.1 percent of the project's total land surface area (**Table 3.6-1**).

The first impact significance criterion described in **Section 4.18.2** says that impacts to rangeland resources would be considered significant if they were to result in a permanent reduction in AUMs available for livestock grazing within an allotment that was greater than 10 percent. Such a reduction would be a decision made by BLM on a case-by-case basis after a thorough examination of an allotment's historic and ongoing forage availability. Ultimately the decision would be based on the long-term loss of available forage within the allotment. While this analysis cannot say how much disturbance each allotment would receive as a result of the CD-C project and to what extent that would translate to a long-term loss of available forage, it is possible to estimate which allotments may be at a greater risk of long-term loss of forage in excess of 10 percent. According to **Table 3.18-2**, the Echo Springs and North LaClede allotments have already had historic initial surface disturbance in excess of 9 percent. Nine other allotments have had historic disturbance in excess of 5 percent but less than 9 percent. Assuming some degree of successful reclamation and a return to pre-disturbance vegetative conditions, none of these allotments may currently be near the 10 percent significance threshold, as the long-term disturbance figures in **Table 3.18-2** would indicate. However, the surface disturbance associated with the Proposed Action—47,200 acres—could bring total initial disturbance to almost 10 percent of the overall project area. If previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then the allotments described in the preceding sentences—and others—could be at risk of long-term forage reductions in excess of 10 percent.

Indirect impacts to vegetation due to dust from unpaved roads would be variable throughout the project area, depending upon the primary factors cited in **Section 3.6.3**. In addition to the primary factors that generate dust on unpaved roads, the amount and timing of precipitation events—especially in the hotter and drier summer season—could play an important role in the amount of dust generated. Wind speed and prevailing direction in relation to the horizontal azimuth of the road would be important secondary factors, especially with north/south-oriented roads such as Sweetwater County Road (SWCR) 23 which extends from Wamsutter to the north boundary of the project area. The poor palatability of dust-covered vegetation could cause animals to concentrate in dust-free locations, leading to over-utilization and lowered plant productivity/cover in these areas. Increased dust may also affect animal health. These impacts could include reduced weight gains or required lowering of stocking rates in affected allotments.

The Proposed Action could result in impacts to livestock operations as a result of increased death loss, unusable forage due to dust, declining rangeland health and forage productivity, and disruptions to

livestock-management actions. Suggestions for voluntary coordination may or may not be implemented and death loss of young animals and disruptions to livestock-management actions would still be likely to occur. Existing standards and mitigations may not adequately address issues with dust and road alterations to overland hydrology. Therefore, reduction in forage palatability from dust and declining rangeland health and productivity due to accelerated erosion from roads could still occur.

The Proposed Action would result in increased traffic and increased speeds on the improved roads within the CD-C project area, particularly during the drilling and field-development phase. The potential for livestock/vehicle collisions would be increased, especially during the calving/lambing season and during nighttime hours. Roads on moderate to steep slopes that result in long-term changes to overland hydrology and desertification impacts below these locations would also lead to lower weight gains or require reduced stocking rates. New and improved access roads could, however, improve livestock operations by improving access for viewing the allotment, facilities, and animals; for doctoring sick animals; and for transporting animals in or out of an allotment.

The potential exists for disruptions to livestock management. Traffic along roads that pass through shipping pastures or by corrals when in use may interrupt or complicate this work, extending the time and increasing the cost to complete it. Herding of animals through areas being developed or moving around them would increase the complexity and time to accomplish these tasks. In some allotments, management flexibility may be sacrificed to avoid or to minimize these types of impacts.

There is also potential for damage to range improvements from the movement of heavy trucks, drilling equipment, and heavy construction equipment.

Disturbance of soils and increased vehicle activity would increase the potential for introduction, establishment, and spread of undesirable non-native weedy species. This can reduce forage palatability and animal weight gains, in addition to affecting trail routes and animal health, particularly increasing death loss with sheep.

4.18.3.2 Alternative A: 100-Percent Vertical Drilling

Alternative A (**Section 2.2.2**) is similar to the Proposed Action except this alternative assumes that no wells would be drilled using directional drilling rigs. Impacts to the range resource resulting from implementation of Alternative A would be similar to the Proposed Action with the exception that the total amount of initial disturbed area would increase from 47,200 acres to 61,696 acres, a 31-percent increase; the total long-term disturbed area following successful reclamation would increase from 18,861 acres to 24,133 acres.

Under Alternative A, the rangeland forage resource on the 47 CD-C grazing allotments would initially be reduced by the forage equivalent of approximately 7,174 AUMs (1,686 more AUMs than the Proposed Action). Assuming successful reclamation occurs, the long-term forage loss equivalent under Alternative A would be about 2,806 AUMs for the 47 allotments versus 613 more AUMs than the Proposed Action.

The greatly increased disturbance acreage under this alternative would make it more likely that an allotment would approach or exceed the 10-percent significance criterion. The 61,696 acres of new disturbance amounts to a 110-percent addition to historic disturbance. If historic development patterns were to continue, some allotments, including the eleven that have historic disturbance in excess of 5 percent, could be nearing the criterion percentage even if reclamation efforts were successful.

The greater amount of construction activities, increased soil-surface disturbance, and higher traffic volumes associated with Alternative A would likely increase the potential for introduction and spread of invasive weed species, as well as increasing the total fugitive dust load within the project area.

4.18.3.3 Alternative B: Enhanced Resource Protection

Alternative B (**Section 2.2.3**) was developed to prevent significant impacts to the range and other resources by implementing protections and mitigations beyond those normally applied. Alternative B also recognizes that development may be more intensive than currently expected and may result in impacts to vegetation communities faster than anticipated. This alternative would combine a prescriptive and adaptive management approach, which includes assessing the specific issue, designing and implementing a response, monitoring and evaluating results, and adjusting the management response when needed on a case-by-case basis.

The enhanced resource protections for the livestock resource would go into effect immediately and be applied to all future APDs. They include mitigation of impacts on livestock water features, annual meetings conducted by the BLM with natural gas Operators and grazing permittees to discuss project-specific impacts, notification of the affected grazing permittees when drilling is to take place within their allotment, thorough power-washing of all field vehicles associated with natural gas operations, and control of fugitive dust on well sites, pipelines, and access roads.

Surface-disturbance thresholds would trigger further mitigation activities. If surface disturbance were to reach 5 percent of an allotment, a review of reclamation success in the allotment would take place and planning for further development, including potential range improvement projects, would take place. If the amount of unreclaimed surface disturbance were to reach 8 percent, the BLM would require that mitigation be implemented to avoid reaching the significance level of a permanent 10-percent loss of vegetation.

Under Alternative B, the initial disturbance would be 45,516 acres (a decrease of 1,684 acres compared to the Proposed Action) resulting in an initial forage loss equivalent to approximately 5,293 AUMs (195 fewer AUMs than the Proposed Action). Assuming successful reclamation efforts, the long-term disturbance area would decrease to 18,249 acres (a decrease of 612 acres compared to the Proposed Action) resulting in a long-term forage loss equivalent of about 2,122 AUMs (71 fewer AUMs than the Proposed Action).

The decreased surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion. More importantly however, the two thresholds would assure that timely intervention took place before the 10-percent significance threshold was approached.

The reduction in the amount of construction activities, reduced soil-surface disturbance, and diminished traffic volumes associated with Alternative B would decrease the potential for introduction and spread of invasive weed species, as well as decreasing the total fugitive dust load within the project area.

4.18.3.4 Alternative C: Cap on Surface Disturbance, 60 Acres and 30 Acres per Section

Under Alternative C (**Section 2.2.4**), the types of impacts to the range resource would be similar to those described for the Proposed Action (**Section 4.18.3.1**). For this alternative, the scope and intensity of the impacts would be less widespread because of the surface cap restrictions. Under Alternative C, the maximum initial disturbance would be 42,955 acres (a decrease of 4,245 acres compared to the Proposed Action) resulting in an initial forage loss equivalent to approximately 4,995 AUMs (493 fewer AUMs than the Proposed Action). Assuming successful reclamation efforts, the long-term disturbance area would decrease to 17,318 acres (a decrease of 1,543 acres compared to the Proposed Action) resulting in a long-term forage loss equivalent of about 2,014 AUMs (179 fewer AUMs than the Proposed Action).

With this alternative there would be fewer well locations developed. Therefore, fewer access roads would be developed and habitat fragmentation would be less extensive than for the Proposed Action. The impacts to the range resource associated with implementation of Alternative C would be similar in nature,

but somewhat less in magnitude, compared to impacts associated with the Proposed Action (**Section 4.6.3.1**).

The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion. The 42,955 acres of new disturbance would be a 9-percent reduction from the Proposed Action. However, this is still a substantial addition to historic disturbance and, if previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then the 11 allotments with historic disturbance in excess of 5 percent—and others—may be at risk of long-term forage reductions in excess of 10 percent.

On federal lands, invasive weed programs would be implemented per stipulations outlined in individual right-of-way applications and APDs.

4.18.3.4 Alternative D: Directional Drilling

Under Alternative D (**Section 2.2.5**), the types of impacts to the range resource would be similar to those described for the Proposed Action (**Section 4.18.3.1**) but the scope and intensity of the impacts would be less widespread because of the expected reduction in surface disturbance. Estimated initial surface disturbance for this alternative would be 36,449 acres, a decrease of 10,751 acres from the Proposed Action. The forage lost initially under this alternative is estimated to be 4,238 AUMs (1,210 fewer than the Proposed Action). The estimated 14,952 acres of long-term disturbance would be 3,908 acres less than the Proposed Action, representing 1,739 AUMs (454 fewer AUMs than the Proposed Action).

The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion. The 36,449 acres of new disturbance would be a 22.8-percent reduction from the Proposed Action. However, this addition to historic disturbance could cause the 11 allotments with historic disturbance in excess of 5 percent—and others—to be at risk of long-term forage reductions in excess of 10 percent if previously disturbed areas are not being returned to pre-disturbance vegetative conditions.

With this alternative there would be fewer well locations developed—an estimated 4,032 compared to the 6,126 estimated for the Proposed Action. This 35-percent reduction in well locations would likely lead to similar reductions in the number of access roads and road miles with associated reductions in potential collision hazard and dust accumulation on nearby forage.

4.18.3.5 Alternative E: No Action

Under the No Action Alternative it is assumed that no further natural gas development would occur within the CD-C project area and there would be no new disturbance except where APDs have been approved by the BLM for previously authorized activities. There would consequently be no new surface disturbance and no new impacts on rangeland. Grazing would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of forage caused by dust.

4.18.4 Impact Summary

Rangeland impacts associated with the Proposed Action and Alternatives would include disturbed land and associated loss of available forage. Other impacts include those from dust-reducing forage palatability, impacts to livestock operations (e.g. leaving gates open, impacts to fences or range improvements), possible increases in invasive plant species, and accidental injury or death of livestock from vehicle collisions. **Table 4.0-1** shows the anticipated surface disturbance for the alternatives compared to the Proposed Action.

Under the Proposed Action, assuming reclamation and reseeding efforts are successful, during the projected 45- to 55-year life of the project, the initial 47,200 acres of disturbance would be reduced to

about 18,861 acres, resulting in a long-term loss of about 2,193 AUMs. Two allotments and possibly more would be at risk of exceeding the RMP significance criteria of a permanent reduction in AUMs greater than 10 percent.

Under Alternative A, the initial 61,696 acres of disturbance would be reduced to about 24,133 acres over the life of the project, resulting in a long-term loss of about 2,806 AUMs. Allotments would be at a greater risk of exceeding the RMP significance criteria of a permanent reduction in AUMs greater than 10 percent.

Under Alternative B, the initial 45,516 acres of disturbance would be reduced to about 18,249 acres over the life of the project, resulting in a long-term loss of about 2,122 AUMs. Many of the impacts associated with the Proposed Action would be reduced under this alternative (e.g. dust, controlling the spread of invasive plants, and impacts to range improvements). The two-phase process to identify allotments which are approaching the RMP significance criteria should reduce the risk of allotments exceeding the criteria.

The use of surface-disturbance caps under Alternative C would result in reduced surface impact. During the life of the project, the initial 42,955 acres of disturbance would be reduced to about 17,318 acres, resulting in a long-term loss of about 2,014 AUMs. The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion but, if previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then some allotments may be at risk of long-term forage reductions in excess of 10 percent.

Under Alternative D, the initial 36,449 acres of disturbance would be reduced to about 14,952 acres over the life of the project, resulting in a long-term loss of about 1,739 AUMs. The reduced surface disturbance under this alternative would make it less likely that an allotment would approach or exceed the 10-percent significance criterion but, if previously disturbed areas are not being returned to pre-disturbance vegetative conditions, then some allotments may be at risk of long-term forage reductions in excess of 10 percent.

Because it is assumed that there would be no development under Alternative E, No Action, there would be no new impacts of the type described in the Proposed Action, such as deaths of livestock and damage to fences and other range improvements. Grazing would continue to be affected by earlier habitat alterations, by human activity in the vicinity of natural gas production facilities, by traffic in the project area, and by diminished palatability of forage caused by dust.

4.18.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Rangeland impacts associated with the CD-C project—a reduction in available forage, reduced forage palatability, negative effects on livestock operations (e.g. leaving gates open, damaged fences and range improvements), accidental injury or death of livestock from vehicle collisions—would continue throughout the life of the project. The most effective mitigation for reduced forage is to minimize the amount of new disturbance. Alternatives C and D would produce the least amount of new disturbance. Impacts would be further reduced with the application of mitigation measures found in **Appendix C** and the successful implementation of current BLM reclamation guidelines and recommendations described in **Appendix E.** The addition of the following measures not found in Appendix C would further minimize impacts to the range:

- The Operators could, in cooperation with the applicable county, establish reasonable speed limits within the project area, such as Carbon County has done on 20 Mile Road south of Rawlins, to enhance personnel safety, reduce fugitive dust, and reduce potential for livestock/wildlife/wild horse collisions
- Heavy equipment exceeding the recommended gross vehicle weight would not be allowed to use cattle guard crossings.

- All gates within the project area would be left as they are found (i.e., open gates would be left open, closed gates would be closed).
- The Operators could coordinate with affected livestock operators to minimize disruption during livestock operations, including lambing/calving season.
- The BLM could require that off-road activity be minimized.
- The BLM could require that no vehicle activity be allowed on recently reclaimed sites (including pipeline rights-of-way), wetland areas, or other sensitive sites.
- Sites undergoing reclamation could be signed at all possible entry sites, especially gathering pipelines that connect several well pads. Signs should state "Authorized Vehicles Only" to allow maintenance work on valves, for example, by responsible Operators.

Where vegetation improvement projects exist, additional acreage may be treated to replace disturbance impacts and balance or reimburse investment costs for the permittees and BLM.

4.19 OIL AND GAS AND OTHER MINERALS

4.19.1 Introduction

The Proposed Action and the action alternatives would involve recovery of natural gas resources, which would cause a loss of reserves in the ground. The recovered natural gas would provide a needed energy resource and would generate private and public revenues.

The occurrence and potential for occurrence of locatable and other leasable mineral resources have been identified in the project area (**Section 3.19**). Although potential for development of those resources is low, their development would not be precluded by the development of the oil and gas resource. Multiple development of public land minerals is anticipated by regulation and the granting of oil and gas leases and permits to develop those leases does not "preclude the issuance of other permits or leases for the same lands for deposits of other minerals with suitable stipulations for simultaneous operation, nor the allowance of applicable entries, locations or selections of leased lands with a reservation of the mineral deposits to the United States." (43 CFR 3000.7) The development of natural gas would in turn require the development of aggregate minerals—sand, gravel, and klinker—for building materials for roads, well pads, and other ancillary facilities.

4.19.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) prescribes the following management objectives for mineral resources:

1. Provide for exploration and development of locatable minerals, except in withdrawn areas.
2. Provide opportunities for exploration and development of conventional and unconventional oil and gas, coal, and other leasable minerals.
3. Provide opportunities for exploration and development of salable minerals.

Impacts of the CD-C project would be considered significant if they:

1. caused a substantial reduction in leasing and development of non-oil and gas leasable minerals.
2. caused a substantial reduction in the development of locatable and salable minerals.

4.19.3 Direct and Indirect Impacts

4.19.3.1 Proposed Action and All Action Alternatives

Some deposits of uranium are known to occur within the project area but no development is occurring and none is anticipated in the foreseeable future and so no impacts are expected. The principal leasable

minerals found in the project area are coal and natural gas. Coal seams of the Fort Union Formation, the Lance Formation, and the Mesaverde Group are found within and adjacent to the project area but no development is occurring and none is anticipated in the foreseeable future. The Proposed Action and action alternatives are not expected to affect the coal resource in any way.

Development of the natural gas resource would be affected by the Proposed Action and alternatives. Successful natural gas field development would result in the ultimate recovery of the natural gas resource from the target formations, under economic conditions favorable to development, and would substantially increase natural gas supply, regionally and nationally. Under the Proposed Action and all action alternatives, recoverable natural gas reserves produced over the life of the project are estimated at 12.02 Tcf; liquid condensate is estimated at 167.3 million barrels (**Section 4.14.2.2, Socioeconomics**). With this amount of production from the target formations, it is expected that the oil and natural gas resource in the CD-C project area would have been substantially depleted, pending new technology or the discovery of new reserves.

Development of surface mineral material deposits mined in support of CD-C development activities would occur as a result of any of the action alternatives. Construction-grade materials such as sand, stone, gravel, pumice, pumicite, clay, and rock are likely to be obtained from local sources. Currently permitted sources have been identified (**Map 3.19-1**) and other sources are likely to be developed. The total quantities required are not known..

4.19.3.2 Alternative E -- No Action

Under Alternative E, No Action, it is assumed that no new development would take place and no more reserves of natural gas or liquid condensate would be produced in the CD-C project area.

4.19.4 Impact Summary

Under the Proposed Action and all action alternatives, the fluid mineral resources of the CD-C project area would be developed fully—12.02 Tcf of natural gas and 167.3 million barrels of liquids— in the context of known reserves and current extraction technologies. Under Alternative E, it is assumed that the fluid mineral resources would not be developed. Development of surface mineral material deposits mined in support of CD-C development activities would not occur. Deposits of coal and uranium are not expected to be affected by the Proposed Action and the action alternatives.

4.19.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Because no unmitigated adverse impacts are expected, no additional mitigation measures would be necessary.

4.20 HEALTH AND SAFETY

4.20.1 Introduction

Health and safety impacts associated with the action alternatives would be similar to those associated with existing conditions in the project area. As the level of gas development increases in the area the potential for accidents increases due to the number of vehicles, rigs, other heavy equipment, and personnel in the area. The greatest potential for health and safety impacts includes the occupational hazards associated with oil and gas exploration and development, and vehicular travel on improved and unimproved roads.

4.20.2 Management Objectives and Impact Significance Criteria

The Rawlins RMP (BLM 2008a) does not identify any specific health and safety standards or impact significance criteria.

In general, health and safety effects of the action alternatives would be considered significant if they resulted in substantially increased risk to the general public. Health and safety are regulated by state and federal environmental and safety agencies such as the WDEQ, the EPA, OSHA, Wyoming OSHA, and the WOGCC.

4.20.3 Direct and Indirect Impacts

4.20.3.1 Proposed Action

Direct and indirect health and safety risks arising from the Proposed Action include oil and gas occupational hazards, the operation of vehicles on improved and unimproved roads, natural gas pipeline operations, winter driving and working conditions, hunting-related firearms accidents, collisions with livestock and big game, and natural hazards associated with wildfires, flash-floods or winter blizzards. A wide variety of hazardous materials are handled and used in gas-field development and operations activities, resulting in an increased risk of inappropriate use, disposal, or accidental release.

Health and safety impacts to the project workforce include industrial and vehicle accidents. Impacts to the general public are generally limited to an increased risk of traffic accidents. The risk of occupational hazards declines substantially once development activities (drilling and completion operations) are concluded. The risk of vehicle accidents impacting the general public and the workforce may decrease during the field-operations phase depending on the volume of produced water and condensate being transported by truck to disposal or sale.

Hazardous materials storage/use and waste management are stringently regulated by the BLM, EPA, WDEQ and WOGCC, and are discussed in **Sections 3.21 and 4.21**. The risk to human health and the environment from these materials is limited to regulatory non-compliance situations and accidental releases or spills.

Occupational and Public Hazards

Health and safety concerns associated with the Proposed Action would be similar to those described in **Section 3.20**. Implementation of the Proposed Action would likely result in an increased risk to the workforce due to the increased number of personnel in the field, the increase in heavy equipment use and drilling operations, and the resultant increase in vehicle traffic. Compliance with the State of Wyoming Department of Employment Workers Occupational Health and Safety (WOSHA) program rules and regulations for construction and oil and gas well drilling, well servicing, and well special servicing operations would aid in reducing project-related occupational hazards. In addition, the BLM considers safety issues during the APD review process (Onshore Order #1) and reminds the Operator of its occupational health and safety responsibilities in 43 CFR Ch. II, 3162.5-3. Compliance with the OSHA standards works to reduce the opportunity for occupational injuries.

The remote nature of the project area further reduces the opportunity for development and production-related hazards to impact the general public. The public using state and federal highways would be affected by increased levels of traffic, specifically semi/haul truck units related to drilling and completion operations and produced-water and condensate-hauling activities. General public use of lease roads is generally related to livestock activities and recreation, including hunting. Persons pursuing these activities would be at a greater risk of collision with pick-up trucks being driven by field personnel (pumpers and field technicians) and semi-haul trucks. Compliance with WOGCC underground power certification regulations would reduce the opportunity for faulty electrical installations on well sites. In addition, the extremely rural nature of the area and land-ownership patterns (the “Checkerboard”) do not encourage or support residential development, further reducing the opportunity for the public to be affected by underground electrical hazards and other possible hazards.

Pipeline Hazards

Implementation of the Proposed Action would increase the miles of gas-gathering and transmission pipeline installed in the project area as well as the number of natural gas compression and stabilization facilities. Natural gas transmission and gathering pipeline operations are regulated by the federal Office of Pipeline Safety (OPS). Operators of the gas-transmission infrastructure are required to comply with the applicable OPS regulations including implementing stringent system maintenance programs, emergency response planning, risk-management planning, and task specific personnel training in operations and maintenance for each natural gas pipeline system. Compliance with the OPS program requirements reduces the opportunity for pipeline accidents and, likewise, the risk to the general public and employees.

Other Risks and Hazards

The opportunity for accidents involving the general public and the workforce increases as the volume of activity in the field and on the road increases. All actions required to implement the Proposed Action would result in some increased level of risk to the general public and the workforce. Effective contractor and personnel training, emergency-response planning, and coordination with emergency responders should reduce the risks associated with field development and operations.

Highway and road-safety impacts related to the Proposed Action and alternatives are discussed in **Section 4.16 Transportation**. There are inherent risks associated with the operation of vehicles on improved and unimproved roads. Awareness training alerts field personnel to variable road-surface conditions including the risk of collision with the general public, livestock, and wildlife. As a result of greater access to previously inaccessible areas, the public may also be exposed to hazardous driving conditions and wildlife on the roads. With the exception of semi-haul trucks, the public would be exposed to these same hazards wherever they were recreating; the hazards of backcountry recreation are not limited to the project area.

The public would be exposed to an increased number of large vehicles on county roads and state and federal highways resulting in a greater risk of being involved in an accident. For example, the number of semi trucks needed to accomplish a fracking operation is substantial; when multiplied by 600 wells being completed each year the number of additional large trucks on the roadways is also substantial. The drivers of these commercial big-rigs are required to hold commercial driver's licenses with special operations endorsements and receive training prior to operating such vehicles; however, this does not preclude the possibility of accidents.

Weather-related hazards due to winter driving and working conditions could impact the general public and the workforce.

Natural or accidental fires also pose a risk to the workforce and the public. Adherence to the BLM seasonal fire restrictions and the OPS pipeline regulations would reduce the opportunity of fire-related injury and property loss. Fire as a result of natural gas development and production activity would likely result in damage to the field equipment and the range resource. The opportunity for privately owned structures to be involved in such incidents would be limited; very few privately owned structures exist in the project area outside of Wamsutter.

Hunting-related firearms accidents would be a remote possibility. Site workers are generally proximal to field infrastructure and conscientious hunters avoid shooting toward facilities. The hunting public is at risk for such accidents regardless of where they are hunting. Operations personnel and contractors are not allowed access to firearms when working.

Risk to the public as a direct result of development and production operations is limited. Harm caused by extreme noise events would be limited to situations when individuals might place themselves in close proximity to the noise-emitting operation; noise is discussed in greater detail in **Sections 3.17** and **4.17**.

4.20.3.2 Alternative A: 100-Percent Vertical Drilling

The impacts of implementing Alternative A would be the same as those resulting from the Proposed Action with the exception that drilling vertical wells could result in fewer days of concentrated drilling activity per well when compared to drilling directional and pad wells and, therefore, a slightly lower risk of occupational hazard exposure for the drilling workforce.

4.20.3.3 Alternative B: Enhanced Resource Protection

The impacts of implementing Alternative B would be the same as those resulting from the Proposed Action.

4.20.3.4 Alternative C: Surface Disturbance Cap – High and Low-Density Development Areas

The impacts of implementing Alternative C would be the same as those resulting from the Proposed Action with the exception that travel-related risks to the recreating public may be higher in high-density development areas when compared to low-density development areas.

4.20.3.5 Alternative D: Directional Drilling

The impacts of implementing Alternative D would be the same as those resulting from the Proposed Action. The implementation of the Directional Drilling requirement could slow down development to the extent that it reduces, somewhat, road travel risk to the public.

4.20.3.6 Alternative E: No Action

Under the No Action alternative, occupational health and safety exposure to site workers and exposure to the public would be greatly reduced because it is assumed that no new wells would be drilled. Some exposure would still exist with ongoing production activities.

4.20.4 Impact Summary

The Proposed Action and all action alternatives would result in similar impacts to the public and site workers including increased risk of vehicle collisions on interstate highways and local road systems.

4.20.5 Unavoidable Adverse Impacts and Additional Mitigation Measures

Any increase in the volume of activity in the natural gas field required to implement the Proposed Action and alternatives would increase the risk of accidents and injury to the workforce from project-related activities as well as weather-related incidents, wildfires, and increased noise levels. The resulting increase in traffic using the local transportation network would increase the risk of vehicle collisions with other vehicles, wildlife, and livestock for the workforce as well as the general public. However, effective contractor and personnel training, emergency-response planning, and coordination with emergency responders should reduce the risks associated with field development and operations. The level of risk would be highest during project development.

The operating companies and their contractors are obligated to operate in compliance with applicable local, state, and federal regulations. The BLM recognizes these authorities and requires compliance with the applicable regulations.

In addition to required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs (**Appendix C**), the following mitigation measure would further reduce risks to human health and safety for the workforce and the public:

- Consider cooperatively permitting and operating in-field liquids-gathering and road systems.

4.21 WASTE AND HAZARDOUS MATERIALS

4.21.1 Management Objectives and Impact Significance Criteria

Appendix 32 to the Rawlins RMP (BLM 2008a) sets out objectives for the Hazard Management and Resource Restoration Program (HMRRP), an administrative program that emphasizes management of hazards on public lands to reduce risks to visitors and employees, restore contaminated lands, and carry out emergency response actions. The HMRRP contains the following objectives:

1. Identify and control imminent hazards or threats to human health and/or the environment from hazardous substance releases on public lands.
2. Promote working partnerships with states, counties, communities, other federal agencies, and the private sector to prevent pollution and minimize hazardous waste on public lands.
3. Provide hazardous materials management training to BLM employees and educate public land users concerning laws, rules, and standards.
4. Require potentially responsible parties to undertake response actions and to pay their fair share or face cost recovery.
5. Encourage public collaboration in environmental decision-making.
6. Inventory, assess, and manage the cleanup of hazardous substance release sites on public lands that present a potential risk to human health and/or the environment, and promote healthy ecosystems.
7. Ensure that solid and hazardous waste treatment, storage, and disposal facilities that might affect public lands are properly located, designed, and constructed, consistent with the law, as well as prohibit Resource Conservation and Recovery Act (RCRA) temporary storage facilities on public lands.
8. Reduce hazardous waste produced by BLM activities and from authorized uses of public lands through waste minimization programs that include: recycling, reuse, substitution, and other innovative, safe, and cost-effective methods of pollution prevention.
9. Ensure that authorized activities on public lands comply with applicable federal, state, and local laws, regulations, policies, guidance, and procedures.
10. Ensure appropriate review of authorized activities and application of effective management controls to correct weaknesses.

No specific waste and hazardous materials standards were identified in the Rawlins RMP; however, IM WY-2012-007, Management of Oil and Gas Exploration and Production Pits, includes several standards for waste management from oil and gas operations. This far-reaching IM is not restricted only to issues related to pit management. In general, waste and hazardous materials effects of the action alternatives would be considered significant if they resulted in substantially increased risk to the public.

4.21.2 Direct and Indirect Impacts

4.21.2.1 Proposed Action

Waste Management

Waste management impacts resulting from the Proposed Action would be similar to those currently in place in the project area. Most wastes that would be generated at project locations are exempt from regulation by the RCRA under the oil and gas exploration and production exemption and are considered to be solid wastes. Compliance with all applicable state and federal hazardous substance and waste-management regulations should minimize the threats to human health and the environment from generated waste streams (refer to **Section 3.20.1**).

Drilling wastes (mud and cuttings) would be generated from the drilling of each well. Fresh water/gel drilling mud would be used and reserve pits lined when site-specific conditions dictate. Oil-based fluid drilling would occur minimally and only in closed-loop drilling fluid systems. Reserve pit fluids (mud and water) would be recycled as much as possible to reduce water consumption and conserve mud products. Typically reusable fluids are transported and used to drill additional wells while the cuttings or solids are allowed to dry in the reserve pit before being buried onsite. If used, liners would also be buried onsite. In some situations the cuttings are solidified prior to burial, as allowed in the WOGCC regulations and with BLM approval. On multi-well pad sites the reserve pit would be used for all wells on the pad before being closed. Some Operators use closed-loop drilling fluids systems that reduce the need for reserve pit capacity and facilitate more efficient recycling and reuse of mud products. Reserve-pit management varies by Operator, contractor, and location. Commercial drilling mud-disposal facilities are limited and are experiencing disposal capacity problems. Reserve pits are fenced on three sides during operations and on the fourth side once the drilling rig moves off the location.

Completion/stimulation fluids recovered during flow-back and subsequent production operations would be temporarily contained in completion, flare, or reserve pits, depending on site design and APD approval conditions. These fluids would ultimately be disposed of at evaporation ponds or disposal wells or evaporated onsite. Well bore construction (cement, casing, perforation, pressure testing, etc.) is designed and authorized to preclude the opportunity for completion fluids to impact groundwater or non-target hydrocarbon-bearing zones.

Produced water from conventional wells would continue to be managed as described in **Section 3.21.1**. Produced-water injection is currently used on a limited basis in the project area. The anticipated volume of water produced per well is relatively low at an average of 18 barrels of water per day. However, given the number of additional wells to be drilled, the volumes anticipated are significant. The BLM considered requiring injection of produced water as the preferred method of management; however, the Operators have not been able to identify a reservoir that is capable of taking water at the volumes needed by the production rates projected in the area. Thirty additional water-injection wells are planned by the Operators to handle the anticipated volume of produced water, but injection appears to have limited potential for use within the overall project area. Some Operators currently have water evaporation ponds, which may need to be enlarged due to the increased volume of water produced. An additional 20 produced-water management facilities (i.e. evaporation ponds) are anticipated. Commercial water-disposal operations may also need to enlarge their facilities, as capacity is already limited. Produced water would be transported to off-site facilities by pipeline or truck when not managed at the well site. Produced water of appropriate quality would be used in drilling-mud systems and completion operations; this would reduce the volume of water to be disposed as well as the volume of fresh make-up water needed from other sources (water wells, etc.). Other produced-water disposal and re-use options, such as sub-irrigation drip systems, are being developed and would be considered by the BLM on a case-by-case basis. CBNG produced-water disposal considerations are discussed below.

Avian mortality can be an issue in produced-water disposal pits due to salinity in the water and possible hydrocarbon contamination from condensate carryover. Typically, these facilities are fenced to preclude entry by wildlife. Flagging, netting, or other bird-deterrent devices are the most commonly used methods for achieving compliance with the Migratory Bird Treaty Act and WOGCC regulations. Concern continues as to the effectiveness of these deterrents; the BLM staff advocates the use of netting to preclude or reduce avian losses.

Solid, non-hazardous wastes generated at drilling locations, man camps, and construction sites would continue to be handled as they are currently. Non-hazardous solid wastes would be accumulated in containers (dumpsters, trash cages, etc.) and hauled by commercial contractor to permitted disposal facilities. Alternative WDEQ-permitted disposal sites would need to be identified as local municipal solid-waste disposal facilities are experiencing capacity shortages and some are no longer accepting non-household waste. The need to access alternative disposal sites located further from the development area

results in waste being hauled longer distances at greater cost to the companies and risk to the traveling public.

Industrial non-hazardous and/or exempt hazardous waste such as used glycol, antifreeze, lubricating oil, and batteries are recycled through third-party permitted companies or, as in the case of used lube oils, are legitimately recycled into crude-oil streams, when applicable and appropriate.

In the rare instance that hazardous waste is produced it would be managed as required in the RCRA regulations. The BLM does not allow disposal of hazardous waste on federally managed lands; the WDEQ Solid and Hazardous Waste Disposal (WDEQ SHWD) program is the appropriate regulatory authority for these waste streams. Disposal of hazardous wastes in reserve pits is not allowed by any agency.

Sanitary wastes would be transported by commercial contractors to permitted facilities. Alternatively, some permanent and long-term temporary facilities (such as man camps and field offices) would have approved septic systems in place. It can be anticipated that capacity concerns would arise relative to local municipal sanitary-waste disposal facilities.

Commercial disposal facilities are typically located on privately owned lands and are permitted through the WOGCC and/or WDEQ. The current and anticipated levels of development activity and the resultant waste-disposal demand would result in a reduced design life for permitted facilities (municipal or commercial), necessitating the enlargement of existing sites or the permitting and construction of additional facilities.

CBNG Produced-Water Management

Coalbed natural gas (CBNG) development has different produced-water management issues when compared to conventional gas production. The greatest of these concerns are the volume of water produced and the quality of the water, both of which depend on the producing formation. Various produced-water management scenarios would be considered by the BLM in project-specific NEPA analysis if and when proposals are brought forward by CBNG proponents in the project area. Technological advances may make it possible to separate water and gas down-hole, thereby reducing the volume of water removed and managed on the surface. As with conventional produced water, CBNG water may be used for drilling and completion operations, if the water quality is appropriate.

Hazardous Materials

Hazardous materials are used in drilling, field development, construction, completion, and production operations. Implementation of the Proposed Action would result in the increase in hazardous materials being transported, stored, and used in the project area. IM WY-1994-081, IM WY-1997-011 and WY-94-059 require that NEPA documents list and describe any hazardous or extremely hazardous materials that would be produced, used, stored, transported, or disposed of as a result of a proposed project, this compilation can be found in **Appendix K, Hazardous Materials Management Summary**. The quantities of hazardous substances used in the development or operation of wells would be kept in limited quantities on all sites and at the production facilities as needed for operations. None of the chemicals that would be used meet the criteria for being an extremely hazardous material/substance (40 CFR 355) or meet the quantities criteria per IM WY-93-344. Materials would not be stockpiled at well locations.

Each Operator (and its subcontractors as applicable and appropriate) is required to comply with the following state and federal programs which are intended to reduce risk to human health and the environment from the use, storage, and transportation of hazardous materials. Implementation of the Proposed Action would require updating these program plans. Compliance with and implementation of the required plans would reduce the risk to human health and the environment from hazardous material releases in the project area.

- A **Hazard Communications Program** (Haz-Com or Worker Right-to-Know) is required by OSHA and is intended to reduce the risk of occupational exposure to hazardous materials.
- A **Community Right-to-Know** (the Superfund Amendments and Reauthorization Act, or the Emergency Planning and Community Right-to-Know Act), required by the EPA, is intended to provide state and local emergency responders with information regarding the material hazards, location, and volumes of material that may be encountered when responding to an emergency.
- **Spill Prevention, Countermeasure, and Control Plans** are required by the EPA and are intended to preclude the release of oils, such as diesel fuel, gasoline, crude oil, or condensate, into the waters of the United States; these plans must also provide response actions to be taken, and notifications to be made, in the event a release occurs.
- **Emergency Response Plans** are required by the BLM; these plans provide the BLM and operations personnel information about actions to be taken in the event an emergency situation (accidental fire, chemical or oil releases, well blow-out, etc.) should arise. These documents would be updated to include increased operations resulting from implementation of the Proposed Action.

4.21.2.2 Alternative A: 100-Percent Vertical Drilling

The impacts of implementing Alternative A would be the same as those resulting from the Proposed Action with the exception that drilling 100-percent vertical wells could result in a larger volume of drilling fluid being used in the development of the field.

4.21.2.3 Alternative B: Enhanced Resource Protection

The impacts of implementing Alternative B would be the same as those resulting from the Proposed Action except in the defined ERP areas. In these areas, stipulations for enhanced protection could result in concentration of buried reserve pit wastes in cluster development areas and could result in a reduction of vehicle traffic due to the consideration of pipelines to transport produced materials (condensate, produced water, etc.) out of the ERP area.

4.21.2.4 Alternative C: Surface Disturbance Cap – High and Low Density Development Areas

The impacts of implementing Alternative C would be the same as those resulting from the Proposed Action with the exception that the low-density drilling areas could realize a reduced volume of materials produced, transported, or disposed of in those areas of the project area compared to the high-density development areas.

4.21.2.5 Alternative D: Directional Drilling

The impacts of implementing Alternative D would be the same as those resulting from the Proposed Action with the exception that the requirement to drill all wells directionally from a single pad or existing location per section would likely extend the amount of time required to drill and complete each well therefore extending the time period over which development activities occur. While a slowing in project area development activities and associated waste generation may serve to extend the life of existing disposal facilities, the directional requirement may increase the volume of fluids needed for drilling operations but may also make recycling and re-use of these fluids more feasible.

4.21.2.6 Alternative E: No Action

Waste and hazardous material management activities would be greatly reduced because it is assumed that no new wells would be drilled. Some activities would still exist in support of ongoing production activities.

4.21.3 Impact Summary

Currently authorized and approved actions, which would continue under the No Action alternative, are already exerting stress on the permitted and authorized disposal facilities proximal to the project area. Authorization of the Proposed Action or Alternatives A through C would result in further stress to the capacity of permitted waste management units used by the operating companies, including those used for management of solid waste, produced water, and drilling mud. Alternative D may serve to extend the life of some existing disposal facilities because the increase in directional drilling would result in greater recycling of drilling mud and other on-site materials.

4.21.4 Unavoidable Adverse Impacts and Additional Mitigation Measures

Implementation of the Proposed Action would result in an increase in hazardous materials being transported, stored, and used in the project area, and therefore in an increased risk of spills or other accidental releases of these materials. These increased risks would primarily occur during project development. Although the BLM discourages the use of produced water pits, they can be permitted when necessary. Avian mortality may occur in produced-water disposal pits due to salinity in the water and possible hydrocarbon contamination from condensate carryover, despite the use of netting. This increased risk would occur throughout the life of the project.

The operating companies and their contractors are obligated to operate in compliance with applicable local, state, and federal regulations. The BLM recognizes these authorities and requires compliance with the applicable regulations. In addition to required mitigation measures as set forth in the Rawlins RMP and CD-C required Conditions of Approval and BMPs (**Appendix C**), the following mitigation measure would further reduce risks resulting from the generation of waste and the use and transport of hazardous materials:

- Consider cooperatively permitting and operating in-field disposal facilities for solid waste, produced water, drilling mud, and other activities as feasible.