Moxa Arch Area Infill Gas Development Project DRAFT Environmental Impact Statement

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U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

MISSION STATEMENT

It is the mission of the Bureau of Land Managment to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations.

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1.0 INTRODUCTION

These guidelines will provide for consistency in determining requirements for avoiding and mitigating environmental impacts and resource and land use conflicts. Consistency does not mean that identical requirements would be applied to all similar types of activities that may cause similar types of impacts. Nor does it mean that the requirements or guidelines for a single land use activity would be identical in all areas.

The following elements are included in this Appendix:

1. BLM Standard Stipulations, as required in leases and the Kemmerer RMP.
2. Best Management Practices (BMPs), as applied to resources.
3. Mitigation requirements, as applied to resources.

2.0 PURPOSE

The purposes of the "Wyoming BLM Mitigation Guidelines" are to (1) reserve for the BLM the right to modify the operations of all surface and other human presence disturbance activities as part of the statutory requirements for environmental protection, and (2) inform a potential lessee, permittee, or operator of the requirements that must be met when using BLM-administered public lands. These guidelines have been written in a format that will allow for (1) their direct use as stipulations, and (2) the addition of specific or specialized mitigation following the submission of a detailed plan of development or other project proposal and an environmental analysis.

Those resource activities or programs currently lacking a standardized set of permit or operation stipulations can use the mitigation guidelines as stipulations or as conditions of approval, or as a baseline for developing specific stipulations for a given activity or program.

3.0 STANDARD STIPULATIONS

The "Wyoming BLM Standard Oil and Gas Lease Stipulations" were developed in 1986. During their implementation, it was recognized that various land uses, other than those related to oil and gas exploration and development, should be subject to similar kinds of environmental protection requirements. Using the Wyoming BLM standard oil and gas lease stipulations as a basis, development of the "Wyoming BLM Standard Mitigation Measures for Surface-Disturbing Activities" began.

The term "guidelines" better describes the intent and use of these mitigation standards than the terms "stipulations" or "measures." These guidelines are primarily for the purpose of attaining consistency in how requirements are determined for avoiding and mitigating environmental impacts and resource and land use conflicts. Consistency in this sense does not mean that identical requirements would be applied for all similar activities that may cause similar types of impacts. Nor does it mean that the requirements or guidelines for a single activity would be identical in all areas.

Some of the seasonal restrictions in the standard oil and gas lease stipulations contain the statement, "This limitation does not apply to maintenance and operation of producing wells." This statement was included because the stipulations were developed specifically for application to oil and gas leases at the time of issuance, not for activities associated with producing wells. At lease issuance, the only action that can be generally contemplated is the possibility that exploratory drilling may occur somewhere on the lease area. Unfortunately, the provision has been interpreted by some people to mean that the seasonal restriction disappears at the operational stage (i.e., if a producing well is attained). It must be understood that at both the oil and gas exploration stage and the operation or development stages, additional site-specific environmental analyses are conducted and any needed restrictions or mitigations identified become part of the operational or development plan. For example, wells may continue to produce, but related activity may be limited. Thus, it is possible for such seasonal restrictions to continue in effect and be applicable to maintenance and operation of producing wells, if supported by the environmental analyses.

3.1 Big Game Winter Range

Crucial big game winter ranges will be closed from November 15 through April 30. Exceptions may be granted if field inspections reveal a lack of actual or potential wildlife use.

3.2 Raptor Nests

No activity or surface disturbance will be allowed for up to a 0.75 mile radius from active raptor nest sites from February 1 through July 31. A nest site will be considered active if it has been used within the past three years. Actual distances and dates will vary based on topography, species, season of use, and other pertinent factors.

3.3 Greater Sage-Grouse

No activity or surface disturbance will be allowed within 0.25 mile of a sage grouse lek center from March 15 through May 31. The authorized officer may grant exceptions which may include:

- Surface disturbance may be allowed from June 1 through March 14 if the area could be returned to acceptable habitat (i.e., relatively flat with no obstructions) before March 15.
- Surface disturbance may be allowed when a field exam determines the specific area used for strutting. In this case, the restriction would be applied only to the actual lek site and a 500-foot buffer around the perimeter.
- Activities which do not disturb the surface may be allowed any time from June 1 through March 14. Activities which do not disturb the surface may be allowed from March 15 through May 31 from five hours after sunrise until two hours before sunset.

3.4 Riparian and Wetland Areas

No surface disturbance will be allowed within 500 feet of perennial streams or live water. Crossings of perennial streams will be minimized. This is especially important where there is a high density of riparian areas. The use of established roads or temporary bridges will be preferred. When rehabilitation of a riparian area is required, the primary objective will be soil stabilization. The re-establishment of riparian vegetation will always be a key objective. The desired plant species composition after rehabilitation will depend on site-specific objectives.

3.5 Historic Trails

Generally, visual intrusion and surface disturbance will be restricted or prohibited within 1,320 feet from either side of a historic trail, or within the visual horizon of the trail, whichever is closer.

3.6 Threatened, Endangered, and Sensitive Species

Appropriate measures to protect all threatened, endangered, and sensitive plant and animal species will be applied to all actions and use authorizations. These measures could include avoidance, "no surface occupancy," "no surface disturbance," and seasonal restrictions.

The following stipulations to protect bald eagles and peregrine falcons and their habitat are in place:

- A "no surface occupancy" restriction will be applied to leases to protect bald eagle roosting areas. In addition, a 1 mile buffer zone around bald eagle winter roost sites will be closed from November 1 through April 1.
- If any active bald eagle or peregrine falcon nests are found, no activity or surface disturbance will be allowed for up to a 0.75 mile radius from an active nest from February 1 through August 15. A nest site will be considered active if it has been used within the past three years.

Actual distances and dates will vary based on topography, species, season of use, and other pertinent factors.

4.0 BEST MANAGEMENT PRACTICES

4.1 Operator-Committed Reclamation and Mitigation Measures

The Operators would commit to the following reclamation procedures as part of all oil and gas development activities in the MAA:

- The Operators commit to monitor interim and final reclamation operations by performing inspections using an independent third party contractor. The objective is to provide a uniform performance-based evaluation of reclamation efforts and success across the Moxa area, regardless of surface ownership or lease operator. Reclamation performance assessment methodology will be based upon requirements of both the KFO and the State of Wyoming. The duties of the contractor would include:
  - visiting all Moxa locations to document the progress of interim and final reclamation efforts;
  - developing quantifiable documentation submitted to the BLM and State (agencies) on a periodic (TBD) basis (all other alternatives would require annual reports at a minimum per Appendix E);
  - providing location/lease/operator data to the agencies in GIS format; and
  - providing annual summary “progress” reports to the Operators by the contractor to track reclamation effectiveness.
- The Operators commit to engaging the services of reclamation professional/specialist to provide expertise/recommendations to the agencies and the operators. The goal would be to develop a workable written reclamation strategy specifically designed for the MAA that would be provided to the BLM and State of Wyoming. The strategy will incorporate the results of the ongoing monitoring effort and would be modified, if necessary, according to the reclamation monitoring results assessment. When monitoring results demonstrate that reclamation is being performed successfully, the strategy would be finalized as the “Moxa Area Reclamation Plan.” The reclamation specialist would be responsible for:

- development of an Initial Reclamation Plan and periodic revisions, if monitoring results indicate the need to alter reclamation procedures;
- evaluation of reclamation techniques used by the mining/other industries, reclamation techniques used in other BLM Field Offices, and their applicability to oil and gas operations in MAA. The results of the evaluation would be included in the Initial Reclamation Plan; and
- determining how/if reclamation should vary in different areas of the MAA according to:
  - timing (including initiation, evaluation of results, etc.);
  - species composition, considering habitat viability, BLM cover requirements, and SWPPP requirements; and
  - best procedures for an arid environment/drought.

- The Operators would provide funding for inspection and enforcement to augment and provide assistance to KFO inspection and enforcement personnel if determined necessary by the KFO. The need for funding and KFO support would be re-evaluated annually by the KFO and the Operators, concurrent with receipt of the annual reclamation monitoring progress report. The Operators would agree on method to provide funding for the activities contemplated on a yearly basis. The Operators would select a lead party to handle the billing process and to provide supervision of the third party contractors, professionals and specialists. The Operators would meet annually in the fourth quarter to approve a budget and selection of the personnel required herein.
- Offsite mitigation would be considered by the Operators if necessary and reclamation monitoring indicates poor results. The objective of offsite mitigation would be in part to improve/restore habitat in areas that would provide the most benefit to wildlife and result in the fewest conflicts with oil and gas development, as identified in the EIS analysis. The Operators need interagency commitment that any such efforts would be recognized by the BLM and State of Wyoming as actions to enhance species viability across land jurisdictions.

4.2 Operator-Committed BMPs

The Operators would adhere to all conditions included with their leases and to all federal and state laws and regulations. The Operators would also commit to performing the following BMPs, per the requirements in BLM IM No. 2007-021:

- Interim reclamation of well locations and access roads soon after the well is put into production.

  The goal of this BMP is to minimize long-term loss of habitat, forage, visual resources, soils, and to prevent the introduction of invasive species. Portions of well pads and roads that would not be used during production operations would be recontoured, leaving only areas necessary for workovers and operations uncountoured. Salvaged topsoils would be spread across all disturbed areas except those that are needed to accommodate year-round traffic and operations. Well locations, reclaimed roads, and gathering pipeline rights-of-way would be revegetated with a BLM-approved seed mixture. Where practical, road surfaces and turnarounds would also be revegetated. With low traffic roads, this would result in a hardpan, two-track road that is stable and requires less maintenance. To ensure continued energy production operations, the operator would be allowed to drive, park, and set up future workover and maintenance operations on newly revegetated areas. Where there is a moderate to high risk of wildfire, a small buffer area would be left around production facilities or grass would be mowed prior to workover setup. Where future wells are anticipated to be drilled from the same well location within a year or two, approval to delay interim reclamation may be granted.

- Painting of all new facilities a color that best allows the facility to blend with the background, typically a vegetated background.

  The goal of this BMP is to minimize visual contrast by making production facilities less noticeable. Above-ground production facilities would be painted with colors that allow the facilities to blend into the background. The BLM and the Operators would identify the best colors to match the surrounding vegetation and soil types. The Operator may need to paint drill rig anchors and minor working tips and edges of production facilities that are subject to OSHA safety requirements a red, yellow, or orange color. The Operator would not be required to paint wooden structures, including distribution power poles. To minimize contrast, Operators would avoid lighter colors, white doors or roofs, galvanized silver electrical boxes and guardrails, and signs with white backgrounds.

- Design and construction of all new roads to a safe and appropriate standard "no higher than necessary" to accommodate their intended use.

  The goal of this BMP is to minimize long-term loss of habitat, vegetation, soil, and visual resources. All roads would be designed and constructed to an appropriate standard that is no higher than necessary to adequately accommodate their intended function. Design, construction, and maintenance activities would be consistent with national policies for safety and resource protection. Operators would consider the anticipated average daily traffic, vehicle loads, vehicle speeds, potential for use by the public, soil types, season of use, and topography. In some cases, overland travel within a defined corridor or via two-track roads during dry conditions would be preferable to construction of all-weather access roads. On a case-by-case basis, overland travel or two-track roads may be appropriate for exploratory wells or for wells where year-round access needs have been reduced. Where practical, roads should follow the contours of the land to minimize cuts and fills and visually obtrusive lines in the landscape. Overland or two-track roads would not be used in sensitive soil types or during saturated soil conditions.

- Final reclamation and recontouring of all disturbed areas, including access roads, to the original contour or a contour that blends with the surrounding topography.

  The goal of this BMP is to restore the landform, vegetation, habitat, soil, and visual resources to the same conditions that occurred prior to well development. Topsoil will be stripped from areas that have not already been recontoured and redistributed uniformly over all disturbed areas. BLM-approved fertilizers will be used when available to encourage rapid regrowth of BLM-approved seed mixtures. Revegetation could result in color contrast initially that will decrease as native plants and shrubs recolonize. Nearly all roads would be recontoured to ensure that they blend into the surrounding landscape.

4.3 Additional BMPs

In addition, the following BMPs may be applied to reduce resource impacts:

- Installation of raptor perch avoidance.

  The goal of this BMP is to discourage raptor perching on power poles and tank batteries using proven anti-perching devices. This BMP would reduce potential predation of BLM sensitive species, including sage grouse and prairie dogs. Also, perch avoidance mechanisms would reduce potential for electrocution of raptors that may perch on power poles.

- Burying of distribution power lines and/or gathering pipelines in or adjacent to access roads and use of common rights-of-way and utility corridors.

  Burying power lines and gathering lines in or adjacent to the road or in common rights-of-way with existing surface disturbance decreases surface disturbance and visual resource impacts. Buried power lines would minimize issues associated with raptor perching, as discussed for the previous BMP.

- Centralizing production facilities.

  Where necessary to protect visual resources, sensitive wildlife habitat, sensitive soils, or other resources, flow lines (oil, gas, water, condensate) from several wells could be run to centralized tank batteries placed offsite away from sensitive areas. This would reduce large truck traffic to individual wells and would allow for the use of lower standard roads, including two tracks. The ability to use lower standard roads would result in less surface disturbance.

- Increase the amount of field automation.

  Monitoring automated wells from a central office location would decrease the frequency of well visits. The decreased activity within the field would reduce traffic collisions and noise impacts to wildlife, including mule deer, pronghorn, elk, and sage-grouse.

- Locating wellheads below ground surface.

  Where possible, wellheads could be buried to minimize impacts to visual resources and remove perch locations for raptors.

- Minimizing topsoil removal during drilling activities.

  The goal of this BMP is to minimize disturbance to sensitive soils and vegetation. In flat areas, brush-beating, mowing the well location, and/or parking on the grass for drilling and production operations could be used to minimize surface disturbance. Topsoil and subsoil would be excavated only where absolutely necessary, such as for the reserve pit or for leveling the drill rig.

- Drilling multiple wells from a single pad.

  The goal of this BMP is to centralize wells by drilling multiple wells from a single pad to reduce surface disturbance, visual resource impacts, and wildlife habitat fragmentation. Centralizing wells avoids drilling and maintaining wells near sensitive resources and maintains large areas of uninterrupted habitat and unimpacted visual resources. Directionally drilled wells require larger well pads, but with interim reclamation, pad size can be reduced significantly.

- Implementing noise reduction techniques and designs.

  Noise reduction mufflers could be used to comply with noise standards. Additionally, earthen berms, walls, sheds, and/or increasing distance from sensitive areas could be used to reduce sound levels.

- Screening facilities from view and avoiding placement of production facilities on hilltops and ridgelines.

  The goal of this BMP is to minimize impacts to visual resources. Natural and artificial features, such as topography, vegetation, or artificial berms, would be used to help screen facilities. Examples of appropriate screening could include location of facilities in a swale, behind a ridge, or behind a constructed but natural-looking vegetated berm. Locating facilities on ridgelines and hilltops would be avoided to the extent possible.

- Bioremediation of oil field wastes and spills.

  Bioremediation is the process whereby microorganisms digest and remove petroleum hydrocarbons and selected other chemicals from contaminated soil and produce water and carbon dioxide as waste products. On-site bioremediation destroys oil field wastes and spills and reduces costs and potential liability associated with landfill disposal. The BLM would work with industry to identify the most appropriate method to remediate any contamination that might occur.

5.0 MITIGATION MEASURES

In addition to application of BMPs and standard stipulations throughout the MAA, as described in the previous sections, the following mitigation requirements are recommended for consideration by the Authorized Officer as inclusion in the Record of Decision.

- The MAA Operators are required to submit an annual drilling plan to the AO by December 31 of each year. At the same time, the Operators must submit an annual report of reclamation procedures and success/failures that have taken place throughout the year.
- All proposed stream crossings of pipelines will be required to be bored to reduce impacts to aquatic and riparian habitats. This requirement may be waived at the discretion of the AO in the case of unusual circumstances.
- To reduce weed infestation and soil loss throughout the MAA, the Operators will be required to seed well pads with a sterile cover crop immediately after construction. Details of acceptable cover crops and other suggested reclamation procedures can be found in Appendix E of the EIS.
- Operators will be required to participate in and assist with funding for an MAA-wide transportation plan. A transportation plan should be completed no later than 3 years after the issuance of the ROD for the MAA Oil and Gas Infill Project EIS. The goal of the transportation plan should be to identify feasible alternatives for access that meet the objectives of the BLM, Wyoming Department of Transportation, County transportation authorities, and the Operators. The transportation planning process should consider future road use needs, public access, resource values, and safety to avoid haphazard or unnecessary development of roads and utility corridors.
- Operators will be required to use misters to disperse water from pits or reuse the produced water at the next drilling location wherever feasible. This will reduce overall use of water in the MAA and expedite interim reclamation of the well pad location.

Table A-1. Consolidated Table of Application of BMPs and Mitigation Measures for Resources.

Resource	BMPs/Mitigation
Surface Geology	**BMPs/Mitigation** 1) No surface disturbance within 500 feet of perennial streams, live water, or riparian areas. 2) No surface disturbance on slopes exceeding 25% 3) Final reclamation recountouring of all disturbed areas, including access roads, to the original contour or a contour that blends with the surrounding topography (see Appendix E).
Geohazards	1) No surface disturbance on slopes exceeding 25%.
Paleontology	**BMPs/Mitigation** 1) Authorizations for surface-disturbing activities will be conditioned to minimize adverse impacts to paleontological resources. 2) Operations that cause disturbance to the Green River Formation will require a survey by a BLM-approved paleontologist, and mitigation measures may be required, as appropriate. 3) Operations that cause disturbance to the Bridger Formation will require a survey by a BLM-approved paleontologist, and mitigation measures may be required, as appropriate. 4) In the event of discovery of fossil resources during project activities, operations must cease and the BLM must be notified. The BLM will then take appropriate actions, which may include a requirement for surveys and development of additional mitigation measures. 5) In addition to required mitigations, a worker education program relating to the importance of fossil resources and the illegality of unauthorized collecting, combined with strict enforcement provisions by the Operators, would reduce the potential for loss of important paleontological information.
Soils	**BMPs** 1) Avoidance of badland and steep slope (<25%) sensitive soils. 2) Where avoidance is not feasible, incorporate special soil stabilization and erosion control measures. 3) Avoidance of all areas within 500 feet of surface water and riparian areas. 4) Drilling multiple wells from a single pad in sensitive soils (badland and sand dune). 5) Minimizing topsoil removal during drilling activities, including soil excavation only where absolutely necessary, such as for the reserve pit or leveling the drill rig. 6) Centralizing production facilities in sensitive soils. 7) Interim reclamation of well locations and access roads in the first available period within 1 year after the well is put into production (Operator committed).

Resource	BMPs/Mitigation
	Mitigation 1) Seeding well pads with a sterile cover crop immediately following construction. 2) Operators required to submit an annual reclamation monitoring report as part of the annual drilling plan.
Water	**BMPs** 1) Avoidance of all areas within 500 feet of surface water and riparian areas. 2) Continuation of the cementing policy. 3) Following Healthy Rangeland Standard 5 - takes into account chemical characteristics (pH, conductivity, dissolved oxygen); physical characteristics (sediment, temperature, color); and biological characteristics (invertebrates, fecal coliform, and plant and animal species) of water. 4) Drilling multiple wells from a single pad to avoid sensitive areas and decrease surface disturbance in hydrologic units. 5) Collocating gathering lines and power lines with roads to reduce the project footprint and minimize disturbance to visual resources.
	Mitigation 1) Seeding well pads with a sterile cover crop immediately following construction. 2) Pipelines required to be bored under streams unless otherwise authorized by the AO.
Noise	**BMPs/Mitigation** 1) Equip compressors, vehicles, and other sources of noise with effective mufflers or noise suppression systems. 2) Monitor automated wells remotely to decrease traffic noise. 3) Reduce noise levels to 49 dBA or less, particularly during the bird nesting season (1 April through 30 June) to minimize the effects of continuous noise on bird populations. Constant noise generators should be located far enough away from sensitive habitats or muffled such that noise reaching those habitats is less than 49 dBA. 4) From 1 March through 15 May, anthropogenic sources of continuous or frequently intermittent noise should not exceed 10 dBA above natural, ambient noise measured at the perimeter of any occupied sage-grouse lek.
Vegetation/ Wetlands	**BMPs** 1) Interim reclamation of well locations and access roads in the first available period within 1 year after the well is put into production (Operator committed). 2) Use only native species for interim and final reclamation unless authorized by BLM. 3) Follow reclamation procedures (Appendix E). 4) Avoidance of all areas within 500 feet of surface water and riparian areas. 5) Follow the Wyoming BLM Standards for Healthy Rangelands.

Resource	BMPs/Mitigation
	Mitigation 1) Seeding well pads with a sterile cover crop immediately following construction. 2) Operators required to submit an annual reclamation report as part of the annual drilling plan. 3) Treat halogeton infestations prior to surface disturbance or before reclamation to optimize the effectiveness of weed removal. General herbicides may be appropriate for removal of dense stands of halogeton. If weeds are not controlled in the first year of growth prior to weed seed production, a long-term source of weed seed will be present in reclaimed areas. 4) Any unavoidable impacts to wetlands would require mitigation (enhancement, restoration, or creation), as per the requirements of the Clean Water Act. Any mitigation would be developed on a site-specific basis.
Fisheries and Wildlife	**BMPs** 1) Installing raptor perch avoidance structures 2) Burying power lines and gathering pipelines 3) Locating well heads below ground surface 4) Implement noise reduction/mitigation techniques (details in Noise section) 5) Monitor automated wells remotely to decrease traffic collisions and noise. 6) Drilling multiple wells from a single pads in sensitive wildlife habitats 7) Collocate power lines and gathering pipelines in roads in sensitive wildlife habitats 8) Centralizing production facilities in sensitive wildlife habitats 9) Interim reclamation of well locations and access roads in the first available period within 1 year after the well is put into production (Operator committed). 10) Design and construction of all new roads to a safe and appropriate standard "no higher than necessary" to accommodate their intended use (Operator committed).
	Mitigation 1) Pipelines required to be bored under streams unless otherwise authorized by the AO. 2) Implement timing restrictions of stream crossings based on potential species affected within a particular stream. 3) Seeding well pads with a sterile cover crop immediately following construction. 4) Operators required to participate in and assist with funding for a MAA-wide transportation plan. 5) Development of a supplemental Wildlife and Livestock Mitigation document that will identify specific mitigations to be applied both onsite and offsite.
Livestock Grazing and Rangeland Health	**BMPs** 1) Interim reclamation of well locations and access roads in the first available period within 1 year after the well is put into production (Operator committed). 2) Follow rangeland health standards.

Resource	BMPs/Mitigation
	Mitigation 1) Seeding well pads with a sterile cover crop immediately following construction. 2) Operators required to submit an annual reclamation report as part of the annual drilling plan. 3) Operators required to participate in and assist with funding for a MAA-wide transportation plan. 4) Operators required to repair fences damaged or removed for construction. 5) Operators may be required to install stock ponds, guzzlers, or other watering amenities to mitigate for impacts.
Cultural Resources	**BMPs/Mitigation** 1) Avoidance of ground disturbance at significant cultural/historical resource sites and highly sensitive archaeological locales 2) Archaeological excavation or HABS/HAER documentation of significant cultural/historical resource sites or site portions. 3) Native American sensitive/TCP and discovered site consultation 4) Cultural/historical resource treatment planning and/or Programmatic Agreements. 5) No surface disturbance within 0.25 mile of historic trails or the visual horizon, whichever is closer. 6) Paint all facilities a color that best allows the facility to blend with the background (Operator-committed BMP).
Socioeconomics	**Mitigation** 1) Assist local government with funding of public service projects that have been impacted by population growth related to oil and gas development. 2) Work with impacted communities to develop and fund “portable” infrastructure enhancements (infrastructure provided by Operators during “boom” peaks and removed by Operators during “bust” times). 3) Work with the Wyoming Department of Transportation and/or Sweetwater, Lincoln, and Uinta County Road and Bridge Departments to install appropriate road-side signs outside the MAA that indicate potential hazards (e.g., school bus stops, high-traffic volume turnouts, trucks entering roadway). 4) Provide incentives or land for local builders to build housing prior to start-up of MAA drilling activities. The City of Evanston has adequate utility capacity for significant growth. Therefore, these incentives would be best provided in the Evanston area. 5) If housing becomes available in the Evanston area, encourage workers to reside in this area, since facilities and services there are adequate for a larger population base.
Recreation	Same as wildlife and visual resources.

Resource	BMPs/Mitigation
Visual	**BMPs** 1) Restrict visual intrusion in VRM Class I and II areas and within 0.25 mile of historic trails. 2) Screening facilities from view and avoiding placement of production facilities on hilltops and ridgelines. 3) Paint all facilities a color that best allows the facility to blend with the background (Operator-committed BMP). 4) Gravel of road color shall be similar to adjacent dominant soil colors.
Human Health and Safety	The Operators should coordinate emergency response planning with the Uinta, Sweetwater, and Lincoln Counties Emergency Management Agency and provide documentation regarding compliance with Federal Hazardous Material Regulations and the Uniform Fire Code.

A.2. STANDARDS FOR HEALTHY RANGELANDS FOR THE PUBLIC LANDS ADMINISTERED BY THE BUREAU OF LAND MANAGEMENT IN THE STATE OF WYOMING

1.0 INTRODUCTION

According to the Department of the Interior's final rule for grazing administration, effective August 21, 1995, the Wyoming Bureau of Land Management (BLM) State Director is responsible for the development of standards for healthy rangelands on 18 million acres of Wyoming's public rangelands. The development and application of these standards are to achieve the four fundamentals of rangeland health outlined in the grazing regulations (43 CFR 4180.1). Those four fundamentals are: (1) watersheds are functioning properly; (2) water, nutrients, and energy are cycling properly; (3) water quality meets State standards; and (4) habitat for special status species is protected.

Standards address the health, productivity, and sustainability of the BLM administered public rangelands and represent the minimum acceptable conditions for the public rangelands. The standards apply to all resource uses on public lands. Their application will be determined as use specific guidelines are developed. Standards are synonymous with goals and are observed on a landscape scale. They describe healthy rangelands rather than important rangeland by-products. The achievement of a standard is determined by measuring appropriate indicators. An indicator is a component of a system whose characteristics (e.g., presence, absence, quantity, and distribution) can be measured based on sound scientific principles.

Quantifiable resource objectives and specific management practices to achieve the standards will be developed at the BLM Field Office level and will consider all reasonable and practical options available to achieve desired results on a watershed or grazing allotment scale. The objectives shall be reflected in site-specific activity or implementation plans as well as in livestock grazing permits/leases for the public lands. Interdisciplinary activity or implementation plans will be used to maintain or achieve the Wyoming standards for healthy rangelands. These plans may be developed formally or informally through mechanisms available and suited to local needs (such as Coordinated Resource Management [CRM] efforts).

The development and implementation of standards will enable on-the-ground management of the public rangelands to maintain a clear and responsible focus on both the health of the land and its dependent natural and human communities. This development and implementation will ensure that any mechanisms currently being employed or that may be developed in the future will maintain a consistent focus on these essential concerns.

These standards are compatible with BLM's three-tiered land use planning process. The first tier includes the laws, regulations, and policies governing BLM's administration and management of the public lands and their uses. The previously mentioned fundamentals of rangeland health specified in 43 CFR 4180.1, the requirement for BLM to develop these state (or regional) standards, and the standards themselves, are part of this first tier. Also, part of this first tier are the specific requirements of various federal laws and the objectives of 43 CFR 4100.2 that require BLM to consider the social and economic well-being of the local communities in its management process.

These standards will provide for statewide consistency and guidance in the preparation, amendment, and maintenance of BLM land use plans, which represent the second tier of the planning process. The BLM land use plans provide general allocation decisions concerning the kinds of resource and land uses that can occur on the BLM administered public lands, where they can occur, and the types of conditional requirements under which they can occur. In general, the standards will be the basis for development of planning area-specific management objectives concerning rangeland health and productivity.

The third tier of the BLM planning process, activity or implementation planning, is directed by the applicable land use plan and, therefore, by the standards. The standards, as BLM statewide policy, will also directly guide development of the site-specific objectives and the methods and practices used to implement the land use plan decisions.

Activity or implementation plans contain objectives which describe the site-specific conditions desired. Grazing permits/leases for the public lands contain terms and conditions which describe specific actions required to attain or maintain the desired conditions. Through monitoring and evaluation, the BLM, grazing permittees, and other interested parties determine if progress is being made to achieve activity plan objectives.

Wyoming rangelands support a variety of uses, which are of significant economic importance to the state and its communities. These uses include oil and gas production, mining, recreation and tourism, fishing, hunting, wildlife viewing, and livestock grazing. Rangelands also provide amenities which contribute to the quality of life in Wyoming such as open spaces, solitude, and opportunities for personal renewal. Wyoming's rangelands should be managed with consideration of the state's historical, cultural, and social development and in a manner which contributes to a diverse, balanced, competitive, and resilient economy in order to provide opportunity for economic development. Healthy rangelands can best sustain these uses.

To varying degrees, BLM management of the public lands and resources plays a role in the social and economic well-being of Wyoming communities. The National Environmental Policy Act (part of the above-mentioned first planning tier) and various other laws and regulations mandate the BLM to analyze the socioeconomic impacts of actions occurring on public rangelands. These analyses occur during the environmental analysis process of land use planning (second planning tier), where resource allocations are made, and during the environmental analysis process of activity or implementation planning (third planning tier). In many situations, factors that affect the social and economic well-being of local communities extend far beyond the scope of BLM management or individual public land users' responsibilities. In addition, since standards relate primarily to physical and biological features of the landscape, it is very difficult to provide measurable socioeconomic indicators that relate to the health of rangelands. It is important that standards be realistic and within the control of the land manager and users to achieve.

Implementation of the Wyoming standards will generally be done in the following manner. Grazing allotments or groups of allotments in a watershed will be reviewed based on the BLM's current allotment categorization and prioritization process. Allotments with existing management plans and high-priority allotments will be reviewed first. Lower priority allotments will then be reviewed as time allows. The permittees and interested publics will be notified when allotments are scheduled for review and encouraged to participate in the review. The review will first determine if an allotment meets each of the six standards. If it does, no further action will be necessary. If any of the standards are not being met, rationale explaining the contributing factors will be prepared. If livestock grazing practices are found to be among the contributing factors, corrective actions will be developed and implemented. If a lack of data prohibits the reviewers from determining if a standard is being met, a strategy will be developed to acquire the data in a timely manner.

Standard 1

Within the potential of the ecological site (soil type, landform, climate, and geology), soils are stable and allow for water infiltration to provide for optimal plant growth and minimal surface runoff.

THIS MEANS THAT:

The hydrologic cycle will be supported by providing for water capture, storage, and sustained release. Adequate energy flow and nutrient cycling through the system will be achieved as optimal plant growth occurs. Plant communities are highly varied within Wyoming.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Water infiltration rates;
- Soil compaction;
- Erosion (rills, gullies, pedestals, capping);
- Soil microorganisms;
- Vegetative cover (gully bottoms and slopes); and
- Bare ground and litter.

Standard 2

Riparian and wetland vegetation has structural, age, and species diversity characteristic of the stage of channel succession and is resilient and capable of recovering from natural and human disturbance in order to provide forage and cover, capture sediment, dissipate energy, and provide for groundwater recharge.

THIS MEANS THAT:

Wyoming has highly varied riparian and wetland systems on public lands. These systems vary from large rivers to small streams and from springs to large wet meadows. These systems are in various stages of natural cycles and may also reflect other disturbance that is either localized or widespread throughout the watershed. Riparian vegetation captures sediments and associated materials, thus enhancing the nutrient cycle by capturing and utilizing nutrients that would otherwise move through a system unused.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Erosion and deposition rate;
- Channel morphology and flood plain function;
- Channel succession and erosion cycle;
- Vegetative cover;
- Plant composition and diversity (species, age class, structure, successional stages, desired plant community, etc.);
- Bank stability;
- Woody debris and instream cover; and
- Bare ground and litter.

The above indicators are applied as appropriate to the potential of the ecological site.

Standard 3

Upland vegetation on each ecological site consists of plant communities appropriate to the site which are resilient, diverse, and able to recover from natural and human disturbance.

THIS MEANS THAT:

In order to maintain desirable conditions and/or recover from disturbance within acceptable timeframes, plant communities must have the components present to support the nutrient cycle and adequate energy flow. Plants depend on nutrients in the soil and energy derived from sunlight. Nutrients stored in the soil are used over and over by plants, animals, and microorganisms. The amount of nutrients available and the speed with which they cycle among plants, animals, and the soil is a fundamental component of rangeland health. The amount, timing, and distribution of energy captured through photosynthesis are fundamental to the function of rangeland ecosystems.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Vegetative cover;
- Plant composition and diversity (species, age class, structure, successional stages, desired plant community, etc.);
- Bare ground and litter;
- Erosion (rills, gullies, pedestals, capping); and
- Water infiltration rates.

The above indicators are applied as appropriate to the potential of the ecological site.

Standard 4

Rangelands are capable of sustaining viable populations and a diversity of native plant and animal species appropriate to the habitat. Habitats that support or could support threatened species, endangered species, species of special concern, or sensitive species will be maintained or enhanced.

THIS MEANS THAT:

The management of Wyoming rangelands will achieve or maintain adequate habitat conditions that support diverse plant and animal species. These may include listed threatened or endangered species (U.S. Fish and Wildlife Service-designated), species of special concern (Wyoming Game and Fish Department-designated), and other sensitive species (BLM-designated). The intent of this standard is to allow the listed species to recover and be delisted, and to avoid or prevent additional species becoming listed.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Noxious weeds;
- Species diversity;
- Age class distribution;
- Indicators associated with the upland and riparian standards;
- Population trends; and
- Habitat fragmentation.

The above indicators are applied as appropriate to the potential of the ecological site.

Standard 5
Water quality meets State standards.

THIS MEANS THAT:

The State of Wyoming is authorized to administer the Clean Water Act. BLM management actions or use authorizations will comply with all Federal and State water quality laws, rules, and regulations to address water quality issues that originate on public lands. Provisions for the establishment of water quality standards are included in the Clean Water Act, as amended, and the Wyoming Environmental Quality Act, as amended. Regulations are found in Part 40 of the Code of Federal Regulations and in *Wyoming's Water Quality Rules and Regulations*. The latter regulations contain Quality Standards for Wyoming Surface Waters.

Natural processes and human actions influence the chemical, physical, and biological characteristics of water. Water quality varies from place to place with the seasons, the climate, and the kind of substrate through which water moves. Therefore, the assessment of water quality takes these factors into account.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Chemical characteristics (for example, pH, conductivity, dissolved oxygen);
- Physical characteristics (for example, sediment, temperature, color); and
- Biological characteristics (for example, macro- and micro-invertebrates, fecal coliform, and plant and animal species).

Standard 6
Air quality meets State standards.

THIS MEANS THAT:

The State of Wyoming is authorized to administer the Clean Air Act. BLM management actions or use authorizations will comply with all Federal and State air quality laws, rules, regulations, and standards. Provisions for the establishment of air quality standards are included in the Clean Air Act, as amended, and the Wyoming Environmental Quality Act, as amended. Regulations are found in Part 40 of the Code of Federal Regulations and in *Wyoming Air Quality Standards and Regulations*.

INDICATORS MAY INCLUDE, BUT ARE NOT LIMITED TO:

- Particulate matter;
- Sulfur dioxide;
- Photochemical oxidants (ozone);
- Volatile organic compounds (hydrocarbons);
- Nitrogen oxides;
- Carbon monoxide;
- Odors; and
- Visibility.

2.0 DEFINITIONS

Activity Plans: Allotment Management Plans (AMPs), Habitat Management Plans (HMPs), Watershed Management Plans (WMPs), Wild Horse Management Plans (WHMPs), and other plans developed at the local level to address specific concerns and accomplish specific objectives.

Coordinated Resource Management (CRM): A group of people working together to develop common resource goals and resolve natural resource concerns. CRM is a people process that strives for win-win situations through consensus-based decision-making.

Desired Plant Community: A plant community which produces the kind, proportion, and amount of vegetation necessary for meeting or exceeding the land use plan/activity plan objectives established for an ecological site(s). The desired plant community must be consistent with the site's capability to produce the desired vegetation through management, land treatment, or a combination of the two.

Ecological Site: An area of land with specific physical characteristics that differs from other areas both in its ability to produce distinctive kinds and amounts of vegetation and in its response to management.

Erosion: (v.) Detachment and movement of soil or rock fragments by water, wind, ice, or gravity. (n.) The land surface worn away by running water, wind, ice, or other geological agents, including such processes as gravitational creep.

Indicator: An indicator is a component of a system whose characteristics (for example, presence, absence, quantity, and distribution) can be observed, measured, or monitored based on sound scientific principles. An indicator can be evaluated at a site- or species-specific level. Monitoring of an indicator must be able to show change within timeframes acceptable to management and be capable of showing how the health of the ecosystem is changing in response to specific management actions. Selection of the appropriate indicators to be observed, measured, or monitored in a particular allotment is a critical aspect of early communication among the interests involved on-the-ground. The most useful indicators are those for which change or trend can be easily quantified and for which agreement as to the significance of the indicator is broad based.

Litter: The uppermost layer of organic debris on the soil surface, essentially the freshly fallen or slightly decomposed vegetal material.

Management Actions: Management actions are the specific actions prescribed by the BLM to achieve resource objectives, land use allocations, or other program or multiple use goals.

Objective: An objective is a site-specific statement of a desired rangeland condition. It may contain either or both qualitative elements and quantitative elements. Objectives frequently speak to change. They are the focus of monitoring and evaluation activities at the local level. Monitoring of the indicators would show negative changes or positive changes. Objectives should focus on indicators of greatest interest for the area in question.

Rangeland: Land on which the native vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs. This includes lands revegetated naturally or artificially when routine management of that vegetation is accomplished mainly through manipulation of grazing. Rangelands include natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, and wet meadows.

Rangeland Health: The degree to which the integrity of the soil and ecological processes of rangeland ecosystems are sustained.

Riparian: An area of land directly influenced by permanent water. It has visible vegetation or physical characteristics reflective of permanent water influence. Lakeshores and stream banks are typical riparian areas. Excluded are such sites as ephemeral streams or washes that do not have vegetation dependent on free water in the soil.

Standards: Standards are synonymous with goals and are observed on a landscape scale. Standards apply to rangeland health and not to the important by-products of healthy rangelands.

Standards relate to the current capability or realistic potential of a specific site to produce these by-products, not to the presence or absence of the products themselves. It is the sustainability of the processes, or rangeland health, that produces these by-products.

Terms and Conditions: Terms and conditions are very specific land use requirements that are made a part of the land use authorization in order to assure maintenance or attainment of the standard. Terms and conditions may incorporate or reference the appropriate portions of activity plans (for example, Allotment Management Plans). In other words, where an activity plan exists that contains objectives focused on meeting the standards, compliance with the plan may be the only term and condition necessary in that allotment.

Upland: Those portions of the landscape which do not receive additional moisture for plant growth from run-off, stream flow, etc. Typically these are hills, ridge tops, valley slopes, and rolling plains.

APPENDIX B. DEVELOPMENT AND OPERATION PROCEDURES TECHNICAL SUPPORT DOCUMENT

1.0 ACRONYMS AND ABBREVIATIONS

APD	Application for Permit to Drill
AQD	Air Quality Division
BACT	Best Available Control Technology
bbl	barrels
Bcf	billion cubic feet
BLM	Bureau of Land Management
CFR	Code of Federal Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COA	Condition of Approval
DR	Decision Records
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
gal	gallons
LOP	life-of-project
LQD	Land Quality Division
MMcf	million cubic feet
MMcfpd	million cubic feet per day
NEPA	National Environmental Policy Act of 1969
NTC	Notice to Lessees
Operators	oil and gas development companies
OSHA	Occupational Safety and Health Administration
OVM	organic vapor meter
ppm	parts per million
ROW	right-of-way
SWPPP	Storm Water Pollution Prevention Plan
SCADA	Supervisory Control and Automated Data Acquisition
Tcf	trillion cubic feet
TDS	total dissolved solids
TRPH	total recoverable petroleum hydrocarbons
VOC	volatile organic compound
WDEQ	Wyoming Department of Environmental Quality
WDOT	Wyoming Department of Transportation
WOGCC	Wyoming Oil and Gas Conservation Commission
WQD	Water Quality Division
WSEO	Wyoming State Engineer's Office

2.0 INTRODUCTION

This technical support document provides a general summary of the Moxa Arch Area Infill Gas Development Project and includes a Transportation Plan, Reclamation Plan, and Hazardous Materials Summary. These documents are provided in support of the *Moxa Arch Area Infill Gas Development Project Environmental Impact Statement* (EIS). It is not the intent of this document to establish specific procedures for the implementation of the Project, but rather to assist in the analysis of alternatives. Specific conditions of approval, operating procedures, etc., will be established in the Record of Decision when the selected alternative is developed.

This document identifies differences in development actions among alternatives. In any instance where this document might seem to conflict with the EIS, the EIS will take precedence.

3.0 PROJECT DEVELOPMENT

Drilling and development operations would, in most areas, continue year-round, unless prohibited by Standard Stipulations for Surface Disturbing Activities (Appendix A). Drilling would occur at the rate of approximately 186 wells per year over a 10-year period. However, the BLM will not specifically regulate the pace of development within the MAA.

3.1 Traffic Access

Access routes to the Project Area will include I-80 in the south, U.S. Highway 30 through the center, U.S. Highway 189 in the northwest, and State Highway 372 in the northeast. Access within the Project Area boundary will be via the existing road network, which consists of arterial roads and individual well access roads.

3.2 Workovers

Periodically, a workover on a well may be required. A well-servicing rig is generally used during workover operations to perform tasks such as well bore or surface equipment repairs, reservoir evaluation, formation evaluation by wireline, or stimulation treatments to restore or enhance well performance. Workover operations are typically performed during daylight hours and are of short duration; however, depending on the scope of work to be performed, workover operations can sometimes require several days to several weeks to complete. Unless fracture stimulation is necessary, workover operations would typically require from 5 to 10 workers on location at any given time. During fracture treatments, an additional 10 to 20 individuals may be on site. Additional surface disturbance is rarely necessary to conduct workover operations; however, temporary pits may occasionally be used to store fluids. Approval from the BLM Authorized Officer (AO) would be requested should the need for new surface disturbance arise.

3.3 Preconstruction Planning and Site Layout

Pursuant to *Onshore Oil and Gas Order No. 1* and BLM regulation 42 *Code of Federal Regulations* (CFR) § 3162.3-1, each proposed well would require an Application for Permit to Drill (APD), approved by the BLM, prior to any surface disturbance. Each APD would include site-specific information regarding all aspects of well development, including environmental concerns.

Operators and/or their contractors and subcontractors would conduct all phases of project implementation (e.g., well pad construction, road and pipeline construction, drilling and completion operations, maintenance, reclamation, and abandonment) in full compliance with all applicable federal, state, and county plans, laws, and regulations, and according to approved APD specifications, right-of-way (ROW) permits, and potentially site-specific Environmental Assessments (EAs) and Decision Records (DRs). Pursuant to section 390 of the Energy Policy Act of 2005, Pub. L. No. 109-58, § 390(b)(3), 119 Stat. 747-48 (2005), the BLM may exclude from NEPA documentation the approval of individual APDs within a developed field when a NEPA document, such as the EIS for the Moxa Arch Area Infill Gas Development Project, has been prepared. Operators would be fully accountable for their contractors' and subcontractors' compliance with the requirements in the approved permits and/or plans.

If development of federal minerals occurs on private surface, Operators will follow *Onshore Oil and Gas Order No. 1* and CFR 43 Subpart 3814, if applicable, with regard to access for natural gas resource development and remuneration to the landowner for potential damage.

3.4 Construction Operations

3.4.1 Surveying and Notice of Staking or Application for Permit to Drill

Prior to construction activities, the Operators will:

- Submit site-specific applications [Notice of Staking (NOS)/APD/Sundry Notice/ Right-of-Way (ROW) application];
- Survey and stake the location;
- Participate in an onsite evaluation;
- Submit detailed construction plans, as needed; and
- Perform cultural resource, biological, and/or other surveys, as required.

For wells on federal minerals, the Operator must obtain a permit from the BLM prior to ground disturbance activities. To initiate the permitting process, the Operator files either a NOS or an APD with the BLM. These documents are filed with the Kemmerer Field Office. The BLM processes applications to determine if they meet requirements.

A technically and administratively complete APD normally consists of a Surface Use Plan, Drilling Plan, evidence of bond coverage, and other information that may be required by the BLM. A Surface Use Plan describes construction operations, access, water supply, well site layout, production facilities, waste disposal, and restoration/revegetation or reclamation associated with the site-specific well development proposal. The Drilling Plan typically describes the technical drilling aspects of the specific proposal, including subsurface resource protection. Determination of the suitability of an Operator's design, construction techniques, and procedures is made by the BLM during the permitting process.

3.4.2 Pre-construction Activities and Construction Initiation

Prior to APD approval, but after the proposed drill pad and access road are surveyed and staked, onsite inspections are conducted to assess potential impacts, and methods to mitigate impacts and establish them as Conditions of Approval (COAs) to the APD are determined. The BLM notifies the Operator of a date, time, and meeting place to perform an onsite inspection. The objective of the onsite inspection is to review the pad location, well access road, and pipeline route in consideration of topography, location of topsoil/subsoil stockpiles, natural drainage and erosion control, flora, fauna, habitat, historical and cultural resources, paleontological resources, and any other surface issues that may become apparent during the onsite inspection. The attendees of the onsite inspection may include representatives of the Operator, a survey crew, the private landowner (if applicable), and the BLM. Survey stakes indicate the location of the new access road and the orientation of the well pad. Appropriate changes or modifications are made, if needed, to avoid or mitigate impacts to resources such as drainages, archaeological sites, threatened and endangered species, and/or big game calving areas/seasonal restrictions. Excess cut and fill and other issues are also addressed, as appropriate.

During the onsite inspection, the BLM gathers information needed to develop site-specific COAs, which are incorporated into the approved APD. These environmental protection measures address all aspects of oil and gas development, including construction, drilling, production, and reclamation and abandonment.

Construction or surface-disturbing activities will usually occur during daylight hours after approval of an APD by the BLM. Infrequent circumstances may require construction to occur outside of daylight hours. To minimize new construction, the Operators will use the existing ancillary facility infrastructure within the Project Area, where possible, including gas compression facilities, power lines, water disposal and treatment facilities, and gas gathering pipelines.

3.5 Well Pads

The traditional single-well location design has been used previously in the MAA almost exclusively and will continue to be the predominant drill site design in this proposal.

Operators will determine the site of a proposed well based on the location of the subsurface reservoir, the topography of the area, and WOGCC spacing rules. Drill pad size will depend on topography and specific well needs. Well pads will be constructed from the native sand/soil/rock materials present. Mineral materials will not be required. Topsoil and native vegetation will be removed and stockpiled for use in the reclamation process. Locations will be leveled by balancing cut and fill areas. Construction practices may include blasting (required when bedrock is near the surface) or ripping to achieve a level pad. Cut-and-fill slopes will allow for retention of the topsoil during reclamation and subsequent re-establishment of vegetation.

Typically, a well pad will include a 6- to 8-foot-wide cellar to allow access to casing heads, and mouse and rat holes adjacent to the well bore to accommodate drilling operations, a flare pit, and a reserve pit. A fenced reserve pit, approximately 10 to 12 feet deep, will be excavated within the pad to temporarily store drilling fluids, cuttings, and produced water. The dimensions of the pit vary according to well depth and size and shape of location. In non-environmentally sensitive areas, and when a fresh-water-based drilling mud is used, the reserve pit may be unlined pending completion of a soils survey that includes evaluation of the distance to surface water, depth to useable ground water, soil type and permeability, and types of fluids potentially contained in the pit. A reserve pit will be lined, if so specified in the APD, after the onsite evaluation. It will also be constructed to minimize accumulation of surface runoff into the pit through the use of strategically placed subsoil/topsoil storage areas and/or the construction of berms and diversion ditches.

Both the access road and well pad are typically constructed within 3 to 7 days, depending on terrain and site limitations. Depending on availability of equipment and specific well construction requirements, 2 to 8 individuals may be on site at any given time during construction activities. Personnel will access the site using an average of 3 light trucks each day during construction of the access and well pad. Construction equipment may include bulldozers, motor graders, scrapers, backhoes, and trenchers.

A single well pad size will vary depending on the size of the drilling rig used, but will average approximately 2.75 acres based on a 300 x 400-foot drilling site. Long-term disturbance will be the amount of surface remaining on the well pads after reclamation of the reserve pit and other areas unnecessary for ongoing and future operations. After interim reclamation, long-term disturbance associated with an average well pad will be approximately 1.0 acre.

The traditional single-well location design has been previously used in the MAA almost exclusively and will continue to be the predominant drill site design in this proposal.

3.6 Roads

The BLM and the Operators are cooperatively developing long-term management plans (Transportation Plans) for existing and future roads, which are intended to minimize resource conflicts and development costs within the Project Area. Plan objectives are to:

- Facilitate identification of roads not needed for operations;
- Maximize use of the existing road system;

- Minimize the number of loop roads;
- Minimize the crossing of side slopes greater than 40 percent;
- Minimize profile grades; and
- Minimize drainage crossings, with emphasis placed on drainages with potentially large runoff flows and floodplains.

The new roads are expected to cross federal, state, and private surfaces. The exact location of well access roads will be determined at the onsite inspection with the appropriate surface management agency.

New roads may be built in order to move a drill rig and well-service equipment from one site to another and to allow access to each site. The BLM has developed road construction standards in its *Surface Operating Standards for Oil and Gas Exploration and Development, 4th Edition* (Oil & Gas Gold Book) (BLM and USFS, 2005) and in BLM Manual 9113. Construction of new roads and well sites will conform to standards described in the Gold Book. Bulldozers, graders, and other types of heavy equipment are used to construct and maintain the road system using standard cut-and-fill construction techniques. The roads are crowned and ditched, except where the BLM determines that the road can safely be constructed using less disruptive techniques. Major roads in the Project Area are normally limited to one main route that serves the leases in a geographic area, with a maintained side road (access road) to each well. The amount of surface area needed for roads is dependent on topography and type of loads to be transported. Road ROWs in the Project Area are typically 50 feet. Generally, the running surface of the main roads is 20 to 24 feet wide, and the running surface of access roads is 14 to 18 feet wide. These dimensions represent the driving surface of the road, not the maximum surface disturbance associated with ditches, back cuts, or fills. Access road lengths will vary according to the location of a specific well and its relation to the existing road network.

Roads will be built and maintained to provide year-round access. All construction materials for project access roads will consist of native borrow and soil accumulated during road construction. If required by the AO, the access road will be surfaced with gravel or crushed rock, per BLM specifications. Gravel and rock will be obtained from existing permitted or private sources, and road construction will employ standard grading techniques. Road crossings will incorporate culverts, as needed and/or required. Drainage ditches and culverts will be designed to prevent the accumulation of silt or debris and will not be blocked by the roadbed. Water will be diverted from the roadway at frequent intervals. Travel during construction will be restricted to the 50-foot ROW, unless modifications must be made to accommodate slope conditions.

Existing roads that require upgrading will meet standards appropriate to the anticipated traffic flow and all weather-related road requirements. Upgrading may include ditching, drainage, graveling, crowning, and capping the roadbed to provide a well-constructed, safe roadway. Upgrading will not occur during muddy conditions.

3.7 Drilling Operations

Drilling operations will be conducted in compliance with all federal regulations, including Oil and Gas Onshore Orders, all WOGCC rules and regulations, and all applicable local rules and regulations. The Operators anticipate that the drilling rig count within the Project Area would range from 5 to 15 rigs, with an average of 10 rigs operating at any particular time, in order to achieve development objectives.

Following construction of the access road and well pad, a drilling rig will be transported to the well site and erected on the well pad. Wells will be drilled using a conventional mechanically powered mobile drilling rig, which will be erected at the drill site after the conductor pipe has been set. Drilling operations will typically consist of drilling surface hole, running and cementing surface casing, drilling production hole, and running and cementing production casing. Occasionally, intermediate casing will also be run. The rig will then be dismantled and removed from the site.

Fresh water used for drilling purposes will be obtained from the Blacks Fork, Hams Fork, and Green Rivers as a result of water appropriation permits from the State of Wyoming (State Engineer's Office) and from commercial or privately owned water source wells. Water may be recycled for use in drilling, completion, work over, well abandonment, and hydrostatic pipeline testing operations.

Drilling fluids will consist of a fresh water/gel mixture, with water being the main constituent. To achieve borehole stability and minimize possible damage to the gas-producing formations, certain formation-stabilizing and hole-cleaning materials may be added to the drilling fluid. No hazardous substances will be placed in the reserve pit. Reserve pits will be constructed so as not to leak, break, or allow discharge, and in accordance with APD COAs. The reserve pit will be fenced on three sides during drilling operations, and on the fourth side when the rig moves off site. Fences will be constructed according to BLM requirements and as described in Onshore Order No.7.

During drilling operations, a blow out preventor will be installed on the surface casing to prevent uncontrolled entry of reservoir fluids into the well bore, should reservoir pressures exceed the hydrostatic pressure of the well bore fluid. In addition, a flow control manifold consisting of manual and hydraulically operated valves will be installed at ground level.

Prior to setting production casing, open-hole electric and radioactive logs may be run to evaluate production potential. Until new technology becomes available, steel production casing will be run and cemented in place, in accordance with the well design and as specified in the APD and COAs. In some cases, evaluation logs may be run subsequent to setting and cementing production casing, especially in the flank area.

The types of casing used and the depths to which they are set will depend on the physical characteristics of the formations that are drilled and the pressure requirements anticipated during completion and production operations. All casing will be new or reconditioned and tested, in accordance with applicable regulations.

Duration of drilling operations on a given well can vary significantly, depending on depth and conditions encountered while drilling, but number of days on location in the Project Area can range from 10 to 20 days. Drilling operations require 8 to 10 individuals and 6 vehicles on location at any given time each day during normal operations. An additional 10 to 15 individuals and 6 vehicles would be required on location during the running and cementing of casing. Approximately 10,000 barrels of water are needed to perform drilling operations; however, when approved by the appropriate regulatory authority, some water may be conserved by the reuse of some or most of the drilling fluids in subsequent drilling operations.

The BLM, in cooperation with the WOGCC, the Operators, and the Petroleum Association of Wyoming, has issued a cementing policy for the Project Area. The policy ensures the protection of fresh water and other minerals during the drilling and production phases of well development. Wells drilled in the Project Area will adhere to one or more of the following conditions:

1. Production casing will be cemented from total depth to the surface.
2. If production casing is not cemented as described in #1, a cathodic protection system will be installed. This protection system will be designed to ensure casing protection to the shallowest of the following depths:
    a. Top of the Hilliard Shale;

   b. Below any zone with less than or equal to 10,000 parts per million of total dissolved solids; or

   c. Top of cement.

3. If an Operator elects to not follow #1 or #2, it may elect to periodically run corrosion logs on selected wells. The Operator must inform the BLM which wells the logs will be run on, what logs will be run, and at what periodic interval.

4. In addition to adhering to #1, #2, or #3, above, all wells drilled within a 6-mile buffer zone bounding the Known Sodium Leasing Area will set surface casing 100 feet into the Wasatch Formation and cement back to surface (all strings).

The BLM has the authority to modify the above requirements, as necessary. Operators can request waivers on a well-by-well basis.

4.0 COMPLETION OPERATIONS AND TESTING

A typical cased well bore in the Project Area consists of conductor pipe, surface casing, and production casing. The surface and production casing/cementing programs will be designed to isolate and protect shallower formations and aquifers from the production stream, and to minimize the potential for migration of fluids and pressure communication between formations.

Once production casing has been cemented in place, the drilling rig will be released and completion operations will commence using a well-servicing rig or coiled tubing unit. Initial completion operations may also be conducted “rigless,” using cased hole wireline equipment rather than a well servicing unit or coiled tubing unit, until such time that production tubing is installed in the well or other operational requirements dictate the use of a well-servicing rig. In general, the completion of the well will consist of perforating the production casing, productivity and/or formation pressure testing if deemed necessary, stimulation of the formation(s) utilizing hydraulic fracturing technology, flow back of fracturing fluids, flow testing to determine post fracture productivity, and installation of production equipment to facilitate hydrocarbon sales.

Hydrocarbons and water are typically quantified and flared during testing operations, which are conducted on an as-needed basis. Hydraulic fracture stimulation is required on the majority of wells in the Project Area in order to enhance productivity. Numerous combinations of fluids and proppants have been used historically in the Project Area to optimize stimulation results. Currently, the most common stimulation technique uses gelled fresh water (with CO_2 and/or N_2 frequently added for reservoir protection and enhanced flow back) and fracture proppants to provide the bridging and increased permeability necessary for productivity improvement. Sand, resin-coated sand, ceramics, or bauxite can be used in the stimulation process, depending on the design criteria of individual treatments. Gels and other chemical additives provide the fluid viscosity necessary to ensure successful stimulation. The fracturing fluid is pumped down the well bore through the perforations in the casing, and into the formation. Sufficient rate and pressure are reached to induce a fracture in the target formation. No diesel is used in this process. The proppant carried in the fluid serves as a bridge to keep the created fracture open and to provide a flow path that allows reservoir fluids to move more readily into the well bore. Water used for stimulation purposes generally comes from approved appropriations from the Green, Hams Fork, or Blacks Fork Rivers or from water supply wells. Stimulation fluids recovered during flow back and subsequent production operations are temporarily contained in the reserve pit or in tanks on location.

Post-stimulation flow tests allow for recovery of stimulation fluids and evaluation of well productivity. Duration of the tests will vary depending on individual well performance but are typically only long enough for fluid rates to drop to a level that permanent production equipment can safely process. During completion operations, flaring is avoided by routing as much gas as possible to the sales pipeline system, in order to minimize emissions to the atmosphere and conserve the resource. If gas is flared, it occurs during the flow back process. The flared gas is measured using choke nipple calculations or through a temporary flow test separator and metering facility. Flaring takes place at the end of a horizontal flow line placed at a temporary pit or at a vertical flare stack. Flaring occurs at a distance from the wellhead that ensures equipment and structure protection and personnel safety. Following the initial flow period, the well will be shut in until facilities are in place to allow the well to be placed on sales. In some cases, production facilities will be installed prior to completion in order to turn the well to sales immediately following testing. Fluids (primarily water) recovered during flow back operations are contained in the reserve pit or in tanks on location until they are disposed of at evaporation pits or disposal wells.

Completion and testing operations require 3 to 10 days to perform using 2 to 30 individuals and 1 to 20 vehicles. Approximately 2,500 barrels of water are needed to perform completion and testing operations on wells drilled to the Dakota Formation. Water needed for completion and testing operations on wells drilled to the Frontier Formation ranges from 2,500 to 5,000 barrels.

The Operator will plug and abandon wells that prove unproductive, in accordance with federal and state regulations.

5.0 INTERIM RECLAMATION

On producing wells, the reserve pit will be reclaimed, per the requirements specified in the approved APD, after the pit is dry or the fluids have been removed. Plastic liners, if used, will be handled according to BLM standards before backfilling the reserve pit. The reserve pit, the portion of the location and access road not needed for production operations, and pipeline corridors will be rehabilitated according to the requirements specified in the approved APD and COAs.

6.0 PRODUCTION FACILITIES

Well production facilities will be installed as shown on the approved APD, with secondary containment structures conforming to BLM, state, and federal requirements. Facilities on the well pad may include wellhead valves and piping; separation, dehydration, and metering equipment; oil and water production tanks; a dehydrator condensation catchment container; a methanol storage tank and pump; and telemetry equipment. Production equipment will be powered by natural gas and solar panels; power lines will not be required. Most gas will be measured electronically. Telemetry equipment is currently used or is planned for use by most Operators to improve well evaluation, operational efficiency, and to minimize well visits. Production pits will not be used.

Plunger lift equipment is typically installed to provide artificial lift when production volumes drop to a level that prevents efficient removal of liquids from the well bore using reservoir energy. Other types of artificial lift may be considered during the approval of an APD or subsequent to placing a well on production, including types that may result from new technologies.

Some reportable chemicals under the Superfund Amendments and Reauthorization Act (SARA) Title III, such as ethylene glycol and methanol, may be used during production operations. If storage of these chemicals triggers reporting requirements, reports will be filed as required by regulation.

All constructed or installed permanent structures (on site 6 months or longer) will be painted a flat, non-reflective earth-tone color, as specified by the BLM.

7.0 PIPELINES

The Operators will continue to use the several natural gas transmission lines that serve the Project Area.

Gathering lines made of steel or other durable materials will be installed below the ground surface to transport the produced gas from the new wells to the pipeline system. These gathering lines will consist of pipes with a 3- to 4-inch outside diameter. The gas production lines will be located adjacent and parallel to well access roads, where possible, to minimize surface disturbance. The exact location of a gathering line will be determined at the onsite inspection by the appropriate surface management agency. The new pipelines are expected to cross federal, state, and private surfaces in a route developed to minimize resource conflicts and development costs within the Project Area.

Pipeline construction consists of trenching, pipe stringing, bending, welding, coating, lowering pipeline sections into the trench, and backfilling. Construction operations will be confined to the ROW corridor approved in the ROW application. In general, ROW widths will be 50 feet when not adjacent to a road, and as narrow as 30 feet when adjacent to an existing or new road. The pipeline trench will be mechanically excavated with a backhoe or trencher to a minimum depth of 48 inches and a width of 18 to 20 inches. Newly constructed pipelines will be hydrostatically tested to ensure structural integrity. Drilling water may sometimes be used for hydrostatic testing. Approximately 2,700 gallons of water will be required to test one mile of 4-inch pipeline. Hydrostatic test water that is not used in drilling operations will be disposed of as approved by the BLM and/or the state. The Operators will reclaim the pipeline route as specified in the ROW authorization. Pipeline installation will result in short-term disturbance until reclamation is considered complete.

8.0 COMPRESSOR, GAS TREATMENT, AND ANCILLARY FACILITIES

The Operators will use the existing ancillary facility infrastructure within the Project Area, including power lines, water disposal and treatment facilities, and gas gathering and transmission pipelines, to the extent possible.

The existing compression infrastructure, however, is insufficient for compressing the additional gas volumes anticipated from the proposed wells. A reduction in gas gathering system pressure could also necessitate additional compression. Additional compression in the Project Area could range from 17,000 hp (horsepower) to 50,000 hp and will be added to existing compression infrastructure at central facilities in stages over the 10-year period following project implementation. Peak production is expected to occur in the tenth year after project approval. As many as three additional compressor sites (10 acres per site) could be required to accommodate the maximum anticipated compression growth.

Well site compression is practiced infrequently in the Project Area; however, some individual well site compression may be needed and will be applied for on a case-by-case basis. Installation of well site compression is expected to range from ten 125 hp± 2-stage compressors to ten 200 hp± 2-stage compressors. These compressors would be installed on the well pad at most locations, resulting in no additional disturbance; however, in a few cases, it may be necessary to expand a well pad in order to install compression at a well site. Possible additional disturbance from well pad expansion is estimated to be 10 acres.

9.0 PRODUCED WATER DISPOSAL

Produced water may be confined to a storage tank prior to transport by water hauling trucks to disposal facilities. Produced water will be disposed of via subsurface injection, surface evaporative pits, or will be used in subsequent drilling operations. Disposal facilities, including injection wells and evaporative ponds, requiring new construction are anticipated to be built outside of the Project Area.

10.0 MAINTENANCE

New wells will typically be visited daily, but possibly less frequently, after well performance has stabilized and telemetry equipment is installed.

Road travel will be restricted to the width of the running surface of the road. Maintenance on project roads during drilling and construction will be the responsibility of the Operators and will be consistent with the Transportation Plan, annual road plan, well-specific project plan, and BLM specifications. During the duration of the proposed project, the Operators will monitor the project roads and perform appropriate repairs. Repairs may be necessary to correct excessive soil movement, rutting, braiding around problem areas, and/or damage to cattle guards or gates.

11.0 ABANDONMENT AND RECLAMATION

Abandonment of the well and its facilities will be performed in compliance with applicable federal and state regulations, as well as with the COAs to the APDs. Seed mixtures applied during rehabilitation operations will comply with the specifications of the appropriate surface management agency. The Operators will cut off the casing at the base of the cellar or 3 feet below the final graded ground level, whichever is deeper, and cap the casing with a metal plate that has a minimum thickness of 0.25 inch. The cap will be welded in place with the well name and location engraved on the top. The cap will be constructed with a weep hole and placed three feet below ground level or to BLM specifications.

All surface equipment will be removed from the site. The surface will be recontoured to its original appearance, to the extent possible. Topsoil that was stockpiled during location construction will be distributed on the surface of the former location to blend the site with its natural surroundings. All surface disturbance areas will then be planted with a seed mixture of native grass and plant species, as specified by the appropriate surface management agency.

The Operators would monitor reclamation operations by performing inspections using an independent third party contractor. Reclamation performance assessment methodology will be based upon requirements of both the KFO and the State of Wyoming. The progress of interim and final reclamation efforts will be documented and submitted to the BLM and State (agencies). The Operators would provide funding for inspection and enforcement to augment and provide assistance to KFO inspection and enforcement personnel if determined necessary by the KFO.

The Operators would engage the services of reclamation professional/specialist to provide expertise/recommendations and develop a workable written reclamation strategy specifically designed for the MAA that would be provided to the BLM and State of Wyoming. The strategy will incorporate the results of the ongoing monitoring effort and would be modified, if necessary, according to the reclamation monitoring results assessment. Offsite mitigation would be considered by the Operators if necessary and reclamation monitoring indicates poor results.

12.0 HAZARDOUS MATERIALS AND WASTES

A variety of chemicals, including lubricants, paint, and additives, are used to drill and produce a well. Some of these chemicals can contain constituents that are hazardous. Hazardous materials include some greases or lubricants, solvents, acids, paint, and herbicides. Potentially hazardous substances used in the development or operation of wells will be kept in limited quantities on well sites and at the production facilities for short periods of time. Hazardous materials will not be stored at well locations during drilling operations. The transport, use, storage and handling of hazardous materials will follow the procedures specified by the Occupational Safety and Health Act and by the Department of Transportation (DOT) under 49 CFR, Parts 171–180.

No chemicals will be used that qualify as acutely hazardous materials/substances or meet the quantities criteria per BLM Manual 1703. Chemicals subject to reporting under Title III of the SARA in quantities of 10,000 pounds or more will not be used, produced, stored, transported, or disposed of annually during the drilling, completion, or operation of any well in the Project Area. In addition, no extremely hazardous substance, as defined in 40 CFR 355, in threshold planning quantities will be used, produced, stored, transported, or disposed of while producing any well.

Most wastes that will be generated at project locations are exempt from regulation by the Resource Conservation and Recovery Act (RCRA), under the oil and gas exploration and production exemption. Exempt wastes are those generated at the wellhead through the production stream and gas plant, including produced water, drilling mud, well completion/workover fluids, and soils affected by these exempt wastes. Non-exempt wastes may include spent solvents, discarded lubricants, paints, or other substances that contain hazardous materials as defined by RCRA.

Spills and releases can result in soils that are contaminated by produced water, petroleum products, or chemicals. The Operators will develop and maintain Spill Prevention Control and Countermeasure Plans for wells in the Project Area, as required by regulation.

APPENDIX C. AIR QUALITY TECHNICAL SUPPORT DOCUMENT

SECTION 1 AIR QUALITY ANALYSIS

1.1 INTRODUCTION

This draft Air Quality Technical Support Document (AQTSD) summarizes analyses performed to quantify potential air quality impacts from the proposed action and alternatives for the Moxa Arch Area (MAA) Infill Gas Development (Project). The methodologies used in the analysis were originally defined in an air quality impact assessment protocol (Modeling Protocol) prepared by the Natural Resource Group, Inc. (NRG) (2006) with input from the Bureau of Land Management (BLM) and project stakeholders. The AQTSD reviews the study methodologies and summarizes the findings of the air quality impact modeling analyses performed. The location of the MAA in south-central Wyoming required the examination of both the Project and cumulative source impacts in Wyoming, northwestern Colorado, and northeastern Utah within a defined study area (Figure 1-1). The analysis area includes the area surrounding the proposed Project Area and the following federal Prevention of Significant Deterioration (PSD) Class I areas: Bridger Wilderness Area, Fitzpatrick Wilderness Area, Grand Teton National Park, Mount Zirkel Wilderness Area, Teton Wilderness Area, Washakie Wilderness Area, and Dinosaur National Monument (Federal Class II, Colorado Class I). These areas were identified as sensitive areas of concern by project stakeholders.

Impacts analyzed include those on air quality and air quality related values (AQRVs) resulting from air emissions from: (1) project sources within the MAA; (2) non-project, state-permitted and reasonably foreseeable future action (RFFA) sources within the study domain; and (3) non-project, reasonably foreseeable development (RFD) within the study domain. Predicted pollutant concentrations were compared to applicable ambient air quality standards and PSD increments, and were used to assess potential impacts to AQRVs, including visibility (regional haze) and acid deposition.

This document is organized as follows:

- In Section 1, a list of tasks performed for the study is presented.
- In Section 2, the methods used in developing the Project emission inventory as well as the cumulative emissions are described.
- In Sections 3 and 4, respectively, descriptions of the near-field and far-field air quality and AQRV impact assessment methodologies and impacts are provided.
- In Section 5, the ozone (O_3) modeling analyses is presented.
- In Section 6, references are given.

This draft AQTSD presents results of the air quality and AQRV impacts at the far-field Class I areas as estimated by the CALPUFF modeling system. Processing of the CALPUFF modeling results for the far-field Class II areas is ongoing and will be presented, along with the regional ozone assessment, in future drafts of the AQTSD. Because of the size of the files associated with the project, cumulative emissions inventories, and the sources excluded from analysis, they are not included in this copy of the AQTSD but can be requested directly from the administrative record for the Expanded MAA Natural Gas Development Project Draft Environmental Impact Statement (DEIS) project.

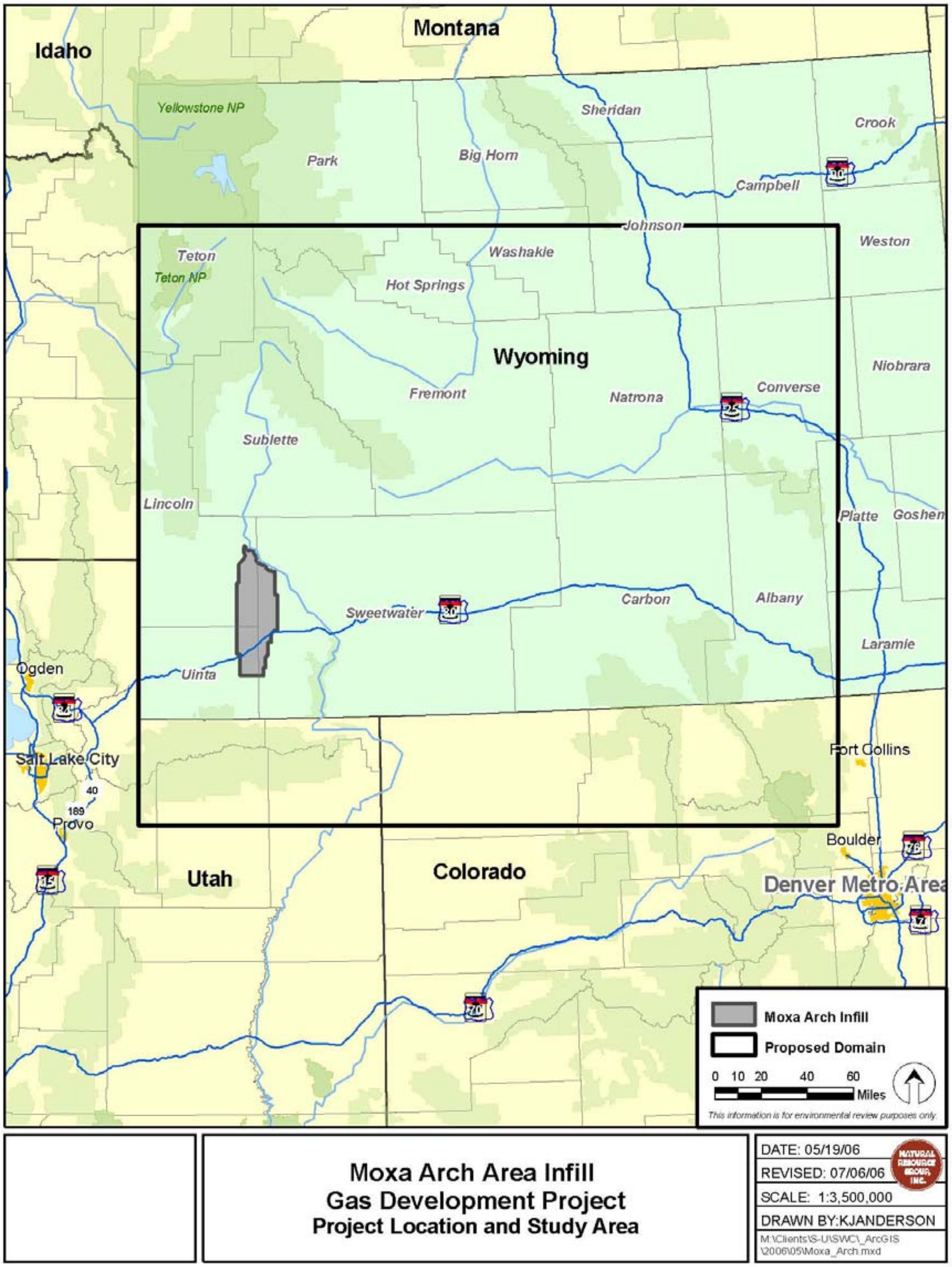

Figure 1-1. Moxa Arch Infill Drilling Project location and air quality study area.

1.2 AIR QUALITY ANALYSIS TASKS

The air quality analysis addressed the impacts on ambient air quality and AQRVs resulting from (1) air emissions from construction and production activities proposed in the MAA from all alternatives, including the No Action Alternative, and (2) air emissions from other documented regional emissions sources within the study area. Ambient air quality impacts were quantified and compared to applicable state and federal standards, and AQRV impacts (impacts on visibility [regional haze] and acid deposition) were quantified and compared to applicable thresholds as defined in the Federal Land Managers' (FLMs') Air Quality Related Values Workgroup (FLAG), Interagency Workgroup on Air Quality Modeling (IWAQM) guidance documents (FLAG 2000; IWAQM 1998), and other state and federal agency guidance.

The following tasks were performed for air quality and AQRVs impact assessment:

- *Project Air Emissions Inventory* - Development of an air pollutant emissions inventory for the Project.
- *Regional Air Emissions Inventory* - Development of an air pollutant emissions inventory for other regional sources not represented by background air quality measurements, including state-permitted sources, RFFA, and RFD.
- *Project Near-Field Analysis* - Assessment of near-field air quality concentration impacts resulting from activities proposed within the MAA.
- *Regional Near-Field Analysis* - Assessment of near-field air quality concentration impacts resulting from activities proposed within the MAA in combination with other existing and proposed regional compressor stations.
- *In-Field Cumulative Analysis* - Assessment of concentration impacts within the MAA resulting from the project and other regional sources inventoried under the “Regional Air Emissions Inventory” task above.
- *Mid-Field Cumulative Analysis* - Assessment of mid-field visibility impacts to regional communities resulting from the Project and other regional sources.
- *Far-Field Direct Project Impact Analysis* - Assessment of far-field air quality concentration and AQRV impacts resulting from proposed Project activities.
- *Far-Field Direct Project Impact Analysis* - Assessment of far-field ozone concentration impacts resulting from proposed Project activities.
- *Far-Field Cumulative Impact Analysis* - Assessment of far-field air quality concentration and AQRV impacts resulting from activities proposed within the MAA combined with other regional sources inventoried under second item above.
- *Far-Field Cumulative Impact Analysis* - Assessment of far-field ozone impacts resulting from activities proposed within the MAA combined with other regional sources inventoried under second item above.

SECTION 2 EMISSIONS INVENTORY

2.1 PROJECT EMISSIONS

The Proposed Action includes the development of up to 1,861 natural gas wells, all of which could be developed on individual well pads. Criteria pollutant and hazardous air pollutant (HAP) emissions were inventoried for construction activities, production activities, and ancillary facilities. Criteria pollutants included nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOCs), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). HAPs consisted of n-hexane; benzene, toluene, ethylbenzene, and xylene (BTEX); and formaldehyde.

All emission calculations were completed in accordance with Wyoming Department of Environmental Quality – Air Quality Division (WDEQ-AQD) oil and gas guidance (WDEQ-AQD 2001) in effect at the time the inventory was conducted, stack test data, Environmental Protection Agency's (EPA's) AP-42, or other accepted engineering methods. Additions to WDEQ-AQD Oil and Gas Production Facility Emission Control and Permitting Requirements for the Moxa Arch and Pinedale Anticline Gas Fields were approved by the Air Quality Team on July 28, 2004. The additional guidance became effective upon approval and applies to all wells reported to WOGCC after the approval date of July 28, 2004. The additional guidance revised emission control requirements and permitting process currently utilized under WDEQ-AQD Notice of Intent (NOI)/Presumptive Best Available Control Technology (P-BACT) permitting processes.

2.1.1 Construction Emissions

Construction activities are a source of primarily criteria pollutants. Emissions would occur from well pad and resource road construction and traffic, rig-move/drilling and associated traffic, completion/testing and associated traffic, pipeline installation and associated traffic, and wind erosion during construction activities. Generally, construction and drilling activities take 2-3 weeks followed by 3-5 weeks of completion, testing, and pipeline construction activities.

Well pad and resource road emissions would include fugitive PM_{10} and $PM_{2.5}$ emissions from two sources: (1) construction activities; and (2) traffic to and from the construction site. Other criteria pollutant emissions would occur from diesel combustion in haul trucks and heavy construction equipment. On resource roads, water would be used for fugitive dust control, resulting in an assumed control efficiency of 50%.

After the pad is prepared, rig-move/drilling would begin. Emissions would include fugitive dust from unpaved road travel to and from the drilling site and emissions from diesel drilling engines. Emissions from well completion and testing would include fugitive PM_{10} and $PM_{2.5}$ from traffic and emissions from haul trucks and other transport vehicles. Also, wind erosion emissions from disturbed areas would occur. During the completion phase, gas and condensate are both vented to the atmosphere and combusted (flared). Emissions from the venting of natural gas include HAPs and VOCs. Flaring emissions from the combustion of natural gas and condensate include nitrogen oxides, carbon monoxide, sulfur dioxide, VOCs, and HAPs.

Pollutant emissions would also occur from pipeline installation activities, including general construction activities, travel to and from the pipeline construction site, and diesel combustion from on-site construction equipment.

Fugitive dust (PM_{10} and $PM_{2.5}$) would occur during well pad, road, and pipeline construction due to wind erosion on disturbed areas.

Table 2-1 shows a summary of single-well construction emissions for both straight and directionally drilled wells. Construction emission calculation details will be provided in future versions of this AQTSD, including all emission factors, input parameters, and assumptions.

Table 2-1. Single-well Construction Emissions Summary for Drilled Wells.

AERMOD* Source ID	PM_{10}	$PM_{2.5}$		NO_x	SO_2		CO
	lb per hour	lb per hour	ton per year	ton per year	lb per hour	ton per year	lb per hour
Drill Rig	3.66	3.66	0.409	5.26	2.83	0.32	6.26
Flare	0.32	0.32	0.01	0.069	0.025	0.00060	15.73
Generator	0.06	0.06	0.00	0.068	0.27	0.013	1.08
Pad Construction	1.48	0.41	0.39	0.082	0.99	0.008	2.81
Compressor Construction	0.87	0.27	0.120	0.058	0.77	0.006	2.09
Roads (fugitive and exhausts)	11.52	1.63	0.17	0.12	1.12	0.014	3.77
Wind Erosion—Drill Pad	20.77	8.31	36.39	--	--	--	--
Wind Erosion---Compressor	11.33	4.53	19.85	--	--	--	--
Wind Erosion---Roads	26.44	10.57	46.31	--	--	--	--
Total Emmissions From All Sources	76.45	29.76	103.649	5.657	6.005	0.3616	31.74

*Aermod is the EPA's proposed dispersion model.

2.1.2 Production Emissions

Field production equipment and operations would be a source of criteria pollutants and HAPs, including BTEX, n-hexane, and formaldehyde. Pollutant emission sources during field production would include:

- combustion engine emissions and dust from road travel to and from well sites;
- diesel combustion emissions from haul trucks;
- combustion emissions from well site heaters;
- fugitive HAP/VOC emissions from well site equipment leaks;
- condensate storage tank flashing and flashing control;
- glycol dehydrator still vent flashing;
- wind erosion from well pad disturbed areas;
- emissions from central and wellhead compressors; and
- natural gas-fired reciprocating internal combustion compressor engines.

Fugitive PM_{10} and $PM_{2.5}$ emissions would occur from road travel and wind erosion from well pad disturbances. Criteria pollutant emissions would occur from diesel combustion in haul trucks traveling in the field during production.

Heaters required at each well site include an indirect heater, a dehydrator reboiler heater, and a separator heater. Heater emissions for all pollutants were calculated using AP-42.

HAPs and VOC emissions would occur from fugitive equipment leaks (i.e., valves, flanges, connections, pump seals, and opened lines). Condensate storage tank flashing and glycol dehydrator still vent flashing emissions also would include VOC/HAP emissions. Emissions from these sources were provided by the Operators. Total production emissions of criteria pollutants and HAPs occurring from a single well are presented in Table 2-2. Detailed production emission calculations will be provided in future versions of this AQTSD, including all emission factors, input parameters, and assumptions.

Table 2-2. Single-Well Production Emissions Summary.

	Traffic Emissions[1]		Production Emissions [2]		Total Emissions	
Pollutant	**(tpy)**	**(lb/hr)**	**(tpy)**	**(lb/hr)**	**(tpy)**	**(lb/hr)**
NO_x	0.2	---	0.171	---	0.391	--
CO	--	2.8	---	0.119	--	2.99
SO_2	2.3	0.4	0.012	0.033	2.312	0.433
PM_{10}	--	1.44	--	0.02	--	1.46
$PM_{2.5}$	0.10	0.13	0.067	0.082	0.093	0.212
VOC	0.3	0.4	3.984	1.44	4.284	1.840
Benzene	--	--	0.16	0.37	0.16	0.37
Toluene	--	--	0.545	0.124	0.545	0.124
Ethylbenzene	--	--	0.045	0.010	0.045	0.010
Xylene	--	--	0.526	0.120	0.526	0.120
n-hexane	--	--	0.073	0.017	0.073	0.017

[1] Includes emissions from all traffic associated with full-field production. PM_{10} and $PM_{2.5}$ emissions.
[2] Includes emissions from indirect heater, separator heater, dehydrator heater, and dehydrator flashing, and fugitive HAP/VOC.

For the near-field modeling discussed in Section 3, a hypothetical well pad configuration was constructed assuming maximum potential emissions. To be conservative, it was assumed that one central compressor (50,000 hp) and one wellhead compressor, which are assumed to occur every 32 wells (200 hp), could occur on the hypothetical well pad. The emissions from these two sources are shown in Table 2-3. For the far-field modeling discussed in Section 4, the central compressors and wellhead compressors were conceptually distributed across the MAA based on the density of the wells assumed in the various alternatives.

Table 2-3. Maximum Compressor Production Emissions (tpy).

Pollutant	Central Compressor	Wellhead Compressor
NO_x	482.80	1.931
CO	965.61	10.57
SO_2	0.966	.004
PM_{10}	0.573	0.128
$PM_{2.5}$	0.573	0.128
VOC	482.80	1.931

2.1.3 Total Field Emissions

Annual emissions in the MAA for the Proposed Action, Alternative A – No Action, and Alternative C and are shown in Table 2-4. The analysis assumes that emissions from Alternative B would be no greater than predicted for Alternative C. Emissions assume construction and production occurring simultaneously in the field and include one year of maximum construction emissions plus one year of production at maximum emission rates.

Construction emissions were based on well construction, drilling, drilling traffic, completion traffic, and completion flaring. Well construction emissions were based on the number of wells constructed per year and the type of well constructed. Drilling, drilling traffic, completion traffic, and completion flaring were based on the number of wells developed per year. As a conservative assumption, completion flaring operations were assumed to occur at all of the wells under construction, and compression was included. Production emissions were calculated based on the total number of producing wells in the field. Total producing wells were equal to the difference in number of wells proposed and the number of wells constructed per year.

Table 2-4. Estimated MAA Infill Drilling Project maximum annual in-field emissions summary - construction and production.

Alternative	Annual Develop-ment Rate per year	Pollutant	Annual Construction Emissions (tpy)	Total Producing wells	Annual Production Emissions (tpy)	Total Emissions (tpy)
Alternative C	207	PM_{10}	385	5,165	662	1047
		$PM_{2.5}$	143		400	543
		NO_x	847		3730	4577
		SO_2	20		26	46
		CO	240		4390	4630
		VOCs	952		13328	14281
Proposed Action	186	PM_{10}	370	1,861	64	434
		$PM_{2.5}$	186		50	236
		NO_x	1005		2473	3477
		SO_2	62		8	70
		CO	188		4341	4529
		VOCs	854		6204	7059
Alternative A -No Action	100	PM_{10}	289	100	56	345
		$PM_{2.5}$	115		18	133
		NO_x	821		301	1123
		SO_2	18		3	22
		CO	229		192	421
		VOCs	512		1393	1905

2.2 CUMULATIVE EMISSIONS INVENTORY

An emissions inventory of industrial sources within the Project's regional modeling domain was prepared for use in the cumulative air quality analysis. The modeling domain included portions of Wyoming, Colorado, Utah, and Idaho (see Figure 2-1 and Figures 4-1 and 4-2). Industrial sources and oil and gas wells permitted within a defined time frame (January 1, 2001 through June 30, 2006) through state air quality regulatory agencies and state oil and gas permitting agencies were first researched. The subset of these sources, which had begun operation as of the inventory end-date, was classified as state permitted sources, and those not yet in operation were classified as reasonably foreseeable future action (RFFA) sources. Also included in the regional inventory were industrial sources proposed under National Environmental Policy Act (NEPA) in the states of Wyoming and Colorado. The developed portions of these projects were assumed to be either included in monitored ambient background or included in the state-permitted source inventory. The underdeveloped portions of projects proposed under NEPA were classified as reasonably foreseeable development (RFD) sources. In accordance with understanding between the BLM and the Air Quality Team, RFD was defined as: (1) the NEPA-authorized but not yet developed portions of Wyoming and Colorado NEPA projects; and (2) not yet authorized NEPA projects for which air quality analyses were in progress and for which emissions had been quantified. These source categories are described in Sections 2.2.1 through 2.2.4 below.

Sources of VOC, PM_{10}, NO_X, and SO_2 emissions within the study area (the CALPUFF/CALMET modeling domain), were inventoried.

2.2.1. EXISTING INVENTORY

Emissions data for sources proposed and operating during the time period that overlaps the Project inventory time-frame and June 30, 2006 were based in part on the Jonah Infill Environmental Impact Statement (EIS), which is a recent cumulative inventory that has been completed as part of a NEPA project in southwest Wyoming. The end-date of the Jonah Infill EIS study is June 30, 2003.

2.2.2 PERMITTED SOURCES

In addition to sources inventoried as part of the Jonah Infill EIS, newly permitted and/or authorized projects through June 30, 2006 were included in the modeling. The cumulative emissions inventory for the Project included emissions sources that:

- Are located within the study area;
- Emit NO_x, SO_2, or $PM_{10}/PM_{2.5}$;
- Began operation or were permitted on or before June 30, 2006; and
- Were permitted on or after July 1, 2006, but are not yet operating (inventoried as RFFA as described in Section 2.2.4).

Actual emissions were used if a minimum of one year of actual data are available. Otherwise, potential-to-emit (maximum permitted) emission rates were used. Emissions decreases were included only if the decrease occurs at a major source and if the decrease was verifiable by WDEQ-AQD. Non-oil and gas sources operating under permit waivers were not inventoried due to their small quantities of emissions. Oil and gas waivers were examined based on emission threshold criteria. Each source was either included as a production site (3 tpy total emissions) or assumed to be included in permitted wells totals obtained for the oil and gas permitting authority. Mobile source emissions not directly resulting from the proposed action, as well as biogenic sources, urban sources, and other non-industrial emission sources, were assumed to be included in monitored background concentrations and were not included in this analysis.

2.2.3. WOGCC/COGCC/UDNR-DOGM/IOGCC Sources

A list of well drilling permits issued between June 30, 2003, and June 30, 2006 was compiled using permit data obtained from WOGCC, COGCC, UDNR-DOGM, and IOGCC. Emissions were calculated by estimating well emissions. Individual well emissions were multiplied by the number of wells installed during the study period in each county within the study area.

2.2.4. RFD and RFFA

Data for RFD and RFFA sources were used in conjunction with well drilling permit data. For the purposes of this project, RFFA was defined as a source that possesses an unexpired air permit issued on or after July 1, 2003, but is not yet operating. The primary source of RFFA information was state permit records obtained through a file data search.

RFD is defined as (1) air emissions from the undeveloped portions of authorized NEPA projects, and (2) air emissions from not-yet-authorized NEPA projects (if emissions were quantified when modeling for the MAA commenced). RFD information was obtained from final NEPA air quality analysis documents that were submitted to BLM for planned project development. Undeveloped portions of these authorized projects were obtained from BLM records tracking project development to determine total wells or other equipment yet undeveloped. For instance, for an authorized gas field development area for which 2,000 wells were projected but only 250 wells had been developed as of the inventory end-date of this study, 250 wells would be included under permitted source inventory and the remaining 1,750 would be considered RFD. RFD information from not-yet-authorized projects was obtained from contractors working on ongoing air quality analyses for NEPA projects.

Full development of proposed projects inventoried as RFD may or may not coincide with full development of the Project. As a result, the inclusion of RFD in the cumulative analysis may result in overly conservative impact estimates. To ensure "reasonable, but conservative" analysis results for all stages of Project development, the cumulative modeling analysis was performed both with and without RFD sources. A map showing NEPA RFD project areas that were examined in this study, as defined in the paragraph above is presented in Figure 2-1. All development areas were reviewed for inclusion, and those projects with significant pollutant emissions during production activities were included as RFD. To ensure a timely, complete modeling analysis, only development authorized through the inventory end-date of June 30, 2006, or quantified as of the beginning of the modeling analysis, was included in the Project analysis.

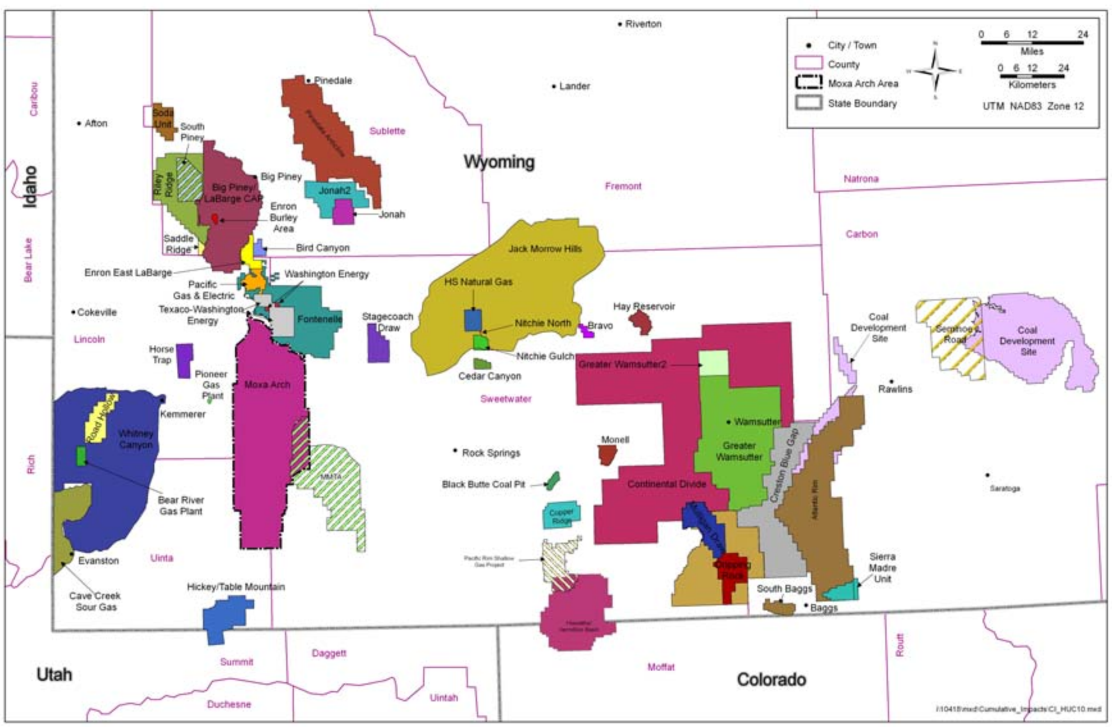

Figure 2-1. Map of the regional inventory area and NEPA project areas.

SECTION 3 NEAR-FIELD MODELING ANALYSIS

3.1 MODELING METHODOLOGY

A near-field ambient air quality impact analysis was performed to quantify the maximum air quality impacts for criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2) and HAPs (BTEX, n-hexane, and formaldehyde) that could occur within and near the MAA. These impacts would result from emissions associated with Project construction and production activities, and are compared to applicable ambient air quality standards and significance thresholds. All modeling analyses were performed in accordance with the Modeling Protocol (NRG 2006) with input from the BLM and members of the Air Quality Team, including the EPA, Forest Service, and WDEQ-AQD.

The EPA's recommended guideline dispersion model (EPA 2005) for near-source impacts, AERMOD (version 02222), was used to assess near-field impacts of criteria pollutants PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, and to estimate short-term and long-term HAP impacts. This version of AERMOD uses the PRIME building downwash algorithms which are the most recent "*state of science*" algorithms for modeling applications where aerodynamic building downwash is a concern. One year of meteorological data was used with the AERMOD dispersion model to estimate these pollutant impacts. Various construction and production activities were modeled to provide for a complete range of impacts for different alternatives and activities. To model the magnitude and duration of emissions from each Project phase (i.e., construction or production), emissions activity was examined to determine the maximum emissions scenario for each pollutant. Representative scenarios of construction and development were developed to maximize any potential impacts. For example, although the Project proposes to use existing compression capacity in the area, a large central compressor with one wellhead compressor nearby was assumed in the near-field analysis.

3.2 METEOROLOGICAL DATA

One year of surface meteorological data, collected in the Jonah area from January 1999 through January 2000, was used in the analysis. A wind rose for these data is presented in Figure 3-1.

The Jonah meteorology data included hourly surface measurements of wind speed, wind direction, standard deviation of wind direction (sigma theta), and temperature. These data were processed using the AERMET preprocessor to produce a dataset compatible with the AERMOD dispersion model. AERMET was used to combine the Jonah surface measurements with twice daily upper-air meteorological sounding data from Riverton, Wyoming cloud cover data collected at Big Piney, Wyoming, and solar radiation measurements collected at Pinedale, Wyoming.

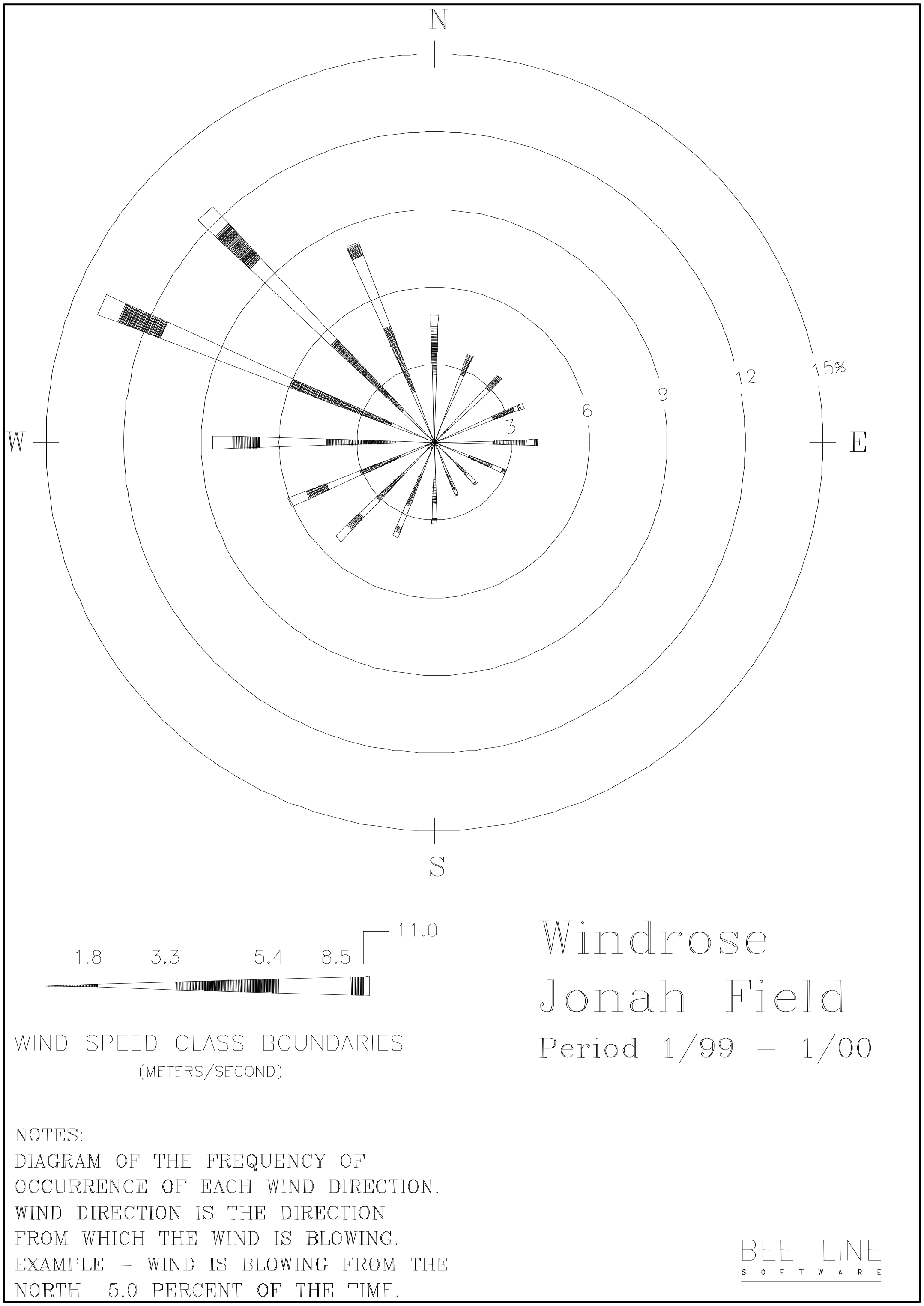

Figure 3-1. Wind Rose for use in near-field modeling for the Project.

3.3 BACKGROUND POLLUTANT CONCENTRATIONS

Background concentration data collected for criteria pollutants at regional monitoring sites were added to concentrations modeled in the near-field analysis to establish total pollutant concentrations for comparison to ambient air quality standards. Table 3-1 shows the most representative monitored regional background concentrations available for criteria pollutants as recommended by WDEQ-AQD in an e-mail from Darla Potter (WDEQ-AQ) to Michele Easley (BLM) dated August 8, 2006.

Table 3-1. Near-Field Analysis Background Ambient Air Quality Concentrations (Micrograms per Cubic Meter [μg/m^3]).

Pollutant	Averaging Period	Measured Background Concentration
CO[1]	1-hour 8-hour	2,229 1,148
NO_2[2]	Annual	3.4
O_3[3]	1-hour 8-hour	169 147
PM_{10}[4]	24-hour Annual	48 25
$PM_{2.5}$[4]	24-hour Annual	15 5
SO_2[5]	3-hour 24-hour Annual	29 18 5

1 Data collected at Rifle and Mack, Colorado, in conjunction with proposed oil shale development during 1980's (Colorado Deparment of Public Health and Environment [CDPHE] 1996).
2 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (Air Resource Specialists [ARS] 2002).
3 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).
4 Data collected by WDEQ/AQD at Rock Springs, Wyoming for 2005.
5 Data collected at Craig Power Plant site and oil shale areas from 1980-1984 (CDPHE 1996).

3.4 CRITERIA POLLUTANT IMPACT ASSESSMENT

The near-field criteria pollutant impact assessment was performed to estimate maximum potential impacts of PM_{10}, $PM_{2.5}$, NO_2, SO_2, and CO from project emissions sources including well site and compressor station emissions. Maximum predicted concentrations in the vicinity of project emissions sources were compared with the Wyoming Ambient Air Quality Standards (WAAQS), Colorado Air Quality Standards (CAAQS), National Ambient Air Quality Standards (NAAQS), and applicable PSD Class II increments, as shown in Table 3-2. This analysis compared potential air quality impacts from Project alternatives to applicable ambient air quality standards and PSD increments. The comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and do not represent a regulatory PSD increment comparison. Such a regulatory analysis is the responsibility of the state air quality agency (under EPA oversight) and would be conducted during the permitting process.

Table 3-2. Ambient Air Quality Standards and Class II PSD Increments for Comparison to Near-Field Analysis Results (µg/m[3]).

Pollutant/Averaging Time	Ambient Air Quality Standards				PSD Class II Increment	Class II Significance Level
	National	Wyoming	Colorado	Utah and Idaho		
Carbon monoxide (CO)						
1-hour	40,000	40,000	40,000	40,000	--	2,000
8-hour	10,000	10,000	10,000	10,000	--	500
Nitrogen dioxide (NO_2)						
Annual	100	100	100	100	25	1
Ozone (O_3)						
1-hour	235	235	235	235	--	--
8-hour	157	157	--	157	--	--
PM_{10}						
24-hour	150	150	150	150	30	5
$PM_{2.5}$						
24-hour	35	35	--	65	NA	--
Annual	15	15	--	15	NA	--
Sulfur dioxide (SO_2)						
3-hour	1,300	1,300	700[5]	1,300	512	25
24-hour	365	260	100[5]	365	91	5
Annual	80	60	15[5]	80	20	1

The EPA's proposed guideline dispersion model, AERMOD, was used to model the near-field concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2. AERMOD was run using one year of AERMET preprocessed meteorology data following all regulatory default switch settings. Because PM_{10}, $PM_{2.5}$, NO_2, and SO_2 emissions would be present during both the access road/well pad construction phase of field development and the production phase, these emissions sources were modeled under both scenarios to determine compliance with the PM_{10}/ $PM_{2.5}$ WAAQS and NAAQS. Carbon monoxide and NOx emissions, primarily from compressor stations, would be greatest during well production.

3.4.1 Construction Emissions

Maximum localized PM_{10}/$PM_{2.5}$, CO, NO_2, and SO_2 impacts would result from well pad and road construction activities and from wind. A conservative case assumption was made to locate a central compressor station nearby. Model receptors were placed at 100-meter (m) intervals beginning 200 m from the edge of the well pad and road. Flat terrain was assumed for each modeling scenario. Figure 3-2 presents the configurations used to model each well pad and resource road scenario. Volume sources were used to represent emissions from roads, and area sources were used for pads and compressor construction areas. AERMOD was used to model each scenario 12 times, once at each of twelve 30º rotations, to ensure that impacts from all directional layout configurations and meteorological conditions were assessed. Wind erosion emissions were modeled for all hours where the wind speed exceeded a threshold velocity defined by emissions calculations performed using AP-42 Section 13.2.5, Industrial Wind Erosion (EPA 2004).

Table 3-3 presents the maximum modeled PM_{10}/$PM_{2.5}$ concentrations for each well pad scenario. When the maximum modeled concentration was added to representative background concentrations, it was demonstrated that PM_{10} and $PM_{2.5}$ concentrations for all scenarios comply with the WAAQS and NAAQS for criteria pollutants modeled and proposed standards for $PM_{2.5}$. (Note: The second highest value was used for the newly proposed 24 hour $PM_{2.5}$ standard. In some of the scenarios the highest value exceeded the standard, but the proposed standard is applicable for those exceedance values that are over the 98 percentile of 24-hour $PM_{2.5}$ concentrations averaged over 3 years. Therefore, the second high gives more than an appropriate cushion for compliance.)

Emissions associated with temporary construction activities do not consume PSD Increment; therefore, temporary PM_{10} emissions from well pad and road construction are excluded from increment consumption analyses.

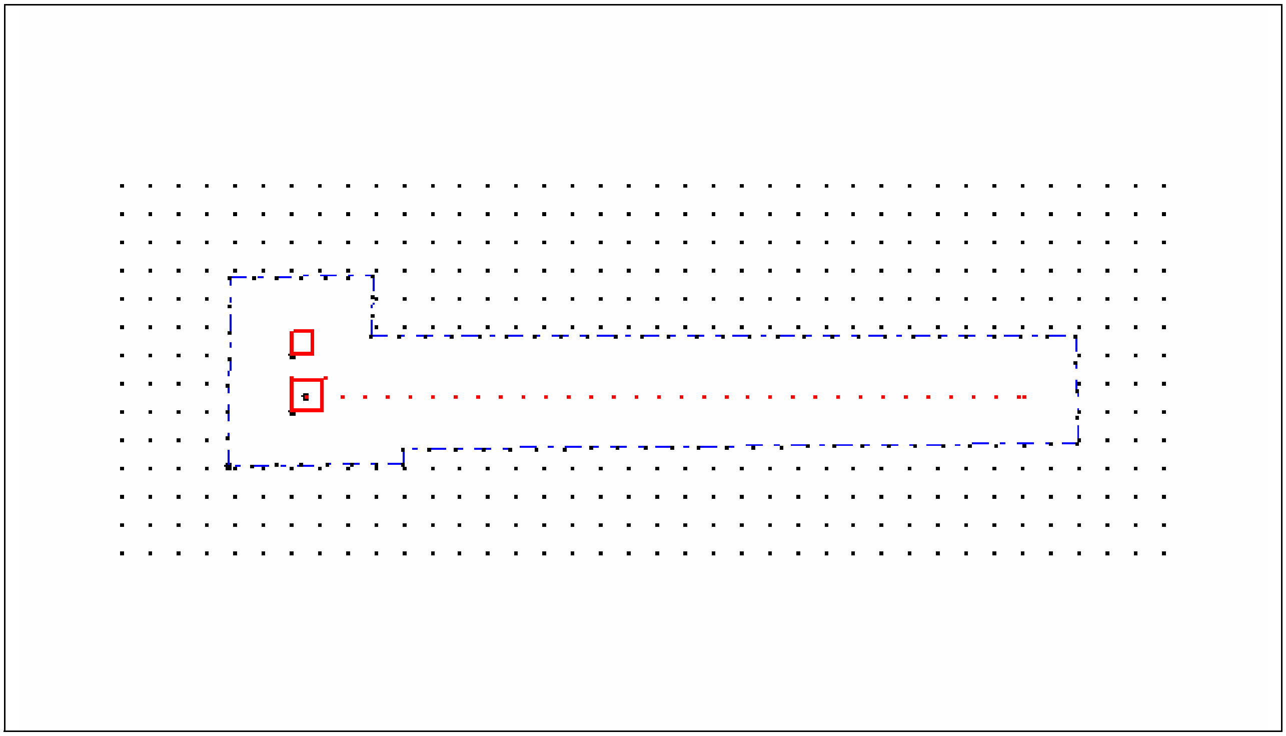

Figure 3-2. Representative Receptor Grid for Construction Emissions (fence line in blue, red boxes and dots are locations of area/volume and point source emissions).

Table 3-3. Maximum Modeled Construction Concentrations, MAA Infill Drilling Project.

Pollutant	Averaging Time	Modeled Value ug/m3	Background Value ug/m3	Total Value ug/m3	WAAQS NAAQS ug/m3	Compliance
$PM_{2.5}$[1]	24 hr	16.7	15	32	35	Y
$PM_{2.5}$	annual	0.86	7.8	9	15	Y
PM_{10}[2]	24 hr	54.4	48	102	150	Y
PM_{10}	annual	2.77	25	28	50	Y
NO_x	annual	1.66	3.4	5	100	Y
CO[2]	1 hr	4,304	2,229	6,533	40,000	Y
CO[2]	8 hr	599	1,148	1,747	10,000	Y
SO_2[2]	3 hr	522	29	551	1300	Y
SO_2[2]	24 hr	81.9	18	100	260	Y
SO_2	annual	0.1	5	5	80	Y

[1] New $PM_{2.5}$ standard used. Because the standard applies to the 98% of 24 hour concentrations measured over a three year average, the second modeled maximum was used

[2] Second highest value was used because the value is not to be exceeded more than once per year

3.4.2 Production Emissions

Emissions from production activities (well site and compression) would result in the maximum near-field PM_{10}/ $PM_{2.5}$, SO_2, NO_2, and CO concentrations. Analyses were performed to quantify the maximum NO_2 impacts that could occur within and near the MAA using the emissions from the existing in-field compressor station and well emissions, anticipated future compression expansions, and proposed Project alternatives. Proposed well emissions include those from well site heaters, truck traffic, and from a water disposal well engine. Although no increases to compression are proposed as part of the Project, a central compressor station was placed in the modeling area as a conservative assumptions.

The AERMOD model is considered appropriate only out to 50 kilometers (km). The MAA, however, exceeds that distance and, as such, a unique modeling approach had to be developed. Modeling analyses were performed to estimate near-field criteria pollutant concentrations for the Proposed Action, Alternative A, and Alternative C. Alternative B was not specifically modeled but results would be expected to be the same or less as for Alternative C. Figures 3-4 through 3-6 illustrate all components of modeled alternatives. For the Proposed Action, the well spacing was 12 wells per square mile (Figure 3-4). The well spacing was 8 wells per square mile for the No Action alternative (Figure 3-5). The well spacing was 16 wells per square mile for Alternative C (Figure 3-6). These spacing requirements represent the maximum number of wells expected for each scenario.

A representative modeling area of one square mile was selected to locate the sources for each alternative. Drill rigs and compressors were identified as point sources (red dots in Figures 3-4 through 3-6) and other well production activities (heaters, flares, fugitive dust) were identified as area sources (red squares in Figures 3-4 through 3-6). Emissions provided in Section 2.1.2 for well site heaters and truck tail pipe emissions were modeled using 105-m-spaced area sources placed in a representative square mile section in the MAA. Point sources were used for modeling all compressor station emissions. To be conservative, the representative square mile was designed to be adjacent to the town of Granger.

The receptor grid points were selected every 25 m along the fence line of the compressors and every 100 m from a distance of 200 m around the area sources. The modeling domain was extended out to 50 km (the expected range of AERMOD). AERMAP was used to determine receptor height parameters from digitized elevation map (DEM) data. To define the terrain in the area surrounding Granger, 88 DEM files were used. Aerodynamic building downwash parameters were considered for each compressor station and drill rig.

The AERMOD model was used to predict maximum NO_x impacts for modeled. Maximum modeled NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with EPA's Tier 2 NO_x to NO_2 conversion method (EPA 2003a).

Maximum predicted pollutant concentrations are given in Table 3-4. As shown in Table 3-4, direct modeled pollutant concentrations from project sources are below the PSD Class II Increment for all pollutants. In addition, when these impacts are combined with representative background concentrations, they are below the applicable WAAQS and NAAQS.

Table 3-4. Maximum Modeled Production Concentrations by Alternative.

Scenario Modeled	Pollutant	Averaging Time	Modeled Value ug/m^3	Back-ground Value ug/m3	Total Value ug/m3	WAAQS NAAQS ug/m^3	Com-pliance
Alternatives B and C	$PM_{2.5}$	24 hr	18.9	15	34	35	Y
	$PM_{2.5}$	annual	1.39	7.8	9	15	Y
	PM_{10}	24 hr	100.8	48	149	150	Y
	PM_{10}	annual	3.6	25	29	50	Y
	NO_x	annual	42	3.4	60	100	Y
	CO	1 hr	2,683	2,229	4,912	40,000	Y
	CO	8 hr	1,446	1,148	2,594	10,000	Y
	SO_2	3 hr	79.3	29	108	1300	Y
	SO_2	24 hr	21.1	18	39	260	Y
	SO_2	annual	5.1	5	18	80	Y
Proposed Action	$PM_{2.5}$	24 hr	18.9	15	34	35	Y
	$PM_{2.5}$	annual	1.39	7.8	9	15	Y
	PM_{10}	24 hr	100.8	48	149	150	Y
	PM_{10}	annual	3.6	25	29	50	Y
	NO_x	annual	22.8	3.4	34	100	Y
	CO	1 hr	1,861	2,229	4,090	40,000	Y
	CO	8 hr	944	1,148	2,092	10,000	Y
	SO_2	3 hr	78.5	29	108	1300	Y
	SO_2	24 hr	17.2	18	35	260	Y
	SO_2	annual	4.2	5	9	80	Y
Alternative A – No Action	$PM_{2.5}$	24 hr	18.9	15	34	35	Y
	$PM_{2.5}$	annual	1.39	7.8	9	15	Y
	PM_{10}	24 hr	100.8	48	149	150	Y
	PM_{10}	annual	3.6	25	29	50	Y
	NO_x	annual	7	3.4	13	100	Y
	CO	1 hr	1,232	2,229	3,461	40,000	Y
	CO	8 hr	240	1,148	1,388	10,000	Y
	SO_2	3 hr	70.8	29	100	1300	Y
	SO_2	24 hr	17.5	18	36	260	Y
	SO_2	annual	3.6	5	9	80	Y

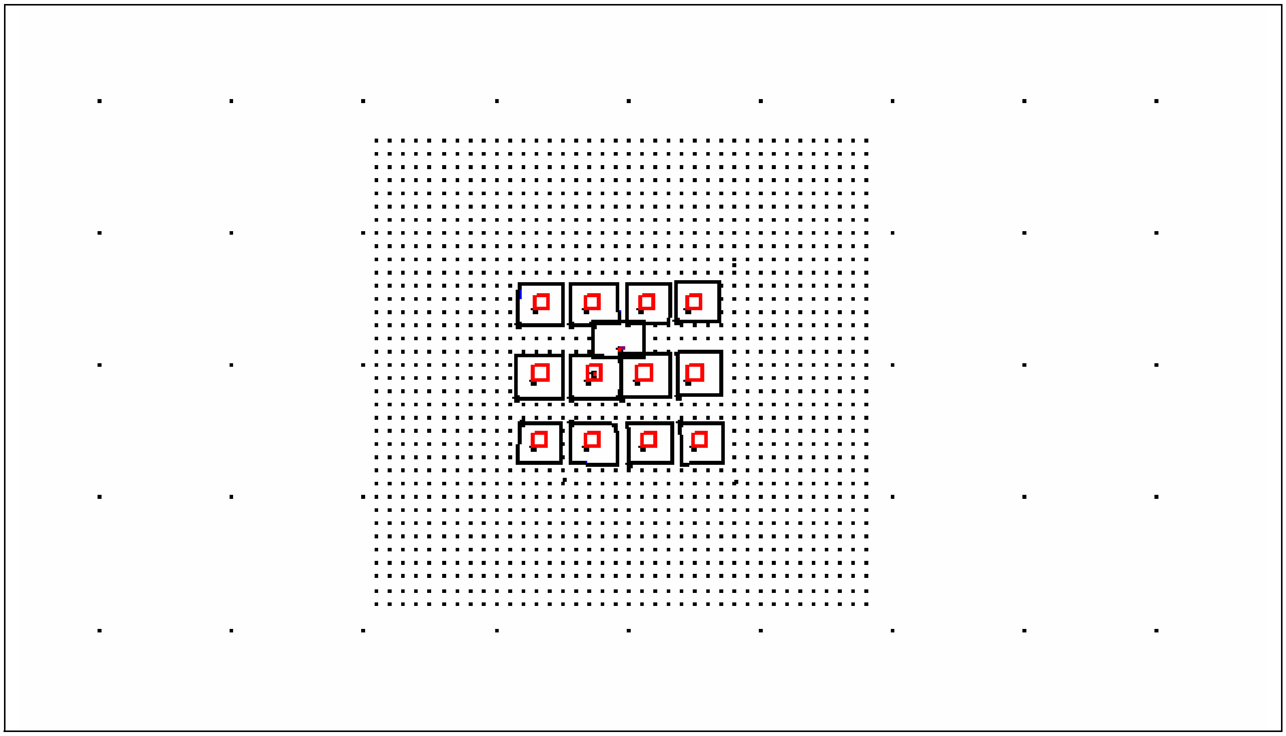

Figure 3-4. Representative receptor grid for the Proposed Action.

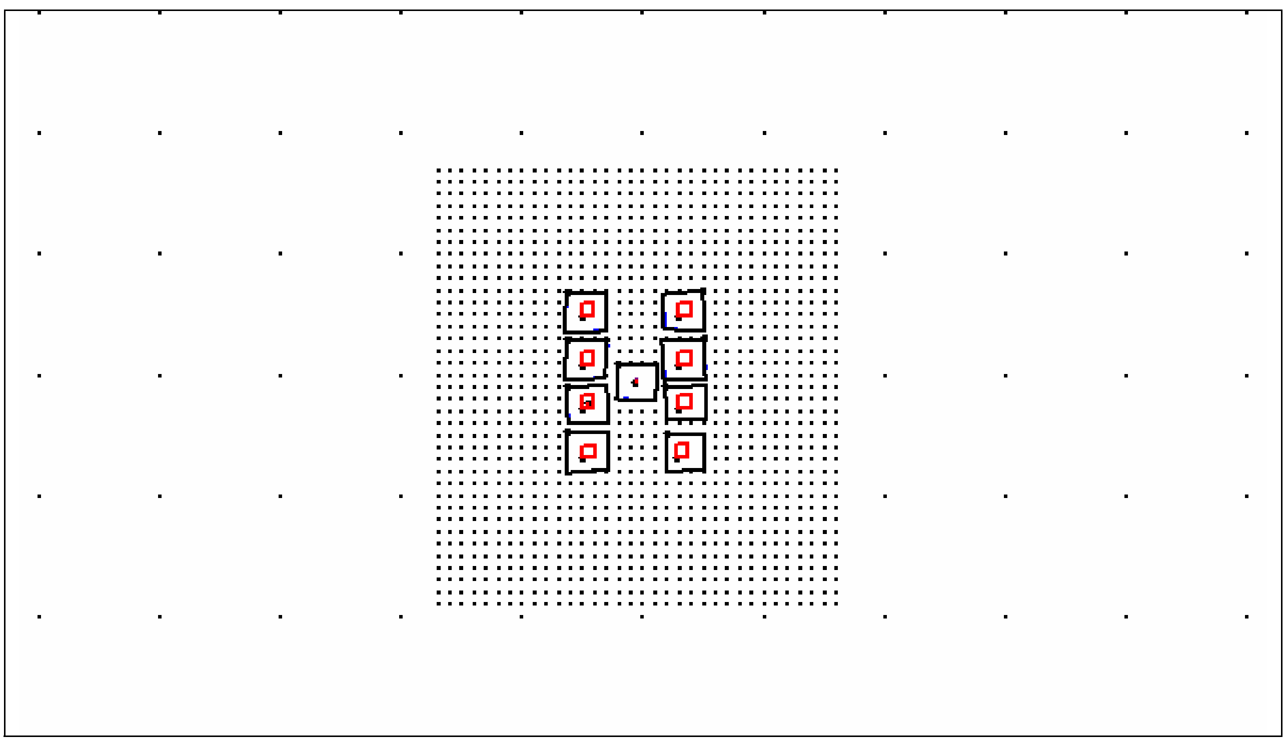

Figure 3-5. Representative receptor grid for Alternative A – No Action.

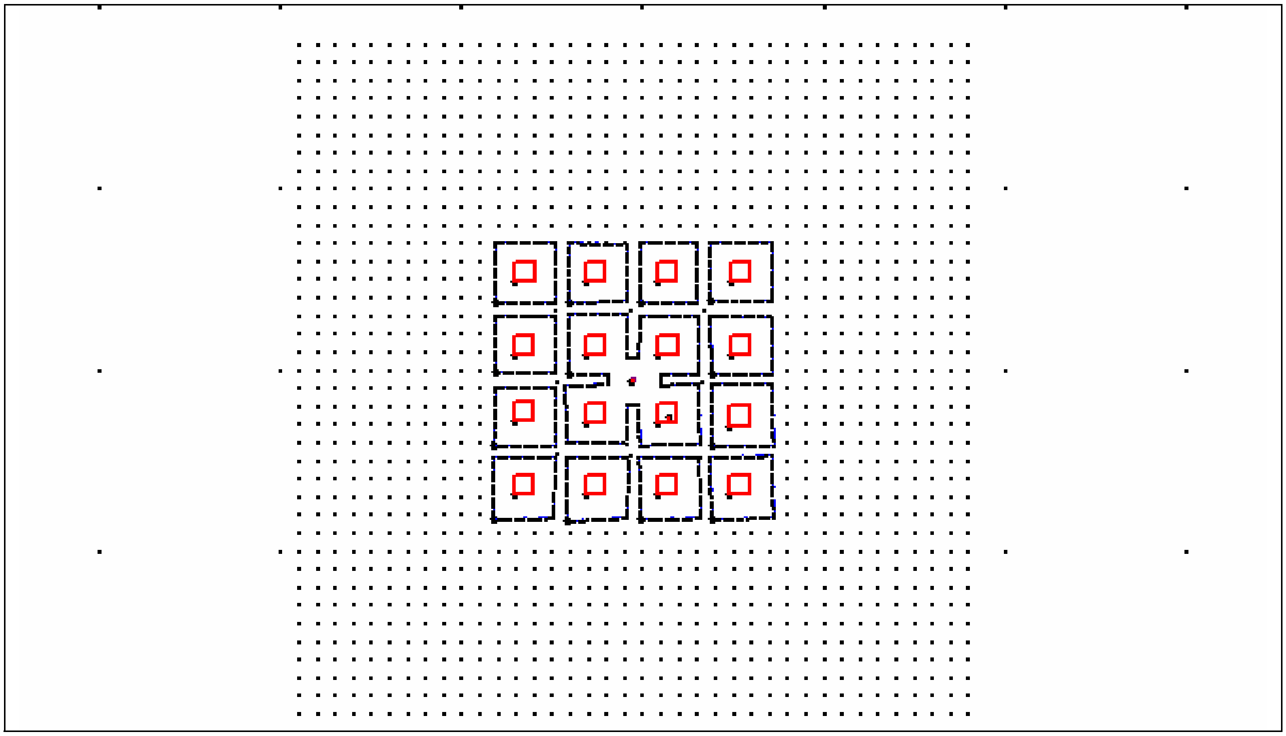

Figure 3-6. Representative receptor grid for Alternatives B and C.

3.5 HAP IMPACT ASSESSMENT

Using the same representative areas, AERMOD was used to determine HAP impacts in the immediate vicinity of the MAA emission sources for short-term (acute) exposure assessment and at the nearest residences at Granger, Wyoming to the MAA for calculation of long-term risk. Sources of HAPs include well-site fugitive emissions (BTEX and n-hexane), completion flaring and venting (BTEX and n-hexane), and compressor station combustion emissions (formaldehyde). Because maximum field-wide annual emissions of HAPs occur during the production phase, only HAP emissions from production were analyzed for long-term risk assessment. Short-term exposure assessments were performed for production HAP emissions using various well densities, and for an individual well construction completion (venting and flaring) event.

Four modeling scenarios were developed for modeling short-term (1-hour) and long term (1-year) HAPs (BTEX, and n-hexane) from well-site emissions. These scenarios were developed to represent the complete range of well densities proposed for the Proposed Action and alternatives. The purpose of modeling this range of well density was to determine the maximum HAP short-term (1-hour) impacts that could occur within and near the MAA. Area sources were used for modeling the well-site fugitive HAP emissions. The HAP emissions for wells with uncontrolled VOC emissions were used. Terrain receptors were spaced evenly at 100 m and at a maximum distance of 200 m from a well, throughout the representative section. The source and receptor layouts used for the short-term HAP modeling are presented in Figures 3-4 through 3-6.

Receptor grids using 100-m spacing were placed at the nearest residential locations along the town of Granger of the MAA. Receptor elevations were determined from U.S. Geological Survey (USGS) DEM data using AERMAP.

Reference Exposure Levels (RELs) are defined as concentrations at or below which no adverse health effects are expected. Because no RELs are available for ethylbenzene and n-hexane, the available

Immediately Dangerous to Life or Health (IDLH) values were used. These REL and IDLH values are determined by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database (EPA 2002). Modeled short-term HAP concentrations are compared to REL and IDLH values in Table 3-5. As shown in Table 3-5 the maximum predicted short-term and long term HAP impacts within and near the MAA would be below the REL or IDLH values under all Project alternatives.

Table 3-5. Maximum Modeled 1-Hour HAP Concentrations, Moxa Arch Infill Drilling Project.

Scenario Modeled	Pollutant	Averaging Time	Max Modeled Value ug/m^3	Granger Modeled Value ug/m^3	RfC Value ug/m3	REL/IDLH Value ug/m3	Com-plianc e
Alts B and C	Benzene	1 hr	16.5	7.71		1,300	Y
	Benzene	Annual	0.35	0.07	30		Y
	Ethylbenzene	1 hr	4.5	2.08		35,000	Y
	Ethylbenzene	Annual	0.1	0.02	1,000		Y
	Formaldehyde	1 hr	91.5	10.5		94	Y
	Formaldehyde	Annual	3.2	0.28	9.8		Y
	N-Hexane	1 hr	7.6	3.55		39,000	Y
	N-Hexane	Annual	0.16	0.032	200		Y
	Toluene	1 hr	55.4	25.87		37,000	Y
	Toluene	Annual	1.19	0.24	400		Y
	Xylene	1 hr	55.5	25.9		22,000	Y
	Xylene	Annual	1.15	0.23	430		Y
Proposed Action	Benzene	1 hr	14.4	10.26		1,300	Y
	Benzene	Annual	0.28	0.053	30		Y
	Ethylbenzene	1 hr	3.89	2.08		35,000	Y
	Ethylbenzene	Annual	0.08	0.015	1,000		Y
	Formaldehyde	1 hr	91.5	10.5		94	Y
	Formaldehyde	Annual	3.2	0.28	9.8		Y
	N-Hexane	1 hr	6.6	4.72		39,000	Y
	N-Hexane	Annual	0.13	0.024	200		Y
	Toluene	1 hr	48.1	34.39		37,000	Y
	Toluene	Annual	0.96	0.18	400		Y
	Xylene	1 hr	46.59	33.29		22,000	Y
	Xylene	Annual	0.93	0.175	430		Y
Alt A - No Action	Benzene	1 hr	15.2	4.1		1,300	Y
	Benzene	Annual	0.246	0.03	30		Y
	Ethylbenzene	1 hr	4.1	1.1		35,000	Y
	Ethylbenzene	Annual	0.069	0.009	1,000		Y
	Formaldehyde	1 hr	91.5	10.5		94	Y
	Formaldehyde	Annual	3.2	0.28	9.8		Y
	N-Hexane	1 hr	7	1.88		39,000	Y
	N-Hexane	Annual	0.112	0.015	200		Y
	Toluene	1 hr	51.1	13.73		37,000	Y
	Toluene	Annual	0.836	0.11	400		Y
	Xylene	1 hr	49.4	13.29		22,000	Y
	Xylene	Annual	0.809	0.109	430		Y

Additional modeling analyses with AERMOD were performed to quantify the maximum short term HAP (BTEX and n-hexane) concentrations that could potential occur from well site completion venting and flaring and compression. For wells that require these activities, it is estimated that venting operations could last up to 4 hours and flaring could last up to 80 hours. A single area source was used for modeling completion venting and flaring and a single point source was used for modeling compression. Beginning at a distance of 200 m from each source, 100-m spaced receptors were used. The results of these modeling analyses indicated that from all operations short-term HAP concentration would be below the REL or IDLH values.

Long-term (annual) modeled HAP concentrations at the nearest residence are compared to Reference Concentrations for Chronic Inhalation (RfCs). A RfC is defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. RfCs exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2002). The maximum predicted annual HAP concentrations at the nearest residential area (Granger) are compared to the corresponding non-carcinogenic RfC in Table 3-5. As shown in Table 3-5 the maximum predicted long-term (annual) HAP impacts at the nearest residence locations at Granger would be below the RfCs for all analyzed alternatives. In addition, formaldehyde impacts at Granger are shown to be below the RfC thresholds when Project source impacts are combined with regional source impacts.

Long-term exposures to emissions of suspected carcinogens (benzene and formaldehyde) were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from these pollutants, and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URF) for carcinogenic constituents

Estimated cancer risks were evaluated based on the Superfund National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1993), where a cancer risk range of 1 x 10-6 to 1 x 10-4 is generally acceptable. Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home.

The adjustment for the MLE scenario is assumed to be 9 years, which corresponds to the mean duration that a family remains at a residence (EPA 1993). This duration corresponds to an adjustment factor of 9/70 = 0.13. The duration of exposure for the MEI scenario is assumed to be 60 years (i.e., the life of project [LOP]), corresponding to an adjustment factor of 60/70 = 0.86. A second adjustment is made for time spent at home versus time spent elsewhere. For the MLE scenario, the at-home time fraction is 0.64 (EPA 1993), and it is assumed that during the rest of the day the individual would remain in an area where annual HAP concentrations would be one-quarter as large as the maximum annual average concentration. Therefore, the final MLE adjustment factor is (0.13) x [(0.64 x 1.0) + (0.36 x 0.25)] = 0.0949. The MEI scenario assumes that the individual is at home 100% of the time, for a final MEI adjustment factor of (0.86 x 1.0) = 0.86.

For each constituent, the cancer risk is computed by multiplying the maximum predicted annual concentration by the URF and by the overall exposure adjustment factor. The cancer risks for both constituents are then summed to provide an estimate of the total inhalation cancer risk.

The modeled long-term risk from benzene and formaldehyde are shown in Table 3-6 for all scenarios. For each scenario, the maximum predicted formaldehyde concentration representative of cumulative impacts was used. Under the MLE scenario, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is below 1 x 10-6 for all cases. Under the MEI analyses, for each modeling scenario, the incremental risk for formaldehyde is less than 1 x 10-6, and both the incremental risk for benzene and the combined incremental risk fall on the lower end of the cancer risk range of 1 x 10-6 to 1 x 10-4.

Table 3-6. Long-term Modeled MLE and MEI Cancer Risk Analyses, MAA Infill Drilling Project. 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.

Scenario Modeled	Pollutant	Averaging Time	Modeled Value ug/m^3	Unit Risk Value ug/m3	Exposure Adjust-ment MLE ug/m^3	Exposure Adjust-ment MEI ug/m^3	Cancer Risk MLE	Cancer Risk MEI
Alternatives B and C	Benzene	Annual	0.07	7.8E-06	0.0949	0.86	5.2E-08	4.7E-07
	Formalde-hyde	Annual	0.28	1.3E-05	0.0949	0.86	3.5E-07	3.1E-06
Proposed Action	Benzene	Annual	0.05	7.8E-06	0.0949	0.86	3.7E-08	3.4E-07
	Formalde-hyde	Annual	0.28	1.3E-05	0.0949	0.86	3.5E-07	3.1E-06
Alternative A-No Action	Benzene	Annual	0.03	7.8E-06	0.0949	0.86	2.2E-08	2.0E-07
	Formalde-hyde	Annual	0.28	1.3E-05	0.0949	0.86	3.5E-07	3.1E-06

SECTION 4 FAR-FIELD ANALYSIS

The far-field analysis quantifies potential air quality and AQRV impacts at Class I and Class II areas away from the Project due to air pollutant emissions of NOx, SO2, PM10, and PM2.5 from the development of the Project. The analyses were performed using the CALMET/CALPUFF modeling system to predict air quality impacts from the Project and cumulative sources at far-field PSD Class I and sensitive Class II areas. A separate analysis was performed to assess the effects of the Project's and cumulative sources' NO_X, VOC and CO emissions on ozone concentrations that is discussed in Section 5. The following are the Class I and sensitive Class II receptor areas analyzed in the far-field modeling:

- Bridger Wilderness Area (Class I);
- Fitzpatrick Wilderness Area (Class I);
- Grand Teton National Park (Class I);
- Mount Zirkel Wilderness Area (Class I);
- Teton Wilderness Area (Class I);
- Washakie Wilderness Area (Class I);
- Bridger Butte (Class II);
- Dinosaur National Monument (Federal Class II, Colorado Class I).
- Gros Ventre Wilderness (Class II);
- Wind River Roadless Area (Class II);

Predicted pollutant concentrations at these areas were compared to applicable national and state ambient air quality standards and PSD Class I and Class II increments and were used to assess potential impacts to AQRVs, which include visibility (regional haze) and acid (Sulfur and Nitrogen) deposition. In addition, analyses were performed for the following seven lakes designated as acid sensitive located within Class I and Class II areas to assess potential lake acidification from acid deposition impacts:

- Deep Lake in the Bridger Wilderness Area;
- Black Joe Lake in the Bridger Wilderness Area;
- Hobbs Lake in the Bridger Wilderness Area;
- Upper Frozen Lake in the Bridger Wilderness Area;
- Lazy Boy Lake in the Bridger Wilderness Area;
- Ross Lake in the Fitzpatrick Wilderness Area;
- Lower Saddlebag Lake in the Popo Agie Wilderness Area;

4.1 MODELING METHODOLOGY

The far-field ambient air quality and AQRV impact assessment quantifies the potential maximum pollutant impacts at Class I areas and sensitive Class II areas in the vicinity of the Project resulting from construction, drilling and production emissions for the proposed Project and alternatives. The study was performed in accordance with the following recent guidance sources:

- Direct guidance provided by representatives of the BLM, WDEQ-AQD, U.S. Fish and Wildlife Service (FWS), the National Park Service (NPS), and the Forest Service.
- Guideline on Air Quality Models, 40 Code of Federal Regulations (C.F.R.), Part 51, Appendix W.
- IWAQM Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts, EPA-454/R-98-019, Office of Air Quality Planning and Standards, December 1998 (IWAQM 1998).
- FLM - FLAG, Phase I Report, December 2000 (FLAG 2000).
- Memorandum from EPA on the regulatory default settings for CALPUFF modeling (Atkinson and Fox 2006).

A Modeling Protocol was prepared prior to conducting the analyses (NRG 2006) and distributed for review. The procedures in the Modeling Protocol were followed in the far-field modeling analyses, with one major exception. During the course of the study, the CALMET/CALPUFF far-field modeling assignment was transferred from NRG to ENVIRON. As ENVIRON had already developed CALMET modeling inputs for the WDEQ PSD NO_2 Increment Consumption Study (ENVIRON 2007). Therefore, rather than following the NRG Modeling Protocol to develop new CALMET modeling inputs, ENVIRON adapted the WDEQ PSD NO_2 Increment Consumption Study CALMET modeling inputs for use in the Project's far-field modeling.

As stated in the Modeling Protocol (NRG, 2006), the recently released latest version of the CALMET/CALPUFF modeling system (CALPUFF Version 6.0 dated April 14, 2006) was used to generate meteorological fields and calculate ambient concentrations and AQRV impacts for three years: 2001, 2002 and 2003.

The CALMET/CALPUFF modeling domain used in the far-field modeling is shown in Figure 4-1, along with the locations of the surface and upper-air meteorological and surface precipitation sites within and near the modeling domain. The CALMET meteorological model was run using meteorological data generated by the mesoscale meteorological (MM5) meteorological model.

Air emissions of NO_x, SO_2, PM_{10}, and $PM_{2.5}$ from production wells, construction, drilling and compressors for the various project alternatives and cumulative emissions from other sources, including all currently operating, proposed, and Reasonable Future Development (RFD) emissions sources within the modeling domain, were modeled. A description of the emissions inventory procedures is described in Section 2 of this AQTSD with the detailed inventory provided in appendices. The processing of these emissions sources for input to the CALPUFF model is described in Section 4.4.4.

CALPUFF output was post-processed with POSTUTIL and CALPOST to estimate: (1) concentrations for comparison to ambient standards and Class I and II PSD Increments; (2) wet and dry deposition amounts for comparison to sulfur (S) and nitrogen (N) deposition thresholds and to calculate acid neutralizing capacity (ANC) for sensitive water bodies; and (3) light extinction for comparison to visibility impact thresholds in Class I and sensitive Class II areas. A discussion of the post-processing methodology to be used is provided in Section 4.5.

4.2 PROJECT MODELING SCENARIOS

The Proposed Action includes a proposal for 1,861 new wells in the MAA. Maximum field-wide emissions for operation and construction were determined and reflect the last year of field development. This year is year 10 for the Proposed Action, year 25 for Alternatives B and C, and year 7 for the No Action alternative. This maximum emissions scenario conservatively assumes that both production emissions (producing well sites and operational ancillary equipment including compressor stations) and construction emissions (drill rigs and associated traffic) occur simultaneously throughout the year.

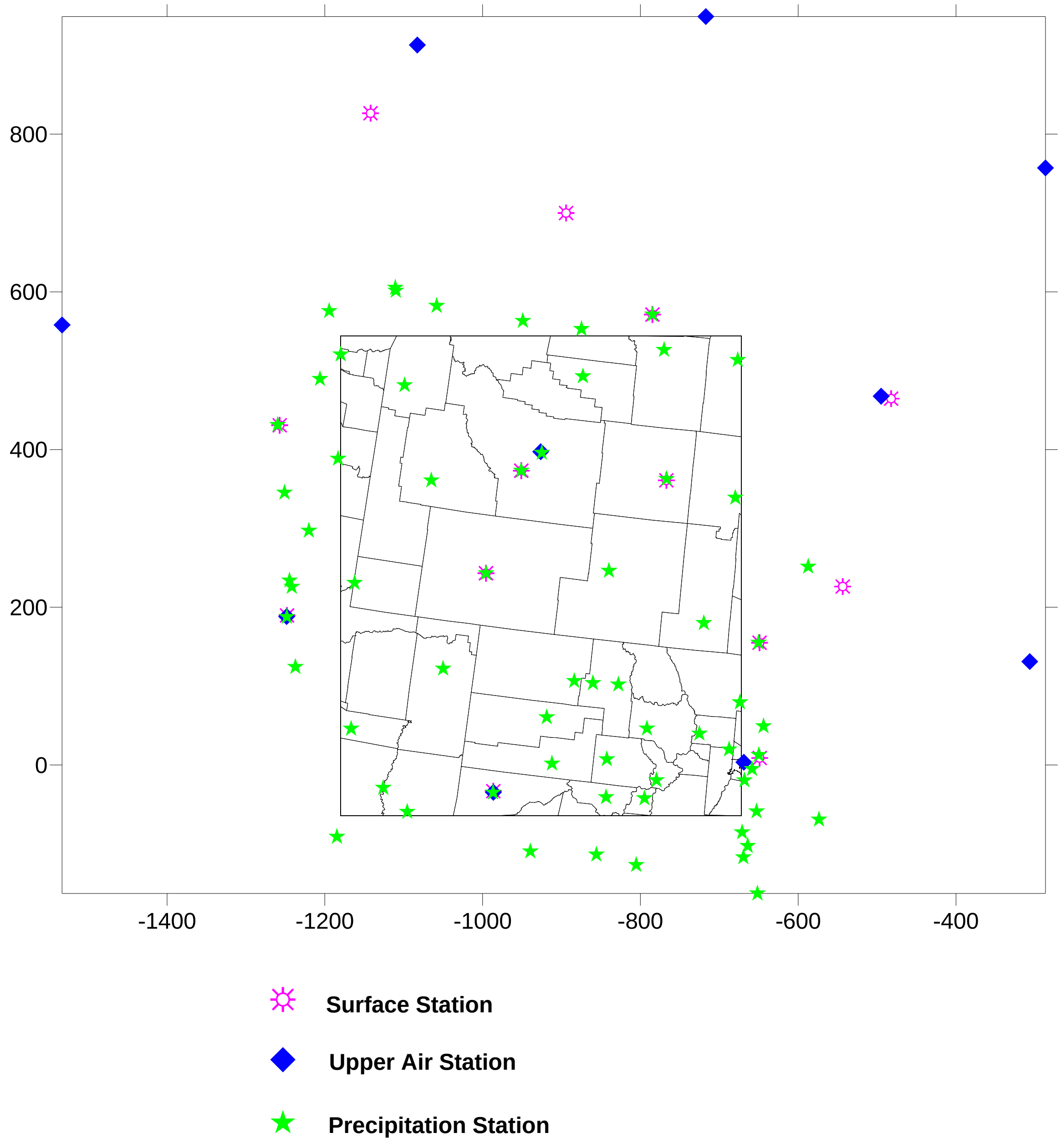

Figure 4-1. CALMET/CALPUFF domain for the Moxa Arch Infill Project showing locations of surface and upper-air meteorological and surface precipitation monitoring sites used in the modeling.

Compression was assumed to operate at 100% of fully permitted capacity. The maximum field-wide emissions scenarios for the three scenarios are summarized in Tables 2-1 through 2-4. The emissions used to develop these field-wide scenarios are described in Section 2.

4.3 METEOROLOGICAL MODEL INPUT AND OPTIONS

CALMET was used to develop wind fields and other meteorological data for the study area within the modeling domain given in Figures 4-1 and 4-2.

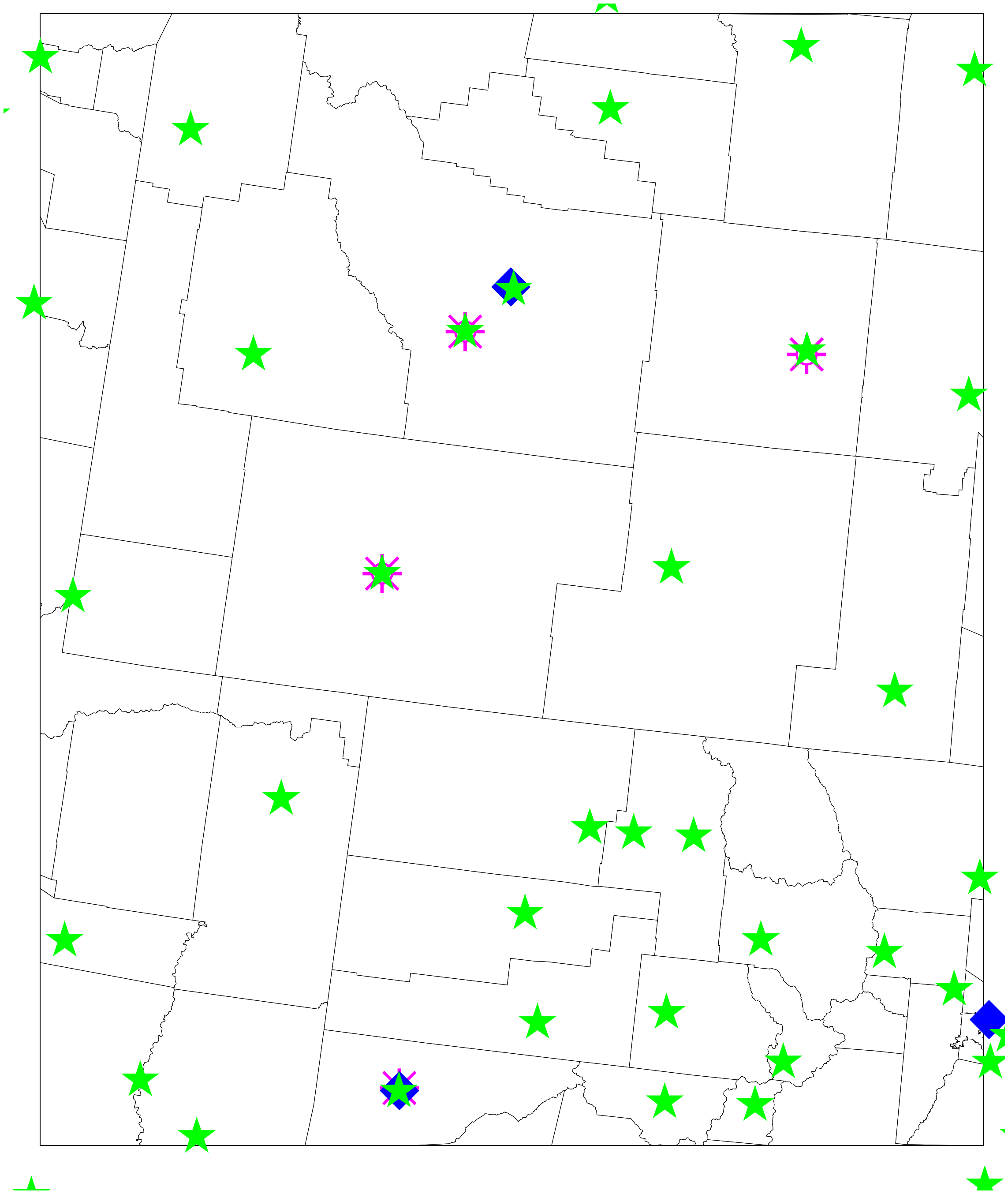

Figure 4-2. Close up of CALMET/CALPUFF domain for the Moxa Arch Infill Project showing locations of surface and upper-air meteorological data and surface precipitation data within the modeling domain. Symbols used for this figure are identical to those for Figure 4-1.

4.3.1 CALMET Geophysical and Meteorological Input Data

The CALMET modeling incorporated regional MM5 model output fields at 12 km and data from 13 surface meteorological stations, 64 precipitation stations, and 10 upper-air meteorological stations.

The uniform horizontal grid was processed to 4 km resolution using a Lambert Conformal Conical (LCC) projection defined with a central longitude/latitude at (-97°, 40°) and first and second latitude parallels at 33° and 45°. The modeling domain consists of 127 by 152 4 km grid cells, and covers the project area and Class I areas and other sensitive Class II areas with at least a 50 km buffer zone beyond the closest receptors in each receptor region. The total area of the modeling domain is 508 km by 608 km. Eleven vertical layers were specified with layer interfaces at 20 m, 100 m, 200 m, 350 m, 500 m, 750 m, 1,000 m, 2,000 m, 3,000 m, 4,000 m, 4,500 m above ground level (AGL).

The 12 km MM5 data used as input to CALMET were specified to be used as the initial guess field (IPROG=14). CALMET then performs a Step 1 procedure that includes accounting for diagnostic wind model effects using the 4 km terrain and land use data to simulate blocking and deflection, channeling, slope flows, etc. For 2001 and 2003, ENVIRON performed 12 km MM5 modeling over a domain centered on Wyoming for the WDEQ PSD NO_2 Increment Consumption Study (ENVIRON, 2007). For 2001, the 12 km MM5 simulation was run using a one-way nesting inside of a 36 km MM5 simulation of the continental U.S. domain that was performed for EPA and used in the Clean Air Interstate Rule (CAIR) development (McNally 2003). For 2003, the 12 km MM5 simulation was nested in a 2003 continental United States 36 km MM5 simulation performed by the Midwest Regional Planning Organization (Baker, 2004a,b). The 2002 12 km MM5 simulation was performed by the Western Regional Air Partnership (WRAP) to support regional haze modeling in the western United States (Kemball-Cook, et al. 2004).

In Step 2 of the CALMET modeling, CALMET incorporates the surface and upper-air meteorological observations in the Step 1 wind fields. Locations of the surface and upper-air meteorological stations and surface precipitation stations used in the analysis are shown in Figures 4-1 and 4-2.

USGS 1:250,000-Scale Land Use and Land Cover (LULC) data, and USGS 1-degree DEM data were used for land use and terrain data in the development of the CALMET wind fields.

4.3.2 CALMET Modeling Options

The CALMET modeling system has numerous options that need to be specified. These options were defined following EPA-recommended regulatory default options as given by Atkinson and Fox (2006), with some exceptions explained below. Table 4-1 lists the EPA-recommended regulatory default options and the option definitions used in this study. Deviations from EPA-recommended defaults are indicated by bold in Table 4-1 and are as follows:

- The EPA-recommended default is to not use any MM5 data (IPROG=0); whereas, for the Project's CALMET modeling, 12 km MM5 data was specified as input for all three years of modeling (IPROG=14). Use of MM5 data is believed to produce more representative CALMET meteorological fields and is encouraged by FLMS and EPA.
- The maximum mixing height for the Project's MM5 modeling is higher (4,500 m AGL) than the EPA-recommended regulatory default value (3,000 m AGL). Although a 3,000 m AGL maximum mixing height may be appropriate for the eastern U.S., mixing heights are higher in the western U.S. In their CALPUFF BART Modeling Protocol the Colorado Department of Health and Environment (2005) present evidence that higher mixing heights are needed in the West so a maximum mixing height for this study was adopted consistent with their findings.

Table 4-1. CALMET options used in the Project's far-field modeling and comparison with EPA regulatory default settings as given by Atkinson and Fox (2006) (deviations from EPA recommended defaults are indicated by bold text).

Variable	Description	EPA Default	Project Values
GEO.DAT	Name of Geophysical data file	GEO.DAT	GEO.DAT
SURF.DAT	Name of Surface data file	SURF.DAT	SURF.DAT
PRECIP.DAT	Name of Precipitation data file	PRECIP.DAT	PRECIP.DAT
NUSTA	Number of upper air data sites	User Defined	10
UPN.DAT	Names of NUSTA upper air data files	UPN.DAT	UPN.DAT
IBYR	Beginning year	User Defines	User Defines
IBMO	Beginning month	User Defines	User Defines
IBDY	Beginning day	User Defines	User Defines
IBHR	Beginning hour	User Defines	User Defines
IBTZ	Base time zone	User Defines	User Defines
IRLG	Number of hours to simulate	User Defines	User Defines
IRTYPE	Output file type to create (must be 1 for CALPUFF)	1	1
LCALGRD	Are w-components and temperature needed?	T	T
NX	Number of east-west grid cells	*ES*	127
NY	Number of north-south grid cells	User Defines	152
DGRIDKM	Grid spacing	User Defines	4 km
XORIGKM	Southwest grid cell X coordinate	User Defines	-1,180.0.
YORIGKM	Southwest grid cell Y coordinate	User Defines	-64.
IUTMZN	UTM Zone	User Defines	NA
LLCONF	When using Lambert Conformal map coordinates, rotate winds from true north to map north?	F	F
XLAT1	Latitude of 1st standard parallel	**30**	**33.**
XLAT2	Latitude of 2nd standard parallel	**60**	**45.**
RLON0	Longitude used if LLCONF = T	**90**	**-97.**
RLAT0	Latitude used if LLCONF = T	**40**	**40.**
NZ	Number of vertical Layers	User Defines	11
ZFACE	Vertical cell face heights (NZ+1 values)	User Defines	0., 20, 100, 200, 350, 500, 750, 1000, 2000, 3000, 4000, 4500
LSAVE	Save met. Data fields in an unformatted file?	T	T
IFORMO	Format of unformatted file (1 for CALPUFF)	1	1
NSSTA	Number of stations in SURF.DAT file	User Defines	13
NPSTA	Number of stations in PRECIP.DAT	User Defines	64
ICLOUD	Is cloud data to be input as gridded fields? 0=No)	0	0
IFORMS	Format of surface data (2 = formatted)	2	2
IFORMP	Format of precipitation data (2= formatted)	2	2
IFORMC	Format of cloud data (2= formatted)	2	2

Variable	Description	EPA Default	Project Values
IWFCOD	Generate winds by diagnostic wind module? (1 = Yes)	1	1
IFRADJ	Adjust winds using Froude number effects? (1= Yes)	1	1
IKINE	Adjust winds using Kinematic effects? (1 = Yes)	0	0
IOBR	Use O'Brien procedure for vertical winds? (0 = No)	0	0
ISLOPE	Compute slope flows? (1 = Yes)	1	1
IEXTRP	Extrapolate surface winds to upper layers? (-4 = use similarity theory and ignore layer 1 of upper air station data)	-4	-4
ICALM	Extrapolate surface calms to upper layers? (0 = No)	0	0
BIAS	Surface/upper-air weighting factors (NZ values)	NZ*0	NZ*0
IPROG	Using prognostic or MM-FDDA data? (0 = No)	**0**	**14**
LVARY	Use varying radius to develop surface winds?	*F*	*F*
RMAX1	Max surface over-land extrapolation radius (km)	User Defines	30.
RMAX2	Max aloft over-land extrapolations radius (km)	User Defines	60.
RMAX3	Maximum over-water extrapolation radius (km)	User Defines	60.
RMIN	Minimum extrapolation radius (km)	0.1	0.1
RMIN2	Distance (km) around an upper air site where vertical extrapolation is excluded (Set to –1 if IEXTRP = ±4)	4	4
TERRAD	Radius of influence of terrain features (km)	User Defines	10.
R1	Relative weight at surface of Step 1 field and obs	User Defines	6.0
R2	Relative weight aloft of Step 1 field and obs	User Defines	12.0
DIVLIM	Maximum acceptable divergence	5.E-6	5.E-6
NITER	Max number of passes in divergence minimization	50	50
NSMTH	Number of passes in smoothing (NZ values)	2,4*(NZ-1)	2,4*(NZ-1)
NINTR2	Max number of stations for interpolations (NA values)	99	99
CRITFN	Critical Froude number	1	1
ALPHA	Empirical factor triggering kinematic effects	0.1	0.1
IDIOPT1	Compute temperatures from observations (0 = True)	0	0

Variable	Description	EPA Default	Project Values
ISURFT	Surface station to use for surface temperature (between 1 and NSSTA)	User Defines	1
IDIOPT2	Compute domain-average lapse rates? (0 = True)	0	0
IUPT	Station for lapse rates (between 1 and NUSTA)	User Defines	1
ZUPT	Depth of domain-average lapse rate (m)	200	200
IDIOPT3	Compute internally initial guess winds? (0 = True)	0	0
IUPWND	Upper air station for domain winds (-1 = 1/r**2 interpolation of all stations)	-1	-1
ZUPWND	Bottom and top of layer for 1st guess winds (m)	1,1000	1,1000
IDIOPT4	Read surface winds from SURF.DAT? (0 = True)	0	0
IDIOPT5	Read aloft winds from UPn.DAT? (0 = True)	0	0
CONSTB	Neutral mixing height B constant	1.41	1.41
CONSTE	Convective mixing height E constant	0.15	0.15
CONSTN	Stable mixing height N constant	2400	2400
CONSTW	Over-water mixing height W constant	0.16	0.16
FCORIOL	Absolute value of Carioles parameter	1.E-4	1.E-4
IAVEZI	Spatial averaging of mixing heights? (1 = True)	1	1
MNMDAV	Max averaging radius (number of grid cells)	1	1
HAFANG	Half-angle for looking upwind (degrees)	30	30
ILEVZI	Layer to use in upwind averaging (between 1 and NZ)	1	1
DPTMIN	Minimum capping potential temperature lapse rate	0.001	0.001
DZZI	Depth for computing capping lapse rate (m)	200	200
ZIMIN	Minimum over-land mixing height (m)	50	50
ZIMAX	Maximum over-land mixing height (m)	3000	4500
ZIMINW	Minimum over-water mixing height (m)	50	50
ZIMAXW	Maximum over-water mixing height (m)	3000	4500
IRAD	Form of temperature interpolation (1 = 1/r)	1	1
TRADKM	Radius of temperature interpolation (km)	500	500
NUMTS	Max number of stations in temperature interpolations	5	5
IAVET	Conduct spatial averaging of temperature? (1 = True)	**1**	**0**
TGDEFB	Default over-water mixed layer lapse rate (K/m)	-0.0098	-0.0098
TGDEFA	Default over-water capping lapse rate (K/m)	-0.0045	-0.0045

Variable	Description	EPA Default	Project Values
JWAT1	Beginning landuse type defining water	999	999
JWAT2	Ending landuse type defining water	999	999
NFLAGP	Method for precipitation interpolation (2= 1/r**2)	2	2
SIGMAP	Precip radius for interpolations (km)	100	100
CUTP	Minimum cut off precip rate (mm/hr)	0.01	0.01
SSn	NSSTA input records for surface stations	User Defines	13
Usn	NUSTA input records for upper-air stations	User Defines	10
PSn	NPSTA input records for precipitations stations	User Defines	64

4.4 DISPERSION MODEL INPUT AND OPTIONS

The CALPUFF model was used to model Project-specific and cumulative emissions of NOx, SO2, fine particulate matter (PMF) and coarse particulate matter (PMC). CALPUFF was run using the EPA-recommended default control file switch settings (Atkinson and Fox, 2006) for almost all parameters. Table 4-2 displays the CALPUFF options selected for Project modeling. Deviations from EPA-recommended defaults are indicated in bold and discussed below. Chemical transformations were modeled using the MESOPUFF II chemistry mechanism for conversion of SO2 to sulfate (SO4) and NOx to nitric acid (HNO3) and nitrate (NO3). Each of these pollutant species was included in the CALPUFF model runs. NOx, HNO3, and SO2 were modeled with gaseous deposition, and SO4, NO3, PMF ($PM_{2.5}$), and PMC (PM2.5-10) were modeled using particle deposition. Total PM10 impacts were determined in the post-processing of modeled impacts, as discussed in Section 4.5.

4.4.1 Background Chemical Species

The CALPUFF chemistry algorithms require hourly measurements of background ozone and constant estimates of background ammonia concentrations for the conversion of SO2 and NO_X to sulfates and nitrates, respectively. Background ozone data for the 2001, 2002, and 2003 meteorology modeling years were specified for seven stations within or near the modeling domain:

- Pinedale, Wyoming
- Centennial, Wyoming
- Yellowstone National Park, Wyoming
- Craters of the Moon National Park, Idaho
- Highland, Utah
- Thunder Basin, Wyoming
- Rocky Mountain National Park, Colorado

Hourly ozone data from these stations were used in the CALPUFF modeling, with a default value of 44.7 parts per billion (ppb) used for hours when the hourly ozone from these seven sites are missing, as discussed in the Modeling Protocol (NRG 2006). Additional observed ozone data are available in the urban Denver, Colorado and Salt Lake City, Utah areas; however, these data are not representative of rural conditions where the sources and receptors of interest reside. Figure 4-3 displays the locations of the ozone monitoring sites in and near the CALMET/CALPUFF modeling domain used in the CALPUFF modeling.

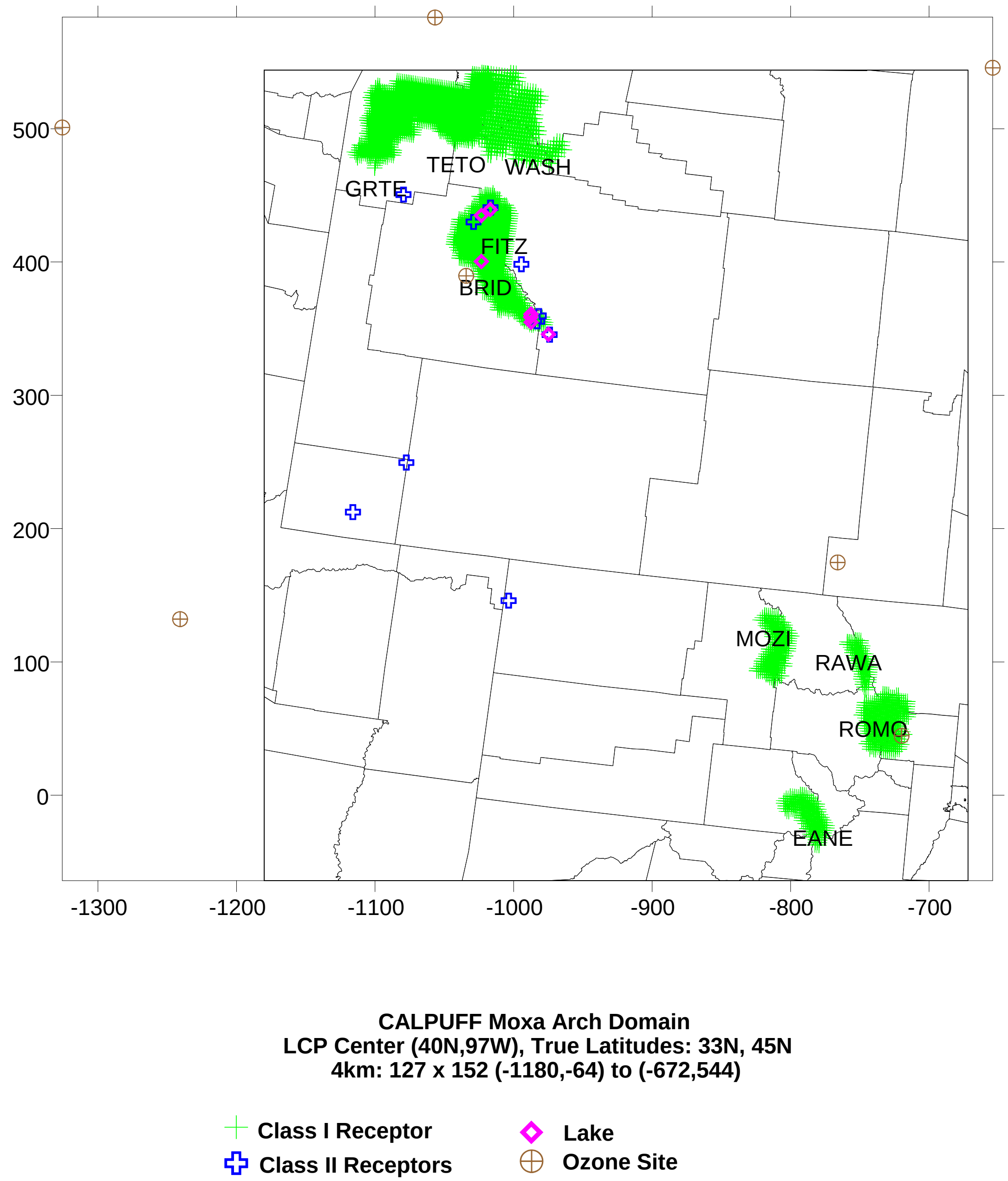

Figure 4-3. Locations of ozone monitoring sites, Class I area receptors, Class II area receptors and sensitive lake receptors within and around the Project's CALMET/CALPUFF modeling domain (ozone monitoring sites located outside the range of this map are plotted on the border).

Table 4-2. CALPUFF options used in the Project's far-field Class I and II area modeling and comparison of EPA regulatory modeling default values (Atkinson and Fox, 2006), deviations from EPA recommended defaults are indicated by bold text.

Variable	Description	EPA Default	Project Values
METDAT	CALMET input data filename	CALMET.DAT	CALMET.DAT
PUFLST	Filename for general output from CALPUFF	CALPUFF.LST	CALPUFF.LST
CONDAT	Filename for output concentration data	CONC.DAT	CONC.DAT
DFDAT	Filename for output dry deposition fluxes	DFLX.DAT	DFLX.DAT

Variable	Description	EPA Default	Project Values
WFDAT	Filename for output wet deposition fluxes	WFLX.DAT	WFLX.DAT
VISDAT	Filename for output relative humidities (for visibility)	VISB.DAT	VISB.DAT
METRUN	Do we run all periods (1) or a subset (0)?	0	0
IBYR	Beginning year	User Defined	User Defined
IBMO	Beginning month	User Defined	User Defined
IBDY	Beginning day	User Defined	User Defined
IBHR	Beginning hour	User Defined	User Defined
IRLG	Length of runs (hours)	User Defined	User Defined
NSPEC	Number of species modeled (for MESOPUFF II chemistry)	**5**	**7**
NSE	Number of species emitted	**3**	**4**
MRESTART	Restart options (0 = no restart), allows splitting runs into smaller segments	**0**	**2 or 3**
METFM	Format of input meteorology (1 = CALMET)	1	1
AVET	Averaging time lateral dispersion parameters (minutes)	60	60
MGAUSS	Near-field vertical distribution (1 = Gaussian)	1	1
MCTADJ	Terrain adjustments to plume path (3 = Plume path)	3	3
MCTSG	Do we have subgrid hills? (0 = No), allows CTDM-like treatment for subgrid scale hills	0	0
MSLUG	Near-field puff treatment (0 = No slugs)	0	0
MTRANS	Model transitional plume rise? (1 = Yes)	1	1
MTIP	Treat stack tip downwash? (1 = Yes)	1	1
MSHEAR	Treat vertical wind shear? (0 = No)	0	0
MSPLIT	Allow puffs to split? (0 = No)	0	0
MCHEM	MESOPUFF-II Chemistry? (1 = Yes)	1	1
MWET	Model wet deposition? (1 = Yes)	1	1
MDRY	Model dry deposition? (1 = Yes)	1	1
MDISP	Method for dispersion coefficients (3 = PG & MP)	3	3
MTURBVW	Turbulence characterization? (Only if MDISP = 1 or 5)	3	3
MDISP2	Backup coefficients (Only if MDISP = 1 or 5)	3	3
MROUGH	Adjust PG for surface roughness? (0 = No)	0	0
MPARTL	Model partial plume penetration? (0 = No)	1	1
MTINV	Elevated inversion strength (0 = compute from data)	0	0
MPDF	Use PDF for convective dispersion? (0 = No)	0	0
MSGTIBL	Use TIBL module? (0 = No) allows treatment of subgrid scale coastal areas	0	0
MREG	Regulatory default checks? (1 = Yes)	1	1
CSPECn	Names of species modeled (for MESOPUFF II, must be SO2, SO4, NOx, HNO3, NO3)	User Defined	SO2, SO4, NOx, HNO3, NO3, PMF, PMC
Specie	Manner species will be modeled	User Defined	SO2, SO4,

Variable	Description	EPA Default	Project Values
Names			NOX, NO3, HNO3, PMF, PMC
Specie Groups	Grouping of species, if any.	User Defined	
NX	Number of east-west grids of input meteorology	User Defined	127
NY	Number of north-south grids of input meteorology	User Defined	152
NZ	Number of vertical layers of input meteorology	User Defined	11
DGRIDKM	Meteorology grid spacing (km)	User Defined	4
ZFACE	Vertical cell face heights of input meteorology	User Defined	0., 20, 100, 200, 350, 500, 750, 1000, 2000, 3000, 4000, 4500
XORIGKM	Southwest corner (east-west) of input meteorology	User Defined	-1180.0
YORIGIM	Southwest corner (north-south) of input meteorology	User Defined	-64.
IUTMZN	UTM zone	User Defined	NA
XBTZ	Base time zone of input meteorology	User Defined	7
IBCOMP	Southwest of Xindex of computational domain	User Defined	1
JBCOMP	Southwest of Y-index of computational domain	User Defined	34
IECOMP	Northeast of Xindex of computational domain	User Defined	127
JECOMP	Northeast of Y- index of computational domain	User Defined	152
LSAMP	Use gridded receptors (T -= Yes)	F	F
IBSAMP	Southwest of Xindex of receptor grid	User Defined	NA
JBSAMP	Southwest of Y-index of receptor grid	User Defined	NA
IESAMP	Northeast of Xindex of receptor grid	User Defined	NA
JESAMP	Northeast of Y-index of receptor grid	User Defined	NA
MESHDN	Gridded receptor spacing = DGRIDKM/MESHDN	1	NA
ICON	Output concentrations? (1 = Yes)	1	1
IDRY	Output dry deposition flux? (1 = Yes)	1	1
IWET	Output wet deposition flux? (1 = Yes)	1	1
IVIS	Output RH for visibility calculations (1 = Yes)	1	1
LCOMPRS	Use compression option in output? (T = Yes)	T	T
ICPRT	Print concentrations? (0 = No)	0	0
IDPRT	Print dry deposition fluxes (0 = No)	0	0
IWPRT	Print wet deposition fluxes (0 = No)	0	0
ICFRQ	Concentration print interval (1 = hourly)	1	1
IDFRQ	Dry deposition flux print interval (1 = hourly)	1	1
IWFRQ	Wet deposition flux print interval (1 = hourly)	1	1

Variable	Description	EPA Default	Project Values
IPRTU	Print output units (1 = g/m**3; g/m**2/s)	1	1
IMESG	Status messages to screen? (1 = Yes)	1	1
Output Species	Where to output various species	User Defined	Default
LDEBUG	Turn on debug tracking? (F = No)	F	F
Dry Gas Dep	Chemical parameters of gaseous deposition species	User Defined	Default
Dry Part. Dep	Chemical parameters of particulate deposition species	User Defined	Default
RCUTR	Reference cuticle resistance (s/cm)	30.	30.
RGR	Reference ground resistance (s/cm)	10.	10.
REACTR	Reference reactivity	8	8
NINT	Number of particle-size intervals	9	9
IVEG	Vegetative state (1 = active and unstressed)	1	1
Wet Dep	Wet deposition parameters	User Defined	Default
MOZ	Ozone background? (1 = read from ozone.dat)	1	1
BCKO3	Ozone default (ppb) (Use only for missing data)	***80***	***44.7***
BCKNH3	Ammonia background (ppb)	**10**	**1.0**
RNITE1	Nighttime SO2 loss rate (%/hr)	0.2	0.2
RNITE2	Nighttime NOx loss rate (%/hr)	2	2
RNITE3	Nighttime HNO3 loss rate (%/hr)	2	2
SYTDEP	Horizontal size (m) to switch to time dependence	550.	550.
MHFTSZ	Use Heffter for vertical dispersion? (0 = No)	0	0
JSUP	PG Stability class above mixed layer	5	5
CONK1	Stable dispersion constant (Eq. 2.7-3)	0.01	0.01
CONK2	Neutral dispersion constant (Eq. 2.7-4)	0.1	0.1
TBD	Transition for downwash algorithms (0.5 = ISC)	0.5	0.5
IURB1	Beginning urban landuse type	10	10
IURB2	Ending urban landuse type	19	19

IWAQM (2000) recommends three values for background ammonia concentrations: 10.0 ppb for grasslands, 1.0 ppb for arid lands, and 0.5 ppb for forested lands. Most of the Class I and sensitive Class II receptor areas for the far-field modeling are in forested areas. However, the project itself and some areas in between the receptor areas are more arid and grassland. Consequently, the mid-level background ammonia concentration of 1.0 ppb was used.

4.4.2. Deviations from EPA-Recommended Default Options

As noted by the bold in Table 4-2, several CALPUFF options deviated from EPA-recommended default settings as reported by Atkinson and Fox (2006). First, the EPA-recommended default does not include any PM species, whereas we include both fine (PMF) and coarse (PMC) PM species. Consequently, there are 2 more emitted (5) and modeled (7) species than in the EPA recommendations (3 and 5, respectively). Second, a background ozone value of 44.7 ppb was specified, which is more representative of average conditions in southwestern Wyoming than the EPA-recommended 80 ppb default value. Finally, the EPA-recommended default value for ammonia is 10.0 ppb that, according to IWAQM (2000), is representative of grasslands. Because our receptors are primarily forested land

(0.5 ppb), and there is a lot of arid land in the region (1.0 ppb), we selected the mid-range background ammonia value (1.0 ppb).

4.4.3 Model Receptors

The NPS has posted receptors for Class I areas that should be used for CALPUFF model applications at which the concentration, deposition, and AQRV impacts are calculated. The NPS Class I area receptors were downloaded from their website and converted to the LCC coordinate system used in the Project's CALPUFF modeling. Discrete receptors were specified for the far-field Class II areas and the seven acid-sensitive lakes. Figure 4-3 displays the locations of the Class I and II area and sensitive lake receptors used in the Project's CALPUFF modeling.

4.4.4 Emissions Processing

CALPUFF source parameters were determined for all Project and regional source emissions of NOx, SO2, PMF, and PMC. Project sources were input to CALPUFF using 4 km^2 area sources at 4 km spacing placed throughout the Project Area to idealize project well operation and construction emissions. For each of the three alternatives, the required number of wells was randomly distributed throughout the Project Area. (Note that the Project area for Alternative C is slightly larger than those of the Proposed Action and No Action alternatives). Once the wells had been located in the Project Area, the wells were assigned to a particular grid cell of the CALPUFF modeling domain, and the emissions for each grid cell was taken to be the sum of the emissions from all wells within that 4 km grid cell. The exact location of the well head compressors is not yet known; therefore, well head compressors were sited within the Project Area based on the randomly chosen well locations. Because it was assumed that there are 30 well head compressors for every 1000 wells, groups of 33 wells were formed, and a well head compressor was placed in the centroid of each group of 33 wells. Once a well head compressor had been located within a 4 km^2 grid cell, the emissions from that well head compressor were added to those of the project wells within that grid cell. Figure 4-4 displays the relationship between the well locations for the Projects Proposed Action alternative and the Class I area receptors used in the CALPUFF modeling.

Point sources were used to represent central compressor stations. Compressor station emissions are provided in Table 2-3. Stack parameters for the central compressor stations were based on those used in the Jonah Infill Project and are shown in Table 4-3.

Table 4-3. Central Compressor Station Stack Parameters.

Stack Height	Stack Height	Temperature	Exit Velocity
0.515 m	10.97 m	730 K	40.48 m/s

Field-wide emissions scenarios for each alternative are summarized in Table 2-4. Figures 4-5 through 4-7 show the randomly chosen well sites for each scenario, their idealization as 4 km area sources, and the locations of well head compressors and central compressor stations.

Non-project regional emissions were input to CALPUFF using point sources to represent state-permitted and RFFA sources. The source parameters used in modeling included all state-permitted and RFFA sources. CALPUFF requires stack parameters (stack diameter and height, exit velocity, and exit temperature) for all point sources. Where stack parameters were not supplied in the state inventories, default stack parameters based on the Atlantic Rim Air Quality Technical Support Document, Appendix C, Table C7 were used. These parameters are shown in Table 4-4. Both state-permitted sources and RFFA emissions were supplied for Wyoming; for Utah and Colorado, only state-permitted sources were supplied.

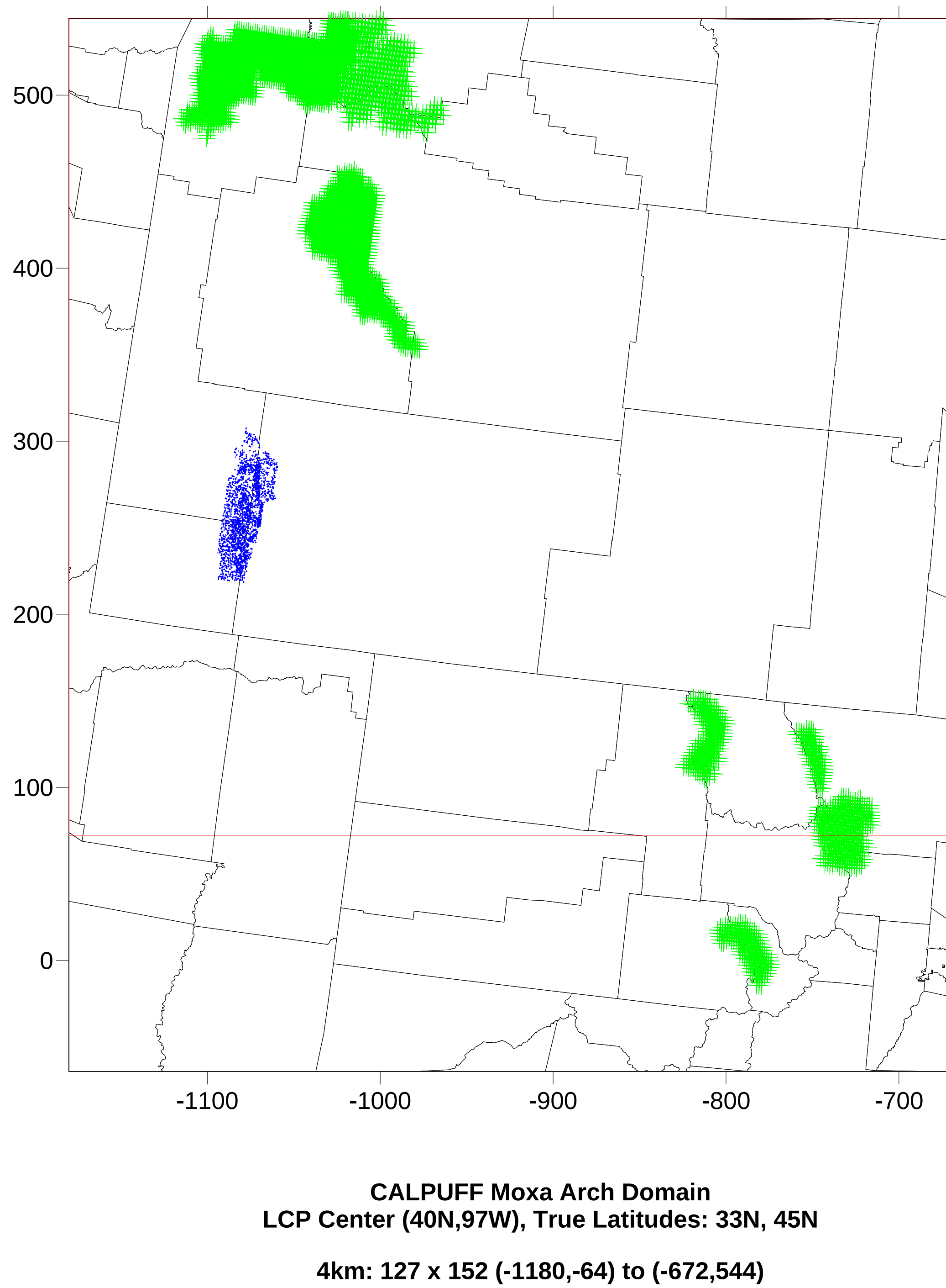

Figure 4-4. CALMET (black border) and CALPUFF (red border) modeling domains. Well locations for the proposed action are shown as blue crosses and Class I area receptors are shown as green crosses.

Table 4-4. Default Stack Parameters for cumulative sources with missing stack parameter data.

Stack Height	Stack Height	Temperature	Exit Velocity
0.51 m	9.82 m	633.80 K	30.08 m/s

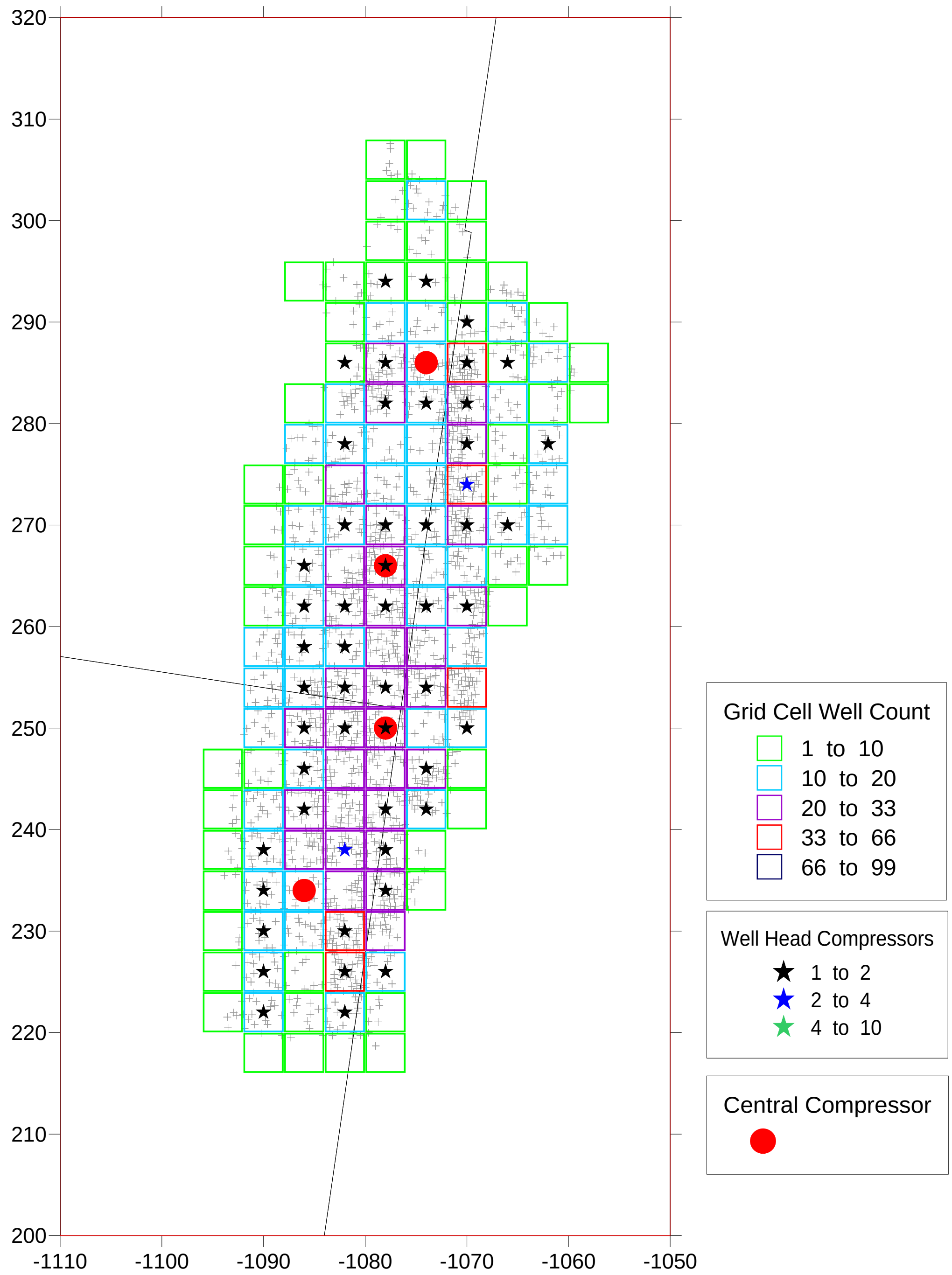

Figure 4-5. Map of Proposed Action showing location of well sites (grey crosses), well head compressors, and central compressor stations. Boxes show idealized area sources that are used to represent the emissions from the well construction and operation activities.

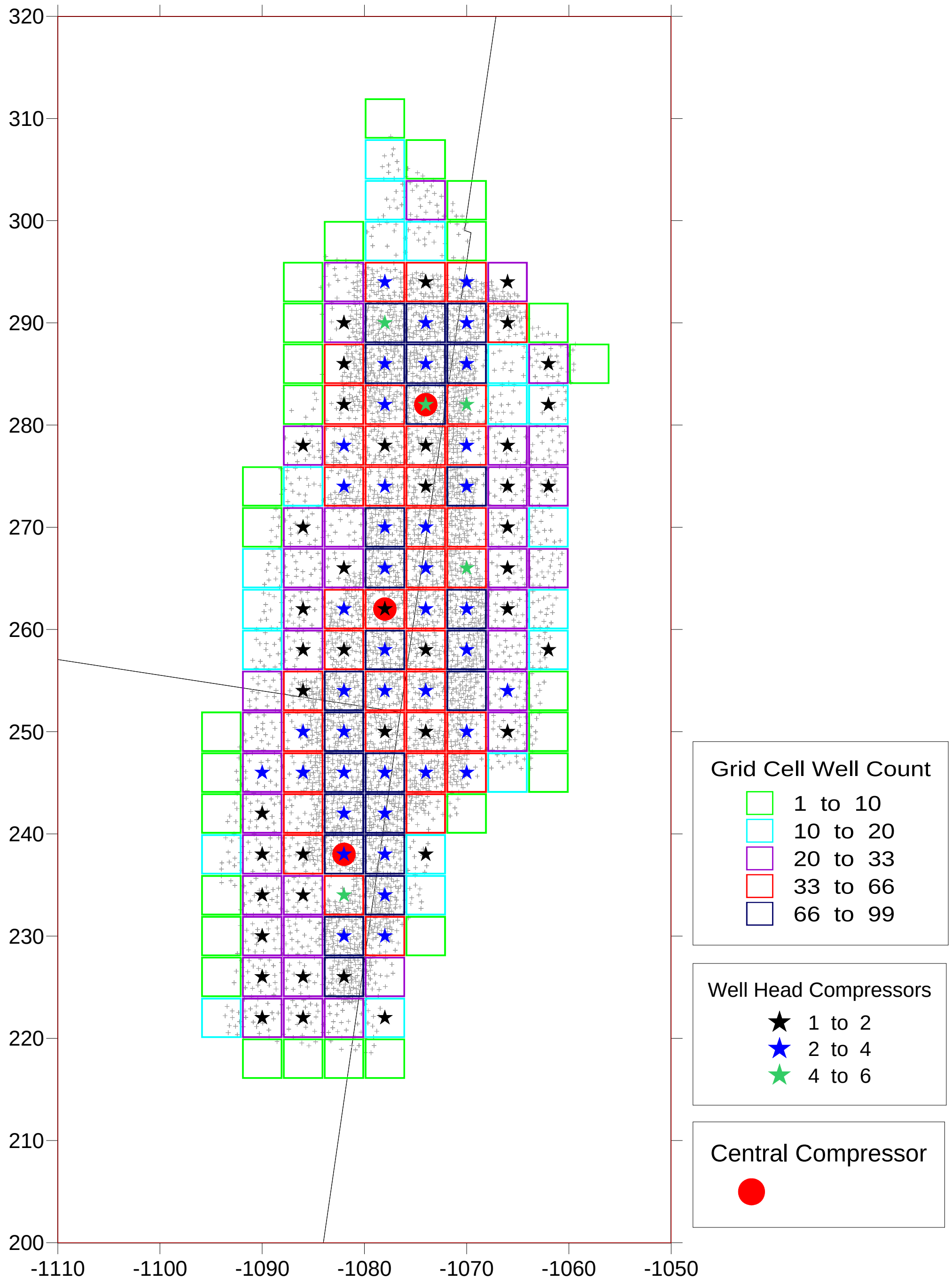

Figure 4-6. Map of Alternative C showing location of well sites (grey crosses), well head compressors, and central compressor stations. Boxes show idealized area sources that are used to represent the emissions from the well construction and operation activities.

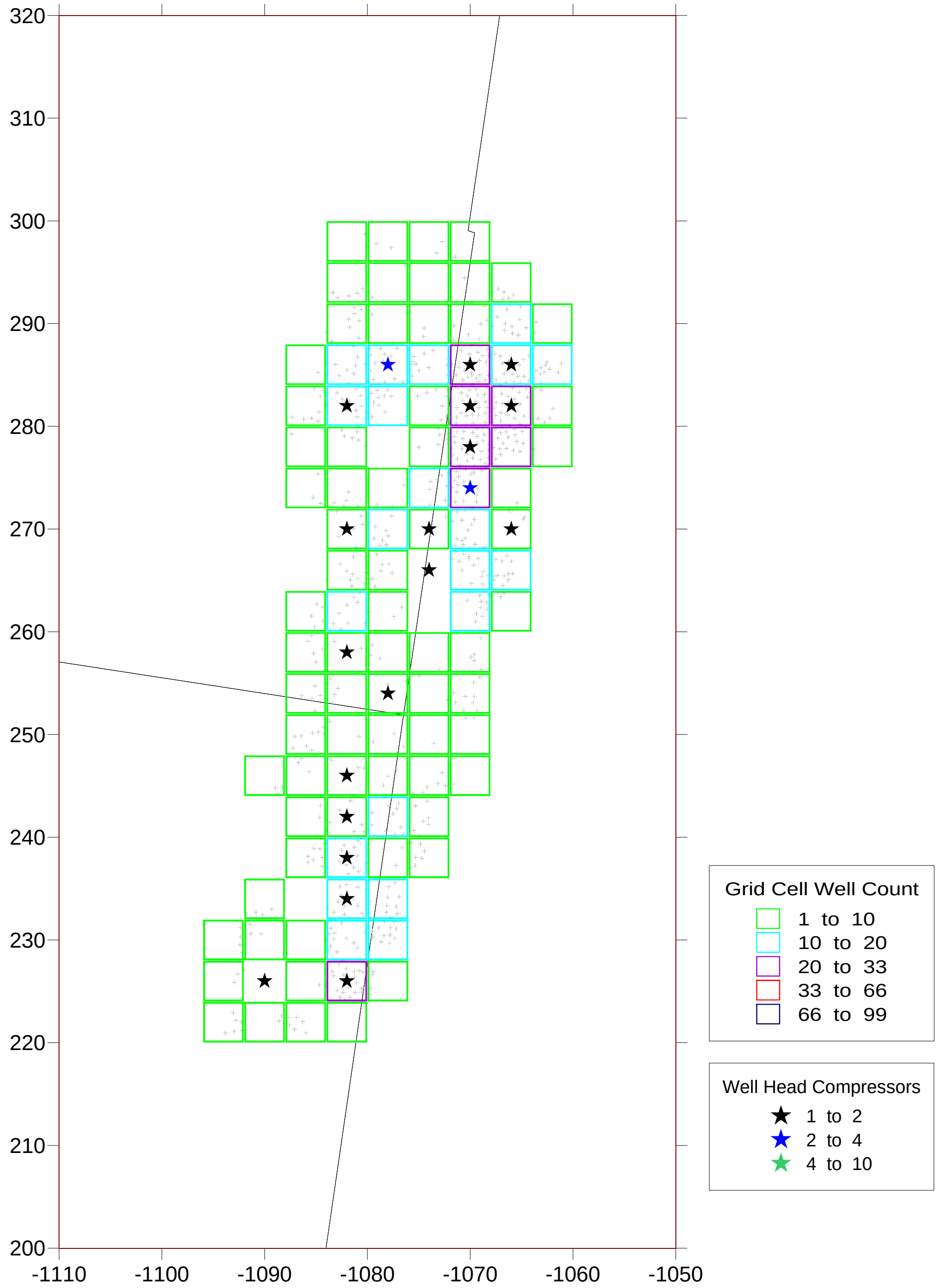

Figure 4-7. Map of Alternative A- No Action scenario showing location of well sites (grey crosses), well head compressors, and central compressor stations. Boxes show idealized area sources that are used to represent the emissions from the well construction and operation activities.

State of Wyoming-permitted and RFFA sources that did not have specific coordinates (i.e. no latitude/longitude or UTM easting/northing coordinate pair was present for that source) were sited at the center of the section if township, range, and section data were available. For cases where no coordinates were given and no township, range, and section data were present, the source was located at the county centroid if county information was given. There were four sources for which no location data of any kind were available, and these sources were placed at the centroid of Sweetwater County.

The Wyoming cumulative emission inventory contains 1,254 state-permitted and RFFA sources. A 3-year simulation with such a large number of sources places prohibitive computational demands on CALPUFF given the number of receptors, the domain size, and the time constraints of the project. Therefore, the number of sources input in CALPUFF that represent the permitted and RFFA sources in Wyoming was reduced by treating emissions from all permitted and RFFA sources with the classification "*production site*" in the same manner as those of the Project well sites. The 901 Wyoming permitted and RFFA production site sources were plotted as 4 km by 4 km area sources, and emissions sources from the remainder of the source classifications were treated as point sources.

RFD emissions were modeled using area sources developed as a best fit to the respective Project Area. The area source definitions for the RFD emissions are shown in Figure 4-8. County-wide well sites were also modeled as area sources, with the counties idealized as polygons suitable for input to CALPUFF. The idealization of the county areas is shown in Figure 4-9.

4.5 POST-PROCESSING PROCEDURES AND BACKGROUND AIR QUALITY DATA

4.5.1 Criteria Pollutants

Ambient air concentration data collected at monitoring sites in the region provide a measure of background conditions in existence during the most recent available time period. Regional monitoring-based background values for criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NO_x, and SO_2) were collected at monitoring sites in Wyoming and northwestern Colorado and are presented in Table 4-5. Ambient air background concentrations were added to modeled pollutant concentrations (expressed in micrograms per cubic meter [$\mu g/m^3$]) to arrive at total ambient air quality impacts for comparison to NAAQS, WAAQS, (CAAQS, and Utah Ambient Air Quality Standards (UAAQS). These background values are based on an e-mail from Darla Potter of WDEQ to Michele Easley of BLM dated August 8, 2006 that supersede the background values given in the Modeling Protocol (NRG 2006).

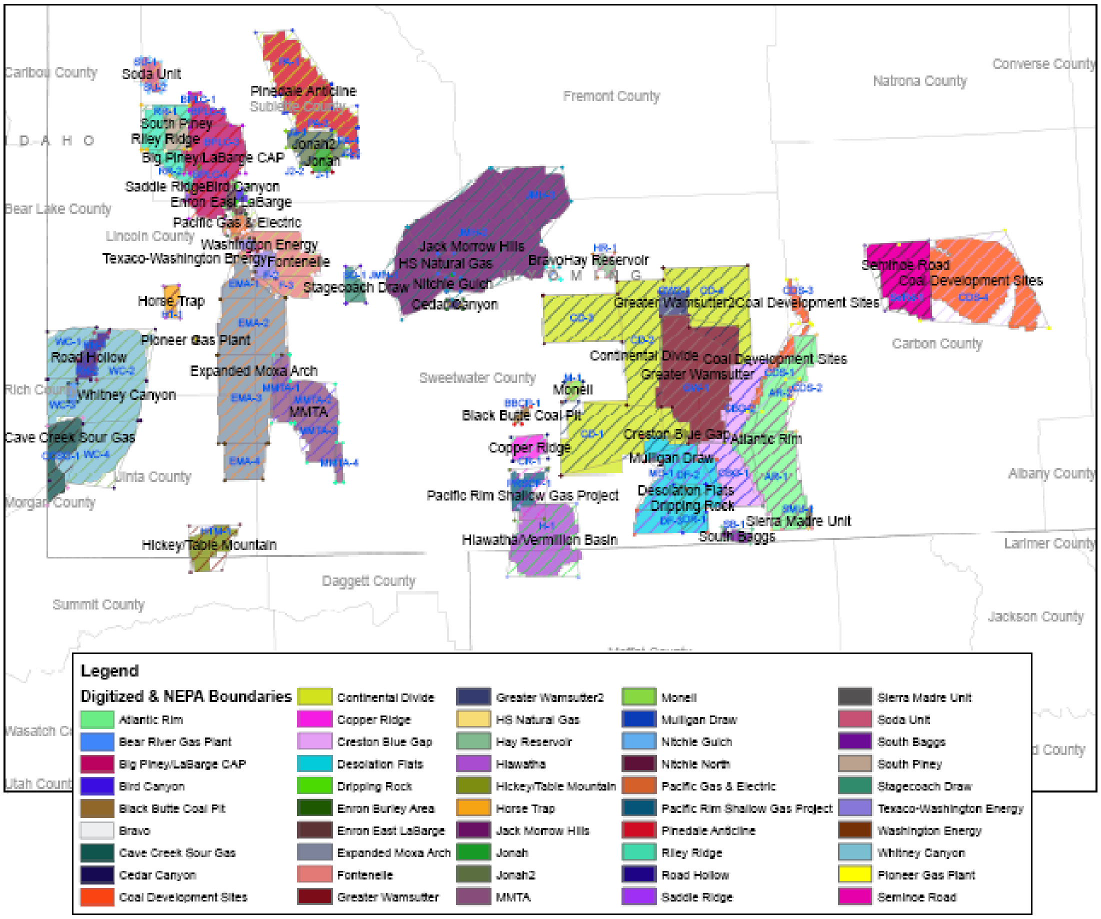

Figure 4-8. Far-field modeling area source idealization of RFD Project areas. This is a preliminary map that shows all NEPA project areas in the modeling domain, and includes project areas that have already been fully developed or will not be developed, and were therefore excluded from the RFD emission inventory for the MAA.

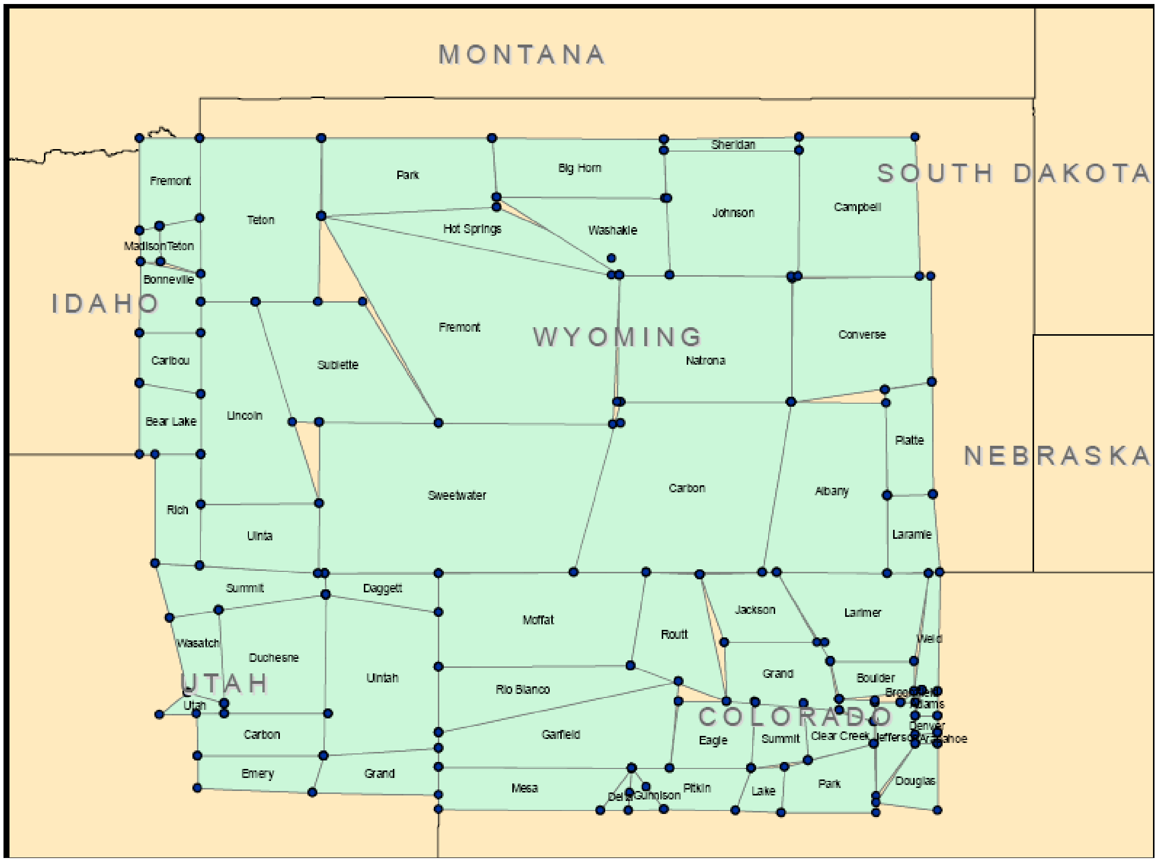

Figure 4-9. Far-field modeling area source idealization of county well site emissions.

Table 4-5. Far-Field Analysis Background Ambient Air Quality Concentrations.

Pollutant	Averaging Period	Measured Background Concentration ($\mu g/m^3$)
Carbon monoxide (CO)[1]	1-hour 8-hour	2,229 1,148
Nitrogen dioxide (NO_2)[2]	Annual	3.4
Ozone (O_3)[3]	1-hour 8-hour	-- 147
PM_{10}[4]	24-hour Annual	48 25
$PM_{2.5}$[4]	24-hour Annual	22 11
Sulfur dioxide (SO_2)[5]	3-hour 24-hour Annual	29 18 5

1 Data collected by Rifle and Mack, Colorado in conjunction with proposed oil shale development during early 1980's (CDPHE, 1996).

2 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (ARS 2002).

3 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS, 2002).

4 Data collected at Green River Basin Visibility Study site, Green River, Wyoming January-December 1997-1999, WDEQ.

5 Data collected at Craig Power Plant site and oil shale areas from 1980-1984 (CDPHE 1996)

4.5.2 Visibility

The proposed visibility analysis differs from previous Wyoming NEPA cumulative air quality impact studies in its update of visibility background to include the most current data available at the time of the Modeling Protocol (NRG 2006). The analysis also used representative monitoring data collected from the Interagency Modeling of Protected Visual Environment (IMPROVE) network for the time period (2000 to 2004) coinciding with the time period that will be used to establish “baseline conditions” under the EPA Regional Haze Rule (EPA, 2003a). Monitored visibility background data that have undergone Quality Assurance (QA)/Quality Control (QC) are currently available through December 31, 2004.

Three separate methods were used for the light extinction analysis using FLAG and IMPROVE background visibility data. Two methods which follow recent CALPUFF modeling guidance for Best Available Retrofit Technology (BART) analyses developed for the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) RPO were also used (VISTAS 2006). Because natural background data are provided for Federal Class I areas only, data from the nearest Federal Class I area were used for the sensitive Class II areas. The natural background visibility data, in units of inverse megameters (Mm^{-1}) that were used with the FLAG visibility analysis (Method 1) for each area analyzed are shown in Table 4-6.

The IMPROVE method uses reconstructed IMPROVE aerosol total extinction data. The IMPROVE background visibility data are provided as reconstructed aerosol total extinction data, based on the quarterly mean of the 20% cleanest days measured at the Bridger and North Absaroka Wilderness Areas and Yellowstone National Park IMPROVE sites for the 5-year period, years 2000 through 2004, as shown in Table 4-7 (Method 2). These 5 years are defined as baseline condition years for tracking progress under *Guidance for Tracking Progress Under the Regional Haze Rule (EPA 2003a)*. The IMPROVE method also uses monthly relative humidity factors as provided in the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*.

Visibility data from the Bridger Wilderness Area IMPROVE site were used for the Bridger, Fitzpatrick, Gros Ventre, and Wind River Roadless Aresa. Visibility data from the Yellowstone National Park IMPROVE site were used for the Teton Wilderness Area and for Grand Teton and Yellowstone National Parks. Data from the North Absaroka site were used for the North Absaroka and Washakie Wilderness Areas. Monthly relative humidity data were available for the Bridger, Fitzpatrick, Teton, and Washakie Wilderness Areas, and for Grand Teton and Yellowstone National Parks. Relative humidity data for the Bridger Wilderness Area were used for the Gros Ventre and Wind River Roadless Area analyses.

The two BART screening methods (Method 3a and 3b) used the background visibility data provided in Appendix B of the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule* (EPA, 2003b). Method 3b used the best days background visibility condition and Method 3a used the annual average background. These background data given in deciview (dv) units are shown in Table 4-8. The BART methods require monthly relative humidity factors as provided in the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule*. Because the background visibility and relative humidity data are provided for Federal Class I areas only, data from the nearest Federal Class I area were used for the sensitive Class II areas.

Table 4-6. FLAG Report Background Extinction Values (FLAG, 2000) used in the Method 1 visibility assessment.

Site	Season	Hygroscopic (Mm^{-1})	Non-hygroscopic (Mm^{-1})
Bridger Wilderness Area (also used for Popo Agie Wilderness Area, Wind River Roadless Area, and mid-field Wyoming regional community locations; Boulder, Cora, and Pinedale)	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5
Fitzpatrick Wilderness Area	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5
North Absaroka Wilderness Area	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5
Teton Wilderness Area	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5
Washakie Wilderness Area	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5
Grand Teton National Park (Also used for Gros Ventre Wilderness area)	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5
Yellowstone National Park	Winter	0.6	4.5
	Spring	0.6	4.5
	Summer	0.6	4.5
	Fall	0.6	4.5

Table 4-7. IMPROVE Background Aerosol Extinction Values (CIRA 2006) used in the Method 2 visibility assessment.

IMPROVE Site	Quarter	Hygroscopic (Mm^{-1})	Non-hygroscopic (Mm^{-1})
Bridger	1	0.775	1.233
	2	1.565	3.283
	3	1.791	4.965
	4	0.704	1.192
North Absaroka	1	0.774	1.565
	2	1.326	2.249
	3	1.360	4.931
	4	0.600	1.368
Yellowstone	1	1.104	1.588
	2	1.453	2.983
	3	1.550	5.414
	4	0.738	1.544

Table 4-8. Default Natural Conditions (EPA, 2003b).

Site	Annual Average (dv)	Best Days (dv)
Bridger Wilderness	4.52	1.96
Fitzpatrick Wilderness	4.53	1.97
North Absaroka Wilderness	4.53	1.97
Teton Wilderness	4.53	1.97
Washakie Wilderness	4.53	1.97
Grand Teton National Park	4.53	1.97
Yellowstone National Park	4.56	2.00

[1] Default natural conditions from Appendix B (EPA 2003b)

4.5.3 Lake Chemistry

The most recent lake chemistry background ANC data were obtained from the FLMs for each sensitive in the study area. The 10th percentile lowest ANC values were calculated for each lake following procedures provided from the Forest Service. The ANC values proposed for use in this analysis and the number of samples used in the calculation of the 10th percentile lowest ANC values is provided in Table 4-9.

4.6 CLASS I AREA FAR-FIELD AIR QUALITY AND AQRV IMPACT ASSESSMENT

CALPUFF modeling was performed to compute direct impacts for the Project and to estimate cumulative impacts from the Project and other regional emission sources. The analyzed alternatives represent maximum emissions scenarios that included the last year of field development at the maximum annual construction activity rate combined with nearly full-field production. Regional emission inventories for existing state-permitted RFFA and RFD sources, as described in Section 2, were modeled in combination with each Project alternative to estimate cumulative impacts for: (1) the Proposed Action; (2) Alternative C; and (3) Alternative A - No Action. Note that a fourth alternative is being analyzed (Alternative B); however, this alternative would have the same or less air emissions as Alternative C so did not require a separate air modeling analysis. Also, since the RFD sources are highly speculative, a scenario was analyzed that consists of the project alternatives plus all cumulative emissions less the RFD sources.

Table 4-9. Background ANC Values for Acid Sensitive Lakes (USFS, 2006).

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg-Min-Sec)	10th Percentile Lowest ANC Value (μeq/l)[1]	Number of Samples	Monitoring Period
Bridger	Black Joe	42º44'22"	109º10'16"	67.1	67	1984-2005
Bridger	Deep	42º43'10"	109º10'15"	59.7	64	1984-2005
Bridger	Hobbs	43º02'08"	109º40'20"	69.9	71	1984-2005
Bridger	Lazy Boy	43º19'57"	109º43'47"	10.8	3	1997-2004
Bridger	Upper Frozen	42º41'08"	109º09'38"	6.0	8	1997-2005
Fitzpatrick	Ross	43º22'41"	109º39'30"	53.7	49	1988-2005
Popo Agie	Lower Saddlebag	42º37'24"	108º59'38"	55.2	48	1989-2005

[1] μeq/l = microequivalents per liter

For each far-field sensitive area, CALPUFF-modeled concentration impacts were post-processed with POSTUTIL and CALPOST to derive: (1) concentrations for comparison to ambient standards (WAAQS, CAAQS, UAAQS, and NAAQS) and PSD Class I and II Increments; (2) deposition rates for comparison to sulfur and nitrogen deposition thresholds and to calculate changes to ANC at sensitive lakes; and (3) light extinction changes for comparison to visibility impact thresholds.

4.6.1 Far-Field Concentration Impacts

The CALPOST and POSTUTIL post-processors were used to summarize concentration impacts of NO2, SO2, PMF, and PMC at PSD Class I and sensitive PSD Class II areas. Predicted impacts are compared to applicable ambient air quality standards, PSD Class I and Class II increments, and significance levels. Table 4-10 lists the ambient standards and PSD Class I and II increments that the estimated concentration impacts due to the Project alone and the Project plus cumulative emissions will be compared against.

PM10 concentrations were computed by adding predicted CALPUFF concentrations of PMF, PMC, SO4 and NO3, whereas PM2.5 concentrations were calculated as the sum of modeled PMF, SO4, and NO3 concentrations.

4.6.1.1 Class I Area Far-Field Concentration Results

The maximum predicted concentrations of NO2, SO2, PM10, and PM2.5 at any receptor within each of the PSD Class I areas for each modeled Project alternative are shown in Tables 4-11a-c. The highest estimated concentration impacts at any Class I area and any Project alternative occur for Alternative C at the Bridger Wilderness area. Most of the impacts are 1% or less of the PSD Class I area increments. The largest impact is for 24-hour PM10 where Alternative C is estimated at values ~6% of the PSD Class I area increment at Bridger. The far-field results demonstrate that the maximum air quality impacts for the Proposed Action and all alternatives would not exceed any PSD Class I increment at any Class I area.

Table 4-10. Ambient Air Quality Standards and Class I and II PSD Increments for comparison to fair-field model estimates.

Pollutant / Averaging Time	Ambient Air Quality Standards (µg/m^3)				PSD Increment (µg/m^3)	
	National	Wyoming	Colorado	Utah	Class II	Class I
Carbon Monoxide (CO)						
1-hour[1]	40,000	40,000	40,000	40,000	--	--
8-hour[1]	10,000	10,000	10,000	10,000	--	--
Nitrogen Dioxide (NO_2)						
Annual[2]	100	100	100	100	25	2.5
Ozone (O_3)						
1-hour	--	--	235	235	--	--
8-hour[3]	157	157	--	157	--	--
PM_{10}						
24-hour[1]	150	150	150	150	30	4
Annual[2]	50	50	50	50	17	8
$PM_{2.5}$						
24-hour[1]	65	65	--	65	--	--
Annual [4]	15	15	--	15	--	--
Sulfur Dioxide (SO_2)						
3-hour[1]	1,300	1,300	700[5]	1,300	512	2
24-hour[1]	365	260	100[5]	365	91	5
Annual[2]	80	60	15[5]	80	20	25

1 No more than one exceedance per year.
2 Annual arithmetic mean.
3 Average of annual fourth-highest daily maximum 8-hour average.
4 Annual arithmetic mean
5 Category III Incremental standards (increase over established baseline).

Table 4-11a. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the Moxa Arch Infill Drilling Project Proposed Action.

Species and Averaging Time	PSD Class I Area Increment (μg/m^3)	Concentration Estimates (μg/m^3)					
		BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0006	0.0002	0.0001	0.0002	0.0000	0.0001
SO_2 24-Hour*	5.00	0.0077	0.0035	0.0015	0.0022	0.0010	0.0009
SO_2 3-Hour*	25.00	0.0261	0.0113	0.0067	0.0171	0.0037	0.0039
PM_{10} Annual	4.00	0.0115	0.0040	0.0017	0.0036	0.0013	0.0013
PM_{10} 24-Hour*	8.00	0.1602	0.0720	0.0433	0.0638	0.0314	0.0269
NO_2 Annual	2.50	0.0125	0.0022	0.0006	0.0021	0.0003	0.0003
2002							
SO_2 Annual	2.00	0.0004	0.0001	0.0001	0.0002	0.0000	0.0001
SO_2 24-Hour*	5.00	0.0058	0.0021	0.0029	0.0020	0.0012	0.0017
SO_2 3-Hour*	25.00	0.0217	0.0092	0.0153	0.0066	0.0051	0.0089
PM_{10} Annual	4.00	0.0074	0.0029	0.0015	0.0048	0.0010	0.0012
PM_{10} 24-Hour*	8.00	0.1093	0.0571	0.0395	0.0569	0.0260	0.0253
NO_2 Annual	2.50	0.0062	0.0015	0.0010	0.0025	0.0003	0.0004
2003							
SO_2 Annual	2.00	0.0004	0.0001	0.0000	0.0002	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0066	0.0019	0.0011	0.0018	0.0011	0.0009
SO_2 3-Hour*	25.00	0.0369	0.0128	0.0060	0.0078	0.0044	0.0086
PM_{10} Annual	4.00	0.0070	0.0028	0.0011	0.0043	0.0009	0.0010
PM_{10} 24-Hour*	8.00	0.1315	0.0803	0.0327	0.0476	0.0225	0.0353
NO_2 Annual	2.50	0.0071	0.0019	0.0005	0.0021	0.0004	0.0006

* Highest second high at any monitor in the Class I area.

Table 4-11b. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the MAA Project Alternatives B and C.

Species and Averaging Time	PSD Class I Area Increment (µg/m³)	Concentration Estimates (µg/m³)					
		BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0005	0.0002	0.0000	0.0001	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0069	0.0031	0.0013	0.0018	0.0008	0.0008
SO_2 3-Hour*	25.00	0.0230	0.0095	0.0055	0.0142	0.0033	0.0034
PM_{10} Annual	4.00	0.0318	0.0110	0.0044	0.0089	0.0034	0.0034
PM_{10} 24-Hour*	8.00	0.4359	0.1884	0.1021	0.1378	0.0756	0.0663
NO_2 Annual	2.50	0.0262	0.0046	0.0012	0.0040	0.0006	0.0007
2002							
SO_2 Annual	2.00	0.0003	0.0001	0.0001	0.0002	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0052	0.0019	0.0025	0.0017	0.0011	0.0014
SO_2 3-Hour*	25.00	0.0184	0.0087	0.0131	0.0055	0.0043	0.0072
PM_{10} Annual	4.00	0.0201	0.0079	0.0040	0.0118	0.0026	0.0032
PM_{10} 24-Hour*	8.00	0.3153	0.1334	0.0949	0.1274	0.0660	0.0620
NO_2 Annual	2.50	0.0127	0.0031	0.0020	0.0047	0.0006	0.0008
2003							
SO_2 Annual	2.00	0.0003	0.0001	0.0000	0.0002	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0056	0.0017	0.0010	0.0016	0.0009	0.0008
SO_2 3-Hour*	25.00	0.0297	0.0108	0.0049	0.0065	0.0038	0.0076
PM_{10} Annual	4.00	0.0194	0.0077	0.0030	0.0107	0.0024	0.0027
PM_{10} 24-Hour*	8.00	0.3426	0.2067	0.0837	0.1288	0.0586	0.0953
NO_2 Annual	2.50	0.0146	0.0039	0.0011	0.0041	0.0008	0.0013

* Highest second high at any monitor in the Class I area.

Table 4-11c. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the Moxa Arch Infill Drilling Project No Action Alternative.

Species and Averaging Time	PSD Class I Area Increment (µg/m³)	Concentration Estimates (µg/m³)					
		BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0025	0.0009	0.0004	0.0005	0.0002	0.0002
SO_2 3-Hour*	25.00	0.0071	0.0028	0.0017	0.0043	0.0009	0.0010
PM_{10} Annual	4.00	0.0053	0.0017	0.0006	0.0012	0.0005	0.0005
PM_{10} 24-Hour*	8.00	0.0755	0.0274	0.0138	0.0153	0.0103	0.0092
NO_2 Annual	2.50	0.0036	0.0006	0.0001	0.0004	0.0001	0.0001
2002							
SO_2 Annual	2.00	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0016	0.0007	0.0008	0.0005	0.0003	0.0004
SO_2 3-Hour*	25.00	0.0060	0.0029	0.0040	0.0019	0.0013	0.0024
PM_{10} Annual	4.00	0.0032	0.0012	0.0006	0.0016	0.0004	0.0005
PM_{10} 24-Hour*	8.00	0.0578	0.0145	0.0136	0.0157	0.0102	0.0090
NO_2 Annual	2.50	0.0017	0.0004	0.0002	0.0005	0.0001	0.0001
2003							
SO_2 Annual	2.00	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
SO_2 24-Hour*	5.00	0.0017	0.0006	0.0003	0.0005	0.0003	0.0003
SO_2 3-Hour*	25.00	0.0088	0.0028	0.0015	0.0017	0.0012	0.0023
PM_{10} Annual	4.00	0.0031	0.0012	0.0005	0.0015	0.0004	0.0004
PM_{10} 24-Hour*	8.00	0.0533	0.0307	0.0123	0.0166	0.0091	0.0151
NO_2 Annual	2.50	0.0019	0.0005	0.0001	0.0005	0.0001	0.0002

* Highest second high at any monitor in the Class I area.

Table 4-12 (a-c) displays the maximum estimated PSD pollutant concentrations at Class I areas due to the various Project alternatives plus the Cumulative Emissions inventory and compares them to the PSD Class I increments. The highest estimated impacts occur for the Bridger Wilderness Area in the Cumulative Emissions plus Alternative C scenario, with impacts as follows:

- Less than 1% of the PSD Class I increments for annual, 24-hour and 3-hour SO_2 concentrations;
- Less than 3% and 20% of the PSD Class I area increments for annual and 24-hour $PM_{10,}$ respectively; and
- Less than 8% of the PSD Class I area increment for annual $NO_{2.}$

Table 4-12 (a-c) shows that the estimated air quality impacts due to any of the Project alternatives plus the cumulative emissions would not exceed any PSD Class I area increment at any Class I area.

Table 4-12a. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the Proposed Action plus the cumulative emissions.

Species and Averaging Time	PSD Class I Area Increment (μg/m^3)	Concentration Estimates (μg/m^3)					
		BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0025	0.0008	0.0004	0.0018	0.0003	0.0003
SO_2 24-Hour*	5.00	0.0270	0.0081	0.0062	0.0244	0.0050	0.0046
SO_2 3-Hour*	25.00	0.0934	0.0236	0.0311	0.0707	0.0168	0.0204
PM_{10} Annual	4.00	0.1001	0.0374	0.0145	0.0593	0.0102	0.0098
PM_{10} 24-Hour*	8.00	1.2271	0.4663	0.4342	0.7103	0.2525	0.2299
NO_2 Annual	2.50	0.1797	0.1028	0.0113	0.0305	0.0049	0.0043
2002							
SO_2 Annual	2.00	0.0019	0.0007	0.0004	0.0024	0.0002	0.0003
SO_2 24-Hour*	5.00	0.0191	0.0116	0.0085	0.0262	0.0051	0.0056
SO_2 3-Hour*	25.00	0.1101	0.0373	0.0496	0.0900	0.0155	0.0160
PM_{10} Annual	4.00	0.0691	0.0292	0.0096	0.0558	0.0066	0.0076
PM_{10} 24-Hour*	8.00	0.9061	0.5574	0.2323	0.4752	0.1711	0.1681
NO_2 Annual	2.50	0.1571	0.1085	0.0089	0.0345	0.0043	0.0049
2003							
SO_2 Annual	2.00	0.0018	0.0007	0.0003	0.0024	0.0002	0.0003
SO_2 24-Hour*	5.00	0.0217	0.0077	0.0053	0.0239	0.0039	0.0059
SO_2 3-Hour*	25.00	0.0800	0.0255	0.0202	0.0848	0.0154	0.0195
PM_{10} Annual	4.00	0.0814	0.0308	0.0084	0.0638	0.0064	0.0070
PM_{10} 24-Hour*	8.00	1.2909	0.4071	0.2610	0.5391	0.1096	0.1203
NO_2 Annual	2.50	0.1686	0.1032	0.0097	0.0343	0.0048	0.0058

* Highest second high at any monitor in the Class I area.

Table 4-12b. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for Alternative C plus the cumulative emissions.

Species and Averaging Time			Concentration Estimates (μg/m³)				
	PSD Class I Area Increment (μg/m³)	BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0025	0.0008	0.0004	0.0018	0.0003	0.0003
SO_2 24-Hour*	5.00	0.0271	0.0079	0.0062	0.0240	0.0050	0.0046
SO_2 3-Hour*	25.00	0.0908	0.0232	0.0307	0.0679	0.0164	0.0199
PM_{10} Annual	4.00	0.1153	0.0443	0.0171	0.0639	0.0123	0.0120
PM_{10} 24-Hour*	8.00	1.5332	0.5516	0.4538	0.7113	0.2579	0.2329
NO_2 Annual	2.50	0.1901	0.1051	0.0119	0.0321	0.0052	0.0046
2002							
SO_2 Annual	2.00	0.0019	0.0007	0.0003	0.0024	0.0002	0.0003
SO_2 24-Hour*	5.00	0.0188	0.0115	0.0080	0.0261	0.0051	0.0052
SO_2 3-Hour*	25.00	0.1083	0.0369	0.0483	0.0892	0.0155	0.0151
PM_{10} Annual	4.00	0.0799	0.0342	0.0122	0.0614	0.0082	0.0095
PM_{10} 24-Hour*	8.00	1.0171	0.6205	0.3753	0.4783	0.1889	0.2255
NO_2 Annual	2.50	0.1628	0.1101	0.0099	0.0365	0.0046	0.0053
2003							
SO_2 Annual	2.00	0.0018	0.0006	0.0003	0.0024	0.0002	0.0003
SO_2 24-Hour*	5.00	0.0216	0.0077	0.0053	0.0238	0.0038	0.0058
SO_2 3-Hour*	25.00	0.0759	0.0245	0.0201	0.0847	0.0154	0.0178
PM_{10} Annual	4.00	0.0923	0.0356	0.0103	0.0695	0.0079	0.0087
PM_{10} 24-Hour*	8.00	1.3535	0.4082	0.2624	0.5408	0.1414	0.1561
NO_2 Annual	2.50	0.1758	0.1052	0.0101	0.0363	0.0052	0.0064

* Highest second high at any monitor in the Class I area.

Table 4-12c. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the No Action alternative plus cumulative emissions.

Species and Averaging Time	PSD Class I Area Increment ($\mu g/m^3$)	BRID	FITZ	GRTE	MOZI	TETO	WASH
			Concentration Estimates ($\mu g/m^3$)				
2001							
SO_2 Annual	2.00	0.0022	0.0007	0.0003	0.0017	0.0003	0.0003
SO_2 24-Hour*	5.00	0.0251	0.0074	0.0061	0.0224	0.0049	0.0045
SO_2 3-Hour*	25.00	0.0831	0.0219	0.0268	0.0629	0.0153	0.0179
PM_{10} Annual	4.00	0.0955	0.0350	0.0134	0.0571	0.0094	0.0091
PM_{10} 24-Hour*	8.00	1.2192	0.4378	0.4064	0.7101	0.2378	0.2283
NO_2 Annual	2.50	0.1728	0.1011	0.0110	0.0289	0.0047	0.0040
2002							
SO_2 Annual	2.00	0.0017	0.0006	0.0003	0.0023	0.0002	0.0003
SO_2 24-Hour*	5.00	0.0179	0.0098	0.0067	0.0252	0.0047	0.0041
SO_2 3-Hour*	25.00	0.1026	0.0365	0.0413	0.0861	0.0152	0.0125
PM_{10} Annual	4.00	0.0657	0.0274	0.0088	0.0531	0.0060	0.0069
PM_{10} 24-Hour*	8.00	0.8737	0.5311	0.2110	0.4734	0.1637	0.1469
NO_2 Annual	2.50	0.1533	0.1073	0.0084	0.0326	0.0041	0.0046
2003							
SO_2 Annual	2.00	0.0016	0.0006	0.0002	0.0023	0.0002	0.0002
SO_2 24-Hour*	5.00	0.0215	0.0061	0.0045	0.0233	0.0036	0.0047
SO_2 3-Hour*	25.00	0.0677	0.0230	0.0186	0.0838	0.0149	0.0151
PM_{10} Annual	4.00	0.0780	0.0291	0.0078	0.0613	0.0059	0.0064
PM_{10} 24-Hour*	8.00	1.2741	0.4066	0.2513	0.5375	0.0972	0.1150
NO_2 Annual	2.50	0.1633	0.1017	0.0094	0.0327	0.0045	0.0053

* Highest second high at any monitor in the Class I area.

Table 4-13 (a-c) displays the maximum estimated PSD pollutant concentrations at Class I areas from the project alternatives plus the cumulative emissions inventory without RFD sources. The PSD Class I increments are also shown in Table 4-13. The highest estimated impacts from cumulative emissions without RFD sources plus any Project alternative occur at the Bridger and Mount Zirkel Wilderness Areas for Alternative C, with impacts as follows:

- Less than 1% of the PSD Class I increments for annual, 24-hour and 3-hour SO_2 concentrations;
- Less than 2% and 9% of the PSD Class I area increments for annual and 24-hour PM_{10}, respectively; and
- Less than 6% of the PSD Class I area increment for annual NO_2.

Table 4-13 (a-c) shows that the estimated air quality impacts due to any of the Project alternatives plus the cumulative emissions without RFD sources would not exceed any PSD Class I area increment at any Class I area. As expected, the impacts are slightly less than for the case with the RFD sources included in the cumulative emission inventory (Tables 4-12 [a-c]).

Table 4-13a. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the Proposed Action plus the cumulative emissions without RFD sources.

Species and Averaging Time	PSD Class I AreaIncrement (µg/m³)	BRID	FITZ	GRTE	MOZI	TETO	WASH
			Concentration Estimates (µg/m³)				
2001							
SO_2 Annual	2.00	0.0016	0.0005	0.0002	0.0013	0.0002	0.0002
SO_2 24-Hour*	5.00	0.0150	0.0062	0.0040	0.0184	0.0037	0.0038
SO_2 3-Hour*	25.00	0.0606	0.0201	0.0154	0.0633	0.0129	0.0152
PM_{10} Annual	4.00	0.0473	0.0229	0.0083	0.0547	0.0062	0.0060
PM_{10} 24-Hour*	8.00	0.5781	0.2583	0.1887	0.7103	0.1462	0.1313
NO_2 Annual	2.50	0.1506	0.0978	0.0084	0.0290	0.0038	0.0036
2002							
SO_2 Annual	2.00	0.0012	0.0004	0.0002	0.0018	0.0002	0.0002
SO_2 24-Hour*	5.00	0.0166	0.0072	0.0079	0.0190	0.0039	0.0035
SO_2 3-Hour*	25.00	0.0997	0.0306	0.0401	0.0716	0.0132	0.0110
PM_{10} Annual	4.00	0.0374	0.0191	0.0054	0.0499	0.0042	0.0050
PM_{10} 24-Hour*	8.00	0.3904	0.3100	0.1167	0.4199	0.1084	0.0906
NO_2 Annual	2.50	0.1424	0.1049	0.0067	0.0324	0.0033	0.0040
2003							
SO_2 Annual	2.00	0.0009	0.0003	0.0001	0.0018	0.0001	0.0002
SO_2 24-Hour*	5.00	0.0152	0.0058	0.0030	0.0211	0.0028	0.0041
SO_2 3-Hour*	25.00	0.0476	0.0198	0.0138	0.0842	0.0108	0.0146
PM_{10} Annual	4.00	0.0383	0.0183	0.0043	0.0577	0.0037	0.0040
PM_{10} 24-Hour*	8.00	0.5873	0.2452	0.0949	0.5391	0.0640	0.0677
NO_2 Annual	2.50	0.1492	0.0991	0.0072	0.0321	0.0038	0.0046

Table 4-13b. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for Alternative C plus the cumulative emissions without RFD sources.

Species and Averaging Time	PSD Class I Area Increment (µg/m^3)	Concentration Estimates (µg/m^3)					
		BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0015	0.0005	0.0002	0.0013	0.0002	0.0002
SO_2 24-Hour*	5.00	0.0149	0.0061	0.0038	0.0180	0.0037	0.0038
SO_2 3-Hour*	25.00	0.0606	0.0199	0.0138	0.0604	0.0129	0.0148
PM_{10} Annual	4.00	0.0631	0.0299	0.0110	0.0593	0.0083	0.0081
PM_{10} 24-Hour*	8.00	0.7387	0.3386	0.2682	0.7112	0.1598	0.1439
NO_2 Annual	2.50	0.1609	0.1002	0.0089	0.0306	0.0041	0.0039
2002							
SO_2 Annual	2.00	0.0012	0.0004	0.0002	0.0017	0.0001	0.0002
SO_2 24-Hour*	5.00	0.0164	0.0070	0.0075	0.0189	0.0037	0.0035
SO_2 3-Hour*	25.00	0.0979	0.0302	0.0387	0.0707	0.0132	0.0110
PM_{10} Annual	4.00	0.0483	0.0240	0.0079	0.0555	0.0058	0.0070
PM_{10} 24-Hour*	8.00	0.4352	0.3403	0.2175	0.4257	0.1242	0.1418
NO_2 Annual	2.50	0.1475	0.1065	0.0076	0.0344	0.0036	0.0045
2003							
SO_2 Annual	2.00	0.0009	0.0003	0.0001	0.0017	0.0001	0.0002
SO_2 24-Hour*	5.00	0.0148	0.0058	0.0029	0.0211	0.0028	0.0040
SO_2 3-Hour*	25.00	0.0463	0.0177	0.0138	0.0841	0.0108	0.0138
PM_{10} Annual	4.00	0.0493	0.0232	0.0062	0.0634	0.0052	0.0057
PM_{10} 24-Hour*	8.00	0.6598	0.2671	0.1158	0.5408	0.0936	0.1289
NO_2 Annual	2.50	0.1553	0.1011	0.0076	0.0340	0.0043	0.0052

Table 4-13c. CALPUFF estimated PSD pollutant concentrations impacts at Class I areas for the No Action Alternative plus cumulative emissions without RFD sources.

Species and Averaging Time	PSD Class I Area Increment (μg/m^3)	Concentration Estimates (μg/m^3)					
		BRID	FITZ	GRTE	MOZI	TETO	WASH
2001							
SO_2 Annual	2.00	0.0012	0.0004	0.0001	0.0012	0.0001	0.0002
SO_2 24-Hour*	5.00	0.0144	0.0059	0.0032	0.0164	0.0035	0.0038
SO_2 3-Hour*	25.00	0.0606	0.0180	0.0114	0.0514	0.0128	0.0131
PM_{10} Annual	4.00	0.0427	0.0206	0.0072	0.0525	0.0054	0.0052
PM_{10} 24-Hour*	8.00	0.5774	0.2261	0.1495	0.7101	0.1400	0.1293
NO_2 Annual	2.50	0.1445	0.0962	0.0080	0.0274	0.0036	0.0034
2002							
SO_2 Annual	2.00	0.0010	0.0004	0.0002	0.0016	0.0001	0.0002
SO_2 24-Hour*	5.00	0.0152	0.0064	0.0058	0.0180	0.0030	0.0032
SO_2 3-Hour*	25.00	0.0922	0.0284	0.0325	0.0677	0.0131	0.0110
PM_{10} Annual	4.00	0.0341	0.0173	0.0045	0.0472	0.0036	0.0043
PM_{10} 24-Hour*	8.00	0.3121	0.2860	0.1095	0.4166	0.1010	0.0744
NO_2 Annual	2.50	0.1394	0.1038	0.0060	0.0306	0.0031	0.0038
2003							
SO_2 Annual	2.00	0.0007	0.0003	0.0001	0.0016	0.0001	0.0001
SO_2 24-Hour*	5.00	0.0137	0.0057	0.0024	0.0203	0.0026	0.0038
SO_2 3-Hour*	25.00	0.0463	0.0176	0.0134	0.0829	0.0108	0.0121
PM_{10} Annual	4.00	0.0349	0.0167	0.0037	0.0552	0.0032	0.0034
PM_{10} 24-Hour*	8.00	0.5800	0.2438	0.0884	0.5368	0.0545	0.0577
NO_2 Annual	2.50	0.1448	0.0976	0.0070	0.0305	0.0035	0.0041

The CALPUFF-estimated maximum concentration increment due to any alternative with the cumulative emissions at any Class I area were combined with the existing maximum background concentrations (see Table 4-5) in the region to obtain a Total estimated concentrations that is compared against the NAAQS, WAAQS, UAAQS, and CAAQS in Table 4-14. The maximum CALPUFF-estimated impact due to any Project Alternative plus the cumulative sources always occurs at the Bridger Class I Area and always occurs for Alternative C. Table 4-14 clearly shows that when the Project plus the cumulative source impacts at any Class I area are added to the maximum background concentrations to obtain a total concentration, they do not exceed any federal or state ambient air quality standards.

In summary, the modeling results indicate that, for the Proposed Action, Alternative C, and No Action Project alternatives, neither direct Project impacts nor Project impacts taken together with cumulative source impacts would exceed any air quality standards (WAAQS, UAAQS, CAAQS, and NAAQS) or PSD Class I area increments. The PSD demonstrations are for informational purposes only and do not constitute a regulatory PSD increment consumption analysis.

Table 4-14. Comparison of maximum existing background concentrations (Table 4-5) plus maximum estimated impacts at any Class I area due to any Project Alternative plus cumulative sources, with federal and state ambient air quality standards.

Pollutant / Averaging Time	Ambient Air Quality Standards (μg/m^3)				Estimated Impact (μg/m^3)		
	National	**Wyoming**	**Colorado**	**Utah**	**Total**	**Bckgd**[1]	**Incmnt**[2]
Nitrogen Dioxide (NO_2)							
Annual	100	100	100	100	**3.6**	3.4	0.19
PM_{10}							
24-hour	150	150	150	150	**53**	48	5.07
Annual	50	50	50	50	**27**	25	1.53
$PM_{2.5}$							
24-hour	65	65	--	65	**27**	22	5.07
Annual	15	15	--	15	**13**	11	1.53
Sulfur Dioxide (SO_2)							
3-hour	1,300	1,300	700[5]	1,300	**31**	29	1.53
24-hour	365	260	100[5]	365	**18**	18	0.03
Annual	80	60	15[5]	80	**5**	5	0.003

1 Maximum current background concentration in the region (Table 4-5)
2 Maximum Cumulative Emissions Plus Project increment concentration at any Class I area for any of the modeling years (occurs a Bridger Wilderness Area and for 2001)

4.6.1.2 Class II Area Far-Field Concentration Results

The maximum predicted concentrations of NO2, SO2, PM10, and PM2.5 at any receptor within each of the sensitive PSD Class II receptor areas for each modeled Project alternative are shown in Table 4-15 (a-c). The highest estimated concentration impacts at any Class II area and any Project alternative occur for Alternative C at the Bridger Butte area. No PSD Class II increment is exceeded at any Class II area for any of the three modeled scenarios.

Table 4-16 displays the maximum estimated PSD pollutant concentrations at any receptor within each of the Class II areas due to the various Project alternatives plus the cumulative emissions inventory and compares them to the PSD Class II increments and Proposed SIL. The highest estimated impacts due to the cumulative emissions plus any Project alternative occurs for the Bridger Butte Area and the cumulative plus Alternative C, with impacts as follows:

- Less than 1% of the PSD Class II increments for annual, 24-hour and 3-hour SO_2 concentrations;
- Less than 2% and 16% of the PSD Class II area increments for annual and 24-hour $PM_{10,}$ respectively; and
- Less than 2% of the PSD Class II area increment for annual $NO_{2.}$

With the addition of the cumulative emissions to the three Project scenario emissions, the proposed SIL are not exceeded for any site during the three year modeling period. These results show that the maximum air quality impacts from the Proposed Action or any of the alternatives, taken together with the cumulative emission inventory, would not exceed any PSD Class II increment at any Class II area.

In Table 4-17 (a-c), the maximum estimated PSD pollutant concentrations at any receptor within each of the Class II areas due to the various Project alternatives plus the cumulative emissions inventory without RFD sources are displayed and compared to the PSD Class II increments and Proposed SIL. As in the case in which the RFD was included in the cumulative emission inventory, the estimated air quality impacts due to any of the Project alternatives plus the cumulative emissions would not exceed any PSD Class II area increment at any Class II area, nor would they exceed the Proposed SIL. Comparison of Tables 4-16 and 4-17 shows that the impacts on Class II areas are slightly smaller when the effects of the RFD sources are removed.

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Table 4-15a. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for the Proposed Action.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Proposed SIL (μg/m³)	PSD Increment (μg/m³)	Bridger Butte	Deep Lake	Dinosaur National	Gros Ventre Wilderness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddlebag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0075	0.0003	0.0006	0.0001	0.0001	0.0001	0.0001	0.0004	0.0003
SO_2 24-Hour*	5	91.00	0.1435	0.0025	0.0079	0.0023	0.0018	0.0017	0.0012	0.0054	0.0034
SO_2 3-Hour*	25	512.00	0.4591	0.0082	0.0262	0.0092	0.0088	0.0071	0.0062	0.0156	0.0100
PM_{10} Annual	1	17.00	0.1184	0.0058	0.0128	0.0027	0.0026	0.0029	0.0019	0.0085	0.0068
PM_{10} 24-Hour*	5	30.00	2.0556	0.0542	0.2261	0.0729	0.0580	0.0461	0.0410	0.1139	0.0695
NO_2 Annual	1	25.00	0.2790	0.0037	0.0127	0.0014	0.0012	0.0010	0.0006	0.0076	0.0051
2002											
SO_2 Annual	1	20.00	0.0048	0.0002	0.0006	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002
SO_2 24-Hour*	5	91.00	0.0510	0.0027	0.0054	0.0021	0.0018	0.0011	0.0016	0.0049	0.0036
SO_2 3-Hour*	25	512.00	0.1963	0.0104	0.0180	0.0149	0.0059	0.0046	0.0052	0.0166	0.0123
PM_{10} Annual	1	17.00	0.0799	0.0047	0.0110	0.0018	0.0019	0.0027	0.0016	0.0062	0.0052
PM_{10} 24-Hour*	5	30.00	1.0053	0.0832	0.1381	0.0406	0.0386	0.0584	0.0329	0.0920	0.0848
NO_2 Annual	1	25.00	0.1716	0.0021	0.0146	0.0012	0.0009	0.0009	0.0007	0.0038	0.0027
2003											
SO_2 Annual	1	20.00	0.0042	0.0002	0.0006	0.0001	0.0001	0.0001	0.0001	0.0003	0.0002
SO_2 24-Hour*	5	91.00	0.0849	0.0018	0.0052	0.0015	0.0023	0.0010	0.0016	0.0029	0.0023
SO_2 3-Hour*	25	512.00	0.2366	0.0089	0.0173	0.0090	0.0088	0.0082	0.0060	0.0148	0.0103
PM_{10} Annual	1	17.00	0.0719	0.0037	0.0135	0.0020	0.0020	0.0020	0.0015	0.0053	0.0042
PM_{10} 24-Hour*	5	30.00	1.5269	0.0597	0.2157	0.0537	0.0533	0.0415	0.0398	0.0713	0.0686
NO_2 Annual	1	25.00	0.1517	0.0021	0.0130	0.0012	0.0013	0.0008	0.0008	0.0043	0.0029

* Highest second high at any monitor in the Class I area.

Table 4-15b. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for Alternative C.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL (μg/m^3)	PSD Increment (μg/m^3)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wilder ness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0054	0.0002	0.0004	0.0001	0.0001	0.0001	0.0001	0.0004	0.0003
SO_2 24-Hour*	5	91.00	0.1002	0.0021	0.0055	0.0022	0.0015	0.0015	0.0010	0.0046	0.0029
SO_2 3-Hour*	25	512.00	0.3315	0.0067	0.0187	0.0081	0.0077	0.0059	0.0053	0.0136	0.0087
PM_{10} Annual	1	17.00	0.2593	0.0157	0.0286	0.0072	0.0071	0.0078	0.0052	0.0233	0.0185
PM_{10} 24-Hour*	5	30.00	4.6561	0.1462	0.4982	0.1834	0.1558	0.1111	0.0995	0.2895	0.1899
NO_2 Annual	1	25.00	0.4550	0.0075	0.0200	0.0030	0.0025	0.0020	0.0012	0.0156	0.0105
2002											
SO_2 Annual	1	20.00	0.0035	0.0002	0.0005	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002
SO_2 24-Hour*	5	91.00	0.0365	0.0024	0.0044	0.0017	0.0015	0.0010	0.0013	0.0041	0.0031
SO_2 3-Hour*	25	512.00	0.1452	0.0095	0.0144	0.0135	0.0053	0.0044	0.0047	0.0138	0.0102
PM_{10} Annual	1	17.00	0.1764	0.0126	0.0261	0.0049	0.0050	0.0072	0.0043	0.0165	0.0139
PM_{10} 24-Hour*	5	30.00	2.0478	0.1854	0.3130	0.0981	0.0997	0.1349	0.0828	0.2150	0.1889
NO_2 Annual	1	25.00	0.2817	0.0042	0.0244	0.0024	0.0019	0.0019	0.0014	0.0077	0.0055
2003											
SO_2 Annual	1	20.00	0.0031	0.0002	0.0005	0.0001	0.0001	0.0001	0.0001	0.0002	0.0002
SO_2 24-Hour*	5	91.00	0.0614	0.0015	0.0041	0.0014	0.0020	0.0009	0.0014	0.0024	0.0020
SO_2 3-Hour*	25	512.00	0.1784	0.0075	0.0135	0.0080	0.0074	0.0067	0.0050	0.0124	0.0083
PM_{10} Annual	1	17.00	0.1559	0.0099	0.0307	0.0055	0.0056	0.0053	0.0041	0.0145	0.0115
PM_{10} 24-Hour*	5	30.00	3.2085	0.1437	0.4640	0.1466	0.1370	0.1035	0.1073	0.1717	0.1657
NO_2 Annual	1	25.00	0.2422	0.0042	0.0216	0.0025	0.0027	0.0016	0.0016	0.0086	0.0058

* Highest second high at any monitor in the Class I area.

Table 4-15c. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for the No Action Alternative.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wilder-ness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0015	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
SO_2 24-Hour*	5	91.00	0.0278	0.0007	0.0014	0.0007	0.0005	0.0005	0.0003	0.0014	0.0009
SO_2 3-Hour*	25	512.00	0.0841	0.0024	0.0048	0.0026	0.0021	0.0018	0.0017	0.0043	0.0029
PM_{10} Annual	1	17.00	0.0467	0.0025	0.0043	0.0011	0.0011	0.0012	0.0008	0.0037	0.0030
PM_{10} 24-Hour*	5	30.00	0.8113	0.0227	0.0654	0.0264	0.0219	0.0165	0.0152	0.0494	0.0317
NO_2 Annual	1	25.00	0.0607	0.0010	0.0026	0.0003	0.0003	0.0003	0.0001	0.0021	0.0014
2002											
SO_2 Annual	1	20.00	0.0010	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
SO_2 24-Hour*	5	91.00	0.0121	0.0008	0.0013	0.0006	0.0004	0.0003	0.0004	0.0013	0.0011
SO_2 3-Hour*	25	512.00	0.0388	0.0028	0.0040	0.0044	0.0019	0.0015	0.0016	0.0044	0.0037
PM_{10} Annual	1	17.00	0.0317	0.0019	0.0040	0.0007	0.0007	0.0010	0.0006	0.0025	0.0021
PM_{10} 24-Hour*	5	30.00	0.3667	0.0222	0.0404	0.0182	0.0135	0.0140	0.0121	0.0344	0.0291
NO_2 Annual	1	25.00	0.0386	0.0005	0.0030	0.0003	0.0002	0.0002	0.0002	0.0010	0.0007
2003											
SO_2 Annual	1	20.00	0.0008	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0001	0.0001
SO_2 24-Hour*	5	91.00	0.0160	0.0004	0.0011	0.0005	0.0006	0.0003	0.0005	0.0007	0.0006
SO_2 3-Hour*	25	512.00	0.0434	0.0021	0.0039	0.0026	0.0023	0.0018	0.0016	0.0033	0.0026
PM_{10} Annual	1	17.00	0.0265	0.0015	0.0045	0.0009	0.0009	0.0008	0.0006	0.0023	0.0018
PM_{10} 24-Hour*	5	30.00	0.4959	0.0190	0.0577	0.0246	0.0272	0.0145	0.0164	0.0232	0.0220
NO_2 Annual	1	25.00	0.0314	0.0005	0.0027	0.0003	0.0003	0.0002	0.0002	0.0011	0.0007

Table 4-16a. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for the Proposed Action plus the cumulative emissions.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL ($\mu g/m^3$)	PSD Incre-ment ($\mu g/m^3$)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wild-erness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0100	0.0012	0.0021	0.0007	0.0006	0.0007	0.0005	0.0019	0.0014
SO_2 24-Hour*	5	91.00	0.1546	0.0105	0.0216	0.0097	0.0084	0.0087	0.0067	0.0129	0.0101
SO_2 3-Hour*	25	512.00	0.4725	0.0321	0.0709	0.0297	0.0219	0.0234	0.0234	0.0503	0.0329
PM_{10} Annual	1	17.00	0.1434	0.0347	0.0370	0.0316	0.0268	0.0233	0.0176	0.0453	0.0397
PM_{10} 24-Hour*	5	30.00	2.3484	0.2648	0.4382	0.5200	0.6078	0.2438	0.3903	0.2888	0.3335
NO_2 Annual	1	25.00	0.3507	0.0481	0.2145	0.0396	0.0570	0.0505	0.0204	0.0511	0.0545
2002											
SO_2 Annual	1	20.00	0.0078	0.0011	0.0032	0.0005	0.0005	0.0007	0.0004	0.0016	0.0012
SO_2 24-Hour*	5	91.00	0.1105	0.0137	0.0581	0.0157	0.0065	0.0110	0.0063	0.0153	0.0137
SO_2 3-Hour*	25	512.00	0.2537	0.0419	0.1607	0.0654	0.0246	0.0477	0.0266	0.0633	0.0541
PM_{10} Annual	1	17.00	0.1043	0.0344	0.0478	0.0179	0.0179	0.0227	0.0135	0.0428	0.0379
PM_{10} 24-Hour*	5	30.00	1.2158	0.3356	0.5054	0.2665	0.2418	0.3051	0.1923	0.4387	0.3759
NO_2 Annual	1	25.00	0.2378	0.0513	0.2980	0.0261	0.0525	0.0546	0.0202	0.0500	0.0564
2003											
SO_2 Annual	1	20.00	0.0070	0.0009	0.0026	0.0005	0.0004	0.0005	0.0004	0.0013	0.0010
SO_2 24-Hour*	5	91.00	0.1299	0.0080	0.0328	0.0086	0.0058	0.0061	0.0057	0.0126	0.0078
SO_2 3-Hour*	25	512.00	0.3474	0.0186	0.1105	0.0268	0.0177	0.0276	0.0142	0.0450	0.0210
PM_{10} Annual	1	17.00	0.0898	0.0280	0.0442	0.0214	0.0193	0.0183	0.0126	0.0357	0.0317
PM_{10} 24-Hour*	5	30.00	1.6411	0.2942	0.4360	0.3027	0.2799	0.2544	0.1748	0.4726	0.3509
NO_2 Annual	1	25.00	0.2091	0.0477	0.3357	0.0353	0.0528	0.0491	0.0192	0.0480	0.0535

Table 4-16b. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for Alternative C plus the cumulative emissions.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL (µg/m³)	PSD Incre-ment (µg/m³)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wilder-ness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0079	0.0012	0.0019	0.0007	0.0006	0.0007	0.0004	0.0018	0.0014
SO_2 24-Hour*	5	91.00	0.1113	0.0104	0.0214	0.0097	0.0083	0.0087	0.0066	0.0127	0.0100
SO_2 3-Hour*	25	512.00	0.3488	0.0314	0.0696	0.0297	0.0213	0.0230	0.0231	0.0503	0.0327
PM_{10} Annual	1	17.00	0.2842	0.0446	0.0529	0.0362	0.0313	0.0282	0.0209	0.0601	0.0515
PM_{10} 24-Hour*	5	30.00	4.8156	0.2781	0.6092	0.6060	0.6252	0.2462	0.4140	0.4118	0.3379
NO_2 Annual	1	25.00	0.5267	0.0519	0.2218	0.0412	0.0583	0.0515	0.0211	0.0591	0.0599
2002											
SO_2 Annual	1	20.00	0.0064	0.0011	0.0031	0.0005	0.0005	0.0007	0.0004	0.0015	0.0012
SO_2 24-Hour*	5	91.00	0.1032	0.0133	0.0567	0.0157	0.0064	0.0109	0.0061	0.0152	0.0134
SO_2 3-Hour*	25	512.00	0.2280	0.0403	0.1594	0.0654	0.0245	0.0474	0.0261	0.0619	0.0533
PM_{10} Annual	1	17.00	0.2008	0.0423	0.0629	0.0210	0.0210	0.0272	0.0162	0.0531	0.0466
PM_{10} 24-Hour*	5	30.00	2.2583	0.4099	0.6417	0.3020	0.3014	0.3560	0.2470	0.4782	0.4097
NO_2 Annual	1	25.00	0.3479	0.0534	0.3078	0.0273	0.0535	0.0555	0.0209	0.0539	0.0592
2003											
SO_2 Annual	1	20.00	0.0059	0.0008	0.0025	0.0005	0.0004	0.0005	0.0003	0.0013	0.0010
SO_2 24-Hour*	5	91.00	0.1077	0.0077	0.0318	0.0086	0.0054	0.0060	0.0057	0.0126	0.0077
SO_2 3-Hour*	25	512.00	0.2785	0.0178	0.1100	0.0254	0.0171	0.0246	0.0142	0.0433	0.0202
PM_{10} Annual	1	17.00	0.1738	0.0342	0.0614	0.0249	0.0228	0.0216	0.0151	0.0450	0.0390
PM_{10} 24-Hour*	5	30.00	3.3227	0.3275	0.6171	0.3605	0.3228	0.2552	0.1967	0.5241	0.3886
NO_2 Annual	1	25.00	0.2995	0.0498	0.3442	0.0367	0.0542	0.0499	0.0200	0.0524	0.0564

Table 4-16c. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for the No Action Alternative plus the cumulative emissions.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL (μg/m³)	PSD Incre-ment (μg/m³)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wilde	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0041	0.0010	0.0016	0.0006	0.0005	0.0006	0.0004	0.0016	0.0012
SO_2 24-Hour*	5	91.00	0.0723	0.0101	0.0210	0.0097	0.0076	0.0085	0.0066	0.0120	0.0098
SO_2 3-Hour*	25	512.00	0.2161	0.0280	0.0665	0.0297	0.0201	0.0224	0.0187	0.0503	0.0309
PM_{10} Annual	1	17.00	0.0716	0.0314	0.0286	0.0300	0.0252	0.0216	0.0164	0.0405	0.0359
PM_{10} 24-Hour*	5	30.00	1.1062	0.2645	0.3322	0.5106	0.5717	0.2422	0.3597	0.2869	0.3329
NO_2 Annual	1	25.00	0.1324	0.0454	0.2044	0.0386	0.0562	0.0498	0.0200	0.0455	0.0508
2002											
SO_2 Annual	1	20.00	0.0040	0.0010	0.0028	0.0005	0.0004	0.0006	0.0004	0.0014	0.0011
SO_2 24-Hour*	5	91.00	0.0804	0.0124	0.0538	0.0157	0.0059	0.0092	0.0053	0.0144	0.0124
SO_2 3-Hour*	25	512.00	0.1552	0.0387	0.1576	0.0652	0.0241	0.0455	0.0234	0.0577	0.0511
PM_{10} Annual	1	17.00	0.0561	0.0316	0.0407	0.0168	0.0167	0.0210	0.0125	0.0391	0.0348
PM_{10} 24-Hour*	5	30.00	0.6204	0.3222	0.4277	0.2665	0.2232	0.2960	0.1661	0.4220	0.3624
NO_2 Annual	1	25.00	0.1049	0.0498	0.2864	0.0252	0.0519	0.0539	0.0197	0.0472	0.0544
2003											
SO_2 Annual	1	20.00	0.0037	0.0007	0.0021	0.0004	0.0004	0.0004	0.0003	0.0011	0.0008
SO_2 24-Hour*	5	91.00	0.0626	0.0067	0.0288	0.0080	0.0042	0.0058	0.0055	0.0124	0.0076
SO_2 3-Hour*	25	512.00	0.2129	0.0173	0.1084	0.0242	0.0148	0.0156	0.0142	0.0370	0.0174
PM_{10} Annual	1	17.00	0.0444	0.0259	0.0352	0.0203	0.0181	0.0171	0.0117	0.0327	0.0292
PM_{10} 24-Hour*	5	30.00	0.6282	0.2848	0.2777	0.2816	0.2770	0.2539	0.1747	0.4576	0.3400
NO_2 Annual	1	25.00	0.0887	0.0461	0.3253	0.0345	0.0519	0.0485	0.0186	0.0449	0.0513

Table 4-17a. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for the Proposed Action plus the cumulative emissions without RFD sources.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL ($\mu g/m^3$)	PSD Incre-ment ($\mu g/m^3$)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wilde	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0095	0.0008	0.0018	0.0003	0.0003	0.0004	0.0003	0.0013	0.0009
SO_2 24-Hour*	5	91.00	0.1502	0.0095	0.0209	0.0062	0.0048	0.0077	0.0048	0.0127	0.0097
SO_2 3-Hour*	25	512.00	0.4630	0.0278	0.0668	0.0220	0.0150	0.0186	0.0135	0.0503	0.0315
PM_{10} Annual	1	17.00	0.1349	0.0207	0.0321	0.0169	0.0161	0.0150	0.0107	0.0253	0.0230
PM_{10} 24-Hour*	5	30.00	2.2094	0.1478	0.3950	0.2863	0.2816	0.1382	0.2075	0.1544	0.1614
NO_2 Annual	1	25.00	0.3450	0.0445	0.2127	0.0307	0.0540	0.0486	0.0190	0.0442	0.0496
2002											
SO_2 Annual	1	20.00	0.0071	0.0008	0.0029	0.0003	0.0003	0.0004	0.0003	0.0011	0.0008
SO_2 24-Hour*	5	91.00	0.1090	0.0116	0.0571	0.0110	0.0044	0.0083	0.0044	0.0136	0.0117
SO_2 3-Hour*	25	512.00	0.2434	0.0369	0.1604	0.0399	0.0121	0.0362	0.0101	0.0571	0.0490
PM_{10} Annual	1	17.00	0.0950	0.0222	0.0401	0.0096	0.0113	0.0152	0.0084	0.0261	0.0239
PM_{10} 24-Hour*	5	30.00	1.1317	0.2936	0.3998	0.1450	0.1856	0.2218	0.1572	0.3435	0.2952
NO_2 Annual	1	25.00	0.2329	0.0480	0.2954	0.0209	0.0500	0.0527	0.0185	0.0441	0.0522
2003											
SO_2 Annual	1	20.00	0.0064	0.0005	0.0024	0.0002	0.0002	0.0003	0.0002	0.0008	0.0006
SO_2 24-Hour*	5	91.00	0.1298	0.0075	0.0324	0.0048	0.0038	0.0054	0.0049	0.0121	0.0077
SO_2 3-Hour*	25	512.00	0.3473	0.0186	0.1092	0.0164	0.0127	0.0167	0.0130	0.0403	0.0210
PM_{10} Annual	1	17.00	0.0838	0.0161	0.0385	0.0109	0.0115	0.0113	0.0073	0.0194	0.0178
PM_{10} 24-Hour*	5	30.00	1.6337	0.1745	0.3660	0.1570	0.1655	0.1574	0.0938	0.2578	0.2054
NO_2 Annual	1	25.00	0.2056	0.0437	0.3332	0.0270	0.0502	0.0477	0.0178	0.0412	0.0482

Table 4-17b. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for Alternative C plus the cumulative emissions without RFD sources.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Proposed SIL ($\mu g/m^3$)	PSD Increment ($\mu g/m^3$)	Bridger Butte	Deep Lake	Dinosaur National	Gros Ventre Wilderness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddlebag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0074	0.0008	0.0016	0.0003	0.0003	0.0004	0.0003	0.0012	0.0009
SO_2 24-Hour*	5	91.00	0.1077	0.0094	0.0208	0.0060	0.0047	0.0077	0.0048	0.0125	0.0097
SO_2 3-Hour*	25	512.00	0.3394	0.0276	0.0649	0.0217	0.0149	0.0180	0.0126	0.0503	0.0309
PM_{10} Annual	1	17.00	0.2757	0.0306	0.0480	0.0214	0.0206	0.0199	0.0140	0.0401	0.0347
PM_{10} 24-Hour*	5	30.00	4.8099	0.1928	0.5947	0.3594	0.2886	0.1885	0.2133	0.3149	0.2394
NO_2 Annual	1	25.00	0.5210	0.0483	0.2200	0.0323	0.0553	0.0496	0.0196	0.0522	0.0550
2002											
SO_2 Annual	1	20.00	0.0058	0.0007	0.0028	0.0003	0.0003	0.0004	0.0003	0.0011	0.0008
SO_2 24-Hour*	5	91.00	0.1017	0.0113	0.0557	0.0110	0.0043	0.0082	0.0044	0.0134	0.0114
SO_2 3-Hour*	25	512.00	0.2216	0.0364	0.1591	0.0399	0.0121	0.0359	0.0100	0.0557	0.0482
PM_{10} Annual	1	17.00	0.1915	0.0300	0.0551	0.0127	0.0144	0.0197	0.0111	0.0364	0.0326
PM_{10} 24-Hour*	5	30.00	2.1741	0.3481	0.5843	0.2023	0.2452	0.2984	0.2119	0.3703	0.3482
NO_2 Annual	1	25.00	0.3430	0.0501	0.3052	0.0221	0.0510	0.0536	0.0192	0.0480	0.0550
2003											
SO_2 Annual	1	20.00	0.0052	0.0005	0.0022	0.0002	0.0002	0.0003	0.0002	0.0008	0.0006
SO_2 24-Hour*	5	91.00	0.1076	0.0073	0.0314	0.0048	0.0038	0.0054	0.0049	0.0121	0.0077
SO_2 3-Hour*	25	512.00	0.2784	0.0178	0.1087	0.0162	0.0126	0.0137	0.0127	0.0386	0.0201
PM_{10} Annual	1	17.00	0.1678	0.0223	0.0557	0.0144	0.0150	0.0146	0.0099	0.0286	0.0250
PM_{10} 24-Hour*	5	30.00	3.3153	0.2373	0.5905	0.2323	0.1894	0.1639	0.1556	0.3092	0.2572
NO_2 Annual	1	25.00	0.2960	0.0458	0.3417	0.0283	0.0516	0.0485	0.0186	0.0456	0.0511

Table 4-17c. CALPUFF estimated PSD pollutant concentrations impacts at Class II areas for the No Action Alternative plus the cumulative emissions without RFD sources.

Species and Averaging Time	Class II Area Thresholds		CALPUFF at Class II Areas								
	Pro-posed SIL (μg/m^3)	PSD Increment (μg/m^3)	Bridger Butte	Deep Lake	Dino-saur National	Gros Ventre Wilder-ness	Lazy Boy Lake	Roadless Area	Ross Lake	Saddle-bag Lake	Upper Frozen Lake
2001											
SO_2 Annual	1	20.00	0.0035	0.0006	0.0013	0.0003	0.0003	0.0004	0.0002	0.0010	0.0007
SO_2 24-Hour*	5	91.00	0.0636	0.0090	0.0202	0.0059	0.0043	0.0075	0.0046	0.0118	0.0094
SO_2 3-Hour*	25	512.00	0.2157	0.0270	0.0606	0.0213	0.0148	0.0159	0.0116	0.0495	0.0304
PM_{10} Annual	1	17.00	0.0631	0.0174	0.0237	0.0153	0.0145	0.0133	0.0095	0.0205	0.0192
PM_{10} 24-Hour*	5	30.00	0.9817	0.1380	0.2755	0.2769	0.2762	0.1366	0.1920	0.1425	0.1543
NO_2 Annual	1	25.00	0.1267	0.0418	0.2026	0.0296	0.0531	0.0479	0.0186	0.0386	0.0459
2002											
SO_2 Annual	1	20.00	0.0033	0.0006	0.0024	0.0002	0.0002	0.0004	0.0002	0.0009	0.0007
SO_2 24-Hour*	5	91.00	0.0786	0.0103	0.0528	0.0100	0.0040	0.0075	0.0041	0.0123	0.0104
SO_2 3-Hour*	25	512.00	0.1549	0.0348	0.1573	0.0397	0.0117	0.0340	0.0092	0.0515	0.0460
PM_{10} Annual	1	17.00	0.0467	0.0193	0.0330	0.0085	0.0102	0.0135	0.0074	0.0224	0.0208
PM_{10} 24-Hour*	5	30.00	0.4866	0.2812	0.2978	0.1327	0.1572	0.1948	0.1303	0.2789	0.2566
NO_2 Annual	1	25.00	0.1000	0.0465	0.2838	0.0201	0.0493	0.0520	0.0180	0.0413	0.0502
2003											
SO_2 Annual	1	20.00	0.0030	0.0004	0.0019	0.0002	0.0002	0.0002	0.0001	0.0006	0.0005
SO_2 24-Hour*	5	91.00	0.0625	0.0064	0.0284	0.0045	0.0036	0.0051	0.0047	0.0119	0.0075
SO_2 3-Hour*	25	512.00	0.2122	0.0164	0.1071	0.0146	0.0125	0.0117	0.0117	0.0351	0.0173
PM_{10} Annual	1	17.00	0.0384	0.0140	0.0296	0.0098	0.0103	0.0101	0.0065	0.0164	0.0153
PM_{10} 24-Hour*	5	30.00	0.5673	0.1651	0.2637	0.1497	0.1629	0.1570	0.0936	0.2428	0.1946
NO_2 Annual	1	25.00	0.0852	0.0421	0.3229	0.0261	0.0492	0.0471	0.0172	0.0381	0.0461

Table 4-18. Comparison of maximum existing background concentrations (Table 4-5) plus maximum estimated impacts at any Class II area from Project Alternatives plus cumulative sources with federal and state ambient air quality standards.

Pollutant / Averaging Time	Ambient Air Quality Standards (μg/m³)				Estimated Impact (μg/m³)		
	National	Wyoming	Colorado	Utah	Total	Bckgd[1]	Incmnt[2]
Nitrogen Dioxide (NO_2)							
Annual	100	100	100	100	**8.2**	3.4	4.8
PM_{10}							
24-hour	150	150	150	150	**56**	48	7.8
Annual	50	50	50	50	**27**	25	1.8
$PM_{2.5}$							
24-hour	65	65	--	65	**23**	15	7.8
Annual	15	15	--	15	**6.8**	5	1.8
Sulfur Dioxide (SO_2)							
3-hour	1,300	1,300	700[5]	1,300	**30**	29	0.73
24-hour	365	260	100[5]	365	**18**	18	0.23
Annual	80	60	15[5]	80	**5**	5	0.065

3 Maximum current background concentration in the region (Table 4-5)
4 Maximum Cumulative Emissions Plus Project increment concentration at any Class I area for any of the modeling years (occurs at Moxa Class II Area and for 2002)

The CALPUFF-estimated maximum concentration increment due to any alternative with the cumulative emissions at any Class II area were combined with the existing maximum background concentrations (see Table 4-5) in the region to obtain a Total estimated concentrations that is compared against the NAAQS, WAAQS, UAAQS, and CAAQS in Table 4-18. The maximum CALPUFF-estimate impact due to any Project Alternative plus the cumulative sources always occurs at the Bridger Butte Class II Area and always occurs for Alternative C. Table 4-18 clearly shows that when the Project plus the cumulative source impacts at any Class II area are added to the maximum background concentrations to obtain a total concentration, federal or state ambient air quality standards would not be exceeded.

In summary, the modeling results indicate that, for the Proposed Action, Alternative C, and No Action, neither direct Project impacts nor Project impacts taken together with cumulative source impacts would exceed any air quality standards (WAAQS, UAAQS, CAAQS, and NAAQS) or PSD Class II area increments. The PSD demonstrations are for informational purposes only and do not constitute a regulatory PSD increment consumption analysis.

4.6.2 Sulfur and Nitrogen Deposition

Maximum predicted sulfur and nitrogen deposition impacts were estimated for each Project alternative and cumulative source scenarios. The POSTUTIL utility was used to estimate total S and N fluxes from CALPUFF predicted wet and dry fluxes of SO2, SO4, NOx, NO3, and HNO3. Note that the nitrogen associated with ammonium (NH_4) that is assumed to be bound to SO_4 and NO_3 was also included in the nitrogen deposition. CALPOST was then used to summarize the annual sulfur and nitrogen deposition values from the POSTUTIL program. The maximum total annual sulfur and nitrogen deposition at any receptor in each Class I and Class II area was reported. Predicted direct project impacts were compared to the NPS Deposition Analysis Thresholds (DATs) for total nitrogen and sulfur deposition in the western U.S., which are defined as 0.005 kg/ha-yr for both nitrogen and sulfur. Total deposition impacts from project alternatives, regional sources, and background values were also compared to Forest Service levels of concern, defined as 5 kg/ha-yr for sulfur and 3 kg/ha-yr for nitrogen (Fox et al. 1989). It is understood that the Forest Service no longer considers these levels to be protective; however, in the absence of alternative FLM-approved values, comparisons with these values were made. The maximum predicted total annual nitrogen and sulfur deposition impacts at Class I areas for the different Project alternatives are given in Table 4-19, whereas the maximum total annual nitorgen and sulfur deposition due to the project alternatives combined with the cumulative emissions are provided in Table 4-20. Modeling results for the Project and the Proposed Action and No Action alternatives indicate that there is no direct Project total nitrogen or sulfur deposition impacts above the NPS western DAT (0.005 kg/ha/yr) at any Class I area. For Alternative C, the maximum nitrogen deposition at the Bridger Class I area just barely exceeds (0.006-0.007 kg/ha/yr) the NPS DAT (0.005 kg/ha/yr) for the three years of modeling (Table 4-19b), but is below the DATs at other Class I areas.

For the project alternatives plus the cumulative emissions, the estimated sulfur deposition is below the NPS DAT for all three years of modeling at all Class I areas. The total nitrogen deposition at several of the Class I areas and years exceeds the NPS DAT due to the project alternatives combined with cumulative emissions. The maximum estimated annual nitrogen at any Class I area for the Project plus cumulative emissions occurs at the Bridger Class I area for 2001 with values of 0.031, 0.034, and 0.029 kg/ha/yr estimated for the Proposed Action, Alternative C, and No Action alternatives (combined with Cumulative Emissions). Although these maximum nitrogen deposition impacts are above the NPS DAT, they are approximately a factor of 100 lower than the Forest Service 3.0 kg/ha/yr level of concern.

When RFD emissions are removed from the cumulative inventory (Table 4-21), the sulfur deposition remains below the NPS DAT for all years and all Class I areas. The total nitrogen deposition at the Bridger, Fitzpatrick, and Mount Zirkel Class I areas exceeds the NPS DAT for all years and all three scenarios. Maximum estimated annual nitrogen (0.0286 kg/ha/yr) occurs at Bridger during 2001 for Alternative C. All maximum nitrogen deposition values are approximately a factor of 100 lower than the Forest Service 3.0 kg/ha/yr level of concern.

Table 4-19a. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for the Proposed Action.

Total Deposition	Nitrogen	Sulfur
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
Bridger		
2001	0.003323	0.000182
2002	0.002946	0.000159
2003	0.002731	0.000158
Fitzpatrick		
2001	0.001457	0.000088
2002	0.001497	0.000077
2003	0.001350	0.000081
Grand Teton		
2001	0.000992	0.000058
2002	0.001019	0.000054
2003	0.000832	0.000051
Mount Zirkel		
2001	0.002068	0.000130
2002	0.001840	0.000107
2003	0.002646	0.000155
Teton		
2001	0.001324	0.000067
2002	0.000931	0.000051
2003	0.001229	0.000083
Washakie		
2001	0.001373	0.000070
2002	0.000956	0.000054
2003	0.001431	0.000094

Table 4-19b. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for Alternative C.

Total Deposition	N	S
FS Threshold	*3.000*	*3.000*
NPS DAT	*0.005*	*0.005*
Bridger		
2001	0.006745	0.000158
2002	0.005914	0.000138
2003	0.005531	0.000138
Fitzpatrick		
2001	0.002941	0.000077
2002	0.003000	0.000068
2003	0.002754	0.000069
Grand Teton		
2001	0.001998	0.000051
2002	0.002037	0.000047
2003	0.001652	0.000043
Mount Zirkel		
2001	0.003983	0.000108
2002	0.003505	0.000087
2003	0.004985	0.000127
Teton		
2001	0.002668	0.000059
2002	0.001824	0.000044
2003	0.002469	0.000072
Washakie		
2001	0.002775	0.000061
2002	0.001888	0.000048
2003	0.002883	0.000081

Table 4-19c. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for the No Action alternative.

Total Deposition	N	S
FS Threshold	*3.000*	*3.000*
NPS DAT	*0.005*	*0.005*
Bridger		
2001	0.000886	0.000050
2002	0.000775	0.000044
2003	0.000716	0.000043
Fitzpatrick		
2001	0.000379	0.000024
2002	0.000375	0.000021
2003	0.000353	0.000022
Grand Teton		
2001	0.000250	0.000016
2002	0.000259	0.000015
2003	0.000218	0.000013
Mount Zirkel		
2001	0.000477	0.000031
2002	0.000429	0.000025
2003	0.000616	0.000037
Teton		
2001	0.000336	0.000018
2002	0.000243	0.000014
2003	0.000328	0.000023
Washakie		
2001	0.000351	0.000019
2002	0.000255	0.000015
2003	0.000388	0.000026

Table 4-20a. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for the Proposed Action and Cumulative Emissions.

Total Deposition	N	S
FS Threshold	*3.000*	*5.000*
NPS DAT	*0.005*	*0.005*
Bridger		
2001	0.030590	0.000905
2002	0.028162	0.000876
2003	0.029676	0.000762
Fitzpatrick		
2001	0.016638	0.000398
2002	0.018862	0.000442
2003	0.016587	0.000383
Grand Teton		
2001	0.005481	0.000249
2002	0.005434	0.000252
2003	0.005085	0.000233
Mount Zirkel		
2001	0.013974	0.001357
2002	0.014172	0.001367
2003	0.017248	0.001758
Teton		
2001	0.006530	0.000350
2002	0.004609	0.000233
2003	0.005073	0.000277
Washakie		
2001	0.006298	0.000358
2002	0.005085	0.000247
2003	0.005877	0.000299

Table 4-20b. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for Alternative C and Cumulative Emissions.

Total Deposition	N	S
FS Threshold	*3.000*	*5.000*
NPS DAT	*0.005*	*0.005*
Bridger		
2001	0.033630	0.000881
2002	0.030816	0.000854
2003	0.032293	0.000742
Fitzpatrick		
2001	0.018122	0.000387
2002	0.020363	0.000432
2003	0.017991	0.000374
Grand Teton		
2001	0.006471	0.000242
2002	0.006447	0.000245
2003	0.005847	0.000227
Mount Zirkel		
2001	0.015889	0.001335
2002	0.015815	0.001348
2003	0.019587	0.001730
Teton		
2001	0.007746	0.000342
2002	0.005501	0.000226
2003	0.006258	0.000266
Washakie		
2001	0.007681	0.000349
2002	0.006017	0.000240
2003	0.007329	0.000286

Table 4-20c. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for the No Action alternative and Cumulative Emissions.

Total Deposition	N	S
FS Threshold	***3.000***	***5.000***
NPS DAT	***0.005***	***0.005***
Bridger		
2001	0.028638	0.000773
2002	0.026251	0.000762
2003	0.027780	0.000647
Fitzpatrick		
2001	0.015561	0.000335
2002	0.017746	0.000386
2003	0.015590	0.000331
Grand Teton		
2001	0.004748	0.000207
2002	0.004676	0.000214
2003	0.004568	0.000204
Mount Zirkel		
2001	0.012382	0.001259
2002	0.012775	0.001286
2003	0.015218	0.001640
Teton		
2001	0.005634	0.000301
2002	0.003920	0.000196
2003	0.004223	0.000220
Washakie		
2001	0.005298	0.000307
2002	0.004384	0.000208
2003	0.004834	0.000231

Table 4-21a. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for the Proposed Action and Cumulative Emissions with no RFD sources.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRID		
2001	2.59E-02	5.65E-04
2002	2.40E-02	6.00E-04
2003	2.47E-02	4.43E-04
FITZ		
2001	1.48E-02	2.57E-04
2002	1.65E-02	2.75E-04
2003	1.47E-02	2.22E-04
GRTE		
2001	4.18E-03	1.59E-04
2002	4.19E-03	1.61E-04
2003	3.74E-03	1.55E-04
MOZE		
2001	1.18E-02	9.80E-04
2002	1.19E-02	1.01E-03
2003	1.44E-02	1.27E-03
TETO		
2001	5.00E-03	2.44E-04
2002	3.67E-03	1.51E-04
2003	3.91E-03	1.80E-04
WASH		
2001	4.91E-03	2.52E-04
2002	4.02E-03	1.72E-04
2003	4.48E-03	1.90E-04

Table 4-21b. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for Alternative C and Cumulative Emissions with no RFD sources.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRID		
2001	2.86E-02	5.43E-04
2002	2.66E-02	5.78E-04
2003	2.73E-02	4.23E-04
FITZ		
2001	1.63E-02	2.46E-04
2002	1.80E-02	2.66E-04
2003	1.61E-02	2.13E-04
GRTE		
2001	5.17E-03	1.52E-04
2002	5.20E-03	1.54E-04
2003	4.50E-03	1.48E-04
MOZE		
2001	1.37E-02	9.58E-04
2002	1.36E-02	9.95E-04
2003	1.67E-02	1.24E-03
TETO		
2001	6.23E-03	2.35E-04
2002	4.56E-03	1.44E-04
2003	5.09E-03	1.69E-04
WASH		
2001	6.29E-03	2.43E-04
2002	4.95E-03	1.66E-04
2003	5.93E-03	1.77E-04

Table 4-21c. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Bridger, Fitzpatrick, Grand Teton, Mount Zirkel, Teton, and Washakie Class I areas for three year CALPUFF modeling for the No Action alternative and Cumulative Emissions with no RFD sources.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRID		
2001	2.39E-02	4.44E-04
2002	2.21E-02	4.86E-04
2003	2.28E-02	3.35E-04
FITZ		
2001	1.37E-02	1.93E-04
2002	1.54E-02	2.20E-04
2003	1.37E-02	1.70E-04
GRTE		
2001	3.45E-03	1.17E-04
2002	3.44E-03	1.21E-04
2003	3.30E-03	1.18E-04
MOZE		
2001	1.02E-02	8.83E-04
2002	1.05E-02	9.33E-04
2003	1.24E-02	1.15E-03
TETO		
2001	4.10E-03	1.95E-04
2002	2.98E-03	1.14E-04
2003	3.06E-03	1.23E-04
WASH		
2001	3.91E-03	2.01E-04
2002	3.32E-03	1.34E-04
2003	3.43E-03	1.22E-04

The maximum predicted total annual nitrogen and sulfur deposition impacts at Class II areas for the different Project alternatives are given in Tables 4-22 a-c. For the Proposed Action alone, the estimated sulfur deposition is below the NPS DAT for all Class II areas (Note that the NPS DATs were developed for Class I areas, their competitions against deposition in Class II areas are provided as information only.). The estimated nitrogen deposition exceeds the NPS DAT for the Bridger Butte and Dinosaur National Monument Areas, with the deposition at Bridger Butte reaching a maximum value of 0.0329 kg/ha/yr, or approximately 1% of the Forest Service 3.0 kg/ha/yr level of concern. In Alternative C, the NPS DAT is exceeded for nitrogen at Bridger Butte, Dinosaur National Monument, and Lower Saddlebag Lake, but deposition levels remain below the Forest Service 3.0 kg/ha/yr level of concern. For the No Action alternative, the NPS DAT is exceeded only at Bridger Butte during 2001.

For the Project alternatives plus the cumulative emissions (Table 4-23 a-c), the estimated sulfur deposition is below the NPS DAT for all sites and all years. The total nitrogen deposition at all Class II areas and all modeling years due to all the Project alternatives combined with Cumulative Emissions exceeds the NPS DAT. The maximum estimated annual nitrogen at any Class II area occurs for the project alternatives plus cumulative emissions at the Dinosaur National Monument Class II area for 2003 with values of 0.0745 kg/ha/yr, 0.0782 kg/ha/yr, and 0.0704 kg/ha/yr estimated for the Proposed Action, Alternative C, and No Action alternatives (combined with Cumulative Emissions). These values correspond to approximately 3% of the Forest Service 3.0 kg/ha/yr level of concern.

When RFD sources are removed from the Cumulative Emissions inventory (Table 4-24), the estimated sulfur deposition remains below the NPS DAT. For nitrogen, the NPS DAT are exceeded for all sites and all years for the Proposed Action and Alternative C, and for all sites except Gros Ventre Wilderness for the No Action alternative. As in the previous case, the maximum values for all three years occur at the Dinosaur National Monument (0.0734 kg/ha/yr, 0.0770 kg/ha/yr, and 0.0692 kg/ha/yr for the Proposed Action, Alternative C, and No Action alternatives, respectively). The Forest Service 3.0 kg/ha/yr level of concern is not exceeded for any project alternative plus cumulative emissions, less the RFD sources for nitrogen or sulfur.

Table 4-22a . Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for the Proposed Action.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	3.29E-02	1.40E-03
2002	2.17E-02	9.76E-04
2003	2.09E-02	8.80E-04
DEE		
2001	1.99E-03	1.23E-04
2002	2.32E-03	1.30E-04
2003	1.81E-03	1.15E-04
DIN		
2001	4.62E-03	2.81E-04
2002	4.88E-03	2.55E-04
2003	5.23E-03	2.74E-04
GEO		
2001	1.35E-03	6.84E-05
2002	1.16E-03	6.15E-05
2003	1.09E-03	6.13E-05
LAZ		
2001	1.10E-03	6.33E-05
2002	1.20E-03	6.27E-05
2003	1.15E-03	6.66E-05
ROA		
2001	1.24E-03	8.21E-05
2002	1.40E-03	7.44E-05
2003	1.06E-03	6.30E-05
ROS		
2001	8.98E-04	5.46E-05
2002	1.08E-03	5.64E-05
2003	1.04E-03	6.62E-05
SAD		
2001	2.71E-03	1.54E-04
2002	2.74E-03	1.54E-04
2003	2.29E-03	1.40E-04
UPP		
2001	2.24E-03	1.34E-04
2002	2.45E-03	1.37E-04
2003	2.00E-03	1.24E-04

Table 4-22b. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for Alternative C.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	5.35E-02	1.01E-03
2002	3.56E-02	7.00E-04
2003	3.40E-02	6.47E-04
DEE		
2001	3.98E-03	1.05E-04
2002	4.65E-03	1.14E-04
2003	3.65E-03	9.91E-05
DIN		
2001	7.71E-03	2.06E-04
2002	8.41E-03	1.91E-04
2003	8.86E-03	2.02E-04
GEO		
2001	2.75E-03	6.00E-05
2002	2.33E-03	5.34E-05
2003	2.26E-03	5.37E-05
LAZ		
2001	2.23E-03	5.50E-05
2002	2.41E-03	5.45E-05
2003	2.35E-03	5.74E-05
ROA		
2001	2.48E-03	7.11E-05
2002	2.81E-03	6.52E-05
2003	2.17E-03	5.51E-05
ROS		
2001	1.81E-03	4.73E-05
2002	2.16E-03	4.90E-05
2003	2.10E-03	5.66E-05
SAD		
2001	5.47E-03	1.33E-04
2002	5.49E-03	1.32E-04
2003	4.62E-03	1.21E-04
UPP		
2001	4.50E-03	1.15E-04
2002	4.92E-03	1.19E-04
2003	4.02E-03	1.08E-04

Table 4-22c. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for the No Action alternative.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	7.18E-03	2.89E-04
2002	4.90E-03	2.10E-04
2003	4.36E-03	1.79E-04
DEE		
2001	5.12E-04	3.30E-05
2002	6.03E-04	3.69E-05
2003	4.66E-04	3.12E-05
DIN		
2001	9.92E-04	6.00E-05
2002	1.04E-03	5.53E-05
2003	1.09E-03	5.86E-05
GEO		
2001	3.48E-04	1.91E-05
2002	3.05E-04	1.67E-05
2003	3.03E-04	1.73E-05
LAZ		
2001	2.91E-04	1.74E-05
2002	3.14E-04	1.71E-05
2003	3.03E-04	1.79E-05
ROA		
2001	3.18E-04	2.20E-05
2002	3.48E-04	2.06E-05
2003	2.83E-04	1.74E-05
ROS		
2001	2.37E-04	1.48E-05
2002	2.80E-04	1.54E-05
2003	2.77E-04	1.76E-05
SAD		
2001	7.07E-04	4.20E-05
2002	7.12E-04	4.22E-05
2003	5.93E-04	3.78E-05
UPP		
2001	5.80E-04	3.63E-05
2002	6.39E-04	3.87E-05
2003	5.13E-04	3.37E-05

Table 4-23a. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for 3-year CALPUFF modeling for the Proposed Action and Cumulative Emissions.

Total Deposition	N	S
FS Threshold	*3.000*	*3.000*
NPS DAT	*0.005*	*0.005*
BRB		
2001	4.37E-02	2.04E-03
2002	3.30E-02	1.92E-03
2003	3.13E-02	1.67E-03
DEE		
2001	1.30E-02	6.11E-04
2002	1.53E-02	6.60E-04
2003	1.29E-02	5.38E-04
DIN		
2001	5.05E-02	9.02E-04
2002	6.48E-02	1.30E-03
2003	7.45E-02	1.26E-03
GEO		
2001	1.32E-02	3.78E-04
2002	1.02E-02	3.45E-04
2003	1.14E-02	3.35E-04
LAZ		
2001	1.15E-02	3.34E-04
2002	1.20E-02	3.24E-04
2003	1.07E-02	2.97E-04
ROA		
2001	1.08E-02	3.87E-04
2002	1.33E-02	4.47E-04
2003	1.07E-02	3.65E-04
ROS		
2001	6.84E-03	3.00E-04
2002	8.18E-03	2.97E-04
2003	6.45E-03	2.72E-04
SAD		
2001	1.61E-02	8.16E-04
2002	1.77E-02	8.58E-04
2003	1.53E-02	6.81E-04
UPP		
2001	1.44E-02	6.64E-04
2002	1.64E-02	7.00E-04
2003	1.42E-02	5.78E-04

Table 4-23b. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for 3-year CALPUFF modeling for Alternative C and Cumulative Emissions.

Total Deposition	N	S
FS Threshold	*3.000*	*3.000*
NPS DAT	*0.005*	*0.005*
BRB	6.43E-02	1.64E-03
2001	4.69E-02	1.64E-03
2002	4.44E-02	1.43E-03
2003		
DEE	1.49E-02	5.93E-04
2001	1.77E-02	6.43E-04
2002	1.48E-02	5.23E-04
2003		
DIN	5.36E-02	8.27E-04
2001	6.84E-02	1.23E-03
2002	7.82E-02	1.18E-03
2003		
GEO	1.46E-02	3.69E-04
2001	1.14E-02	3.37E-04
2002	1.26E-02	3.28E-04
2003		
LAZ	1.26E-02	3.26E-04
2001	1.32E-02	3.16E-04
2002	1.19E-02	2.88E-04
2003		
2003		
ROA	1.20E-02	3.76E-04
2001	1.47E-02	4.38E-04
2002	1.18E-02	3.57E-04
2003		
ROS	7.76E-03	2.92E-04
2001	9.26E-03	2.89E-04
2002	7.51E-03	2.62E-04
2003		
SAD	1.89E-02	7.95E-04
2001	2.05E-02	8.37E-04
2002	1.77E-02	6.63E-04
2003		
UPP	1.66E-02	6.45E-04
2001	1.89E-02	6.83E-04
2002	1.63E-02	5.61E-04
2003	6.43E-02	1.64E-03

Table 4-23c. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for the No Action alternative and Cumulative Emissions.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	1.79E-02	9.27E-04
2002	1.61E-02	1.15E-03
2003	1.47E-02	9.64E-04
DEE		
2001	1.15E-02	5.21E-04
2002	1.36E-02	5.66E-04
2003	1.16E-02	4.55E-04
DIN		
2001	4.68E-02	6.81E-04
2002	6.10E-02	1.10E-03
2003	7.04E-02	1.04E-03
GEO		
2001	1.22E-02	3.28E-04
2002	9.37E-03	3.01E-04
2003	1.06E-02	2.91E-04
LAZ		
2001	1.07E-02	2.88E-04
2002	1.11E-02	2.79E-04
2003	9.89E-03	2.48E-04
ROA		
2001	9.87E-03	3.27E-04
2002	1.23E-02	3.93E-04
2003	9.95E-03	3.20E-04
ROS		
2001	6.18E-03	2.60E-04
2002	7.38E-03	2.56E-04
2003	5.69E-03	2.23E-04
SAD		
2001	1.41E-02	7.04E-04
2002	1.57E-02	7.47E-04
2003	1.36E-02	5.80E-04
UPP		
2001	1.27E-02	5.66E-04
2002	1.46E-02	6.02E-04
2003	1.28E-02	4.87E-04

Table 4-24a. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for the Proposed Action and Cumulative Emissions with no RFD.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	4.27E-02	1.91E-03
2002	3.18E-02	1.77E-03
2003	3.02E-02	1.47E-03
DEE		
2001	1.08E-02	4.19E-04
2002	1.29E-02	4.61E-04
2003	1.06E-02	3.40E-04
DIN		
2001	4.96E-02	7.78E-04
2002	6.37E-02	1.16E-03
2003	7.34E-02	1.13E-03
GEO		
2001	9.86E-03	1.98E-04
2002	7.90E-03	2.05E-04
2003	8.44E-03	1.85E-04
LAZ		
2001	9.85E-03	2.02E-04
2002	1.02E-02	2.01E-04
2003	9.10E-03	1.70E-04
ROA		
2001	9.51E-03	2.75E-04
2002	1.12E-02	2.80E-04
2003	9.22E-03	2.25E-04
ROS		
2001	5.67E-03	2.01E-04
2002	6.67E-03	1.88E-04
2003	5.21E-03	1.69E-04
SAD		
2001	1.28E-02	5.46E-04
2002	1.44E-02	6.02E-04
2003	1.23E-02	4.38E-04
UPP		
2001	1.18E-02	4.47E-04
2002	1.37E-02	4.85E-04
2003	1.16E-02	3.59E-04

Table 4-24b. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for Alternative C and Cumulative Emissions with no RFD.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	6.33E-02	1.52E-03
2002	4.57E-02	1.49E-03
2003	4.34E-02	1.23E-03
DEE		
2001	1.28E-02	4.02E-04
2002	1.52E-02	4.45E-04
2003	1.24E-02	3.24E-04
DIN		
2001	5.27E-02	7.03E-04
2002	6.72E-02	1.10E-03
2003	7.70E-02	1.06E-03
GEO		
2001	1.13E-02	1.89E-04
2002	9.07E-03	1.97E-04
2003	9.61E-03	1.77E-04
LAZ		
2001	1.10E-02	1.94E-04
2002	1.14E-02	1.93E-04
2003	1.03E-02	1.61E-04
ROA		
2001	1.07E-02	2.64E-04
2002	1.26E-02	2.71E-04
2003	1.03E-02	2.17E-04
ROS		
2001	6.58E-03	1.94E-04
2002	7.75E-03	1.81E-04
2003	6.27E-03	1.59E-04
SAD		
2001	1.56E-02	5.25E-04
2002	1.71E-02	5.80E-04
2003	1.46E-02	4.19E-04
UPP		
2001	1.41E-02	4.29E-04
2002	1.61E-02	4.67E-04
2003	1.36E-02	3.42E-04

Table 4-24c. Maximum Nitrogen and Sulfur deposition (kg/ha/yr) in the Class II areas for three year CALPUFF modeling for the No Action alternative and Cumulative Emissions with no RFD.

Total Deposition	N	S
FS Threshold	***3.000***	***3.000***
NPS DAT	***0.005***	***0.005***
BRB		
2001	1.69E-02	8.05E-04
2002	1.50E-02	1.00E-03
2003	1.37E-02	7.65E-04
DEE		
2001	9.32E-03	3.30E-04
2002	1.12E-02	3.68E-04
2003	9.25E-03	2.56E-04
DIN		
2001	4.60E-02	5.57E-04
2002	5.99E-02	9.63E-04
2003	6.92E-02	9.11E-04
GEO		
2001	8.86E-03	1.48E-04
2002	7.04E-03	1.61E-04
2003	7.65E-03	1.40E-04
LAZ		
2001	9.04E-03	1.56E-04
2002	9.33E-03	1.55E-04
2003	8.26E-03	1.21E-04
ROA		
2001	8.59E-03	2.15E-04
2002	1.02E-02	2.26E-04
2003	8.44E-03	1.79E-04
ROS		
2001	5.00E-03	1.61E-04
2002	5.87E-03	1.47E-04
2003	4.45E-03	1.20E-04
SAD		
2001	1.08E-02	4.34E-04
2002	1.24E-02	4.90E-04
2003	1.06E-02	3.36E-04
UPP		
2001	1.02E-02	3.50E-04
2002	1.19E-02	3.87E-04
2003	1.01E-02	2.68E-04

4.6.3 Acid Neutralizing Capacity Calculations for Sensitive Lakes

The CALPUFF-estimated annual deposition fluxes of sulfur and nitrogen at sensitive lake receptors were used to estimate the change in ANC. The change in ANC was calculated following the January 2000, USDA Forest Service Rocky Mountain Region's *Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide* (USDA Forest Service 2000). The predicted changes in ANC are compared with the USDA Forest Service's Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 microequivalents per liter (μeq/l) and 1 μeq/l for lakes with background ANC values of 25 μeq/l or less. Of the lakes in the study area identified by the USDA Forest Service as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive as they have ANC values of les than 25 μeq/l (6 μeq/l and 10.8 μeq/l, respectively, see Table 4-9). However, at the time of the writing of this preliminary draft AQTSD we did not have the Watershed Area for the Lazy Boy lake so could not perform the ANC calculations for that one lake. These calculations will be updated in subsequent drafts of this AQTSD.

ANC calculations were performed for each of the Project alternatives plus cumulative emissions, with the results presented in Tables 4-25 a-c. For the five sensitive lakes that start with 10% ANC values above 25 μeq/l, for which a change in ANC above 10% is a concern, the maximum changes in ANC are estimated to range from 0.4% to 1.4% so the deposition impacts from direct Project and cumulative emissions would not contribute significantly to an increase in acidification at any of the five sensitive lakes with starting 10% ANC > 25 μeq/l. The Upper Frozen and Lazy Boy lakes are the only lakes starting with 10% ANC < 25 μeq/l for which a change in ANC greater than 1 μeq/l may be a cause for concern. The estimated change in ANC at these two lakes range from 0.14 to 0.61 μeq/l for the project alternatives plus cumulative emission scenarios. Thus the Project's Proposed Action, Alternative C, or No Action alternatives plus the cumulative emissions are estimated to have no adverse impact on lake acidity at any lake in the region.

Table 4-25a. Lake Acid Neutralizing Capacity (ANC) calculations for the Proposed Action plus cumulative emissions.

Lake	10% ANC (ueq/l)	Sample Size	Anu Avg Precip(in)	Ds(kg/ha/yr)	Dn(kg/ha/yr)	ANC(o)(eq)	Hdep(eq)	% ANC change	ANC change in ueq/l
Black Joe	67.1	67	9.3	0.000599	0.015094	94515.709	992.837	1.050	0.472249
Deep	59.7	64	9.3	0.000628	0.015917	19369.556	241.120	1.245	0.497923
Hobbs	69.9	71	9.3	0.000435	0.019802	32414.271	422.400	1.303	0.610295
Lazy Boy	10.8	3	9.3	0.000299	0.008625	3418.576	126.951	3.714	0.268713
Upper Frozen	6.0	8	9.3	0.000679	0.017249	615.344	82.589	13.422	0.539551
Ross	53.7	49	10	0.000290	0.007330	407127.570	2413.327	0.593	0.213272
Lower Saddlebag	55.2	48	30	0.000781	0.016483	43681.802	190.057	0.435	0.160915

Table 4-25b. Lake Acid Neutralizing Capacity (ANC) calculations for Alternative C plus cumulative emissions.

Lake	10% ANC (ueq/l)	Sample Size	Anu Avg Precip(in)	Ds(kg/ha/yr)	Dn(kg/ha/yr)	ANC(o)(eq)	Hdep(eq)	% ANC change	ANC change in ueq/l
Black Joe	67.1	67	9.3	0.000582	0.017198	94515.709	1125.690	1.191	0.535442
Deep	59.7	64	9.3	0.000611	0.018132	19369.556	273.326	1.411	0.564430
Hobbs	69.9	71	9.3	0.000425	0.021408	32414.271	455.822	1.406	0.658584
Lazy Boy	10.8	3	9.3	0.000291	0.009708	1111.037	46.252	4.163	0.301233
Upper Frozen	6	8	9.3	0.000661	0.019650	615.344	93.626	15.215	0.611652
Ross	53.7	49	10	0.000282	0.008347	407127.570	2734.519	0.672	0.241657
Lower Saddlebag	55.2	48	30	0.000760	0.019095	43681.802	218.780	0.501	0.185234

Table 4-25c. Lake Acid Neutralizing Capacity (ANC) calculations for the No Action plus cumulative emissions.

Lake	10% ANC (ueq/l)	Sample Size	Anu Avg Precip(in)	Ds(kg/ha/yr)	Dn(kg/ha/yr)	ANC(o)(eq)	Hdep(eq)	% ANC change	ANC change in ueq/l
Black Joe	67.1	67	9.3	0.000509	0.013547	94515.709	889.533	0.941	0.423112
Deep	59.7	64	9.3	0.000534	0.014293	19369.556	216.129	1.116	0.446316
Hobbs	69.9	71	9.3	0.000376	0.018650	32414.271	397.206	1.225	0.573894
Lazy Boy	10.8	3	9.3	0.000255	0.007841	1111.037	37.441	3.370	0.243849
Upper Frozen	6	8	9.3	0.000579	0.015492	615.344	74.051	12.034	0.483770
Ross	53.7	49	10	0.000247	0.006592	407127.570	2166.498	0.532	0.191459
Lower Saddlebag	55.2	48	30	0.000672	0.014570	43681.802	167.821	0.384	0.142089

4.6.4 Visibility

The CALPUFF model-predicted concentration impacts at far-field PSD Class I receptors were post-processed with CALPOST to estimate potential impacts to visibility (regional haze) for each analyzed alternative and cumulative sources for comparison to visibility impact thresholds. CALPOST estimated visibility impacts from predicted concentrations of PMC, PMF, SO4, and NO3 using the original IMPROVE reconstructed mass extinction equation (Malm, et al., 2000) as recommended by FLAG (2000) and EPA (2003a,b).

Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in FLAG (2000) report results as a percent change in light extinction over Natural Background Conditions. The thresholds of concern are defined as 5% and 10% changes over the reference background visibility for projects sources alone and cumulative source impacts, respectively. Visibility impacts have also been expressed as a change in dv over Natural Background where a 1.0 and 0.5 change in dv is essentially numerically equivalent to a 10% and 5% change in extinction over Natural Background. The BLM considers a 1.0 dv change as a significant adverse impact; however, there are no applicable local, state, tribal, or federal regulatory visibility standards. Note that a 10% change in extinction and a 1.0 change in dv over natural conditions are almost equivalent metrics.

4.6.4.1 Visibility Assessment Methods

As discussed in Section 4.5.2, several visibility assessment methods were used to analyze the potential visibility impacts due to the Project alone for its various alternatives and the Project plus the cumulative emissions. These methods differ on what background Natural Conditions are used (FLAG, IMPROVE, or EPA Default) and whether hourly (MVISBK=2) or monthly (MVISBK=6) relative humidity adjustment factors [f(RH)] are used. The methods analyzed were as follows:

Method 1 -- FLAG Monthly f(RH) and FLAG Seasonal Natural Conditions: Method 1 uses the FLAG (2000) default monthly average f(RH) factors that are built into CALPOST (MVISBK=6) and the FLAG seasonal background conditions listed in Table 4-6.

Method 2 – FLAG Monthly f(RH) and IMPROVE Natural Conditions: Method 2 uses the same FLAG default monthly average f(RH) values but for Natural Conditions uses data from the IMPROVE sites and the Best 20% days from the 2000-2004 5-year baseline.

Method 3a – FLAG Monthly f(RH) and EPA Default Annual Natural Conditions: Method 3a uses the same f(RH) as in Methods 1 and 2 only is using the EPA Default Annual Average Natural Conditions (EPA, 2003b).

Method 3b – FLAG Monthly f(RH) and EPA Default Annual Natural Conditions: Method 3b uses the same f(RH) as in Methods 1 and 2 only is using the EPA Default Best 20% Days Natural Conditions (EPA, 2003b).

Method 4 -- FLAG Hourly f(RH) and FLAG Seasonal Natural Conditions: Method 4 uses the FLAG (2000) hourly average f(RH) factors that are built into CALPOST (MVISBK=2) and the FLAG seasonal background conditions listed in Table 4-6.

4.6.4.2 Visibility Impacts on Class I Areas due to the Project Alternatives Alone

Table 4-26 (a-e) lists the CALPUFF-estimated visibility impacts at the Class I areas due to the various Project alternatives using the five calculation methods described above. The BLM considers a 1.0

change in dv (approximately a 10% change in extinction) to be an adverse impact. Only the No Action alternative has all of its visibility impacts below the 0.5 dv and 1.0 dv change significance thresholds at all Class I Areas. For both the Proposed Action and Alternative C, there are days with estimated changes in extinction above both the 0.5 dv and 1.0 dv change visibility thresholds of concern using the various methods. The largest visibility impacts are estimated to occur at the Bridger Class I area. For example, using Method 3a to estimate the visibility impacts for the Proposed Action and Alternative C, the 1 dv visibility threshold is estimated to be exceeded at Bridger for 2 and 13 days, respectively, for the three years of modeling; the 0.5 dv visibility threshold is estimated to be exceeded at Bridger for 9 and 43 days. The Proposed Action alternative estimates between 1 and 3 days across 3 years at Bridger (0.09% to 0.3% of the time) exceed the 1.0 dv threshold using the 4 methods. Similar results for Alternative C range from 2 to 23 days (0.2% to 2.0% of the time). Across the 2001-2003 period, between 1 and 10 days exceed the 0.5 dv threshold at Bridger using various methods for the Proposed Action. For Alternative C, the 0.5 dv threshold is exceeded between 7 and 39 days across all years at Bridger. The largest visibility impacts are estimated using Method 3b that compares the change in extinction against the EPA default Natural Conditions for the best 20% days.

Proposed New FLAG guidance is reported to be adopting the 98th percentile visibility impact, which would be the 8th highest value in a year and the 22nd highest value in 3 years. None of the Project alternatives have a 98th percentile visibility impact greater than 1.0 dv at any Class I area across all 3 years of modeling.

Table 4-26a. CALPUFF-estimated visibility impacts on Class I areas for the various Project alternatives along using Method 1 -- FLAG Monthly f(RH) with FLAG Seasonal Background.

	Proposed Action			Alternative C			Alternative A - No Action		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	3	1	1.028	18	5	2.096	0	0	0.309
2002	1	1	1.098	5	1	2.186	0	0	0.256
2003	1	0	0.65	9	2	1.253	0	0	0.216
FITZ									
2001	0	0	0.42	3	0	0.871	0	0	0.114
2002	1	0	0.751	1	1	1.457	0	0	0.16
2003	0	0	0.334	2	0	0.67	0	0	0.097
GRTE									
2001	0	0	0.282	1	0	0.579	0	0	0.082
2002	0	0	0.162	0	0	0.336	0	0	0.047
2003	0	0	0.154	0	0	0.31	0	0	0.043
MOZI									
2001	0	0	0.253	1	0	0.515	0	0	0.088
2002	0	0	0.286	1	0	0.553	0	0	0.06
2003	0	0	0.231	0	0	0.454	0	0	0.053
TETO									
2001	0	0	0.194	0	0	0.393	0	0	0.047
2002	0	0	0.12	0	0	0.236	0	0	0.04
2003	0	0	0.097	0	0	0.21	0	0	0.029
WASH									
2001	0	0	0.144	0	0	0.288	0	0	0.037
2002	0	0	0.19	0	0	0.409	0	0	0.093
2003	0	0	0.135	0	0	0.298	0	0	0.043

Table 4-26b. CALPUFF-estimated visibility impacts on Class I areas for the various Project alternatives along using Method 2 -- FLAG Monthly f(RH) with IMPROVE Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A - No Action**		
	#Days ≥ 0.5∈dv	**# Days ≥ 1.0∈dv**	**Max (dv)**	**#Days ≥ 0.5dv**	**# Days ≥ 1.0dv**	**Max (dv)**	**#Days ≥ 0.5dv**	**# Days ≥ 1.0∈dv**	**Max (dv)**
BRID									
2001	1	0	0.706	14	1	1.463	0	0	0.21
2002	1	1	1.217	4	1	2.408	0	0	0.284
2003	0	0	0.444	8	0	0.864	0	0	0.146
FITZ									
2001	0	0	0.286	1	0	0.597	0	0	0.077
2002	1	0	0.833	1	1	1.611	0	0	0.178
2003	0	0	0.227	0	0	0.457	0	0	0.065
GRTE									
2001	0	0	0.272	1	0	0.559	0	0	0.079
2002	0	0	0.156	0	0	0.315	0	0	0.042
2003	0	0	0.123	0	0	0.254	0	0	0.034
MOZI									
2001	0	0	0.287	2	0	0.582	0	0	0.099
2002	0	0	0.222	0	0	0.415	0	0	0.043
2003	0	0	0.253	0	0	0.467	0	0	0.059
TETO									
2001	0	0	0.187	0	0	0.379	0	0	0.045
2002	0	0	0.118	0	0	0.231	0	0	0.039
2003	0	0	0.083	0	0	0.189	0	0	0.028
WASH									
2001	0	0	0.159	0	0	0.317	0	0	0.04
2002	0	0	0.207	0	0	0.446	0	0	0.101
2003	0	0	0.149	0	0	0.329	0	0	0.047

Table 4-26c. CALPUFF-estimated visibility impacts on Class I areas for the various Project alternatives along using Method 3a -- FLAG Monthly f(RH) with EPA Default Annual Natural Conditions.

	Proposed Action			Alternative C			Alternative A - No Action		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	6	1	1.219	24	7	2.464	0	0	0.369
2002	1	1	1.313	7	2	2.589	0	0	0.308
2003	2	0	0.774	12	4	1.484	0	0	0.258
FITZ									
2001	1	0	0.501	4	1	1.034	0	0	0.137
2002	1	0	0.9	2	1	1.734	0	0	0.193
2003	0	0	0.398	2	0	0.796	0	0	0.116
GRTE									
2001	0	0	0.336	1	0	0.689	0	0	0.099
2002	0	0	0.194	0	0	0.39	0	0	0.054
2003	0	0	0.188	0	0	0.376	0	0	0.052
MOZI									
2001	0	0	0.294	2	0	0.597	0	0	0.102
2002	0	0	0.326	1	0	0.629	0	0	0.069
2003	0	0	0.266	1	0	0.521	0	0	0.061
TETO									
2001	0	0	0.232	0	0	0.468	0	0	0.056
2002	0	0	0.141	0	0	0.277	0	0	0.049
2003	0	0	0.115	0	0	0.251	0	0	0.034
WASH									
2001	0	0	0.171	0	0	0.341	0	0	0.045
2002	0	0	0.229	0	0	0.491	0	0	0.112
2003	0	0	0.16	0	0	0.353	0	0	0.051

Table 4-26d. CALPUFF-estimated visibility impacts on Class I areas for the various Project alternatives along using Method 3b -- FLAG Monthly f(RH) with EPA Default Best 20% days Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A – No Action**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRID									
2001	10	1	1.548	39	13	3.08	0	0	0.474
2002	3	1	1.665	11	2	3.231	0	0	0.396
2003	6	0	0.988	17	6	1.877	0	0	0.332
FITZ									
2001	1	0	0.642	5	1	1.316	0	0	0.176
2002	1	1	1.148	3	1	2.188	0	0	0.249
2003	1	0	0.512	3	2	1.017	0	0	0.149
GRTE									
2001	0	0	0.432	3	0	0.882	0	0	0.127
2002	0	0	0.25	2	0	0.501	0	0	0.07
2003	0	0	0.242	0	0	0.484	0	0	0.067
MOZI									
2001	0	0	0.378	2	0	0.764	0	0	0.131
2002	0	0	0.419	2	0	0.804	0	0	0.089
2003	0	0	0.342	3	0	0.668	0	0	0.078
TETO									
2001	0	0	0.298	1	0	0.6	0	0	0.073
2002	0	0	0.182	0	0	0.356	0	0	0.063
2003	0	0	0.149	0	0	0.323	0	0	0.044
WASH									
2001	0	0	0.22	0	0	0.438	0	0	0.058
2002	0	0	0.294	1	0	0.63	0	0	0.144
2003	0	0	0.206	0	0	0.453	0	0	0.065

Table 4-26e. CALPUFF-estimated visibility impacts on Class I areas for the various Project alternatives along using Method 4 -- FLAG Hourly f(RH) with FLAG Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A – No Action**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRID									
2001	2	0	0.845	17	3	1.757	0	0	0.255
2002	2	1	1.345	5	2	2.624	0	0	0.317
2003	1	0	0.609	10	1	1.276	0	0	0.192
FITZ									
2001	0	0	0.369	3	0	0.838	0	0	0.121
2002	1	0	0.939	2	1	1.781	0	0	0.196
2003	0	0	0.364	2	0	0.772	0	0	0.106
GRTE									
2001	0	0	0.399	1	0	0.806	0	0	0.113
2002	0	0	0.153	0	0	0.316	0	0	0.041
2003	0	0	0.164	0	0	0.35	0	0	0.053
MOZI									
2001	0	0	0.432	2	0	0.811	0	0	0.088
2002	1	0	0.581	3	1	1.087	0	0	0.121
2003	0	0	0.414	1	0	0.795	0	0	0.093
TETO									
2001	0	0	0.251	1	0	0.503	0	0	0.06
2002	0	0	0.124	0	0	0.254	0	0	0.038
2003	0	0	0.122	0	0	0.245	0	0	0.034
WASH									
2001	0	0	0.176	0	0	0.349	0	0	0.047
2002	0	0	0.137	0	0	0.277	0	0	0.055
2003	0	0	0.126	0	0	0.275	0	0	0.039

4.6.4.3 Visibility Impacts on Class I Areas due to the Cumulative Emissions plus the Project Alternatives

Table 4-27 (a-e) lists the visibility impacts for the cumulative emissions plus the proposed Project for the various Project alternatives. As noted for the case above when only the Project emissions were considered, the largest impacts occur at the Bridger Wilderness Areas. With the Cumulative Emissions added to the project emissions, all of the Project alternatives produce days that exceed the 1.0 dv threshold using all methods. For example, using Method 1, the 1.0 change in dv threshold is estimated to be exceeded for 94 days, 106 days, and 89 days for the cumulative emissions plus Proposed Action, Alternative C, and No Action alternative at the Bridger Wilderness Areas, which represents 9%, 10% and 8% of the days during the 3 years of modeling. Using Method 3b, the 1.0 change in dv threshold is estimated to be exceeded for 145 days, 162 days, and 140 days for the cumulative emissions plus Proposed Action, Alternative C, and No Action alternative at the Bridger Wilderness Areas, representing 13%, 15% and 13% of the days during the 2001-2003.

Table 4-27a. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus the various Project alternatives along using Method 1 -- FLAG Monthly f(RH) with FLAG Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A - No Action**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRID									
2001	78	45	3.912	87	50	4.183	74	42	3.787
2002	57	22	2.548	60	24	3.432	51	22	2.004
2003	48	27	3.989	54	32	4.135	46	25	3.952
FITZ									
2001	29	8	1.915	33	11	2.193	27	8	1.841
2002	13	3	2.329	18	3	2.825	12	3	2.031
2003	23	7	1.821	26	7	1.84	19	7	1.803
GRTE									
2001	12	4	1.706	16	4	1.726	12	4	1.686
2002	5	1	1.147	8	1	1.205	4	1	1.113
2003	4	0	0.671	6	0	0.731	3	0	0.669
MOZI									
2001	5	0	0.791	8	0	0.994	4	0	0.646
2002	11	1	1.402	19	1	1.641	7	1	1.201
2003	6	0	0.91	9	0	0.994	5	0	0.839
TETO									
2001	9	2	1.279	9	3	1.295	8	2	1.262
2002	2	1	1.037	3	1	1.085	2	1	1
2003	0	0	0.439	2	0	0.54	0	0	0.39
WASH									
2001	5	0	0.903	6	0	0.917	5	0	0.888
2002	2	1	1.047	3	1	1.097	1	1	1.007
2003	1	0	0.561	2	0	0.614	1	0	0.53

Table 4-27b. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus the various Project alternatives along using Method 2 -- FLAG Monthly f(RH) with IMPROVE Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0dv	Max (dv)	#Days ≥ 0.5dv	# Days ≥ 1.0dv	Max (dv)	#Days ≥ 0.5dv	# Days ≥ 1.0∈dv	Max (dv)
BRID									
2001	74	39	4.148	82	45	4.281	71	37	4.142
2002	48	18	2.803	54	20	3.76	44	17	2.21
2003	47	24	4.359	51	26	4.516	45	22	4.299
FITZ									
2001	23	5	2.067	27	6	2.086	23	4	2.047
2002	10	2	2.564	13	3	3.103	7	2	2.104
2003	20	7	1.666	23	7	1.67	20	7	1.664
GRTE									
2001	9	3	1.648	12	3	1.668	9	3	1.629
2002	3	0	0.853	5	0	0.897	2	0	0.827
2003	2	0	0.649	3	0	0.721	1	0	0.602
MOZI									
2001	4	0	0.893	7	2	1.12	3	0	0.684
2002	7	1	1.018	14	1	1.195	6	0	0.869
2003	6	1	1.026	12	1	1.12	4	0	0.946
TETO									
2001	6	1	1.235	8	2	1.25	5	1	1.218
2002	2	0	0.745	2	0	0.78	2	0	0.719
2003	0	0	0.423	1	0	0.521	0	0	0.371
WASH									
2001	5	0	0.991	6	1	1.006	4	0	0.975
2002	2	0	0.807	2	0	0.846	1	0	0.776
2003	0	0	0.44	1	0	0.6	0	0	0.404

Table 4-27c. CALPUFF-estimated visibility impacts on Class I Areas for the Cumulative Emissions plus the various Project alternatives along using Method 3a -- FLAG Monthly f(RH) with EPA Default Annual Natural Conditions.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	86	53	4.533	94	59	4.837	82	49	4.427
2002	62	29	3.009	67	32	4.023	58	28	2.377
2003	55	37	4.655	62	37	4.821	53	32	4.592
FITZ									
2001	34	12	2.252	40	14	2.573	32	11	2.147
2002	19	4	2.751	21	4	3.324	17	4	2.386
2003	29	9	2.142	31	12	2.165	27	9	2.122
GRTE									
2001	14	6	2.01	19	6	2.033	14	6	1.987
2002	9	1	1.309	12	1	1.375	7	1	1.27
2003	4	0	0.768	9	0	0.844	4	0	0.766
MOZI									
2001	7	0	0.915	14	2	1.147	6	0	0.748
2002	17	1	1.585	22	1	1.852	11	1	1.359
2003	9	1	1.051	17	2	1.147	7	0	0.97
TETO									
2001	9	3	1.512	10	3	1.531	9	2	1.492
2002	4	1	1.228	6	1	1.284	3	1	1.185
2003	2	0	0.523	3	0	0.643	0	0	0.47
WASH									
2001	6	2	1.061	7	2	1.078	6	2	1.044
2002	3	1	1.24	3	1	1.299	2	1	1.194
2003	1	0	0.674	3	0	0.737	1	0	0.637

Table 4-27d. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus various Project alternatives along using Method 3b - FLAG Monthly f(RH) with EPA Default Best 20% days Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRID									
2001	101	66	5.541	109	72	5.895	96	64	5.416
2002	79	38	3.737	85	46	4.943	72	36	2.974
2003	69	41	5.683	81	44	5.876	66	40	5.61
FITZ									
2001	48	18	2.823	54	24	3.213	41	18	2.695
2002	25	7	3.429	29	9	4.116	22	7	2.986
2003	34	14	2.689	35	17	2.717	30	12	2.665
GRTE									
2001	24	9	2.527	27	10	2.555	20	7	2.498
2002	12	2	1.66	15	3	1.742	9	2	1.612
2003	10	0	0.981	14	1	1.078	8	0	0.978
MOZI									
2001	19	2	1.166	24	3	1.458	12	0	0.955
2002	23	2	2.002	30	5	2.332	21	1	1.721
2003	20	4	1.337	24	4	1.457	12	1	1.235
TETO									
2001	12	5	1.913	16	6	1.936	11	5	1.888
2002	8	2	1.56	10	2	1.63	5	2	1.506
2003	6	0	0.67	8	0	0.823	6	0	0.602
WASH									
2001	10	4	1.351	11	4	1.371	6	3	1.329
2002	6	1	1.575	7	2	1.648	5	1	1.517
2003	6	0	0.862	8	0	0.942	4	0	0.815

Table 4-27e. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus the various Project alternatives along using Method 4 -- FLAG Hourly f(RH) with FLAG Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	74	42	5.74	82	51	6.041	73	38	5.583
2002	50	25	3.313	54	27	4.092	49	24	3.257
2003	50	31	4.44	54	34	4.564	48	28	4.394
FITZ									
2001	26	7	2.689	34	9	3.032	22	6	2.507
2002	17	6	2.93	20	6	3.443	15	6	2.879
2003	25	10	1.432	27	11	1.448	24	10	1.417
GRTE									
2001	13	4	1.998	16	5	2.217	11	4	1.992
2002	8	1	1.48	9	1	1.551	6	1	1.438
2003	7	1	1.192	9	1	1.2	4	1	1.189
MOZI									
2001	8	1	1.485	14	3	1.826	6	1	1.162
2002	15	2	2.759	19	5	3.168	12	2	2.391
2003	15	2	1.306	17	2	1.591	11	1	1.229
TETO									
2001	8	3	1.501	9	3	1.52	8	2	1.482
2002	5	2	1.195	6	2	1.255	4	1	1.15
2003	2	0	0.557	5	0	0.585	2	0	0.557
WASH									
2001	5	2	1.097	6	3	1.113	5	2	1.079
2002	4	1	1.271	5	1	1.333	4	1	1.221
2003	2	0	0.558	5	0	0.654	1	0	0.504

4.6.4.4 Visibility Impacts on Class I Areas due to the Cumulative Emissions plus the Project Alternatives without RFD

Table 4-28 (a-e) lists the visibility impacts for the cumulative emissions without the RFD sources plus the proposed Project for the various Project alternatives. For all three project scenarios, the 1.0 change in 1 dv threshold is exceeded for at least three Class I areas for all five calculation methods. Using Method 3b, the method that shows the largest impact, the 1.0 dv threshold is estimated to be exceeded for 103 days, 123 days, and 95 days for the cumulative emissions plus Proposed Action, Alterantive C, and No Action alternative at the Bridger Wilderness Area, representing 9%, 11% and 9% of the days during 2001-2003.

Table 4-28a. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 1 -- FLAG Monthly f(RH) with FLAG Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	63	21	2.767	70	31	3.052	57	21	2.76
2002	40	10	1.971	49	13	2.973	37	9	1.738
2003	39	18	3.296	42	22	3.453	37	15	3.236
FITZ									
2001	19	2	1.389	25	4	1.686	15	2	1.244
2002	7	3	1.927	10	3	2.446	5	2	1.487
2003	13	2	1.201	17	3	1.221	12	2	1.182
GRTE									
2001	6	1	1.203	9	2	1.224	6	1	1.183
2002	3	0	0.776	5	0	0.836	3	0	0.742
2003	0	0	0.409	0	0	0.484	0	0	0.394
MOZI									
2001	2	0	0.607	5	0	0.843	0	0	0.472
2002	5	1	1.045	13	1	1.293	2	0	0.836
2003	5	0	0.669	8	0	0.833	4	0	0.577
TETO									
2001	3	0	0.898	4	0	0.915	3	0	0.881
2002	2	0	0.726	2	0	0.776	2	0	0.689
2003	0	0	0.307	0	0	0.41	0	0	0.262
WASH									
2001	3	0	0.638	4	0	0.652	2	0	0.623
2002	1	0	0.741	3	0	0.792	1	0	0.7
2003	0	0	0.376	0	0	0.458	0	0	0.344

Table 4-28b. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 2 -- FLAG Monthly f(RH) with IMPROVE Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	57	19	2.91	71	24	2.912	54	17	2.909
2002	36	8	2.175	40	9	3.263	31	7	1.678
2003	33	15	3.613	36	18	3.782	29	15	3.548
FITZ									
2001	12	1	1.409	17	3	1.429	11	1	1.388
2002	4	2	2.126	7	2	2.692	4	1	1.644
2003	9	3	1.239	13	3	1.243	8	3	1.237
GRTE									
2001	6	1	1.162	8	2	1.182	6	1	1.142
2002	1	0	0.574	2	0	0.619	1	0	0.549
2003	0	0	0.404	0	0	0.477	0	0	0.356
MOZI									
2001	3	0	0.685	4	0	0.951	0	0	0.489
2002	3	0	0.755	7	0	0.937	2	0	0.602
2003	4	0	0.755	8	0	0.912	4	0	0.652
TETO									
2001	3	0	0.867	3	0	0.883	2	0	0.85
2002	1	0	0.52	1	0	0.556	0	0	0.493
2003	0	0	0.296	0	0	0.395	0	0	0.246
WASH									
2001	3	0	0.701	4	0	0.717	3	0	0.685
2002	1	0	0.569	2	0	0.637	1	0	0.537
2003	0	0	0.328	1	0	0.504	0	0	0.268

Table 4-28c. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 3a -- FLAG Monthly f(RH) with EPA Default Annual Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRID									
2001	71	35	3.234	84	42	3.56	66	31	3.226
2002	50	18	2.339	59	21	3.497	41	17	2.049
2003	43	20	3.868	52	25	4.047	42	17	3.799
FITZ									
2001	24	4	1.641	31	7	1.986	21	2	1.463
2002	12	4	2.285	18	4	2.887	11	3	1.77
2003	17	4	1.421	22	5	1.445	13	4	1.399
GRTE									
2001	7	1	1.424	11	2	1.448	6	1	1.399
2002	3	0	0.887	8	0	0.956	3	0	0.849
2003	0	0	0.474	2	0	0.57	0	0	0.452
MOZI									
2001	6	0	0.702	10	0	0.974	2	0	0.547
2002	10	1	1.184	17	1	1.462	4	0	0.948
2003	6	0	0.774	10	0	0.954	5	0	0.669
TETO									
2001	6	1	1.066	6	1	1.086	5	1	1.045
2002	2	0	0.863	3	0	0.921	2	0	0.819
2003	0	0	0.368	0	0	0.489	0	0	0.316
WASH									
2001	5	0	0.751	6	0	0.768	4	0	0.734
2002	1	0	0.88	3	0	0.941	1	0	0.832
2003	0	0	0.452	2	0	0.541	0	0	0.414

Table 4-28d. CALPUFF-estimated visibility impacts on Class I areas for the Cumulative Emissions plus various Project alternatives without RFD sources using Method 3b -- FLAG Monthly f(RH) with EPA Default Best 20% days Natural Conditions.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	90	45	4.007	97	56	4.395	82	41	3.998
2002	63	27	2.928	71	35	4.321	58	27	2.574
2003	53	31	4.76	64	32	4.971	49	27	4.679
FITZ									
2001	33	10	2.072	42	11	2.497	31	8	1.852
2002	19	5	2.863	23	5	3.592	16	5	2.232
2003	26	6	1.799	29	10	1.829	23	5	1.773
GRTE									
2001	14	4	1.803	20	4	1.834	11	3	1.773
2002	6	1	1.132	10	1	1.219	4	1	1.083
2003	3	0	0.608	7	0	0.731	3	0	0.58
MOZI									
2001	10	0	0.898	20	2	1.24	8	0	0.701
2002	17	1	1.503	24	2	1.85	14	1	1.208
2003	12	0	0.988	20	3	1.215	8	0	0.855
TETO									
2001	9	2	1.356	10	3	1.381	8	2	1.331
2002	3	1	1.101	6	1	1.175	2	1	1.045
2003	0	0	0.472	3	0	0.627	0	0	0.406
WASH									
2001	5	0	0.96	6	0	0.982	5	0	0.938
2002	3	1	1.122	4	1	1.199	2	1	1.062
2003	1	0	0.58	4	0	0.693	1	0	0.532

Table 4-28e. CALPUFF-estimated visibility impacts on class I areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 4 - FLAG Hourly f(RH) with FLAG Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRID									
2001	64	24	4.12	69	33	4.473	58	22	3.935
2002	39	16	3.112	44	18	3.555	35	15	3.055
2003	38	18	3.795	42	23	3.927	35	15	3.745
FITZ									
2001	17	2	1.972	22	3	2.341	15	2	1.772
2002	13	5	2.388	16	5	3.002	13	5	2.047
2003	14	0	0.934	21	0	0.996	12	0	0.919
GRTE									
2001	7	3	1.414	11	3	1.578	6	2	1.391
2002	4	1	1.002	7	1	1.077	3	0	0.958
2003	2	0	0.726	5	0	0.734	1	0	0.723
MOZI									
2001	4	1	1.154	10	1	1.507	3	0	0.821
2002	10	1	2.122	15	3	2.557	9	1	1.729
2003	8	1	1.067	14	2	1.424	5	0	0.825
TETO									
2001	5	1	1.064	5	2	1.084	4	1	1.044
2002	3	0	0.846	3	0	0.908	2	0	0.799
2003	0	0	0.382	0	0	0.439	0	0	0.367
WASH									
2001	5	0	0.784	6	0	0.801	4	0	0.766
2002	3	0	0.906	3	0	0.971	2	0	0.855
2003	0	0	0.423	1	0	0.519	0	0	0.368

4.6.4.5 Visibility Impacts at Class II Areas due to the Project Alternatives Alone

Table 4-29 (a-e) lists the CALPUFF-estimated visibility impacts at the Class II areas due to the various Project alternatives using the five calculation methods described above. Due to the Project alone, each alternative has days that exceed the 0.5 dv and 1.0 dv thresholds. The Class II area experiencing the largest and most frequent impacts is Bridger Butte. Across the different methods, the Proposed Action alternative exceeds the 1.0 dv threshold between 18 and 47 days across 3 years at Bridger Butte, and exceeds the 0.5 dv threshold between 30 days and 56 days. Similar results for Alternative C range from 33 days to 54 days for the 1.0 dv threshold and 47 days to 69 days for the 0.5 dv threshold. For Method 1, the Bridger Butte area exceeds the 0.5 dv threshold on 127 days, 169 days, and 44 days during the 2001-2003 period for the Proposed Action, Alternative C, and No Action scenarios, corresponding to 12%, 15% and 4% of days during the 3-year period.

Table 4-29a. CALPUFF-estimated visibility impacts on Class II areas for the various Project alternatives along using Method 1 - FLAG Monthly f(RH) with FLAG Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0dv**	**Max (dv)**
BRB									
2001	48	35	4.56	56	46	6.12	22	7	1.646
2002	45	29	2.702	64	43	4.085	11	0	0.799
2003	34	19	3.83	49	33	5.175	11	2	1.491
DEE									
2001	0	0	0.207	0	0	0.435	0	0	0.068
2002	1	0	0.956	3	1	1.849	0	0	0.215
2003	0	0	0.278	1	0	0.566	0	0	0.074
DIN									
2001	6	0	0.703	11	5	1.36	0	0	0.192
2002	0	0	0.493	6	0	0.948	0	0	0.122
2003	5	0	0.794	14	4	1.393	0	0	0.191
GRO									
2001	0	0	0.316	2	0	0.72	0	0	0.109
2002	0	0	0.166	0	0	0.315	0	0	0.046
2003	0	0	0.259	2	0	0.556	0	0	0.083
LAZ									
2001	0	0	0.265	2	0	0.547	0	0	0.079
2002	0	0	0.17	0	0	0.338	0	0	0.042
2003	0	0	0.3	1	0	0.641	0	0	0.087
ROA									
2001	0	0	0.226	1	0	0.515	0	0	0.076
2002	1	0	0.713	1	1	1.379	0	0	0.134
2003	0	0	0.233	0	0	0.46	0	0	0.072
ROS									
2001	0	0	0.201	0	0	0.454	0	0	0.063
2002	0	0	0.159	0	0	0.314	0	0	0.038
2003	0	0	0.197	0	0	0.419	0	0	0.053
SAD									
2001	0	0	0.45	7	0	0.953	0	0	0.153
2002	1	0	0.707	3	1	1.378	0	0	0.173
2003	0	0	0.318	2	0	0.646	0	0	0.083
UPP									
2001	0	0	0.243	2	0	0.515	0	0	0.088
2002	1	0	0.896	3	1	1.733	0	0	0.206
2003	0	0	0.301	2	0	0.614	0	0	0.08

Table 4-29b. CALPUFF-estimated visibility impacts on Class II areas for the various Project alternatives along using Method 2 -- FLAG Monthly f(RH) with IMPROVE Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRB									
2001	48	34	4.971	58	45	6.631	23	7	
2002	41	23	2.801	56	37	3.445	6	0	
2003	30	18	4.203	47	28	5.628	9	2	
DEE									
2001	0	0	0.223	0	0	0.456	0	0	
2002	1	1	1.06	2	1	2.04	0	0	
2003	0	0	0.188	0	0	0.386	0	0	
DIN									
2001	4	0	0.793	11	3	1.401	0	0	
2002	0	0	0.39	6	0	0.711	0	0	
2003	4	0	0.828	14	4	1.498	0	0	
GRO									
2001	0	0	0.311	1	0	0.637	0	0	
2002	0	0	0.162	0	0	0.329	0	0	
2003	0	0	0.176	0	0	0.379	0	0	
LAZ									
2001	0	0	0.18	0	0	0.372	0	0	
2002	0	0	0.181	0	0	0.349	0	0	
2003	0	0	0.204	0	0	0.437	0	0	
ROA									
2001	0	0	0.153	0	0	0.351	0	0	
2002	1	0	0.792	1	1	1.526	0	0	
2003	0	0	0.158	0	0	0.313	0	0	
ROS									
2001	0	0	0.136	0	0	0.309	0	0	
2002	0	0	0.161	0	0	0.298	0	0	
2003	0	0	0.175	0	0	0.384	0	0	
SAD									
2001	0	0	0.381	3	0	0.785	0	0	
2002	1	0	0.785	2	1	1.524	0	0	
2003	0	0	0.216	0	0	0.463	0	0	
UPP									
2001	0	0	0.272	1	0	0.557	0	0	
2002	1	0	0.994	2	1	1.914	0	0	
2003	0	0	0.205	0	0	0.419	0	0	

Table 4-29c. CALPUFF-estimated visibility impacts on Class II areas for the various Project alternatives along using Method 3a -- FLAG Monthly f(RH) with EPA Default Annual Natural Conditions.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRB									
2001	50	38	5.298	61	49	7.035	26	9	1.942
2002	50	33	3.16	65	47	4.728	16	0	0.949
2003	40	23	4.441	49	34	5.988	14	4	1.762
DEE									
2001	0	0	0.248	3	0	0.519	0	0	0.081
2002	1	1	1.145	3	1	2.196	0	0	0.259
2003	0	0	0.332	2	0	0.675	0	0	0.089
DIN									
2001	8	0	0.813	12	6	1.551	0	0	0.221
2002	2	0	0.566	8	1	1.084	0	0	0.14
2003	6	0	0.909	17	6	1.589	0	0	0.22
GRO									
2001	0	0	0.377	2	0	0.855	0	0	0.13
2002	0	0	0.203	0	0	0.383	0	0	0.056
2003	0	0	0.309	3	0	0.661	0	0	0.101
LAZ									
2001	0	0	0.317	2	0	0.65	0	0	0.095
2002	0	0	0.203	0	0	0.403	0	0	0.051
2003	0	0	0.358	1	0	0.762	0	0	0.104
MOX									
2001	148	80	4.703	219	155	6.587	55	17	1.677
2002	157	94	6.806	223	168	8.8	70	26	2.872
2003	116	63	6.213	198	121	8.809	46	15	3.43
ROA									
2001	0	0	0.27	1	0	0.614	0	0	0.091
2002	1	0	0.856	2	1	1.645	0	0	0.162
2003	0	0	0.279	1	0	0.548	0	0	0.086
ROS									
2001	0	0	0.24	1	0	0.541	0	0	0.075
2002	0	0	0.191	0	0	0.375	0	0	0.046
2003	0	0	0.235	0	0	0.499	0	0	0.063
SAD									
2001	1	0	0.537	10	1	1.131	0	0	0.184
2002	1	0	0.849	5	1	1.644	0	0	0.209
2003	0	0	0.38	4	0	0.769	0	0	0.099
UPP									
2001	0	0	0.29	9	0	0.614	0	0	0.105
2002	1	1	1.074	3	1	2.061	0	0	0.249
2003	0	0	0.36	3	0	0.731	0	0	0.096

Table 4-29d. CALPUFF-estimated visibility impacts on Class II areas for the various Project alternatives along using Method 3b - FLAG Monthly f(RH) with EPA Default Best 20% days Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	54	44	6.428	66	52	8.406	32	14	2.442
2002	56	38	3.919	69	54	5.767	24	3	1.209
2003	46	28	5.433	51	42	7.219	17	8	2.221
DEE									
2001	0	0	0.319	9	0	0.666	0	0	0.105
2002	2	1	1.455	3	1	2.754	0	0	0.333
2003	0	0	0.426	3	0	0.863	0	0	0.115
DIN									
2001	8	3	1.038	15	7	1.961	0	0	0.284
2002	4	0	0.725	14	2	1.379	0	0	0.181
2003	8	3	1.159	20	6	2.008	0	0	0.283
GRO									
2001	0	0	0.484	8	1	1.091	0	0	0.168
2002	0	0	0.261	0	0	0.492	0	0	0.073
2003	0	0	0.398	4	0	0.846	0	0	0.13
LAZ									
2001	0	0	0.407	2	0	0.832	0	0	0.122
2002	0	0	0.261	1	0	0.518	0	0	0.065
2003	0	0	0.46	4	0	0.973	0	0	0.134
MOX									
2001	180	104	5.738	249	181	7.9	76	32	2.116
2002	181	111	8.148	241	194	10.372	91	40	3.573
2003	149	81	7.476	224	140	10.382	56	23	4.24
ROA									
2001	0	0	0.347	3	0	0.786	0	0	0.118
2002	1	1	1.092	2	1	2.077	0	0	0.209
2003	0	0	0.359	2	0	0.702	0	0	0.111
ROS									
2001	0	0	0.309	1	0	0.694	0	0	0.097
2002	0	0	0.245	0	0	0.481	0	0	0.059
2003	0	0	0.302	2	0	0.64	0	0	0.082
SAD									
2001	4	0	0.688	16	4	1.437	0	0	0.236
2002	2	1	1.084	7	2	2.075	0	0	0.269
2003	0	0	0.488	4	0	0.983	0	0	0.128
UPP									
2001	0	0	0.373	15	0	0.786	0	0	0.135
2002	2	1	1.365	3	1	2.588	0	0	0.32
2003	0	0	0.462	4	0	0.934	0	0	0.124

Table 4-29e. CALPUFF-estimated visibility impacts on Class II areas for the various Project alternatives along using Method 4 -- FLAG Hourly f(RH) with FLAG Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRB									
2001	47	35	5.358	57	44	7.004	24	11	2.17
2002	44	23	3.55	63	41	5.157	10	2	1.102
2003	36	22	4.906	47	34	6.205	14	5	2.042
DEE									
2001	0	0	0.252	1	0	0.556	0	0	0.077
2002	1	1	1.272	2	1	2.404	0	0	0.288
2003	0	0	0.243	0	0	0.498	0	0	0.067
DIN									
2001	5	1	1.045	10	4	1.858	0	0	0.235
2002	3	0	0.676	8	2	1.217	0	0	0.149
2003	7	1	1.185	17	5	2.095	0	0	0.262
GRO									
2001	0	0	0.335	2	0	0.753	0	0	0.114
2002	0	0	0.156	0	0	0.325	0	0	0.05
2003	0	0	0.305	2	0	0.651	0	0	0.099
LAZ									
2001	0	0	0.324	1	0	0.728	0	0	0.099
2002	0	0	0.215	0	0	0.423	0	0	0.053
2003	0	0	0.366	1	0	0.775	0	0	0.105
ROA									
2001	0	0	0.304	1	0	0.684	0	0	0.102
2002	1	0	0.935	2	1	1.765	0	0	0.176
2003	0	0	0.187	0	0	0.387	0	0	0.054
ROS									
2001	0	0	0.274	1	0	0.609	0	0	0.084
2002	0	0	0.204	0	0	0.4	0	0	0.049
2003	0	0	0.241	1	0	0.51	0	0	0.064
SAD									
2001	0	0	0.327	7	0	0.706	0	0	0.134
2002	1	0	0.95	5	1	1.82	0	0	0.234
2003	0	0	0.279	2	0	0.561	0	0	0.079
UPP									
2001	0	0	0.254	1	0	0.56	0	0	0.078
2002	1	1	1.184	4	1	2.243	0	0	0.274
2003	0	0	0.279	2	0	0.545	0	0	0.073

4.6.4.6 Visibility Impacts on Class II Areas due to the Cumulative Emissions plus the Project Alternatives

Table 4-30 (a-e) lists the visibility impacts on Class II areas for the cumulative emissions plus the proposed Project for the various Project alternatives. The largest and most frequent impacts are estimated to occur at Bridger Butte, but impacts exceeding the 0.5 dv and 1.0 dv thresholds are found at all sites for at least two of the modeling years for all alternatives. Using Method 1, the 1.0 change in dv threshold is estimated to be exceeded for 102 days, 134 days, and 39 days for the cumulative emissions plus Proposed Action, Alternative C, and No Action alternative at the Bridger Butte Class II area representing 9%, 12%, and 4% of the days during 2001-2003. For Alternative C, the number of days exceeding 1.0 dv change ranges from 121 days to 197 days across the different methods for the 3-year modeling period.

Table 4-30a. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives along using Method 1 -- FLAG Monthly f(RH) with FLAG Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5dv	# Days ≥ 1.0dv	Max (dv)	#Days ≥ 0.5dv	# Days ≥ 1.0dv	Max (dv)	#Days ≥ 0.5dv	# Days ≥ 1.0dv	Max (dv)
BRB									
2001	54	40	5.187	64	50	6.659	39	20	2.335
2002	55	37	3.295	68	47	4.603	33	9	1.637
2003	45	25	4.187	49	37	5.485	22	10	1.94
DEE									
2001	21	2	1.053	30	5	1.154	17	2	1.052
2002	16	5	2.309	22	5	3.093	13	4	1.665
2003	12	4	2	15	5	2.02	10	3	1.987
DIN									
2001	19	7	1.576	25	9	1.996	11	2	1.26
2002	28	7	1.783	35	9	2.061	21	6	1.542
2003	24	8	1.554	31	11	2.101	17	2	1.365
GRO									
2001	25	10	2.518	28	12	2.541	22	10	2.496
2002	13	0	0.898	16	0	0.979	12	0	0.854
2003	16	5	2.121	19	7	2.365	15	3	2.004
LAZ									
2001	13	6	2.115	14	7	2.368	11	5	1.98
2002	5	1	1.832	6	2	1.882	4	1	1.793
2003	12	2	1.256	13	3	1.258	10	2	1.256
ROA									
2001	13	1	1.298	13	1	1.558	11	1	1.163
2002	8	3	2.387	9	3	2.953	8	2	1.9
2003	9	2	1.101	12	2	1.111	8	2	1.092
ROS									
2001	8	3	1.426	9	3	1.65	8	3	1.337
2002	5	1	1.737	5	1	1.788	4	1	1.697
2003	4	0	0.708	6	0	0.709	3	0	0.707
SAD									
2001	35	3	1.126	42	9	1.41	25	3	1.118
2002	23	7	1.822	26	8	2.424	21	6	1.65
2003	13	6	2.224	17	8	2.264	12	5	2.201
UPP									
2001	26	4	1.288	38	5	1.292	22	3	1.285
2002	18	5	2.125	23	6	2.869	16	4	1.518
2003	13	6	2.047	16	7	2.072	12	6	2.031

Table 4-30b. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives along using Method 2 -- FLAG Monthly f(RH) with IMPROVE Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	53	41	5.64	60	50	7.201	38	19	2.571
2002	51	30	3.081	64	42	3.805	27	4	1.18
2003	40	19	4.587	49	32	5.958	19	6	2.149
DEE									
2001	17	1	1.166	25	1	1.169	14	1	1.165
2002	11	3	2.543	11	6	3.394	11	2	1.839
2003	11	6	2.214	12	6	2.236	10	6	2.2
DIN									
2001	14	5	1.762	21	10	2	10	1	1.418
2002	23	4	1.288	34	7	1.494	17	1	1.11
2003	24	5	1.746	29	12	2.053	20	1	1.535
GRO									
2001	22	8	2.781	26	11	2.805	21	7	2.756
2002	9	0	0.871	10	1	1.027	7	0	0.788
2003	10	3	1.455	14	3	1.629	10	3	1.372
LAZ									
2001	12	3	2.079	15	3	2.099	11	3	2.058
2002	4	1	1.273	5	1	1.309	3	1	1.245
2003	11	1	1.391	12	1	1.392	10	1	1.39
ROA									
2001	8	1	1.029	11	2	1.078	7	1	1.021
2002	8	1	2.628	11	1	3.242	7	1	2.096
2003	9	2	1.224	10	2	1.236	9	2	1.215
ROS									
2001	6	2	1.51	7	3	1.528	5	2	1.491
2002	3	1	1.206	3	1	1.242	1	1	1.177
2003	3	0	0.786	4	0	0.787	2	0	0.785
SAD									
2001	30	1	1.247	37	3	1.325	23	1	1.238
2002	16	5	2.011	23	7	2.667	14	5	1.735
2003	12	6	2.459	16	6	2.503	10	6	2.434
UPP									
2001	24	1	1.425	32	4	1.43	20	1	1.423
2002	12	3	2.342	15	7	3.151	11	3	1.678
2003	12	6	2.265	14	6	2.293	12	6	2.248

Table 4-30c. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives along using Method 3a -- FLAG Monthly f(RH) with EPA Default Annual Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	56	44	6	68	53	7.628	44	24	2.762
2002	59	42	3.836	71	53	5.308	42	12	1.864
2003	48	27	4.842	51	41	6.333	28	14	2.284
DEE									
2001	27	5	1.26	40	7	1.367	24	4	1.258
2002	22	8	2.732	25	9	3.635	18	7	1.981
2003	14	7	2.353	19	8	2.376	14	6	2.338
DIN									
2001	21	8	1.803	28	11	2.267	15	2	1.452
2002	34	7	2.029	41	13	2.34	26	7	1.757
2003	33	8	1.787	38	13	2.386	22	5	1.571
GRO									
2001	28	14	2.946	32	16	2.972	26	13	2.92
2002	15	3	1.063	18	4	1.181	13	1	1.001
2003	19	8	2.532	21	9	2.817	18	7	2.394
LAZ									
2001	19	7	2.482	25	7	2.774	17	6	2.327
2002	7	2	2.156	11	2	2.214	5	2	2.11
2003	15	3	1.499	22	5	1.5	15	3	1.498
ROA									
2001	17	2	1.536	21	3	1.839	15	2	1.378
2002	12	4	2.822	15	5	3.475	11	3	2.256
2003	12	2	1.305	17	3	1.317	10	2	1.295
ROS									
2001	10	3	1.684	13	3	1.945	10	3	1.566
2002	5	1	2.046	5	2	2.105	4	1	1.999
2003	8	0	0.849	10	0	0.85	5	0	0.848
SAD									
2001	45	10	1.347	49	16	1.667	38	6	1.337
2002	28	8	2.165	36	8	2.864	25	7	1.947
2003	21	7	2.611	24	8	2.657	20	7	2.584
UPP									
2001	34	8	1.537	43	14	1.543	28	5	1.535
2002	24	7	2.518	27	8	3.378	21	7	1.808
2003	18	8	2.407	20	9	2.436	17	7	2.389

Table 4-30d. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus various Project alternatives along using Method 3b -- FLAG Monthly f(RH) with EPA Default Best 20% days Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	64	48	7.233	75	55	9.071	48	32	3.441
2002	67	45	4.722	76	58	6.439	45	22	2.347
2003	49	36	5.901	53	47	7.612	34	20	2.86
DEE									
2001	43	11	1.598	55	18	1.732	37	11	1.597
2002	27	9	3.404	37	11	4.485	26	9	2.491
2003	22	9	2.945	25	10	2.973	18	9	2.926
DIN									
2001	30	11	2.272	37	16	2.841	22	4	1.838
2002	47	16	2.549	54	24	2.929	41	11	2.215
2003	42	13	2.252	51	21	2.985	38	8	1.986
GRO									
2001	35	20	3.664	38	22	3.695	32	18	3.632
2002	20	8	1.352	21	9	1.5	19	7	1.275
2003	24	9	3.163	26	12	3.508	22	9	2.996
LAZ									
2001	31	9	3.103	37	11	3.456	29	9	2.914
2002	15	3	2.705	19	5	2.776	12	3	2.65
2003	23	6	1.897	25	7	1.898	21	4	1.895
ROA									
2001	22	8	1.941	34	8	2.316	21	6	1.746
2002	16	5	3.513	19	5	4.294	14	5	2.827
2003	18	4	1.654	20	4	1.67	15	4	1.642
ROS									
2001	16	4	2.125	20	5	2.447	13	4	1.98
2002	8	2	2.571	10	2	2.643	7	2	2.514
2003	15	2	1.083	17	4	1.084	13	2	1.082
SAD									
2001	49	19	1.707	62	30	2.104	44	14	1.694
2002	39	13	2.715	51	21	3.564	34	11	2.449
2003	27	12	3.258	35	14	3.314	24	10	3.226
UPP									
2001	49	15	1.944	59	21	1.95	43	11	1.94
2002	36	11	3.146	43	14	4.179	29	10	2.278
2003	24	10	3.01	29	13	3.046	21	9	2.988

Table 4-30e. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives along using Method 4 -- FLAG Hourly f(RH) with FLAG Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**#Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	54	40	5.925	62	48	7.487	39	22	2.942
2002	54	36	4.198	66	46	5.712	33	9	2.122
2003	42	29	5.305	50	37	6.572	28	13	2.569
DEE									
2001	23	2	1.218	32	2	1.449	19	2	1.216
2002	19	7	3.025	22	7	3.984	16	6	2.9
2003	16	4	1.638	17	5	1.656	14	3	1.626
DIN									
2001	24	6	2.662	29	9	3.358	14	1	1.973
2002	28	10	2.737	34	13	3.18	23	9	2.311
2003	31	9	2.261	36	14	2.916	22	6	1.695
GRO									
2001	23	12	2.96	27	13	2.986	23	10	2.933
2002	13	2	1.111	14	2	1.193	11	1	1.057
2003	19	4	2.322	21	8	2.611	18	4	2.172
LAZ									
2001	11	5	3.076	13	5	3.384	10	5	2.905
2002	10	2	2.453	10	2	2.518	10	2	2.401
2003	14	2	1.207	16	3	1.263	12	2	1.205
ROA									
2001	14	1	1.696	15	1	2.026	11	1	1.519
2002	10	5	3.09	12	5	3.764	10	5	2.482
2003	9	0	0.969	12	0	0.979	9	0	0.962
ROS									
2001	7	3	1.987	9	3	2.27	7	3	1.827
2002	7	2	2.342	7	2	2.407	6	1	2.289
2003	7	0	0.889	8	0	0.952	5	0	0.853
SAD									
2001	29	6	1.328	41	12	1.353	26	5	1.316
2002	24	8	3.384	27	11	3.458	24	8	3.328
2003	17	6	1.981	21	7	2.129	13	6	1.914
UPP									
2001	26	2	1.483	36	4	1.49	24	1	1.48
2002	23	7	2.99	24	8	3.691	20	7	2.939
2003	17	5	1.661	20	5	1.685	15	5	1.647

4.6.4.7 Visibility Impacts on Class II Areas due to the Cumulative Emissions plus the Project Alternatives Without RFD Sources

Table 4-31 (a-e) lists the visibility impacts for the cumulative emissions plus the proposed Project for the various Project alternatives without the RFD sources. Maximum impacts in terms of magnitude and frequency are felt at Bridger Butte. Using Method 1, the 1.0 change in dv threshold is estimated to be exceeded for 98 days, 132 days, and 29 days for the cumulative emissions plus Proposed Action, Alternative C, and No Action alternative at the Bridger Butte Class II Area, representing 9%, 12%, and 3% of the days during the 3 years of modeling. Thus, the cumulative emissions without RFD plus each of the alternatives are estimated to have an adverse impact on visibility at a Class II area.

Table 4-31a. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 1 -- FLAG Monthly f(RH) with FLAG Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A**		
	#Days ≥ 0.5dv	**# Days ≥ 1.0dv**	**Max (dv)**	**#Days ≥ 0.5dv**	**# Days ≥ 1.0dv**	**Max (dv)**	**#Days ≥ 0.5dv**	**# Days ≥ 1.0dv**	**Max (dv)**
BRB									
2001	53	39	5.122	63	49	6.603	37	16	2.262
2002	53	35	3.162	66	46	4.486	29	4	1.402
2003	43	24	4.136	49	37	5.436	21	9	1.877
DEE									
2001	11	0	0.721	20	0	0.95	8	0	0.679
2002	9	5	1.868	13	5	2.686	8	2	1.317
2003	9	1	1.484	10	1	1.505	8	1	1.47
DIN									
2001	18	6	1.562	22	9	1.872	11	2	1.254
2002	27	6	1.652	33	7	1.933	20	6	1.407
2003	24	8	1.521	30	11	2.08	16	1	1.23
GRO									
2001	18	2	1.8	21	4	1.824	16	2	1.775
2002	7	0	0.71	10	0	0.81	4	0	0.654
2003	8	1	1.276	10	1	1.542	8	1	1.149
LAZ									
2001	9	2	1.484	11	2	1.754	8	2	1.341
2002	3	1	1.221	4	1	1.274	3	1	1.179
2003	6	0	0.809	7	0	0.899	4	0	0.808
ROA									
2001	4	0	0.973	6	1	1.241	2	0	0.834
2002	5	1	1.985	5	2	2.573	5	1	1.477
2003	4	0	0.756	7	0	0.767	3	0	0.747
ROS									
2001	4	1	1.004	5	1	1.238	3	0	0.92
2002	2	1	1.203	3	1	1.257	2	1	1.16
2003	0	0	0.48	2	0	0.59	0	0	0.471
SAD									
2001	16	0	0.766	31	1	1.253	8	0	0.698
2002	12	5	1.578	19	6	2.075	9	2	1.548
2003	9	3	1.417	14	3	1.46	8	2	1.392
UPP									
2001	16	0	0.818	28	0	0.953	9	0	0.816
2002	9	5	1.724	13	5	2.497	8	3	1.324
2003	9	1	1.492	13	2	1.519	8	1	1.476

Table 4-31b. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 2 -- FLAG Monthly f(RH) with IMPROVE Seasonal Background.

	Proposed Action			Alternative C			Alternative A		
	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)	#Days ≥ 0.5 dv	# Days ≥ 1.0 dv	Max (dv)
BRB									
2001	53	39	5.122	63	49	6.603	36	16	2.477
2002	53	35	3.162	66	46	4.486	23	2	1.084
2003	43	24	4.136	49	37	5.436	18	6	2.079
DEE									
2001	11	0	0.721	20	0	0.95	5	0	0.754
2002	9	5	1.868	13	5	2.686	9	2	1.321
2003	9	1	1.484	10	1	1.505	6	1	1.632
DIN									
2001	18	6	1.562	22	9	1.872	10	1	1.411
2002	27	6	1.652	33	7	1.933	14	1	1.011
2003	24	8	1.521	30	11	2.08	17	1	1.384
GRO									
2001	18	2	1.8	21	4	1.824	12	1	1.967
2002	7	0	0.71	10	0	0.81	1	0	0.531
2003	8	1	1.276	10	1	1.542	4	0	0.776
LAZ									
2001	9	2	1.484	11	2	1.754	5	1	1.377
2002	3	1	1.221	4	1	1.274	1	0	0.812
2003	6	0	0.809	7	0	0.899	2	0	0.896
ROA									
2001	4	0	0.973	6	1	1.241	3	0	0.725
2002	5	1	1.985	5	2	2.573	6	1	1.633
2003	4	0	0.756	7	0	0.767	4	0	0.833
ROS									
2001	4	1	1.004	5	1	1.238	3	1	1.029
2002	2	1	1.203	3	1	1.257	1	0	0.798
2003	0	0	0.48	2	0	0.59	1	0	0.517
SAD									
2001	16	0	0.766	31	1	1.253	4	0	0.775
2002	12	5	1.578	19	6	2.075	11	3	1.373
2003	9	3	1.417	14	3	1.46	7	3	1.545
UPP									
2001	16	0	0.818	28	0	0.953	5	0	0.905
2002	9	5	1.724	13	5	2.497	10	2	1.217
2003	9	1	1.492	13	2	1.519	7	1	1.638

Table 4-31c. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 3a - FLAG Monthly f(RH) with EPA Default Annual Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	# Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**# Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**# Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	54	44	5.928	67	53	7.567	40	19	2.662
2002	56	42	3.684	70	52	5.178	38	10	1.599
2003	46	27	4.785	51	40	6.278	26	12	2.21
DEE									
2001	18	0	0.858	28	1	1.128	13	0	0.815
2002	12	5	2.218	18	5	3.167	10	4	1.559
2003	11	1	1.753	14	3	1.778	10	1	1.737
DIN									
2001	20	7	1.796	26	10	2.128	13	2	1.445
2002	31	6	1.881	40	12	2.197	24	6	1.605
2003	28	8	1.733	34	13	2.362	20	3	1.417
GRO									
2001	20	6	2.118	26	9	2.146	17	4	2.09
2002	8	0	0.859	13	0	0.979	8	0	0.791
2003	11	1	1.536	15	3	1.85	9	1	1.384
LAZ									
2001	12	2	1.752	12	2	2.065	9	2	1.584
2002	6	1	1.444	6	2	1.507	5	1	1.395
2003	6	0	0.969	11	1	1.066	4	0	0.968
ROA									
2001	9	1	1.154	11	1	1.47	9	0	0.991
2002	7	3	2.355	12	3	3.038	6	2	1.76
2003	5	0	0.899	9	0	0.913	5	0	0.889
ROS									
2001	5	2	1.19	6	2	1.464	4	2	1.081
2002	3	1	1.423	3	2	1.486	2	1	1.373
2003	2	0	0.572	5	0	0.702	2	0	0.561
SAD									
2001	27	0	0.911	40	5	1.483	17	0	0.838
2002	20	6	1.863	25	7	2.46	16	5	1.828
2003	13	3	1.675	15	6	1.725	10	3	1.645
UPP									
2001	20	0	0.981	29	1	1.132	13	0	0.978
2002	17	5	2.05	21	6	2.949	14	4	1.567
2003	11	2	1.763	15	6	1.795	10	2	1.744

Table 4-31d. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus various Project alternatives without RFD sources using Method 3b - FLAG Monthly f(RH) with EPA Default Best 20% days Natural Conditions.

	Proposed Action			**Alternative C**			**Alternative A**		
	# Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**# Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**# Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	61	47	7.151	74	55	9.003	46	31	3.32
2002	64	42	4.543	74	58	6.289	43	18	2.02
2003	49	35	5.834	53	47	7.55	31	15	2.771
DEE									
2001	30	3	1.094	39	7	1.433	19	2	1.04
2002	21	6	2.781	26	8	3.927	18	6	1.97
2003	14	5	2.21	20	7	2.241	11	4	2.191
DIN									
2001	26	9	2.263	36	15	2.671	21	4	1.829
2002	44	14	2.368	52	20	2.755	36	9	2.028
2003	39	12	2.186	48	20	2.956	33	7	1.794
GRO									
2001	27	11	2.659	30	14	2.694	23	8	2.625
2002	16	2	1.096	17	5	1.248	14	1	1.011
2003	15	6	1.942	18	9	2.331	14	4	1.754
LAZ									
2001	16	4	2.209	26	6	2.595	15	4	2.002
2002	8	2	1.829	14	2	1.906	7	2	1.768
2003	13	2	1.234	18	4	1.357	11	2	1.233
ROA									
2001	17	1	1.467	22	3	1.859	14	1	1.261
2002	12	5	2.947	15	5	3.772	12	5	2.219
2003	12	2	1.146	17	2	1.163	9	2	1.133
ROS									
2001	11	3	1.511	15	3	1.853	9	3	1.376
2002	6	2	1.802	6	2	1.88	5	1	1.74
2003	7	0	0.732	8	0	0.898	3	0	0.719
SAD									
2001	40	4	1.161	50	15	1.876	27	2	1.069
2002	27	8	2.345	38	11	3.076	23	7	2.303
2003	19	6	2.114	28	8	2.176	16	6	2.077
UPP									
2001	34	5	1.249	48	12	1.438	26	3	1.246
2002	24	7	2.575	30	8	3.666	20	7	1.98
2003	19	6	2.223	22	8	2.261	14	6	2.199

Table 4-31e. CALPUFF-estimated visibility impacts on Class II areas for the Cumulative Emissions plus the various Project alternatives without RFD sources using Method 4 -- FLAG Hourly f(RH) with FLAG Seasonal Background.

	Proposed Action			**Alternative C**			**Alternative A**		
	# Days ≥ 0.5 dv	**# Days ≥ 1.0 dv**	**Max (dv)**	**# Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**	**# Days ≥ 0.5 dv**	**# Days ≥ 1.0 dv**	**Max (dv)**
BRB									
2001	52	39	5.906	61	46	7.471	37	21	2.917
2002	51	32	4.057	65	45	5.591	28	7	1.818
2003	40	27	5.247	50	35	6.515	26	12	2.493
DEE									
2001	15	0	0.918	22	1	1.204	13	0	0.791
2002	12	6	2.791	15	6	3.485	9	6	2.741
2003	9	1	1.19	13	2	1.209	7	1	1.177
DIN									
2001	22	5	2.456	28	8	3.166	13	1	1.752
2002	25	8	2.517	30	11	2.969	21	8	2.081
2003	29	9	2.07	33	13	2.737	19	5	1.45
GRO									
2001	17	4	2.141	20	6	2.169	16	4	2.112
2002	6	0	0.863	8	0	0.947	5	0	0.808
2003	11	1	1.431	12	1	1.747	8	1	1.268
LAZ									
2001	8	2	2.18	11	2	2.516	6	2	1.993
2002	7	2	1.67	8	2	1.74	6	1	1.614
2003	7	0	0.782	8	1	1.079	3	0	0.779
ROA									
2001	6	1	1.287	11	1	1.632	5	1	1.104
2002	7	5	2.589	9	5	3.296	7	5	1.949
2003	4	0	0.666	5	0	0.675	3	0	0.658
ROS									
2001	5	2	1.406	5	2	1.706	3	2	1.237
2002	5	1	1.65	5	2	1.72	4	1	1.593
2003	1	0	0.577	4	0	0.709	1	0	0.541
SAD									
2001	21	0	0.842	30	2	1.061	13	0	0.829
2002	15	7	3.2	20	8	3.275	11	6	3.143
2003	11	2	1.455	15	5	1.611	8	2	1.384
UPP									
2001	16	0	0.949	26	1	1.196	14	0	0.946
2002	14	6	2.816	16	6	3.234	9	6	2.765
2003	10	2	1.184	14	3	1.251	9	2	1.169

SECTION 5 REGIONAL OZONE ASSESSMENT

5.1 INTRODUCTION

The proposed Project will result in an increase in emissions of nitrogen oxide, VOC, and carbon monoxide that are precursors to ozone. Ozone is typically formed in the atmosphere due to a series of complex chemical reactions involving VOC and NOx in the presence of sunlight usually on hot stagnant sunny days (note that recent relatively high ozone events in southwestern Wyoming have occurred on cold winter days with snow cover). The chemistry of ozone formation is complex and highly nonlinear and needs to account for the presence of all sources. The current NAAQS for ozone is defined as the three year average of the fourth highest daily maximum 8-hour ozone concentration with a threshold of 0.08 ppm (or 85 ppb). The state of Wyoming has also adopted a state standard for 8-hour ozone (WAAQS) that is the same as the federal standard (NAAQS). Recent ozone measurements in southwestern Wyoming have raised concerns regarding its future attainment status. Measured ozone concentrations from the Jonah monitoring site in Sublette County, Wyoming have recorded an average fourth highest 8-hour ozone concentration during the 2005-2006 two-year monitoring period of 0.071 ppm (71 ppb). This is particularly a concern because the Clean Air Science Advisory Committee (CASAC) has recently recommended that EPA should lower the 8-hour ozone standard to 0.070 ppm. Thus, the effect of the Project, and other cumulative emissions in the region, on ozone concentrations needs to be assessed.

In the past, ozone impacts due to proposed new sources have been evaluated using the Scheffe Tables (Scheffe 1988). Scheffe Tables consist of a lookup table of maximum potential incremental ozone production estimates from a source based on VOC/NOx emissions. The ozone increment from the source is added to the maximum measured background ozone and is compared against the ozone NAAQS to determine whether the new source(s) could potentially cause an exceedance of the ozone standard. However, the Scheffe Tables are designed for maximum 1-hour ozone, and their developer (Dr. Richard Scheffe of the EPA Office of Air Quality and Planning Standards) has opposed their continued use, so alternative approaches are needed to address ozone issues in an EIS.

EPA modeling guidance for 8-hour ozone modeling recommends the use of Eulerian photochemical grid models (PGMs) to address ozone issues (EPA 2007; 2006; 1999; 1991). This is in contrast to Lagrangian plume models that are typically used to model the impacts due to a small number of sources, as was done in the near-field (AERMOD) and far-field (CALPUFF) modeling for the Project discussed in Sections 3 and 4, respectively. PGMs model the emissions from all sources (e.g., on-road and non-road mobile, point, area, biogenic, and other sources) which is necessary to simulate ozone formation. PGMs divide the modeling domain into an array of grid cells and require three-dimensional meteorological fields, gridded emissions, boundary conditions (i.e., transported pollutants from outside of the modeling domain), and other inputs. PGMs can incorporate state-of-science chemistry, transport, dispersion and deposition processes. To assess the potential impacts from the addition of new emission sources (e.g., the proposed Project and cumulative emissions) using PGMs, two simulations are typically performed:[1] (1) a base case and (2) a scenario where the new emissions are added to the base case. The difference in the two PGM simulations is the resultant incremental ozone impact due to the new sources.

There has been a reluctance to use PGMs for NEPA and PSD assessments of air quality and AQRV impacts from a single source or small group of sources due to the increased data (e.g., all sources are

[1] Note that some PGMs incorporate source apportionment as a diagnostic probing tool that can track the ozone formation due to separate groups of sources within a single simulation.

modeled) and computational requirements of PGMs. However, for ozone modeling, use of PGMs is recommended by EPA (EPA, 2007; 006; 1999; 1991) and is the most reliable modeling approach.

In this section, the application of a PGM to assess the potential ozone impacts due to emissions from the Project and cumulative sources in the study area is described.

5.2 OZONE MODELING APPROACH

Prior to performing the ozone modeling of the Project and cumulative emissions, a Modeling Protocol was prepared that detailed the assumptions, models, databases, and how the results would be interpreted. The Protocol was presented to BLM and the cooperating agencies (Tai and Morris 2007; SWCA 2006) for review.

5.2.1 Model Selection

The followingtwo main photochemical grid models are currently being used to address 8-hour ozone issues:

- The Community Multi-scale Air Quality (CMAQ) modeling system (Byun and Ching, 1999) developed by EPA is publicly available free of charge from the CMAS Center (http://www.cmascenter.org/); and
- The Comprehensive Air-quality Model with extensions (CAMx) that was developed by ENVIRON (2006) can also be downloaded free of charge (www.camx.com).

Both CMAQ and CAMx are current state-of-science models capable of simulating ozone formation due to new sources, such as those being considered in this application. For this study, the CAMx model was selected for the following reasons:

- CAMx includes algorithms for enhancing photolysis rates due to the presence of snow on the ground, which is important because some of the highest ozone measurements recorded in southwestern Wyoming have occurred in the winter when snow is present.
- CALMET meteorological data can be processed for input to CAMx, whereas CMAQ is designed to run solely off meteorological data from MM5 or WRF – the MM5 and WRF prognostic models have difficulty in simulating stagnant conditions because they try to organize the simulated flows; and, therefore, overestimate wind speeds during periods of light winds. On the other hand, stagnant observations that are input into CALMET will be reflected in the CALMET wind fields.
- CAMx incorporates two-way grid nesting that allows concentrations to feed back and forth between coarse and fine grids, whereas CMAQ only supports one-way grid nesting that only allows concentrations to flow from the coarser to the finer grids, but not vice versa. Thus, CAMx is able to more cost –effectively estimate ozone impacts over a larger area.
- CAMx includes a flexi-nesting feature that allows for the run time interpolation of coarse grid data to finer grids that is not available in CMAQ.
- CAMx is easier to use and more flexible.

5.2.2 Selection of a Modeling Period and Development of Modeling Databases

The ozone issue in southwestern Wyoming is complicated by the fact that elevated ozone levels have been recorded in the winter, which is in contrast to most areas whose highest ozone events occur during the summer. Consequently, the concept of an ozone season is difficult to define for the region. Thus, it was decided to simulate an entire year to be sure to capture all potential high ozone conditions in the region.

Developing an annual PGM database from scratch is quite labor and time intensive. Fortunately, the WRAP has developed 2002 annual PGM modeling databases for the continental U.S. (Tonnesen et al., 2005; 2006) that can be adapted to assess the potential ozone impacts of the proposed Project as well as the other cumulative emissions sources in southwestern Wyoming, northeastern Utah, and northwestern Colorado. Thus, the 2002 annual period was selected due to the ability to leverage off of the WRAP modeling databases.

5.2.3 Development of a 2002 Ozone Modeling Database

The WRAP annual 2002 modeling database for the CAMx model was adapted for simulating ozone formation due to emissions from the Project and cumulative emissions in southeastern Wyoming and vicinity.

5.2.3.1 Modeling Domains and Grid Resolution

The WRAP developed a 2002 modeling database with a 12 km western U.S. modeling domain nested within a 36 km continental U.S. domain (Tonnesen et al. 2005; 2006). For simulating ozone formation from the Project and cumulative emissions in Wyoming and surrounding states, a higher resolution grid is needed, and is more consistent with EPA guidance (EPA 2007; 2006; 1999; 1991). Thus, a 12/4 km two-way nested grid modeling domain was defined for simulating ozone due to emissions from the Project and cumulative emissions as depicted in Figure 5-1. To define boundary conditions (BCs) for the Project's 12/4 km modeling domain (i.e., the assumed concentrations along the lateral boundaries of the 12 km grid shown in Figure 5-1), a 2002 Base Case simulation was performed for the WRAP 36 km continental U.S. domain and the results processed to generate hourly BC inputs for the 12/4 km domain (Figure 5-1). The resulting 36/12/4 km modeling domain used is shown in Figure 5-2 with one-way grid nesting between the 36 km and 12 km grids and two-way grid nesting between the 12 km and 4 km grids. Table 5-1 gives the definitions of the 36/12/4 km grid used in the Project's ozone modeling.

Table 5-1. Grid definitions used in the Project's ozone modeling based on a Lambert Conformal Conic (LCC) projection with origin at (-97, 45) and true latitudes at (33, 45).

Grid	X-Offset (km)	Y-Offset	NX	NY
36 km	-2,736.0	-2,088.0	148	112
12 km	-1,452.0	-192.0	89	86
4 km	-1,192.0	140.0	83	83

The same vertical layer structure used by WRAP was used in this study (Tonnesen et al. 2005; 2006). The WRAP vertical layer structure consists of 19 vertical layers from the surface to 100 mb (approximately 15 km AGL, with a surface layer that is approximately 35 m thick.

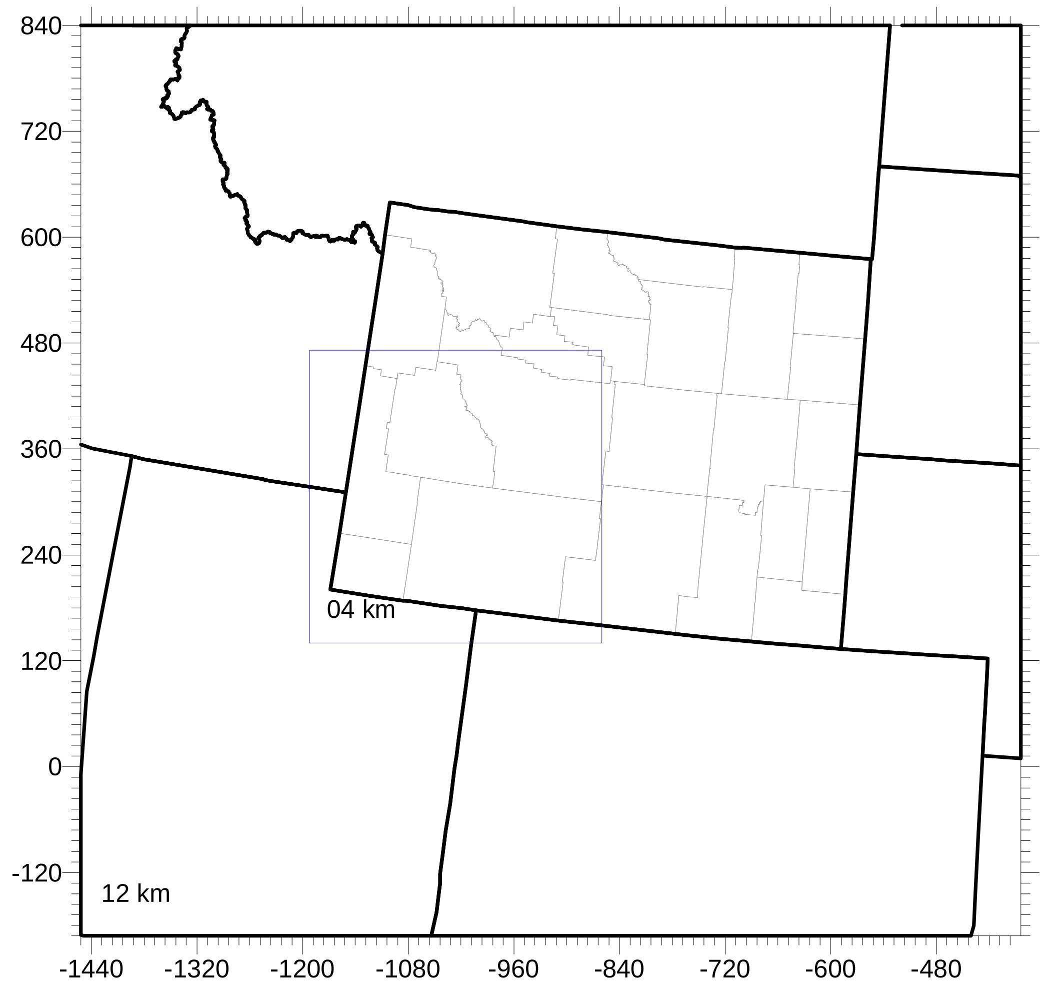


Figure 5-1. 2002 12/4 km two-way grid nested modeling domain used for the Project and cumulative emissions.

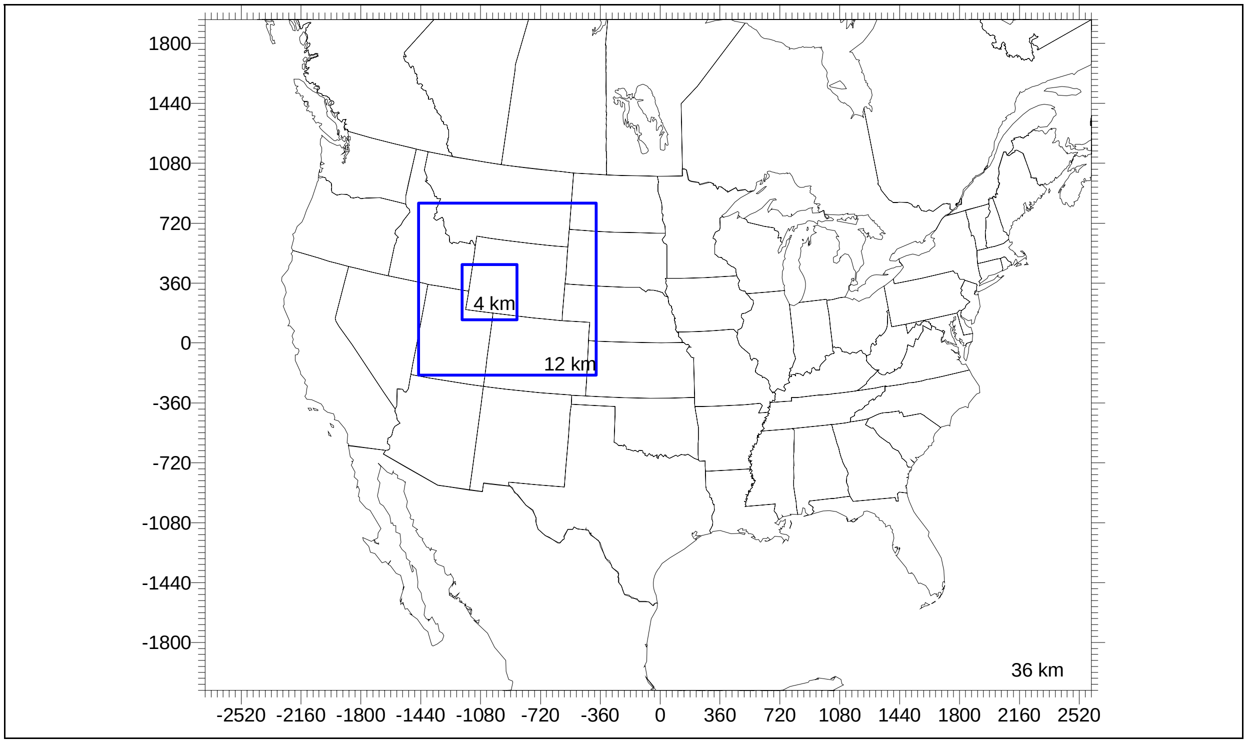


Figure 5-2. 2002 36/12/4 km ozone modeling domain for the Project and cumulative sources, one-way grid nesting was used between the 36 and 12 km grids, whereas two-way grid nesting was used between the 12 and 4 km grids.

5.2.3.2 Meteorological Inputs

The CAMx meteorological inputs for the 36 km and 12 km grids were based on the WRAP 36 km and 12 km MM5 simulations, respectively (Kemball-Cook et al. 2004). The MM5CAMx preprocessor was used to process and reformat the MM5 output for hourly meteorological inputs into CAMx for the 36 km and 12 km grids over the 2002 annual period.

For the 4 km grid, the CALMET model was used to generate wind and temperature fields for layers below approximately 3,000 m AGL. For winds above approximately 3,000 AGL and other meteorological variables, the 12 km MM5 output were interpolated to 4 km and processed for input into CAMx.

For the 4 km wind field below 3,000 m AGL, CALMET was run in a similar manner as discussed in Section 4. For the initial guess field, 12 km MM5 data was provided as input into CALMET, which applied the diagnostic wind effects and then integrated the surface and upper-air meteorological observations into the fields. There were two main reasons that CALMET was used for the 4 km wind fields rather than just interpolating the 12 km MM5 data onto the 4 km grid:

- The MM5 and other prognostic models have difficulty in simulating stagnant conditions, as discussed above. Such stagnant limited mixing conditions are believed to be important for producing elevated ozone in southwestern Wyoming.
- The CALMET model would introduce 4 km terrain effects through its diagnostic wind model that would not be present in the 12 km MM5 data.

Note that another alternative would be to run the MM5 model at 4 km for the 4 km modeling domain and the 2002 annual modeling period. However, this would still not address the difficulty in MM5's simulations of stagnant flow conditions and would result in serious schedule and resource issues in the study.

Figure 5-3 displays the Project's 12/4 km modeling domain and the locations of the surface and upper-air meteorological monitoring sites used in the 4 km CALMET simulation. Also shown in Figure 5-3 are the locations of the seven CASTNet ozone monitoring sites used in the ozone model performance evaluation that is discussed in Section 5.3.2.

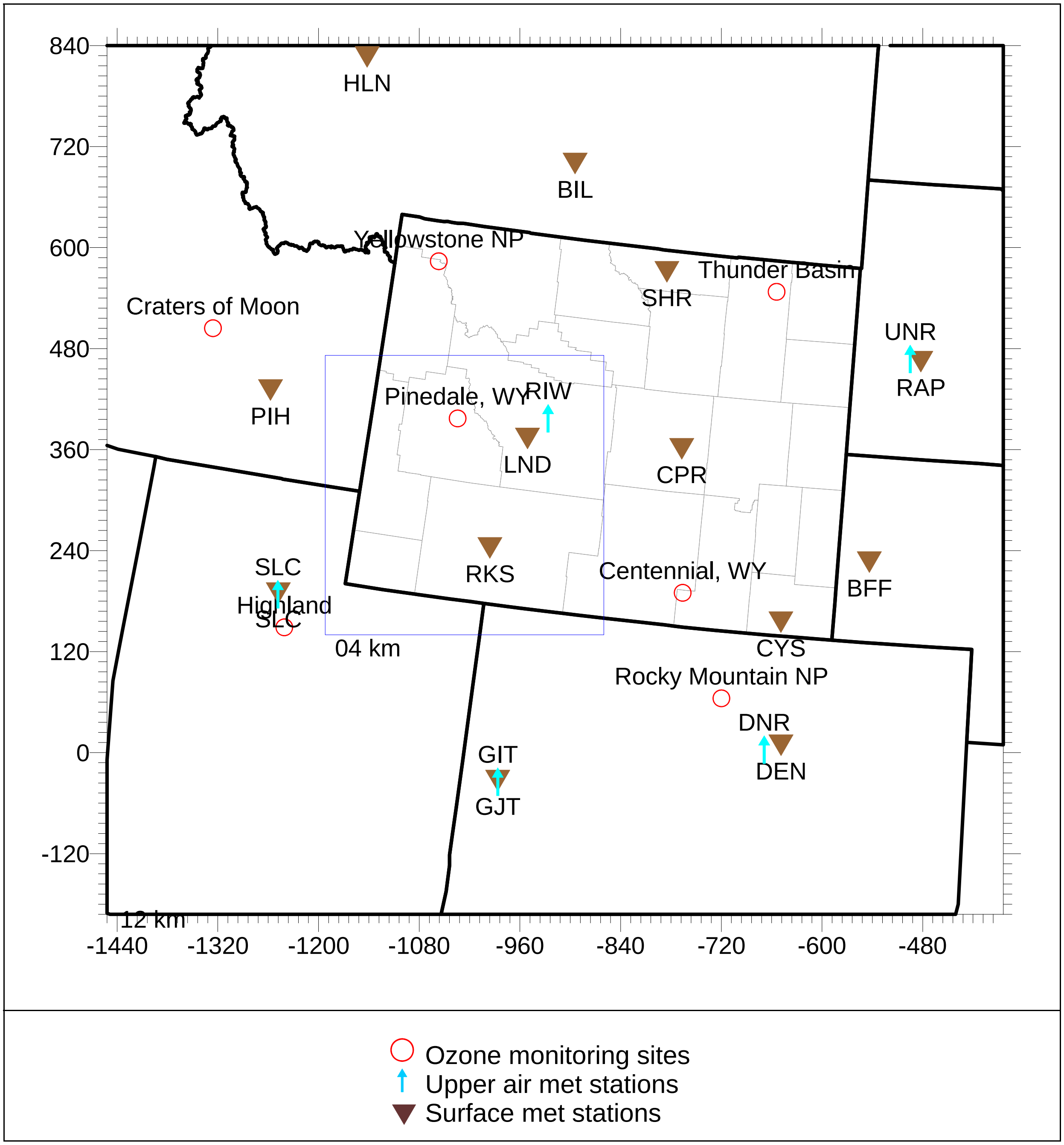


Figure 5-3. 2002 12/4 km modeling domain showing locations of surface and upper-air meteorological monitoring sites and the seven ozone monitoring sites.

5.2.3.2 Emission Inputs

Two emission scenarios were generated for ozone modeling: (1) a 2002 Base Case emissions scenario, and (2) a 2002 scenario with the base case plus the Project and Cumulative Emissions. For the Project, emissions for the Proposed Action alternative were used in the Project plus Cumulative Emissions scenario.

The emission inputs for the 2002 Base Case modeling were based on the WRAP 2002 36 km Base02b emission scenario. For the 2002 36 km CAMx simulation used to define the BCs for the 12/4 km domain, the WRAP Base02b 36 km emissions were used. For the 2002 Base Case emissions scenario and the 12 km domain, the WRAP Base02b 36 km emissions were mapped to the 12 km grid and windowed to match the 12 km grid domain. The 4 km 2002 Base Case emissions were obtained by flexi-nesting the 12 km emissions. Flexi-nesting interpolates the surface gridded 12 km emissions to the 4 km grid and treats point source emissions at the grid resolution where the point source resides (e.g., 4 km).

Area source emissions for the Project and cumulative emissions were first gridded to the 4 km grid. Then, they were input into CAMx as point sources with locations at the center of the 4 km grid cell in which they are located. Project and cumulative point sources were input as point sources in CAMx. A key component in the processing of the Project and cumulative emissions was the speciation of the VOC emissions into the CB05 chemical mechanism. For each source, an SCC code was assigned so that it could be cross-referenced to the correct VOC speciation profile in the emissions modeling.

Figure 5-4 displays the 2002 Base Case low-level gridded and elevated point source emissions for the 12/4 km modeling domain. The low-level gridded emissions include on-road mobile, non-road mobile, area, biogenic, and low-level point sources. The fact that the 2002 Base Case emissions were based on the WRAP 36 km emissions is clearly evident in the low-level emissions (Figure 5-4b). The urban areas of Denver, Colorado and Salt Lake City, Utah are clearly evident in the 2002 Base Case emissions displays.

Figure 5-5 displays the elevated point source emissions for the Project plus cumulative emissions scenario. Because emissions from the Project and cumulative sources were all represented as point sources so they can be treated by the high resolution 4 km grid, then the low-level gridded emissions for the Project plus cumulative emissions scenario are the same as the 2002 Base Case (Figure 5-4a). Figure 5-6 displays the difference between the Project and cumulative emissions and the 2002 Base Case emission scenarios. Cumulative emissions from the Project are clearly evident, along with cumulative emissions in the Pinedale/Jonah, Continental Divide, and other project areas. The higher resolution representative of the Project and cumulative emissions is also clearly evident in Figure 5-6.

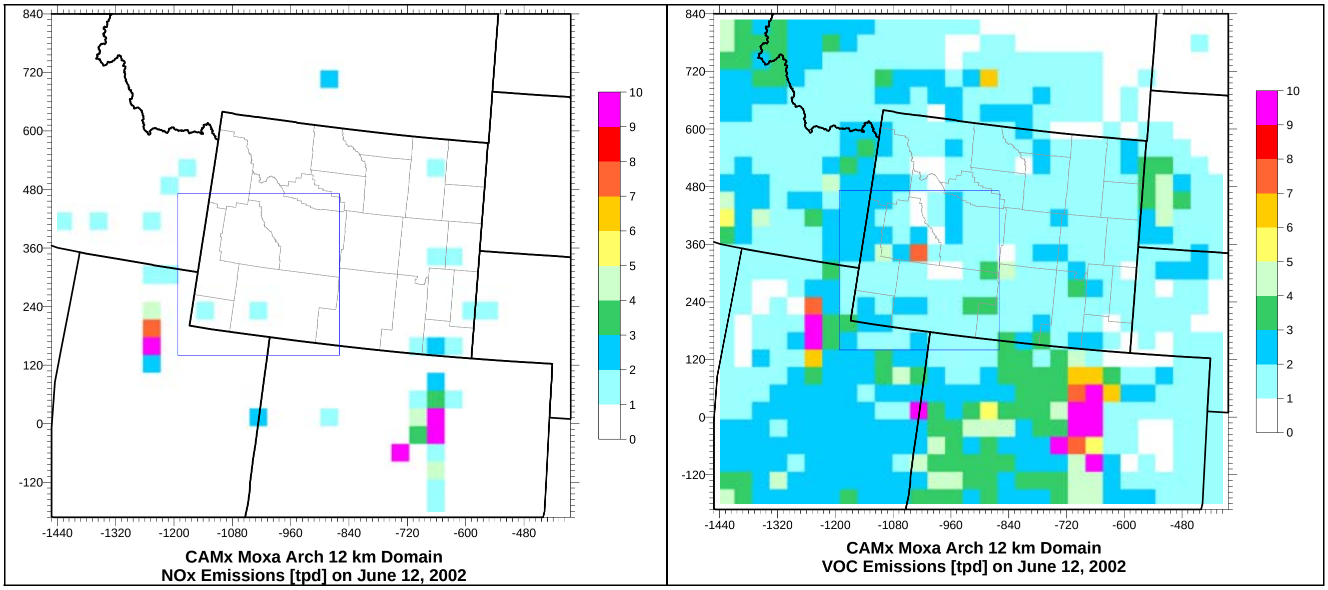


Figure 5-4a. Surface layer gridded NOx (left) and VOC (right) emissions (on-road and non-road mobile, area, biogenic and low-level point sources) for the 2002 Base Case emissions scenario (tons per day).

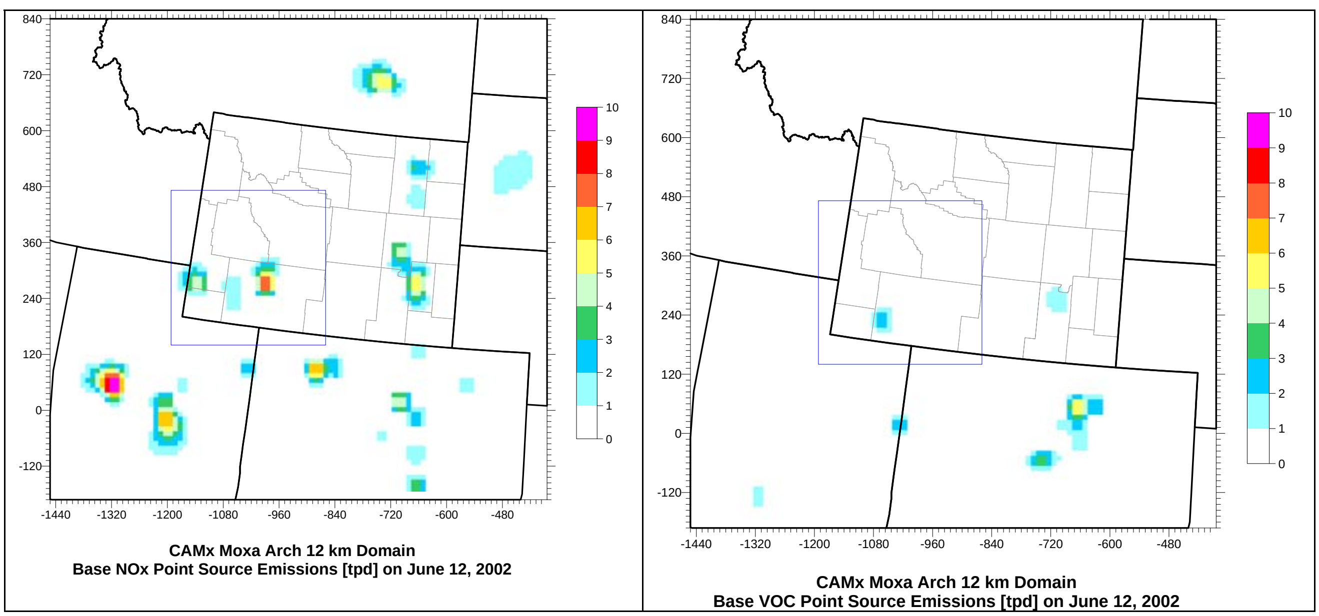


Figure 5-4b. Elevated point source NOx (left) and VOC (right) emissions for the 2002 Base Case emissions scenario (tons per day).

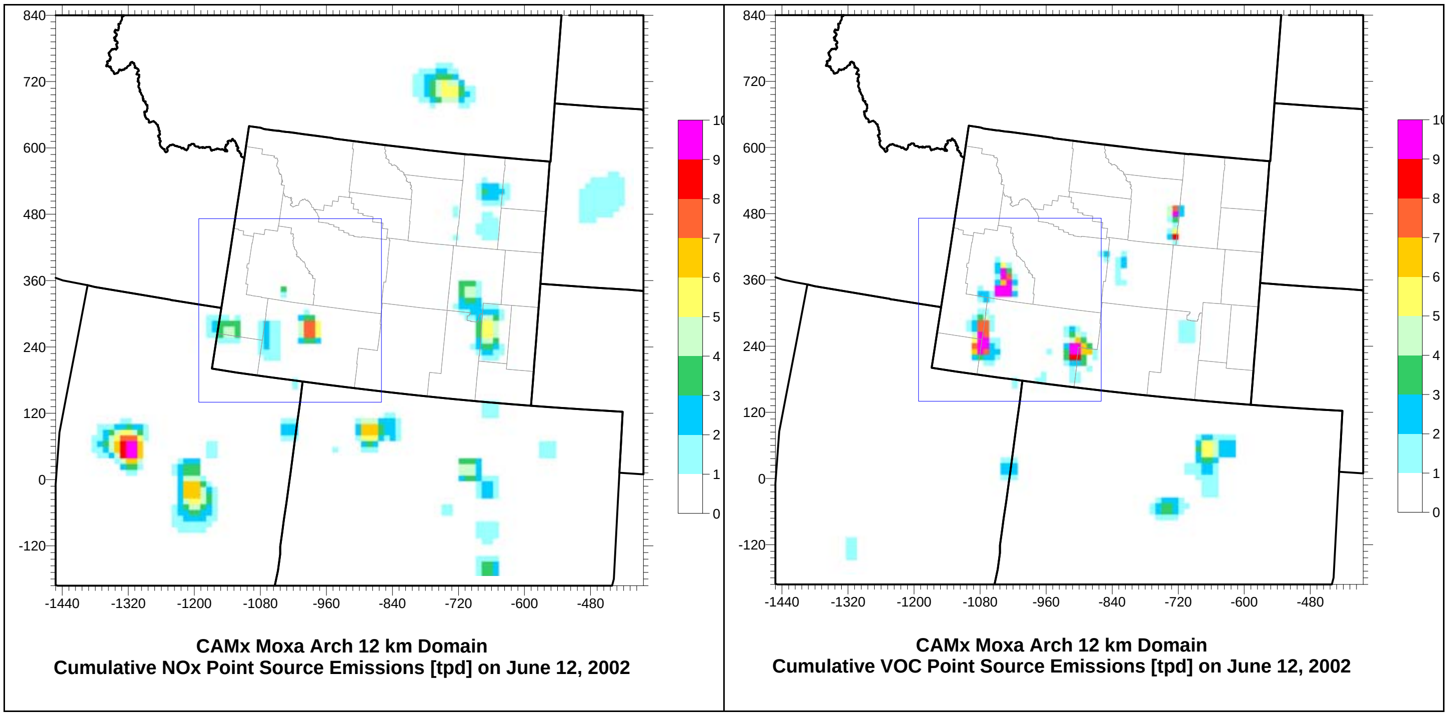


Figure 5-5. Elevated point source NOx (left) and VOC (right) emissions for the Project plus Cumulative emissions scenario (tons per day).

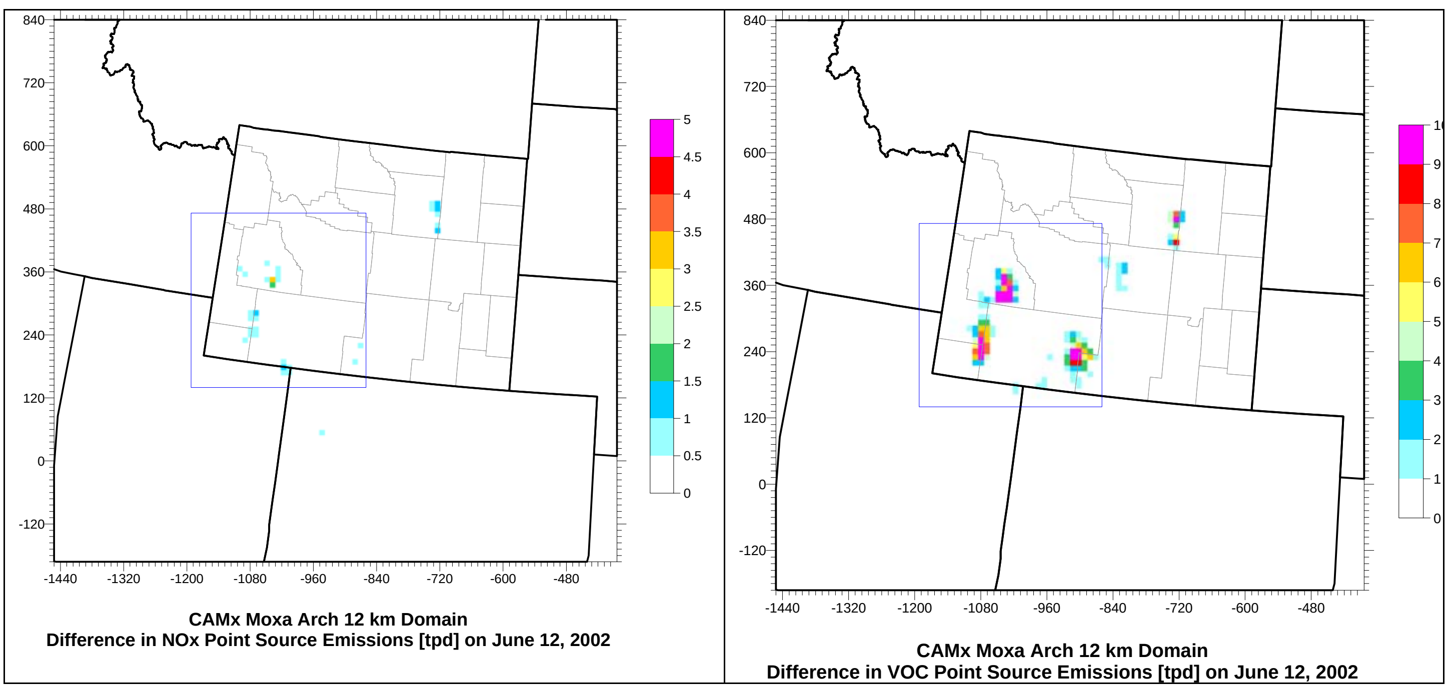


Figure 5-6. Differences in elevated point source NOx (left) and VOC (right) emissions for the Project plus Cumulative minus the 2002 Base Case emissions scenario (tons per day).

5.2.3.3 CAMx Model Options

CAMx model options specified for this application include the following:

- Use of the latest CB05 chemical mechanism.
- CMC fast chemistry solver.
- PPM advection solver.
- No Plume-in-Grid (PiG) algorithm.
- CAMx was run in the ozone-only mode (i.e., the PM chemistry was turned off to speed up the simulations as there is little feedback from PM to ozone chemistry).

5.3 2002 BASE CASE MODELING RESULTS

Using the hourly BCs generated from the 2002 36 km CAMx simulation and WRAP 2002 Base02b emissions, a 2002 12/4 km Base Case simulation was performed.

5.3.1 Comparison of Modeled versus Observed Peak 2002 Ozone Concentrations

The ozone standard is expressed as the three-year average of the fourth highest daily maximum ozone concentration at a monitor. Consequently, the model's ability to predict the highest ozone concentrations at an ozone monitor is of particular concern, particularly the fourth highest 8-hour ozone concentrations. Figures 5-7 and 5-8 display the spatial distribution of the fourth highest model estimated daily maximum 8-hour ozone concentration during the 2002 modeling year on the 4 km and 12 km modeling domains, respectively. Also shown in Figures 5-7 and 5-8 are the fourth highest observed daily maximum 8-hour ozone concentrations that are plotted at the location of the monitoring site. The model estimated fourth highest daily maximum ozone concentrations in the 4 km domain range from 50 ppb to 84 ppb, with the highest values occurring in northeastern Utah and northwestern Colorado, with the lowest values occurring near Palisades Reservoir, Idaho on the Wyoming-Idaho border. However, most of the model-estimated fourth highest daily maximum 8-hour ozone concentrations are in the 60 ppb to 80 ppb range. At the location of the Pinedale monitoring site, where the fourth-highest observed value of 73 ppb is recorded, the modeled value appears to be ~70 ppb. Note that the model estimates slightly higher ozone in the higher terrain of the Wind River Range than is recorded at the Pinedale monitoring site.

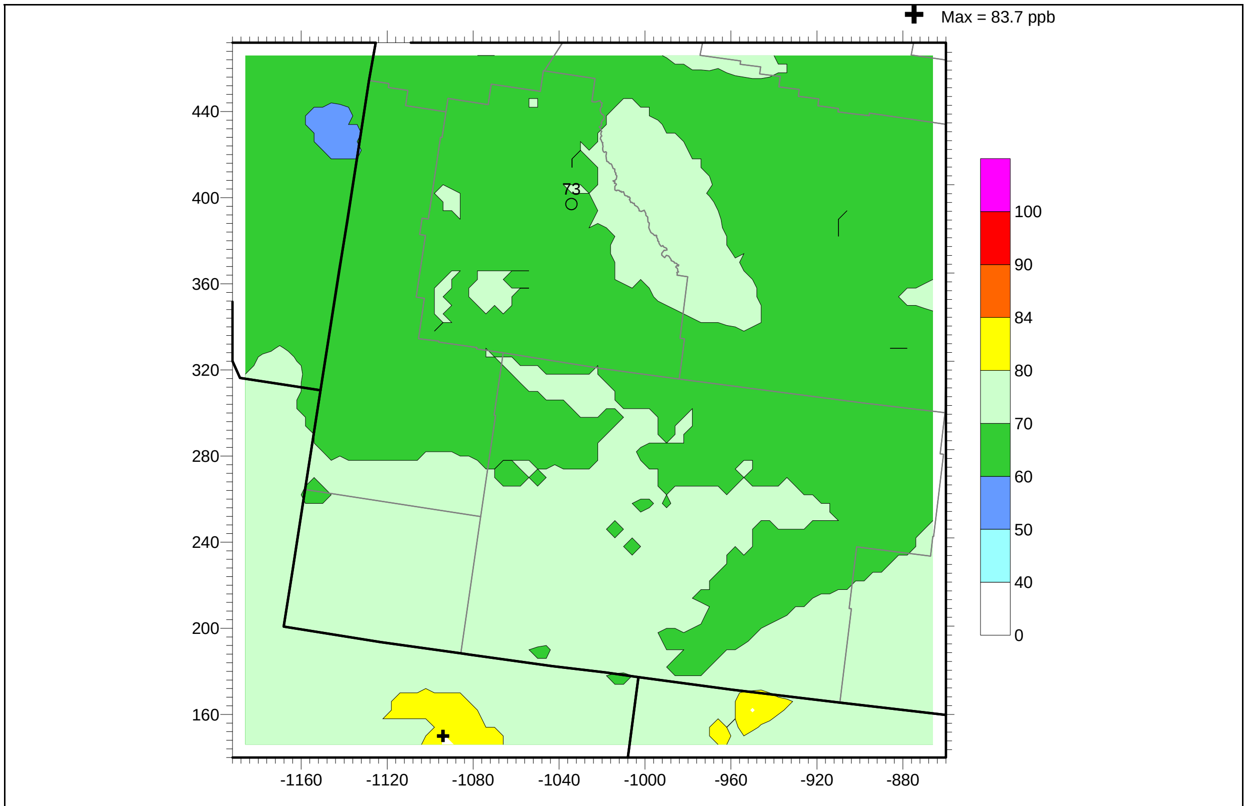
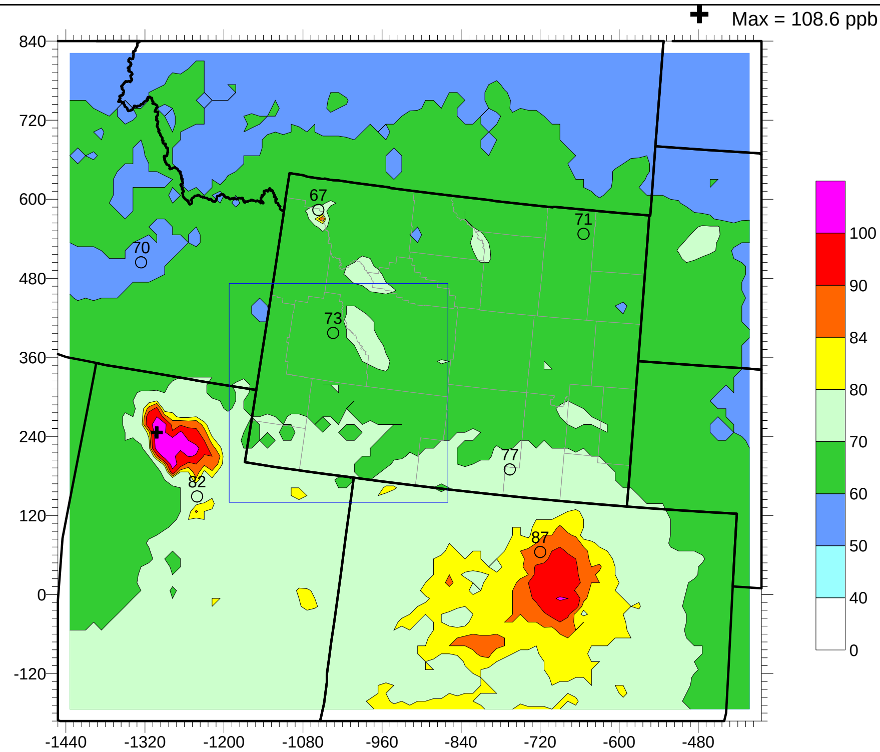


Figure 5-7. Model estimated fourth highest daily maximum 8-hour ozone concentration in the 4 km grid for the 2002 Base Case with superimposed observations.

In the 12 km grid, the maximum fourth-highest model-estimated daily maximum 8-hour ozone concentrations occur in the Salt Lake City, Utah and Denver, Colorado areas. This is consistent with the observed fourth-highest daily maximum 8-hour ozone concentrations that recorded values of 82 ppb at the Highland monitor south of Salt Lake City and 87 ppb at the Rocky Mountain National Park monitor northwest of Denver. The spatial distributions of the predicted and observed 4th highest daily maximum 8-hour ozone concentrations are consistent with one another, with the possible exception of the Yellowstone National Park monitor in northeastern Wyoming; the model estimates an isolated increase in ozone near Yellowstone; whereas, the monitored value is the lowest in the domain (67 ppb).



CAMx Moxa Arch 12 km Domain
Fourth Highest Daily Maximum 8-hour Ozone in 2002

Figure 5-8. Model estimated fourth highest daily maximum 8-hour ozone concentration in the 12 km grid for the 2002 Base Case with superimposed observations.

The four highest modeled and observed daily maximum 8-hour ozone concentrations at the Pinedale and Centennial monitors during 2002 are shown in Table 5-2a. When performing 8-hour ozone projections, EPA recommends using the highest modeled daily maximum 8-hour ozone concentration near (within 15 km) the monitor, so the four highest modeled maximum values near the monitor were compared with the four highest observed values in Table 5-2b. There is agreement between the modeled and observed four highest daily maximum 8-hour ozone concentrations at the two monitors, with differences at the monitors ranging from -1.4% to -6.7% for Pinedale and -1.5% to -3.8% for Centennial. The agreement with the four highest observed daily maximum 8-hour ozone concentrations is even better when looking at the modeled maximum near the monitor with agreement ranging from -4.7% to +2.0% at Pinedale and -0.2% to -1.6% for Centennial.

Table 5-2a. Comparison of four highest predicted and observed daily maximum 8-hour ozone concentrations at the Pinedale and Centennial monitoring sites for 2002.

Rank	Observed (ppb)	Predicted (ppb)	Difference (%)
Pinedale Monitor			
1st High	76.50	75.46	-1.4%
2nd High	76.41	71.27	-6.7%
3rd High	72.94	70.70	-3.1%
4th High	72.69	68.69	-5.5%
Centennial Monitor			
1st High	79.13	76.48	-3.3%
2nd High	79.00	76.01	-3.8%
3rd High	77.94	75.61	-3.0%
4th High	76.66	75.51	-1.5%

Table 5-2b. Comparison of four highest predicted and observed daily maximum 8-hour ozone concentrations at the Pinedale and Centennial monitoring sites for 2002 using maximum modeled values near (< 15 km) the monitoring sites.

Rank	Observed (ppb)	Predicted (ppb)	Difference (%)
Pinedale Monitor			
1st High	76.50	78.01	+2.0%
2nd High	76.41	72.85	-4.7%
3rd High	72.94	72.70	-0.3%
4th High	72.69	72.06	-0.9%
Centennial Monitor			
1st High	79.13	78.29	-1.1%
2nd High	79.00	77.75	-1.6%
3rd High	77.94	76.80	-1.5%
4th High	76.66	76.47	-0.2%

5.3.2 Statistical Ozone Model Performance Evaluation

The modeled surface ozone concentrations estimates were compared against the observed ozone concentrations from the seven CASTNet monitoring sites shown in Figure 5-3 using graphical and statistical performance measures. Particular emphasis was placed on ozone model performance at the Pinedale CASTNet site because that was the only site located within the 4 km domain and because it lies between the Project and the Bridger Class I area. The ozone model performance at the Centennial CASTNet that lies just east of the 4 km domain was analyzed separately.

Figures 5-9 and 5-10 compare time series of predicted and observed daily maximum 8-hour ozone concentrations for 2002 at the Pinedale and Centennial ozone monitors sites, respectively. Although there is a lot of a day-to-day variation between the modeled and observed 8-hour ozone concentrations, the model generally matches the magnitudes of the observed values on average for most of the year until around August, when the modeled values start to become lower than observed. In particular, the model fails to capture the relatively high observed ozone at the end of August 2002. The modeled lowest 8-hour ozone days appear to be lower (~30 ppb) than the lowest observed days (~40 ppb), but the ozone magnitudes on the highest modeled days (~75 ppb) matches the observed magnitudes well, although there appears to be less modeled high days than observed, which is due to the August-December 2002 underestimation period. The reasons why the model begins an underestimation tendency in August is unclear.

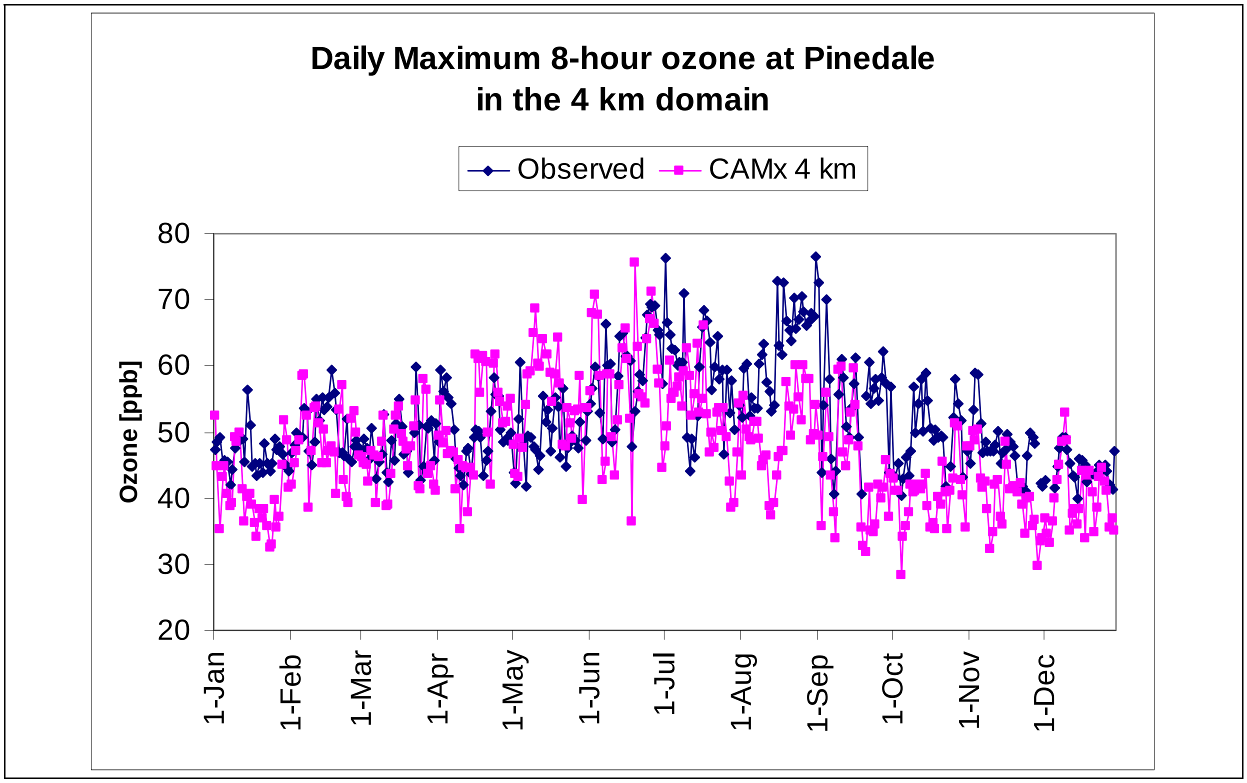


Figure 5-9. Comparisons of predicted and observed daily maximum 8-hour ozone concentrations (ppb) at the Pinedale CASTNet site.

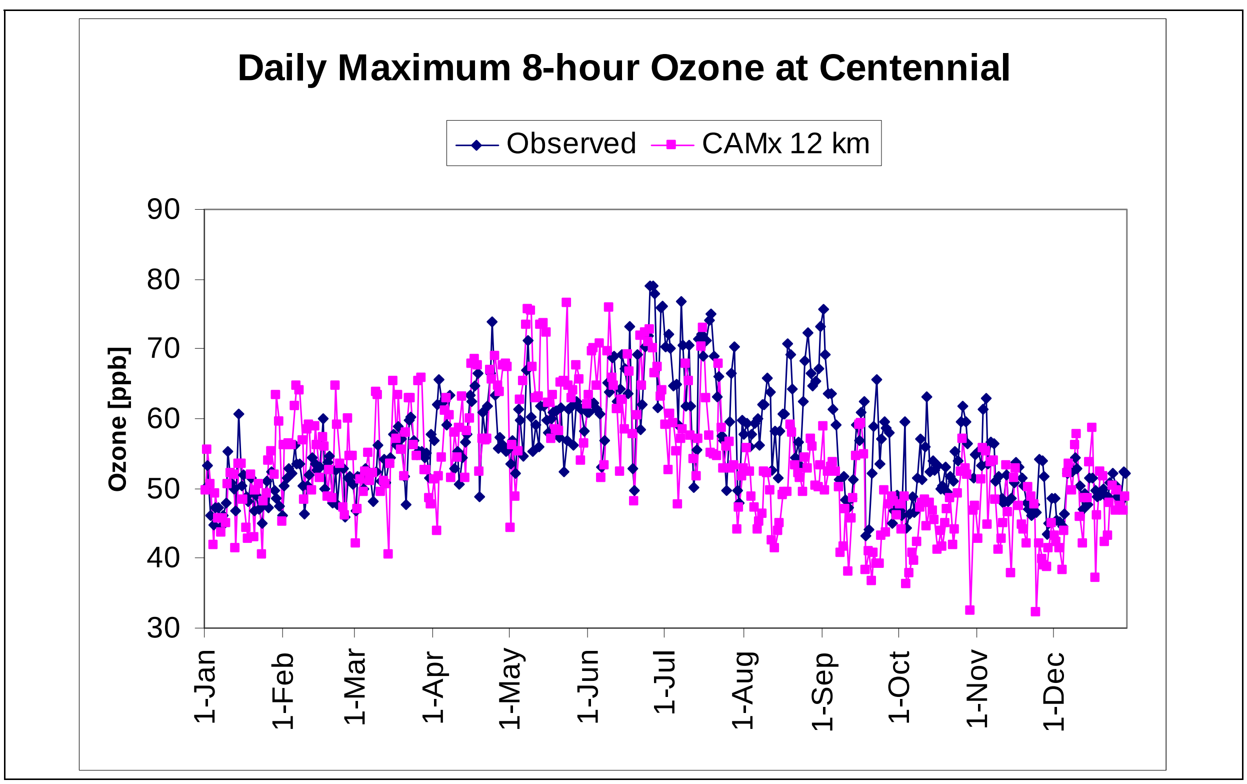


Figure 5-10. Comparisons of predicted and observed daily maximum 8-hour ozone concentrations (ppb) at the Centennial CASTNet site.

EPA has developed the following model performance goals for 1-hour ozone statistical measures (EPA 1991):

- Mean Normalized Bias (MNB) $\leq \pm 15\%$
- Mean Normalized Gross Error (MNGE) $\leq$ 35%

Figure 5-11 and 5-12 display the MNB and MNGE ozone performance metrics using the daily maximum 8-hour ozone concentrations by month for the, respectively, 4 km and 12 km modeling grids using “Soccer Plots”. Soccer Plots plot the MNB statistical performance measure on the x-axis and MNGE metric on the y-axis with a box around the MNB $\leq \pm 15\%$ and MNGE $\leq 35\%$ performance goals. When the monthly symbol falls within the box, EPA’s MNB and MNGE model performance goals are achieved. For 7 months of 2002, the monthly model performance statistics within the 4 km domain (i.e., the Pinedale ozone monitor) achieve EPA’s MNB and MNGE performance goals. For the months of January, February, August, September and October, the MNB is below -15%, so does not achieve EPA’s performance goal for this metric, although the MNGE metric goal (< 35%) is achieved by a fair margin (~20%) for all months. The worst performing month is August (-23% MNB), which is consistent with the Pinedale time series shown in Figure 5-9.

Better ozone model performance metrics are seen across the 12 km modeling domain within only two months (August and September) with MNB performance metric not achieving EPA’s goals (Figure 5-11).

The comparisons of the predicted and observed 8-hour ozone concentrations presented in Figures 5-8 through 5-11 are for daily maximum 8-hour ozone concentrations paired in time (by day) and space (at the ozone monitor). When projecting 8-hour ozone concentrations, EPA guidance recommends using the daily maximum 8-hour ozone concentrations “near the monitor” to account for the fact that there may be small spatial displacements in the modeled ozone fields. In the 1999 EPA draft 8-hour ozone modeling guidance, EPA recommended that predicted 8-hour ozone concentrations near the monitor should be within $\pm 20\%$ of the observed value on a majority of the days.

EPA guidance for making 8-hour ozone projections defines “near the monitor” as being within approximately 15 km. This turns out to be an array of 7 x 7 grid cells for the 4 km grid and 3 x 3 grid cells for the 12 km grid. The next issue is which model-estimated daily maximum 8-hour ozone concentration to match up with the observed value at the monitor, which is examined three ways:

> Spatial Paired: Select the model estimated daily maximum 8-hour ozone concentrations at the monitor, as was done in the discussion above.
>
> Maximum Value: Select the maximum model estimated daily maximum ozone concentrations in the array of cells (7 x 7 for 4 km and 3 x 3 for 12 km) centered on the monitor. This approach is identical to how modeled 8-hour ozone concentrations are selected for projecting 8-hour ozone concentrations.
>
> Closest Value: Select the modeled daily maximum 8-hour ozone concentrations near the monitor that best matches the observed value.

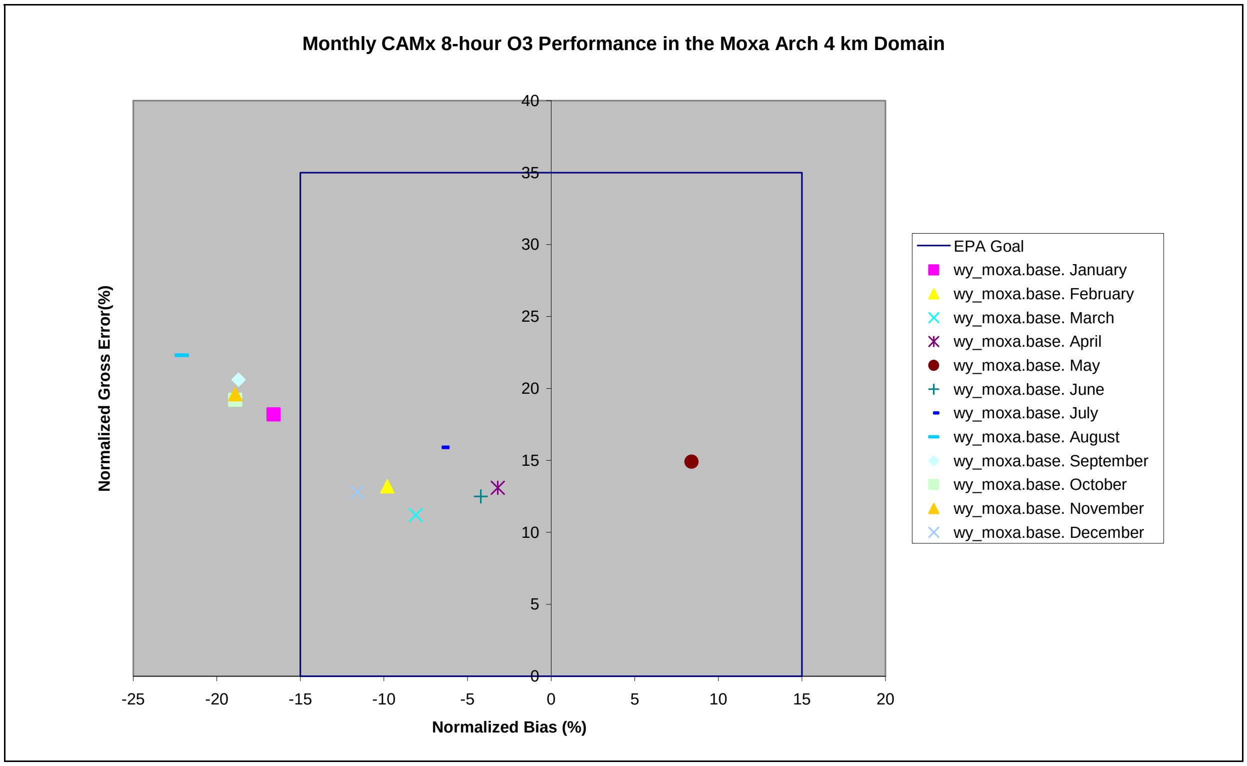


Figure 5-11. Soccer Plots of the monthly MNB versus MNGE for daily maximum 8-hour ozone concentrations in the 4 km grid (i.e., Pinedale monitoring site).

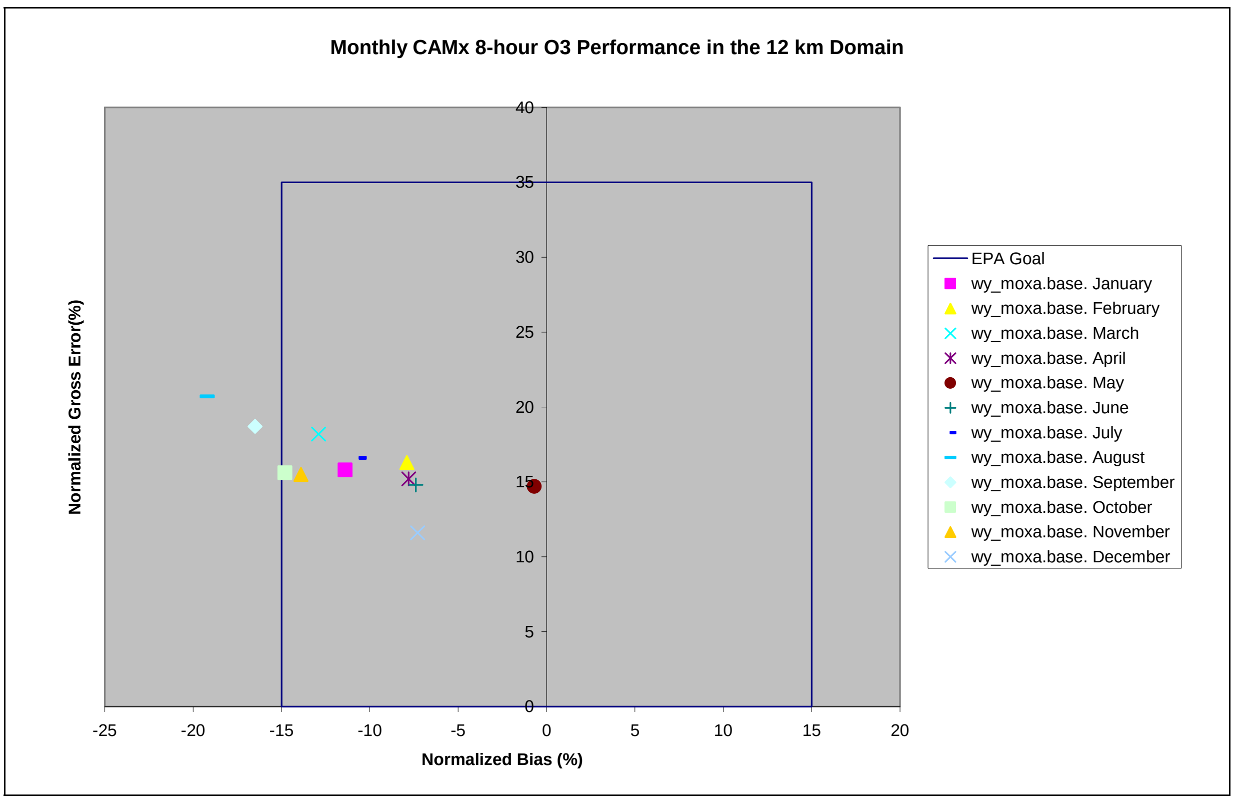


Figure 5-12. Soccer Plots of the monthly MNB versus MNGE for daily maximum 8-hour ozone concentrations in the 12 km grid (i.e., 7 CASTNet sites).

Figure 5-13 displays the comparisons of the predicted and observed 8-hour ozone concentrations in a scatter plot for these three methods of matching the modeled values with the observed values at the Pinedale monitoring site. The 1:1 line of perfect agreement is a solid line and predicted/observed pairs within the dotted lines are within ±20% of each other. Also shown in Figure 5-13 are the Quantile-Quantile (Q-Q) plots of the frequency distribution of the annual predicted and observed daily maximum 8-hour ozone concentrations. The closer the Q-Q plots are to the 1:1 sold line indicates how well the annual frequency distribution of the predicted and observed daily maximum 8-hour ozone concentrations matches each other. The Q-Q plots of predicted and observed daily maximum 8-hour ozone concentrations at the Pinedale monitor show the model under-predicting at low ozone concentrations but for the mid-level and higher ozone values matching much better, albeit with a slight underestimation tendency.

Figure 5-14 displays the same information as Figure 5-13 but for the Centennial monitor. Again, a vast majority of the modeled daily maximum 8-hour ozone concentrations are within 20% of the observed value on the same day and the Q-Q plots indicate that the modeled and observed daily maximum 8-hour ozone concentrations in 2002 have a very similar frequency distribution, albeit with the modeled values slightly lower.

A comparison of the predicted and observed daily maximum ozone concentrations across all seven sites in the 12 km domain is given in Figure 5-15. When looking at the maximum modeled value near the monitor (Figure 5-14, middle), there are a few days with extremely high modeled values (~100 ppb) but lower observed values (~40 ppb). These days occur at the Yellowstone NP monitor and are due to a highly localized modeled ozone spike (see Figure 5-8), the cause of which is unknown.

At the Pinedale monitoring site, the predicted daily maximum 8-hour ozone value near the monitor is within ±20% of the observed value on 74%, 78%, and 89% of the days during 2002 depending on whether the Spatially Paired, Maximum or Nearest value is used (Table 5-3). Similar numbers for the Centennial site are 84%, 85%, and 89% and for all the ozone monitoring sites 72%, 74%, and 84%. Thus, the model is predicting daily maximum 8-hour ozone concentrations near the monitor to within ±20% of the observed value most of the time.

Table 5-3. Summary of modeled daily maximum 8-hour ozone concentrations within 20% of the observed value on the same day at the Pinedale and Centennial monitors, across all 7 monitors in the 12 km domain and for the Spatial Paired, Maximum and Nearest predicted value near the monitor.

	Spatially Paired	Maximum Value	Nearest Value
Pinedale 4 km (357 days)			
Within ±20%	74%	78%	89%
> +20%	6%	12%	2%
< -20%	20%	10%	9%
Centennial 12 km (359 days)			
Within ±20%	84%	85%	89%
> +20%	4%	6%	2%
< -20%	12%	9%	9%
12 km All Sites (2,287 days)			
Within ±20%	72%	78%	84%
> +20%	4%	8%	2%
< -20%	23%	14%	14%

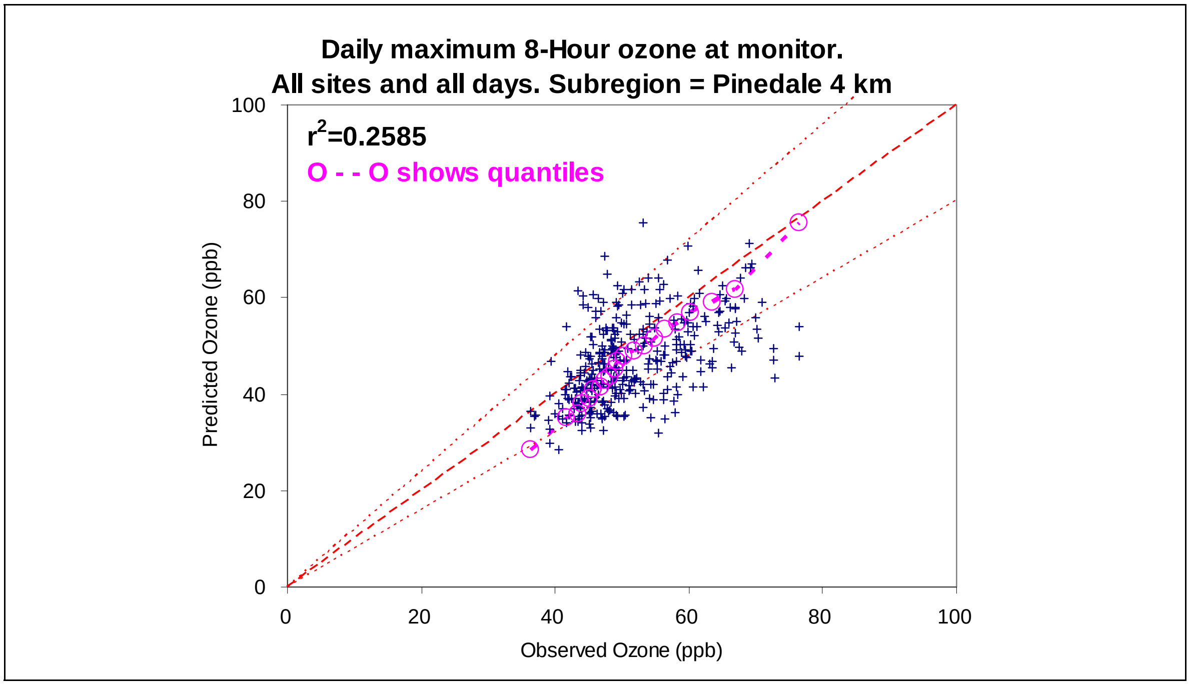


Figure 5-13a. Comparison of predicted and observed daily maximum 8-hour ozone concentrations at the Pinedale monitor using the Spatial Paired modeled value near the monitor.

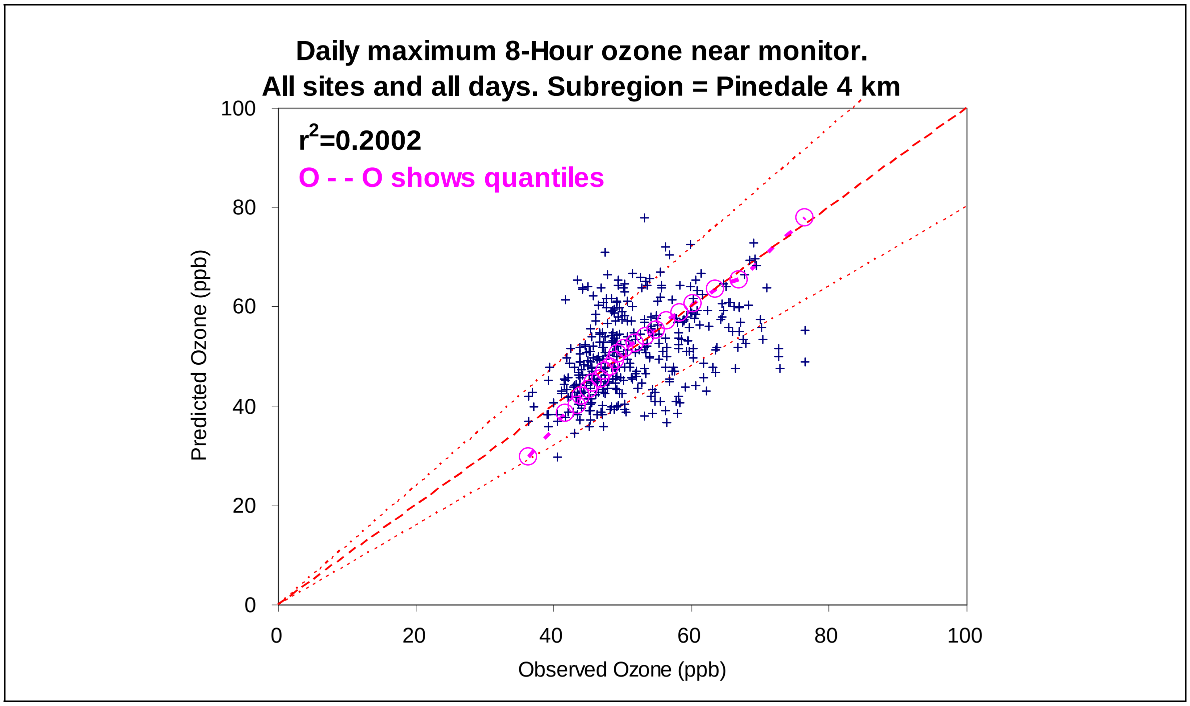


Figure 5-13b. Comparison of predicted and observed daily maximum 8-hour ozone concentrations at the Pinedale monitor using the Maximum modeled value near the monitor.

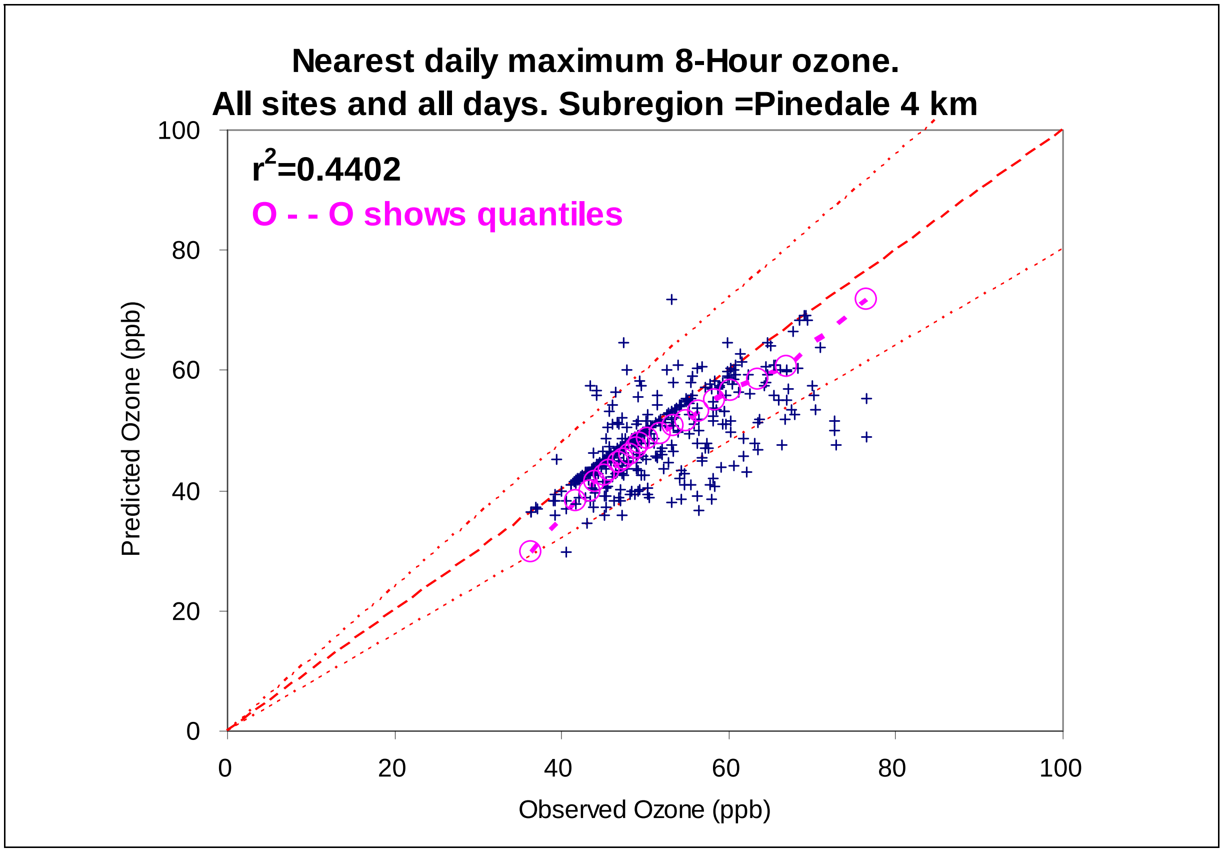


Figure 5-13c. Comparison of predicted and observed daily maximum 8-hour ozone concentrations at the Pinedale monitor using the Closest modeled value near the monitor.

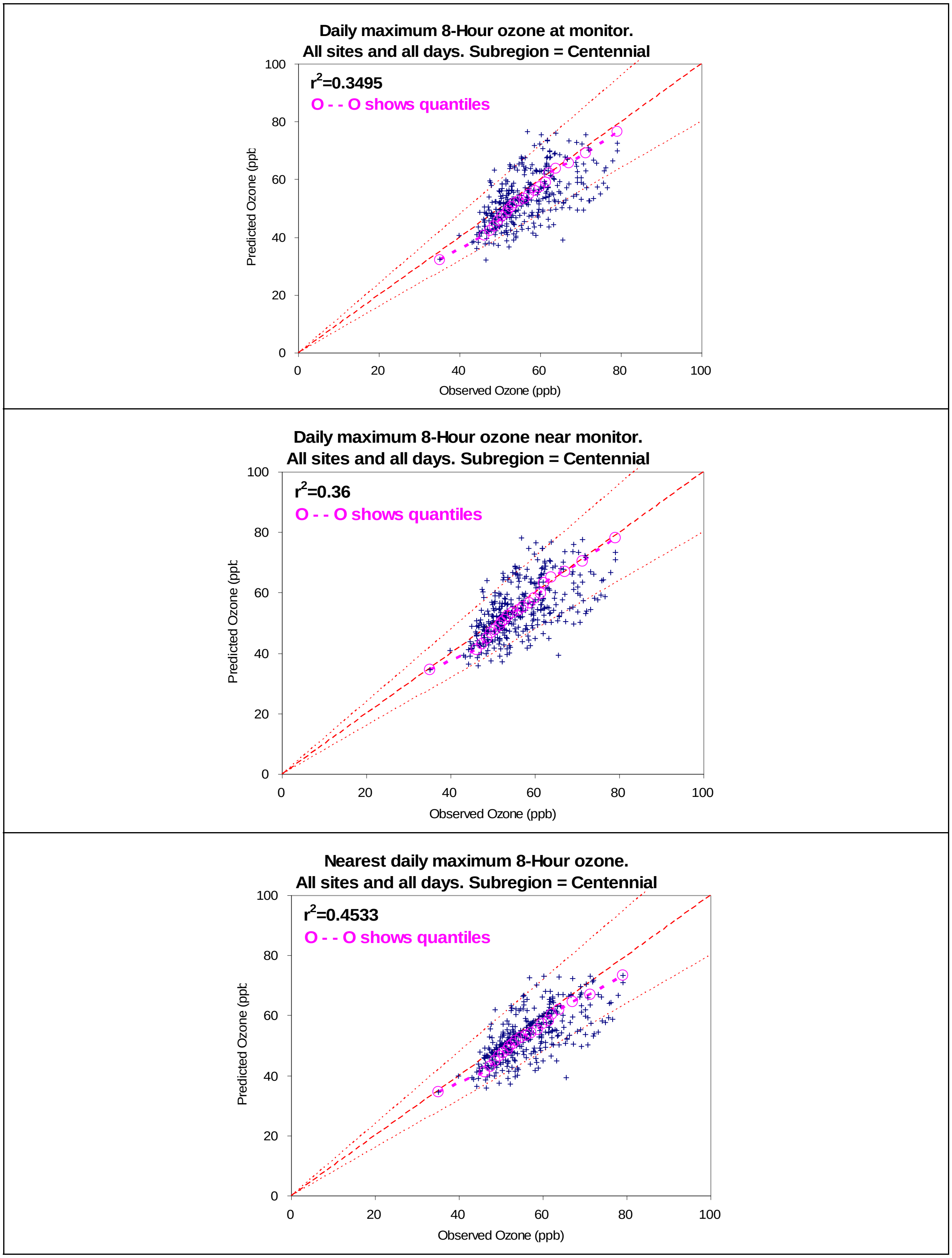


Figure 5-14. Comparison of predicted and observed daily maximum 8-hour ozone concentrations at the Centennial monitor using the Spatially Paired (top), Maximum (middle) and Closest (bottom) modeled value near the monitor.

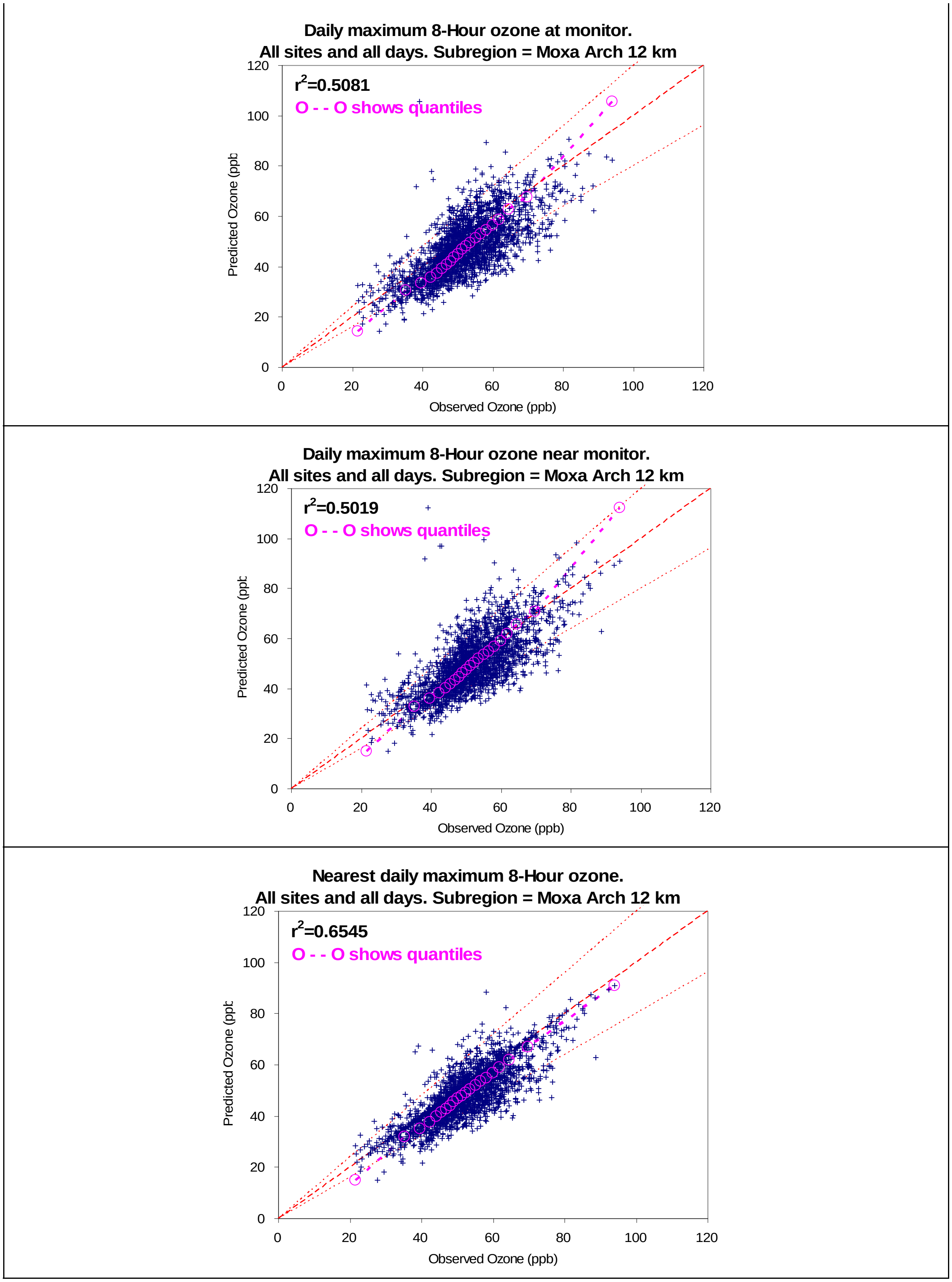


Figure 5-15. Comparison of predicted and observed daily maximum 8-hour ozone concentrations across 7 monitors in the 12 km grid using the Spatially Paired (top), Maximum (middle) and Closest (bottom) modeled value near the monitor.

5.3.3 Ozone Model Performance Evaluation Conclusions

The CAMx 2002 12/4 base case simulation reproduces the observed ozone to within EPA's performance goals, although with a small underestimation bias. The observed highest ozone concentrations at the Pinedale and Centennial CASTNet monitors in southwestern Wyoming are generally reproduced by the model to within $\pm$5%. On a day-by-day basis, the observed daily maximum ozone concentrations are replicated by the model to within $\pm$20% for a vast majority of the modeling days. Thus, the model appears to be reliable enough to perform an assessment of the potential ozone impacts of the Project and cumulative emissions.

5.4 OZONE IMPACT ASSESSMENT

The impact of the Project and other new sources in the region (cumulative emissions) on ozone concentrations were analyzed in two ways. The first approach follows EPA's guidance for projecting future year ozone concentrations for determining attainment of the ozone NAAQS (EPA, 2007). The second approach uses the modeled absolute model predictions and compares the modeled fourth highest 8-hour ozone concentration estimates with the 8-hour ozone NAAQS.

5.4.1 Results using EPA Guidance Ozone Projection Approach

EPA guidance for projecting 8-hour ozone concentrations recommends using the model in a relative sense to scale the observed 8-hour ozone Design Values (EPA 2007). These model scaling factors are a ratio of the future-year to current-year modeled 8-hour ozone concentrations and are called relative response factors (RRFs). The future-year Design Value (DVF) is obtained from the current-year Design Value as follows:

DVF = DFC x RRF

The RRFs are defined as the ratio of the average 8-hour ozone concentrations near the monitor for the future-year to the current-year model simulation for all days in which the current-year modeled 8-hour ozone value is greater than a threshold. EPA recommends using a threshold value of 70 ppb to 85 ppb. By near the monitor, EPA means within approximately 15 km.

The EPA projection approach was modified slightly to address the data sparse and relatively lower (compared to urban locations) ozone conditions of southwest Wyoming and include an additional level of conservatism as follows:

- RRFs and 8-hour ozone projections were performed for every grid cell in the 12/4 km modeling domain using modeling results in each grid cell.
- A threshold of 70 ppb was used (i.e., RRFs for a grid cell is based on the ratio of the average daily maximum 8-hour ozone concentrations for the Cumulative Emissions to Base Case emissions scenario when the Base Case ozone is 70 ppb or greater).
- The observed starting point for the 8-hour ozone projections in every grid cell of the 12/4 km domain was the 75 ppb maximum 8-hour ozone background concentrations provided by WDEQ-AQD (Table 4-5).

The WDEQ-AQD 75 ppb maximum background 8-hour ozone value was used rather than the actual observed 8-hour ozone Design Values in this projection approach because of the sparse ozone network in this region of the country. Even for the Jonah ozone monitor that has recorded 8-hour ozone concentrations approaching the ozone NAAQS has only 2 years of data so an 8-hour ozone Design Value cannot be calculated because 3 years of valid data.

5.4.1.1 Projected 8-Hour Ozone Near the Project

The spatial distribution of estimated daily maximum 8-hour ozone concentrations near the Project due to emissions from the Project's Proposed Action Alternative and Cumulative Emissions are shown in Figure 5-16. Using a 75 ppb background ozone concentration and the EPA-recommended RRF projection approach, the maximum estimated daily maximum 8-hour ozone concentrations near the Project is 76.6 ppb, which is below the 8-hour ozone standard of 84 ppb. Thus, the proposed Project and other Cumulative Emissions in the area are not projected to violate the 8-hour ozone standard near the Project.

5.4.1.2 Projected 8-Hour Ozone in 12/4 km Domain

The projected 8-hour ozone concentrations in the 4 km and 12 km modeling domains using the EPA guidance projection approach are shown in Figure 5-17. The maximum projected 8-hour ozone concentration is 77.6 ppb and 77.3 ppb in the 4 km and 12 km domains, respectively. These values are below the ozone NAAQS and demonstrate that the proposed Project and other Cumulative Emissions would not cause a violation of the ozone NAAQS.

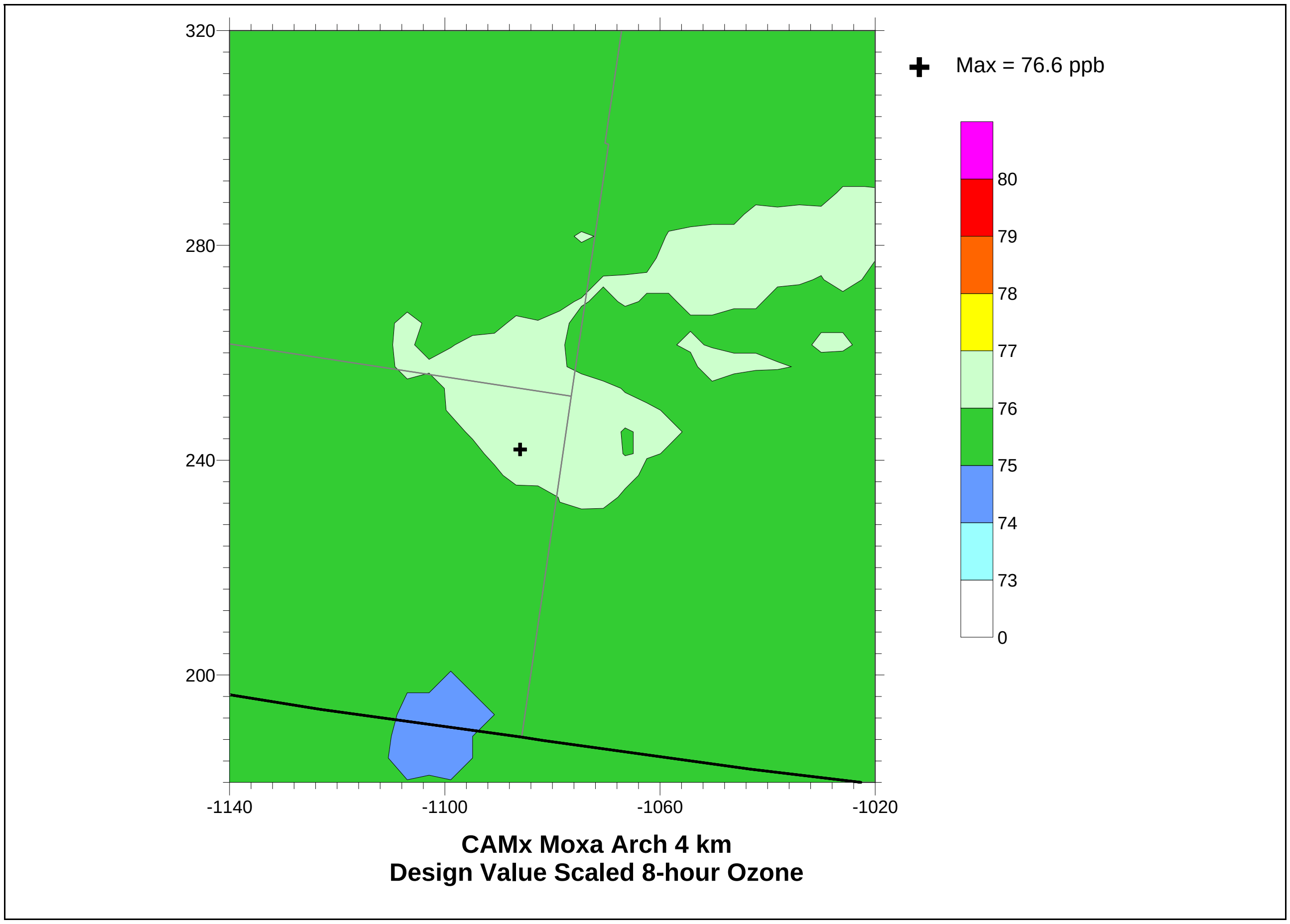


Figure 5-16. Projected daily maximum 8-hour ozone concentrations near the Project for the Project plus Cumulative Emissions scenario using the EPA Guidance RRF projection approach.

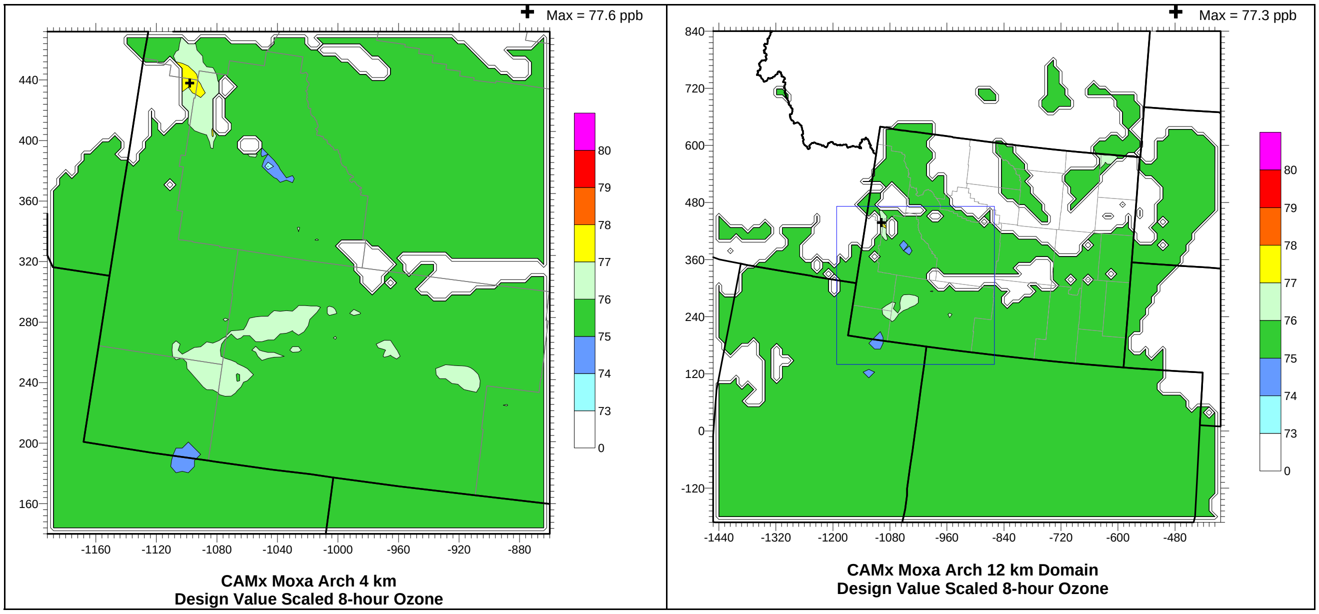


Figure 5-17. Projected daily maximum 8-hour ozone concentrations in the 4 km (left) and 12 km (right) modeling domains for the Project plus Cumulative Emissions scenario using the EPA Guidance RRF projection approach.

5.4.2 Absolute Modeling Results

The second approach used for assessing the potential ozone impacts from the Project and other new sources in the region is to analyze the absolute modeled concentrations for the Project plus Cumulative Emissions scenario.

5.4.2.1 Absolute Ozone Results Near the Project

Figure 5-18 displays the fourth highest daily maximum 8-hour ozone concentrations near the Project estimated by the CAMx model for the Project plus Cumulative Emissions scenario. The estimated peak 8-hour ozone concentration near the project is 77.8 ppb, which is below the ozone NAAQS of 85 ppb.

Figure 5-19 displays the estimated incremental 8-hour ozone concentration near the Project due to new emissions from the Project plus Cumulative Emission sources. These incremental ozone estimates were obtained by taking the difference between the fourth highest daily maximum ozone concentrations for the Project plus Cumulative Emissions simulation and the fourth highest 8-hour ozone concentrations from the 2002 Base Case simulation. The fourth highest 8-hour ozone concentrations in the vicinity of the Project are estimated to increase from 0 ppb to 2.5 ppb, with the maximum increase occurring southeast of the Project.

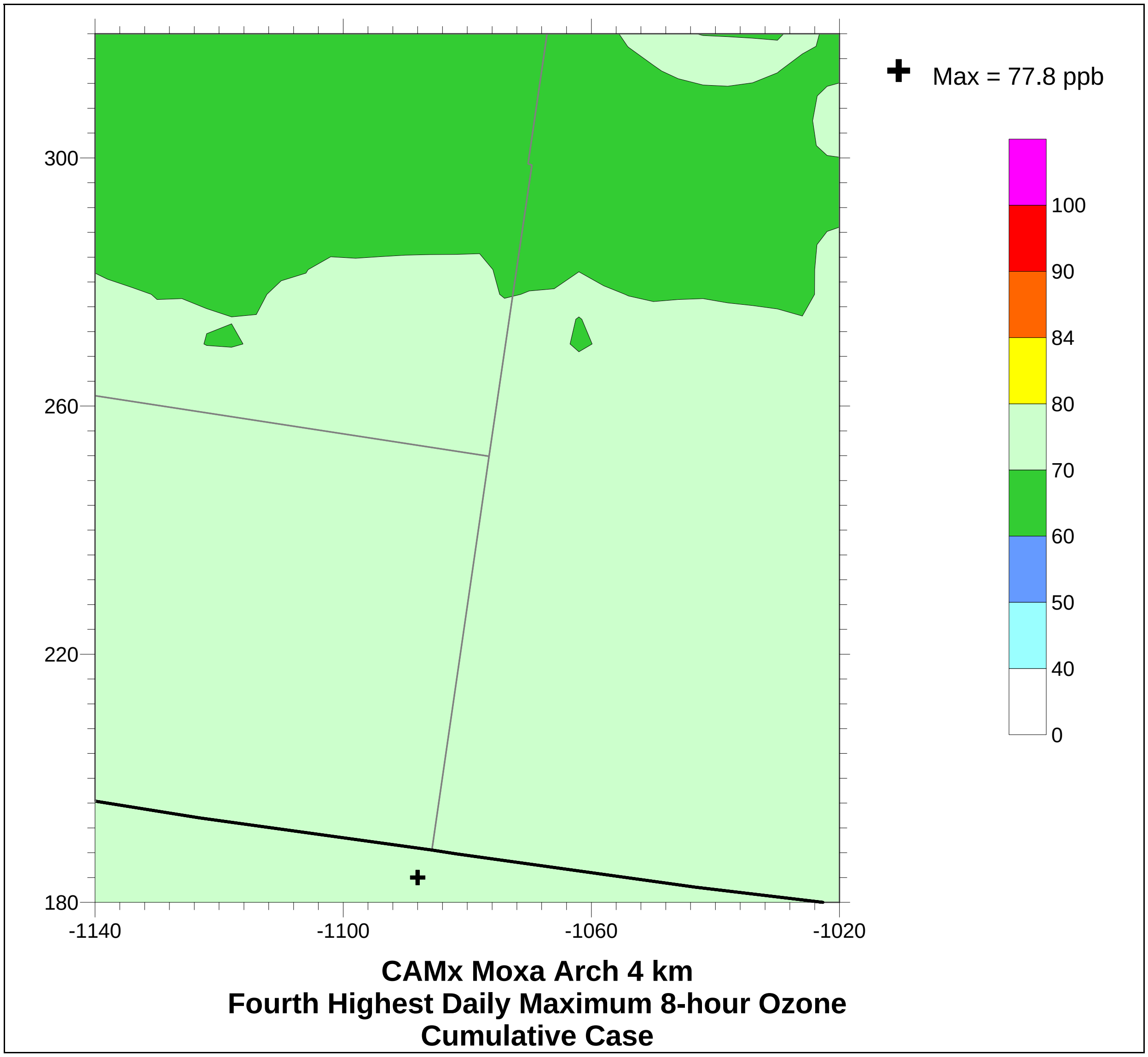
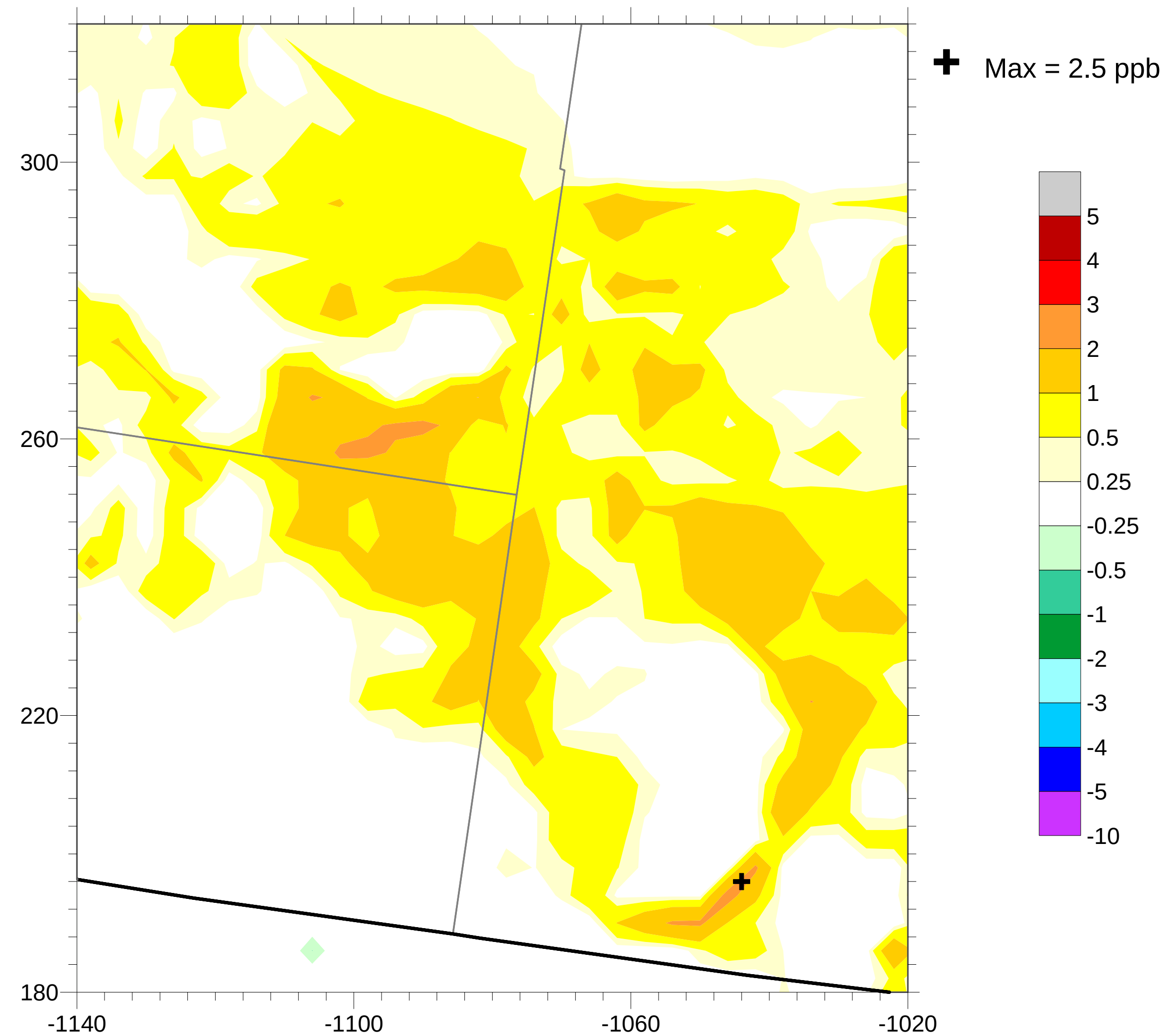


Figure 5-18. Estimated fourth highest daily maximum 8-hour ozone concentrations near the Project for the Project plus Cumulative Emissions scenario for the absolute modeling results method.



CAMx Moxa Arch 4 km
Difference in the Fourth Highest Daily Maximum 8-hour Ozone
Cumulative - Base Case

Figure 5-19. Estimated incremental 8-hour ozone concentrations due to emissions from the Project plus Cumulative Emissions scenario near the Project location for the absolute modeling results method.

5.4.2.2 Absolute Ozone Results in 12/4 km Domain

Figure 5-18 displays the estimated fourth highest daily maximum 8-hour ozone concentrations in the 4 km and 12 km domains for the Project plus Cumulative Emissions scenario. The maximum estimated 8-hour ozone concentration in the 4 km domain is 83.8 ppb, which occurs in northeastern Colorado, south of the Project and other new sources. In fact, the maximum 8-hour ozone concentrations for the 2002 Base Case were 83.7 ppb, which occurred in northeastern Utah (see Figure 5-8). All estimated fourth highest 8-hour ozone concentrations in the 4 km domain are less than the 8-hour ozone NAAQS of 85 ppb.

In the 12 km grid, the fourth highest estimated ozone concentration exceeds the 8-hour ozone NAAQS only in the Denver, Colorado and Salt Lake City, Utah urban plumes. Note that when doing ozone modeling of urban areas, finer grid resolution is used because using coarse grid resolution may overestimate urban ozone concentrations by overstating the dilution of urban NOx and mixing it with the rural biogenic VOC emissions.

The incremental ozone formed in the 4 km and 12 km domains due to the Project and other Cumulative Emissions are shown in Figure 5-20. In the 4 km grid, the maximum estimated ozone increase is 14.5 ppb and occurs in the Pinedale/Jonah area. In the 12 km domain, the maximum ozone increase is 5.1 ppb and also occurs in the Pinedale/Jonah area. These results illustrate the need for using a 4 km grid for ozone modeling of the new sources.

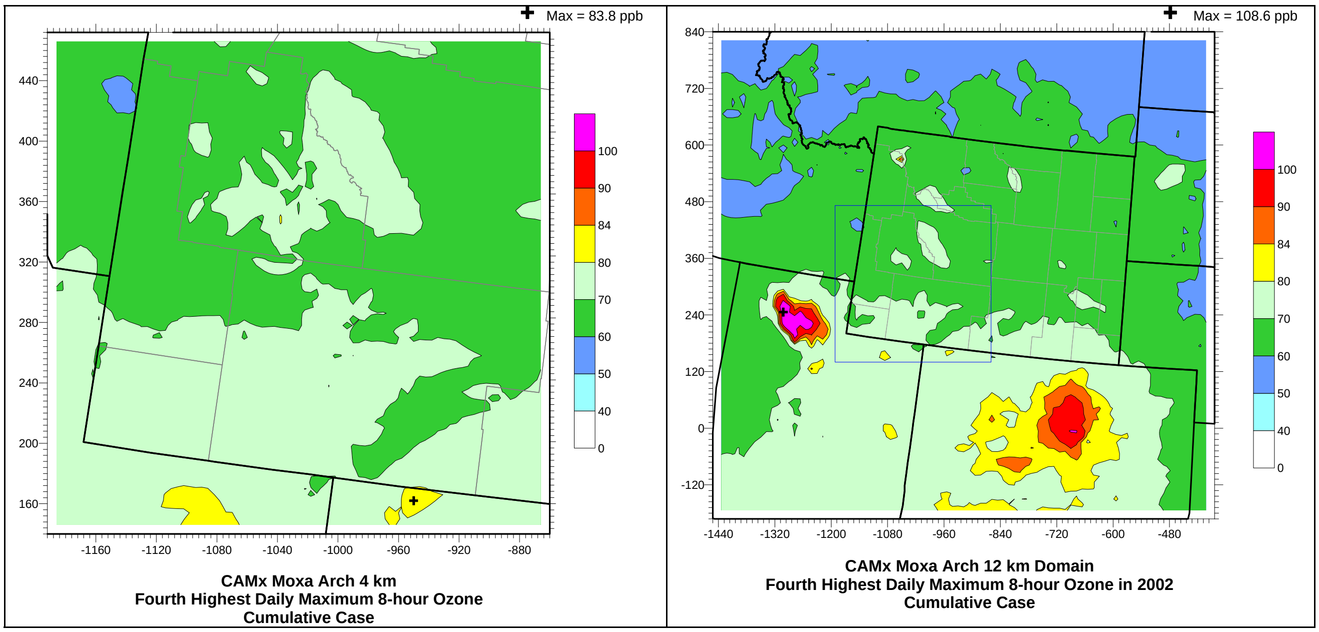


Figure 5-20. Estimated fourth highest daily maximum 8-hour ozone concentrations in the 4 km (left) and 12 km (right) domain for the Project plus Cumulative Emissions scenario.

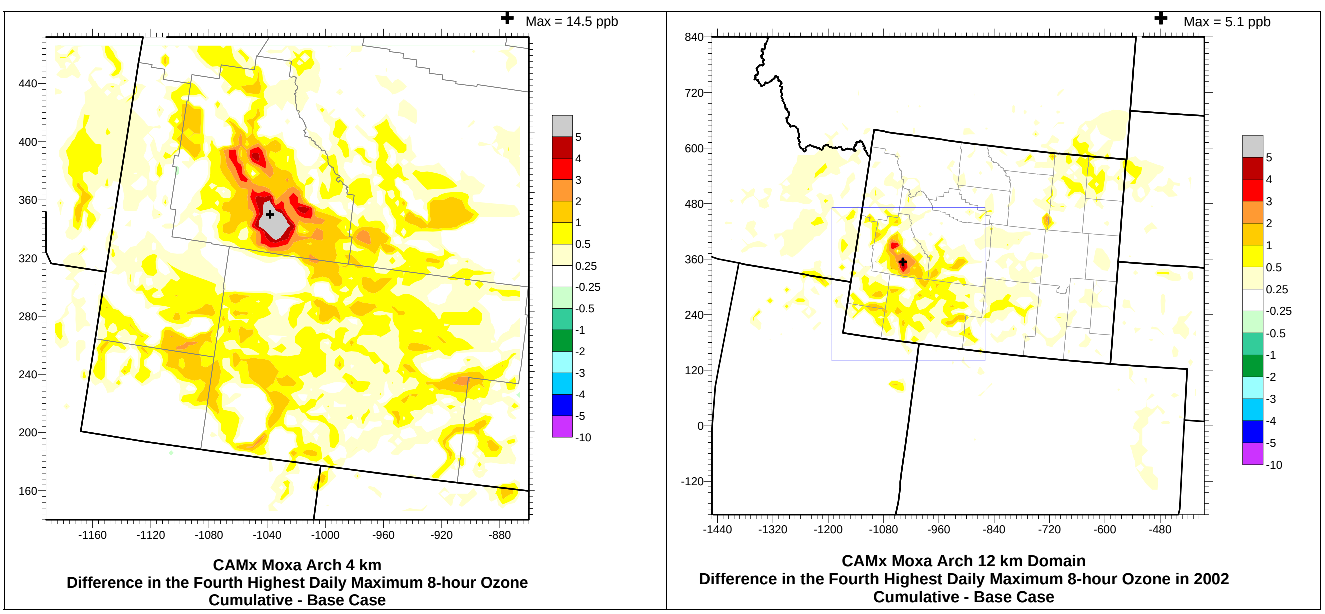


Figure 5-21. Estimated incremental 8-hour ozone concentrations due to emissions from the Project plus Cumulative Emissions scenario in the 4 km (left) and 12 km (right) domains.

5.4.3 Incremental Ozone Impact Sensitivity Analysis

In this section a sensitivity analysis is performed that adds the spatially varying maximum incremental 8-hour ozone contribution due the Moxa Arch Project and cumulative sources to the maximum background 8-hour ozone contribution in Wyoming that was provided by the WDEQ-AQD. Because the maximum incremental concentrations due to the Project And cumulative emissions and maximum background 8-hour ozone background concentration occurs at different locations and time periods, the 8-hour concentration estimates obtained by adding them together would greatly overstate any expected actual ozone values, which is why this is referred to as a sensitivity analysis rather than the an 8-hour ozone projection. The maximum background 8-hour ozone values provided by the WDEQ (147 μg/m3 or 75 ppb) is based on observed ozone during the Green River Visibility The study that occurred during 1998-2001 (ARS, 2002) so is not even concurrent with the time period of the CAMx modeling (2002). Because of the discrepencies in the two datasets, these results are discussed only in this Technical Support Document and are not included in the DEIS.

5.4.3.1 Ozone Sensitivity Analysis Near the Project

Near the Project, the addition of the maximum incremental ozone contribution due to the Project plus cumulative emissions to the maximum 75 ppb background ozone provided by the WDEQ-AQD produces a peak ozone value of 77.5 ppb that occurs to the southeast of the project and is below the 8-hour ozone NAAQS (Figure 5-22).

5.4.3.2 Ozone Sensitivity Analysis in the 4 km and 12 km Domains

Figure 5-23 displays the spatial distribution of 8-hour ozone concentrations in the 4 km and 12 km domains that results from adding the maximum incremental ozone due the Project and cumulative emissions to an assumed 75 ppb background value. In the 12 km domain the maximum 8-hour ozone concentrations produced by this sensitivity analysis is 80.1 ppb. In the 4 km domains the maximum 8-hour ozone concentration produced by the sensitivity analysis is 89.5 ppb. Note that this is not a projected exceedance of the 8-hour ozone NAAQS because of the very conservative nature of this sensitivity analysis where we add a maximum incremental ozone concentration that occurred in one location and time to a maximum background ozone that occurred at a different location and time so produces a much higher ozone that would be expected to occur. However, it does identify an area southwest of the Wind River Range where ozone should be evaluated in more detail.

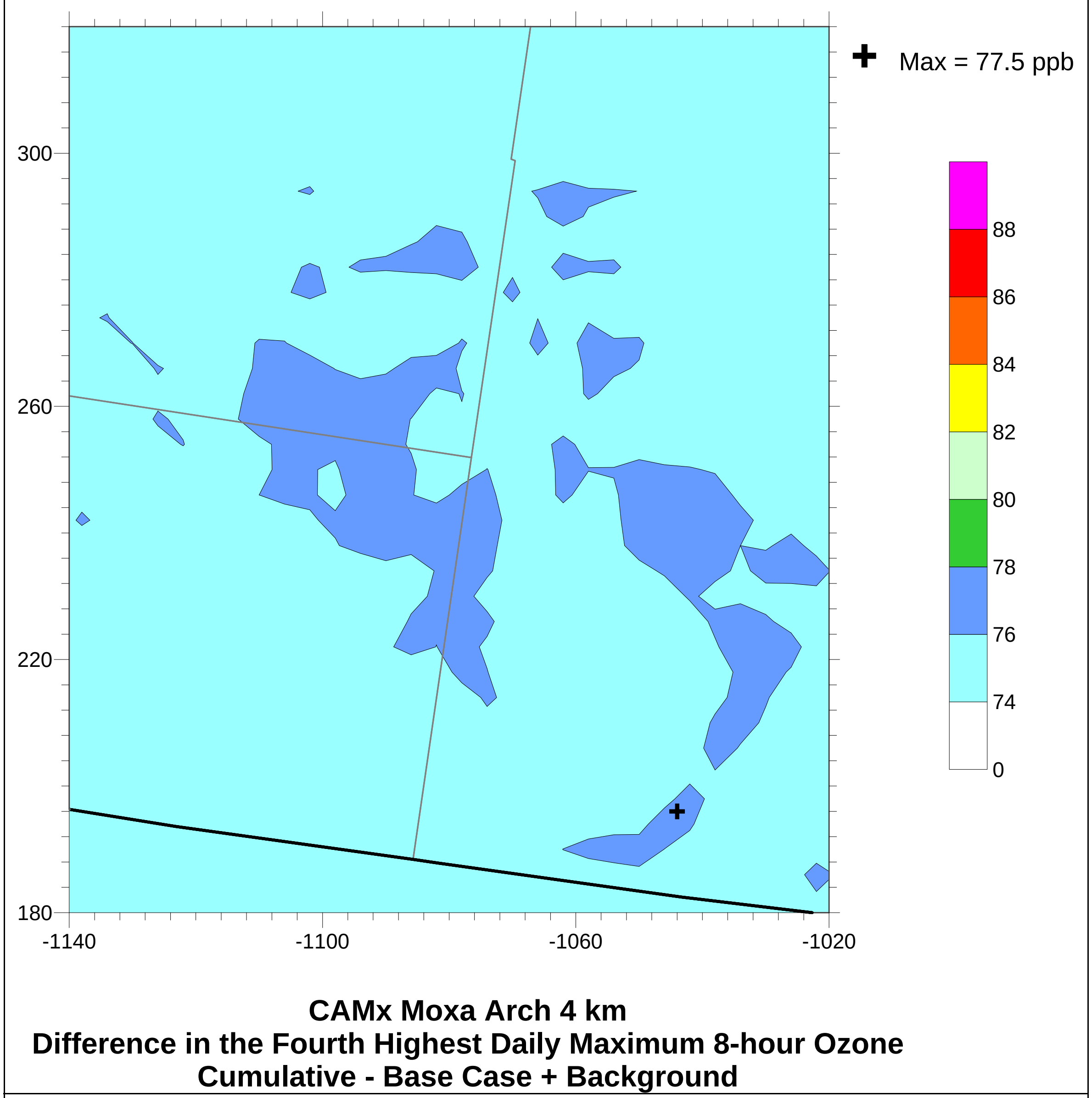


Figure 5-22. Addition of the maximum incremental ozone concentrations due to the Project plus Cumulative Emissions to an assumed maximum 75 ppb background near the Project.

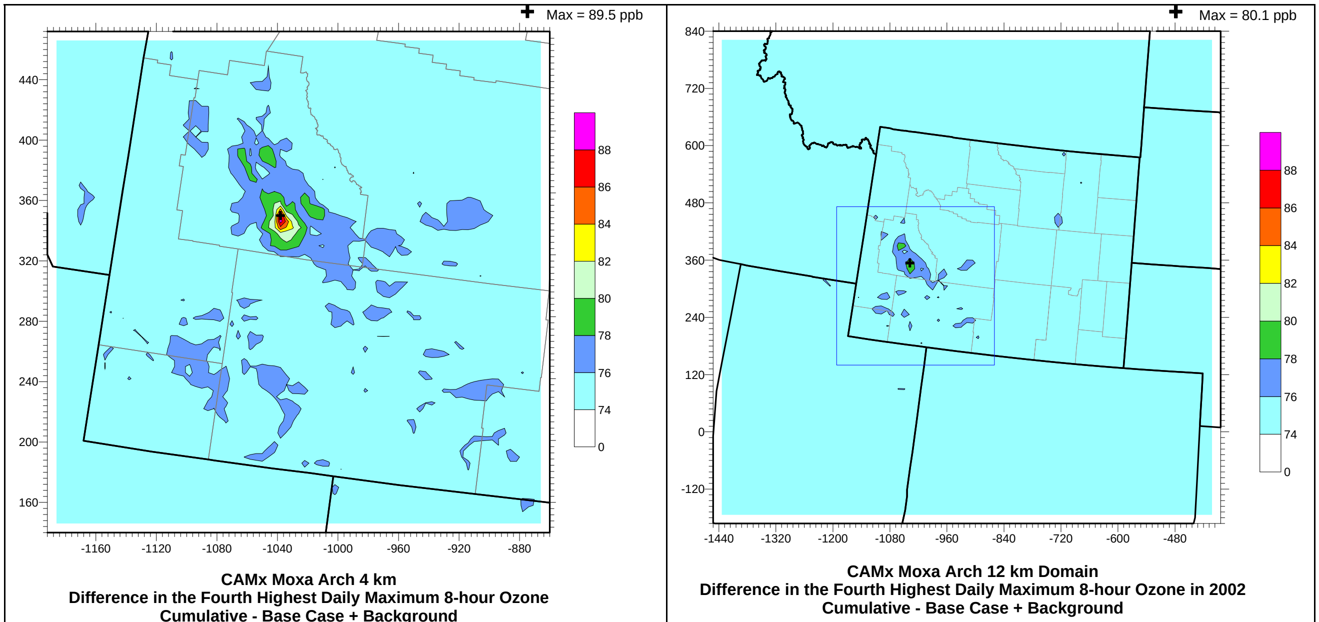


Figure 5-23. Incremental 8-hour ozone concentrations due to the Project plus Cumulative Emissions added to an assumed 75 ppb ozone background in the 4 km (left) and 12 km (right) grids.

5.5 Conclusions of Ozone Modeling Analysis

Table 5-4 summarizes the maximum estimated 8-hour ozone concentrations near the Project and in the 4 km grid domain using the EPA RRF projection approach and the absolute model predictions and the 2002 Base Case and Project and Cumulative Emissions annual CAMx simulations. Using these two projection techniques the maximum 8-hour ozone concentrations are projected to be below the 8-hour ozone NAAQS.

Table 5-4. Maximum projected 8-hour ozone concentrations near the Project and in the 4 km grid domain due to Base Case emissions plus the Project and Cumulative Emissions and comparisons with the NAAQS.

Domain	8-Hour Ozone NAAQS (ppb)	Projected Maximum 8-Hour Ozone (ppb)	
		EPA Guidance Approach	Absolute Model Predictions
Near the Project	85	76.6	77.8
4 km Domain	85	77.6	83.8

The Project and Cumulative Emissions CAMx simulation only evaluated the Proposed Action. Alternatives A, B, and C were not run with CAMx. The No Action Alternative has emissions that are much lower than the Proposed Action with NOx and VOC emissions that are 26% and 7% of the Proposed Action, respectively. Thus the No Action alternative would have lower ozone than the Proposed Action alternative so would also not jeopardize compliance with the 8-hour ozone NAAQS.

Alternative C has NOx and VOC emissions that are, respectively, 1.96 and 2.30 times the Proposed Action alternative emissions. The maximum ozone increment near the Project due to the Proposed Action alternative was 2.5 ppb. Assuming the larger of the NOx/VOC emissions increase for Alternative C (2.30) gives an estimate of the ozone increment of 5.75 ppb (2.3 x 2.5). When added to the 75 ppb maximum background, a conservative \ maximum 8-hour ozone concentration of 80.8 ppb is obtained, which is below the 8-hour ozone NAAQS. The ozone formation is non-linear; therefore, the 2.30 factor is uncertain. However, it is our best and likely conservative estimate of the effects of emissions from Alternative C on ozone concentrations in the area, and still leads to ozone that is below the 8-hour ozone NAAQS. Ozone formation for Alternative B would not be greater than that for Alternative C and thus would also be expected to be below the 8-hour ozone NAAQS.

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APPENDIX D. BIOLOGICAL ASSESSMENT

1.0 INTRODUCTION

This Biological Assessment (BA) is an evaluation of the potential effects of the Moxa Arch Infill Gas Development Project (Proposed Action) on federally threatened or endangered species listed under the Endangered Species Act of 1973, as amended *et seq*. (ESA). Candidate species for listing under the ESA are also discussed. The BA results will help determine whether any such listed species or their critical habitats are likely to be affected by the Proposed Action. This report will also be used in determining whether formal consultation with the U.S. Fish and Wildlife Service (USFWS) is necessary, per 50 CFR 402.12.

Section 7 of the ESA requires federal agencies to ensure that actions authorized, funded, or carried out by federal agencies are not likely to jeopardize the continued existence of proposed, candidate, threatened, or endangered species, or result in the destruction or adverse modification of their critical habitats. This process ensures that listed, proposed, and candidate species receive full consideration in the decision-making process prior to implementation of the Proposed Action. The Bureau of Land Management (BLM) maintains an interest in protecting candidate species under their sensitive species policy (BLM Manual 6840), with the goal that actions on BLM-administered lands consider the welfare of these species and do not contribute to the need to list any of the sensitive species under the provisions of the ESA.

2.0 PROJECT DESCRIPTION

2.1 PROJECT AREA

The Proposed Action area is BLM-administered federal, state, and private lands in the Moxa Arch Area (MAA) of southwestern Wyoming. The MAA consists of approximately 475,808 surface acres (approximately 744 square miles) of mixed (checkerboard) ownership of federal, state, and private lands in western Sweetwater, southeastern Lincoln, and northeastern Uinta counties, Wyoming. The MAA is located within Townships 15 through 23 North (T15–23N), Ranges 111 through 113 West (R111–113W), 6th Principal Meridian, west of Green River, Wyoming, east of Lyman and Opal, Wyoming, and south of the Green River and Fontenelle Reservoir (Figure 1). Interstate 80 (I-80) bisects the southern third of the MAA.

2.2 PROJECT DESCRIPTION

The BLM Kemmerer Field Office (KFO) received a proposal from EOG Resources, Inc. (EOG) and other companies (Operators) to expand the existing natural gas drilling and field development operations in the MAA. Oil and gas leases of the subsurface mineral estate beneath these lands have been issued by the BLM (federal estate), the State of Wyoming, and private owners. While numerous alternatives and specific actions were considered, four alternatives have been developed for the proposed project: the Proposed Action, Alternative A–No Action, Alternative B, and Alternative C. Descriptions of each alternative are discussed in detail in Chapter 2 of the Draft Environmental Impact Statement (DEIS) (BLM 2007) and are summarized below.

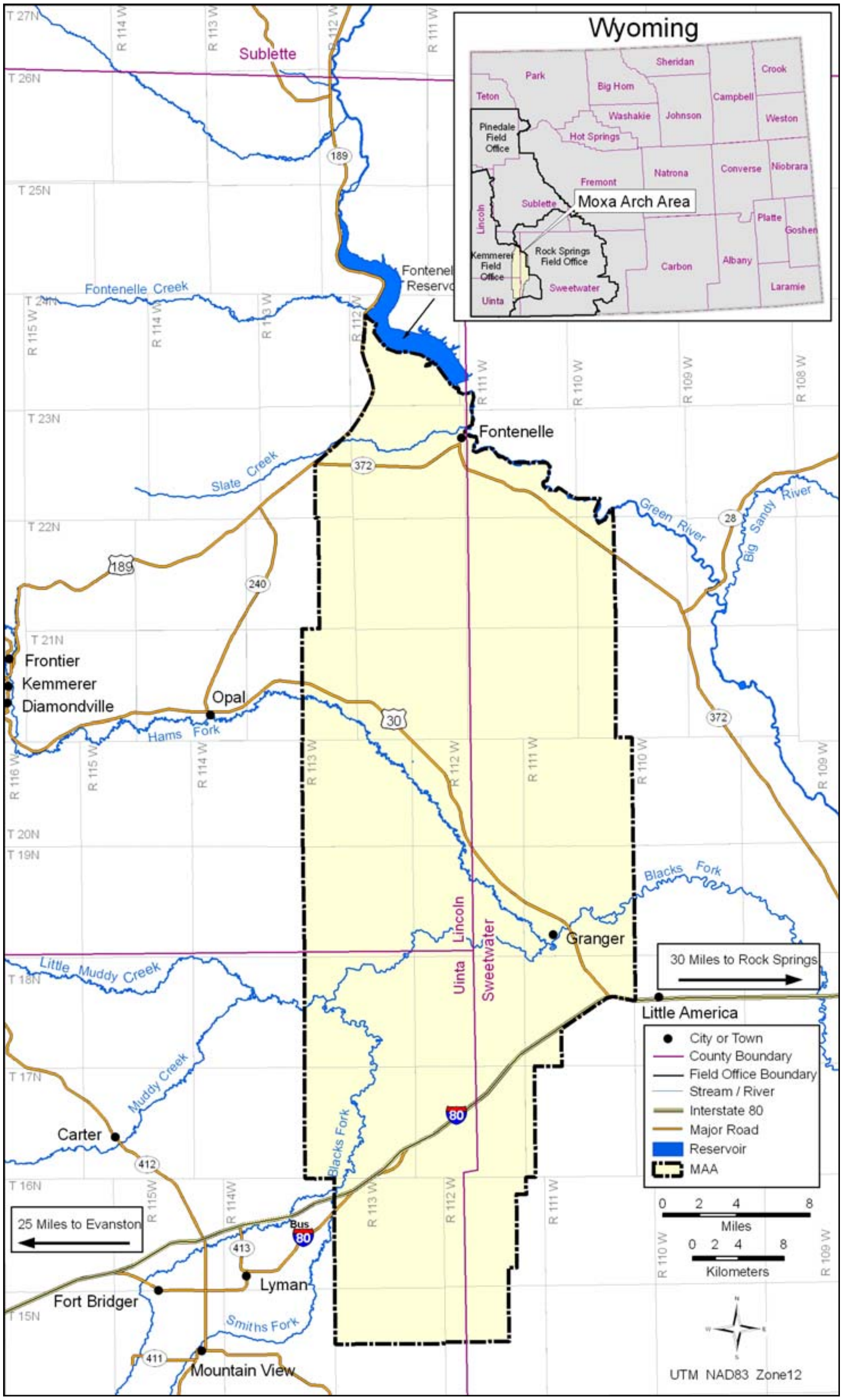

Figure 1. Project Location Map.

2.2.1. Proposed Action

Collectively, the Operators propose to drill 1,861 wells from 1,861 well pads to supplement existing production in the Project Area. The Operators estimate that approximately 1,226 additional wells would be drilled in the core area, and approximately 635 additional wells would be drilled in the flank area (Figure 2). The Operators anticipate drilling infill wells to the Frontier and Dakota Formations at densities ranging from 4 to 12 wells per section (approximately 160 to 53 acres per well) in the core area and approximately 2 wells per section in the flank area. Additional wells would be drilled conventionally (i.e., with vertical well bores). All proposed wells would be drilled during an approximate 10-year period after project approval. Although actual operations are subject to change as conditions warrant, the Operators' long-term development plan is to drill approximately 186 wells per year until the resource base is fully extracted. The average life expectancy of a well is anticipated to be 40 years.

Facilities associated with the project may include roads, gas pipelines, production facilities (separation, dehydration, metering, treating, fluid storage, compression), disposal well and/or surface disposal facilities, and equipment storage facilities. In general, gas will be transported via subsurface pipelines to centralized compression and treatment facilities, although some well site compression may be needed. Additional compression of the gathering system in the project area will likely be required and added to existing compression infrastructure over the 10-year development period. Additionally, it is estimated that 3 to 4 new compressors could be required to accommodate the maximum anticipated compression growth that would result from the Proposed Action. These additional compression facilities would likely be constructed on federal surface.

Current pipelines in the MAA and throughout southwestern Wyoming would likely be sufficient to transport the recovered resources to market. Produced water will be transported by truck to water disposal wells or evaporation ponds. Project development will result in the construction of new roads and the use of roads previously constructed in the Project Area. New roads are expected to consist primarily of access roads. Existing arterial roads will provide the main access to the Project Area.

The area of surface disturbance associated with drilling and completion activities would be approximately 18,650 acres. Most of the disturbance would occur on private lands. Approximately 3.9% of the Project Area would be affected by short-term disturbance during construction, drilling, and completion activities. Because of the 10-year drilling schedule associated with the Operators' Proposed Action, approximately 1,865 acres (0.39% of the MAA) of new disturbance would occur each year for 10 years.

After interim reclamation is completed, the area of additional long-term disturbance associated with project development would be approximately 5,997 acres. It is expected that this level of disturbance would be present for the life of the wells that are drilled (approximately 50 years: 10 years of drilling and 40 years of production). The Operators would continue to limit long-term surface disturbance as much as possible through the implementation of a road network that minimizes the construction of new access roads and by reclaiming as much of the short-term disturbance associated with roads and locations as is reasonable without limiting the requirements for ongoing and future production operations. The Operators would adhere to all conditions included with their leases and to all federal and state laws and regulations.

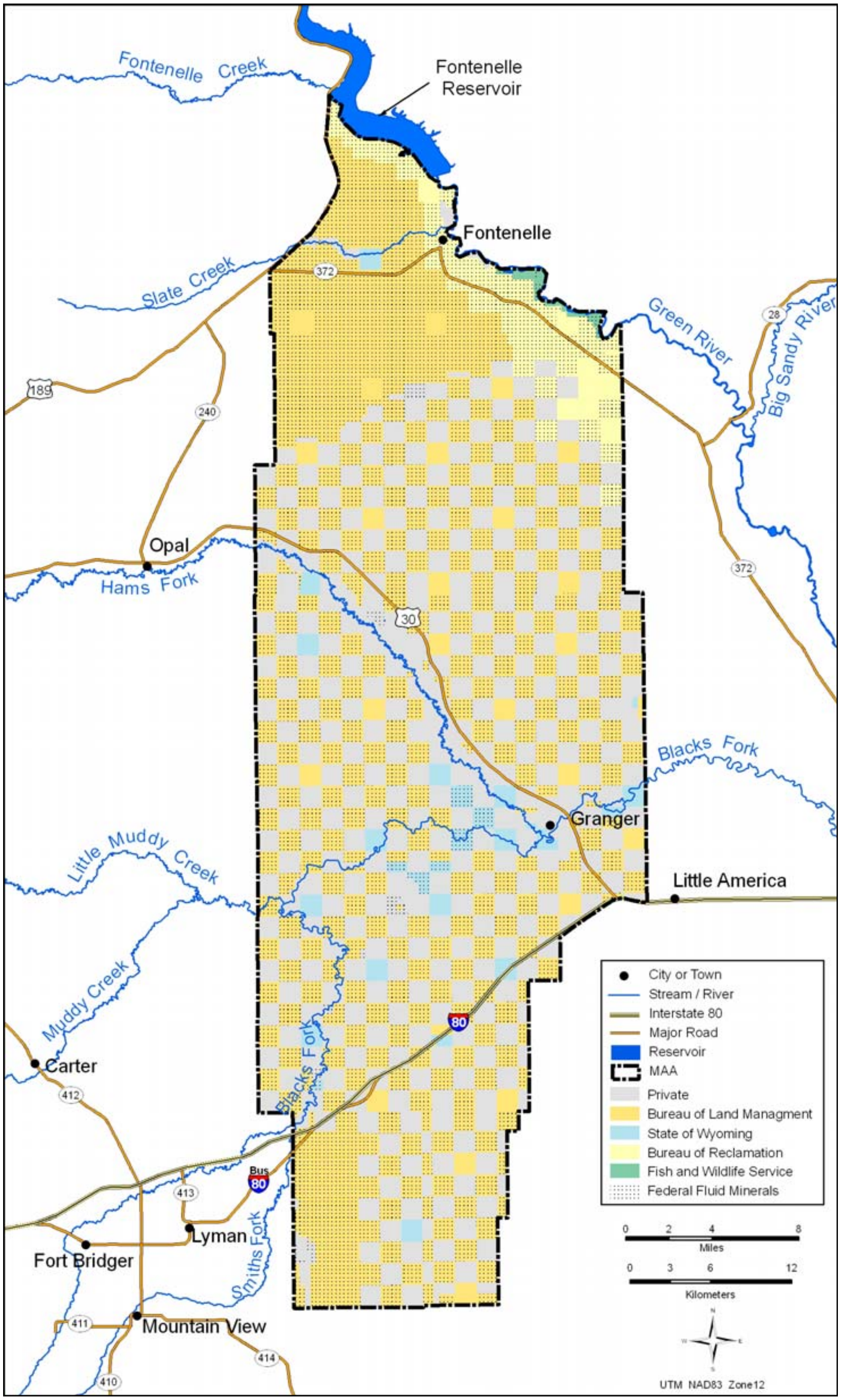

Figure 2. Surface and Federal Fluid Mineral Ownership of the MAA.

Assuming a maximum of 2.0 acre-feet of surface water per well would be required for drilling, completion, hydrostatic testing, and dust control activities, approximately 3,722 acre-feet of water would be required over the life of the Proposed Action. No more than approximately 374 acre-feet would be required in any year under the Proposed Action. Water used for drilling purposes (for all alternatives) will be obtained from the Blacks Fork, Hams Fork, and Green Rivers as a result of water appropriation permits obtained from the State of Wyoming (State Engineer's Office) and from commercial or privately owned water source wells. This level of water removal from the three river systems is not likely to have a noticeable or measurable impact to stream flows.

2.2.2. Alternative A–No Action

As part of the No Action Alternative, the BLM would reject the Operators' proposal and continue with implementation of the 1997 Record of Decision (ROD) (BLM 1997). Authorizations for, and impacts from, previously approved development and surface disturbance would continue.

As of June 2007, of the 1,325 well pads authorized in the 1997 ROD, approximately 655 have been constructed and are in production or have not been plugged and abandoned. At current drilling rates, approximately 6 years would be required to drill the remaining 670 wells in the MAA. However, this would be beyond the 10-year drilling phase that was evaluated under the prior EIS. At the time of publication of this DEIS it is likely that the number of remaining wells in each zone will be lower than the number reported as of June 2007.

New, short-term construction-related surface disturbance under the No Action Alternative would be approximately 10,258 acres. The area of long-term surface disturbance associated with the No Action Alternative would drop to approximately 2,848 acres after interim reclamation. This would increase total surface disturbance in the MAA to approximately 2.3%. Because of the 6-year drilling schedule anticipated for the No Action Alternative, approximately 1,709 acres (0.36% of the MAA) of new disturbance would occur each year for 6 years.

Approximately 1,340 acre-feet of water would be required over the life of the No Action Alternative and no more than approximately 223 acre-feet would be required in any year. This alternative would use less water than the Proposed Action: approximately 2,382 acre-feet over the life of the project (LOP) and 191 acre-feet per year.

Because the No Action Alternative incorporates the impacts of continued drilling under the 1997 ROD and does not eliminate future drilling, it will also be evaluated as a low field development alternative.

2.2.3. Alternative B

Alternative B would place a limit on the amount of active surface disturbance in the MAA. The intent of this alternative is to allow the operators to fully develop the MAA while conserving key resource values and meeting the objectives of the RMP and BLM's multiple use management goals. Alternative B would allow for full field development under a scenario with the same surface disturbance allowed for Alternative A/No Action. Alternative B would allow for the drilling of up to 5,165 additional wells across all lands in the MAA (see Alternative C) over a 25 year period as long as active, un-reclaimed surface disturbance associated with oil and ga drilling and exploration activities across the MAA is less than the 10,921 acres (2.3% of the MAA) as projected for Alternative A/No Action. If active oil and gas related disturbance in the MAA exceeds 10,921 acres at any point during the approximate 25 year drilling phase of Alternative B, no new wells would be approved for federal lands or the federal mineral estate until reclamation reduces disturbance below the threshold.

The Operators would submit quantifiable documentation and summary reports to the BLM to determine how many acres are available under the surface disturbance limit. The Operators would also provide an annual drilling plan that would outline the numbers of wells to be drilled, the estimated disturbance associated with those wells, and the location of the wells. Operators could drill up to 205 wells per year in the MAA as specified for Alternative C. However, the number of wells actually drilled per year would depend on the acreage available under the 10,921 acre cap and the estimated acres of disturbance for new wells proposed in the operators' drilling plan. Those areas not meeting the minimum standards for reclamation (in the Reclamation Plan) would be considered disturbed until evidence is provided that reclamation standards have been met.

Optional development and operating practices are available to reduce disturbance while still allowing development of the gas resources in the MAA. Other options are available to minimize disturbance and Operators would be encouraged to utilize newly available technologies, reclamation techniques, and drilling and operations processes to reduce surface disturbance. The techniques identified in the following list are not required under this alternative but may be utilized by the operators to maintain surface disturbance below the maximum threshold of 10,921 acres.

- Burying of gathering pipelines in or adjacent to access roads and use of common ROWs and utility corridors.
- Centralizing production facilities.
- Minimizing topsoil removal during drilling activities.
- Drilling multiple wells from a single pad.

Up to 10,300 acre-feet of water would be required over the LOP under Alternative B, depending on the actual number of wells drilled and acres disturbed. Annual water use would be no more than 414 acre-feet and would depend on the number of wells approved in a given year.

2.2.4. Alternative C

Alternative C would allow the drilling of up to 16 well pads per square mile across the core of the MAA, and 4 well pads per square mile in the flank of the MAA. Based on data provided by the Operators in the MAA, this spacing is a conservative estimate of what would be required to maximize resource extraction in the core and allow for full definition of resource potential in the flank area. Infill drilling as part of Alternative C would consist of approximately 5,165 new wells across the MAA. Based on current drilling rig availability estimates, if wells are drilled at a rate of approximately 205 per year, all wells would be drilled during an approximate 25-year period after project approval. To reduce disturbance, roads and gathering pipelines would be collocated for all well pads. An estimated 8 to 12 new compressors could be required to accommodate the additional gas produced.

The area of surface disturbance associated with drilling and completion activities would be approximately 45,573 acres. Most of the disturbance would occur on BLM-administered lands. Approximately 9.6% of the Project Area would be affected by short-term disturbance. Because of the 25-year drilling schedule associated with Alternative C, approximately 1,823 acres (0.38% of the MAA) of new disturbance would occur each year for 25 years.

After interim reclamation is completed, the area of long-term disturbance associated with project development would be approximately 15,357 acres. It is expected that this level of disturbance would be present for the life of the wells that are drilled (approximately 65 years; 25 years for drilling and 40 years for operations).

Approximately 10,300 acre-feet of water would be required over the LOP under Alternative C. No more than approximately 414 acre-feet would be required in any year for Alternative C. This alternative would use approximately 6,578 acre-feet more water than the Proposed Action.

3.0 AFFECTED ENVIRONMENT

3.1 CLIMATE

The MAA is located in a semi-arid, mid-continental climate regime typified by dry, windy conditions, limited rainfall, and long, cold winters (Trewatha and Horn 1980). Table 1 summarizes climate components in the area potentially affected by the Proposed Action, based on data collected at several long-term meteorological stations located near the MAA.

Table 1. Summary of Climate (1958–2005).

Wyoming Meteorological Station	Description
Kemmerer Water Treatment Station	Mean annual temperature: 39.3 °F Mean annual precipitation: 9.78 inches Mean annual snow depth: 2 inches Mean annual snowfall: 50.9 inches
Rock Springs	Mean annual temperature: 44.1 °F Mean annual precipitation: 8.51 inches Mean annual snow depth: 1 inch Mean annual snowfall: 49.2 inches
LaBarge	Mean annual temperature: 39 °F Mean annual precipitation: 8.03 inches Mean annual snow depth: 1 inch Mean annual snowfall: 31.7 inches

Source: Western Regional Climate Center 2006.

The MAA is subject to strong, gusty winds that are often accompanied by snow and blizzard conditions during winter months. Winds frequently originate from the west to northwest, and the mean annual wind speed is 9.0 miles per hour.

3.2 TOPOGRAPHY

Topography within the MAA consists of low relief plains, low hills, and occasional buttes and rims. Elevations range from 7,200 feet southeast of I-80 to approximately 6,200 feet above mean sea level where the Blacks Fork River exits the MAA. The MAA is drained by a series of easterly flowing, principally intermittent and ephemeral streams.

3.3 GEOLOGY

The MAA is located within the Bridger Basin (Raisz 1963) portion of the Wyoming Basin physiographic province (Fenneman 1931). The greater Green River structural basin comprises the bulk of the Wyoming Basin and occupies much of southwestern Wyoming and portions of northwestern Colorado. The Green River Basin was subdivided during the latter portions of the Laramide Orogeny, in the early Tertiary period, into the present series of separated structural basins by the creation of thrust-induced, regional anticlines (Lillegraven, Snoke, and McKenna 2002).

The buried Moxa Arch is situated in the western half of the Bridger topographic basin and does not display the relief exhibited by the natural gas-productive Rock Springs Uplift to the east. The Bridger

Basin is bounded to the northeast and south by the basement-cored Wind River Range and Uinta Mountains, respectively. The western border is formed by surface expression of the Cordilleran Overthrust Belt, 12 or more miles west of the MAA. The Arch trends in a slightly arcuate north-south orientation, roughly parallel to the structural grain of the Overthrust Belt.

Surface geology is composed of outcrops of the Bridger Formation and the Laney Member of the upper Green River Formation, both Eocene in age. Approximately 95% of the MAA is underlain by the Bridger Formation, consisting of mudstones, claystones, siltstones, and sandstones with minor interbeds of marl and limestone and some thin lignites and tuff. The Laney Member consists primarily of shale, siltstone, and marlstone in the MAA (Love and Christiansen 1985; Sullivan 1980). Overlying the bedrock formations are areas of Quaternary alluvium along major drainages, colluvium, wind-blown sand, and terrace gravels (M'Gonigle and Dover 1992; Dover and M'Gonigle 1993). The Eocene rocks form complex inter-fingering relationships between the Green River Formation to the east and the semi-contemporaneous upper Wasatch and lower Bridger Formations to the west. Depositional environments consist of early Eocene fluvial sediments of the main body of the Wasatch Formation, succeeded by lacustrine (Green River) and lake-marginal (lower Bridger) middle Eocene sediments.

3.4 SOILS

Soils within the MAA are developing on mostly smooth and undulating topographic surfaces with inclusions of locally high relief in areas of badlands, tableland breaks, and stream valleys and terraces. Differences in parent material, moisture, elevation, topographic slope, aspect, position, and management, including erosion condition, are the main factors that contribute to differentiation of soils into various types, each composed of a unique set of characteristics.

Existing soils information is compiled in the Soils and Water Resources Technical Report (SWRTR) for the Expanded Moxa Arch Area Natural Gas Development Project (BLM 1995b). More recent soils mapping and information for the MAA is not available (Natural Resources Conservation Service [NRCS] 2005; Roberts 2006). Soils information compiled in the 1995 SWRTR was provided by statewide NRCS (Soil Conservation Service [SCS]) soils reports published in the 1970s and 1980s, as well as unpublished NRCS soils data.

3.4.1 Soil Characteristics

Within the MAA, soils are grouped into three geomorphology-controlled classes based on geologic substrate (BLM 1995b):

- residuum and colluvium of sedimentary uplands,
- alluvial deposits of stream floodplains and low terraces, and
- alluvial deposits of alluvial fans, and high stream terraces.

Aeolian deposits, including sand dunes, occupy areas in both the sedimentary uplands and the high stream terraces.

3.4.2 Soil Types

3.4.2.1 Sedimentary Upland Soils

Soils of the sedimentary uplands occupy nearly level to rolling plains over approximately 85% of the MAA. Site-specific slopes range from approximately 0% (flat) to 70% (very steep). These soils are developing in residuum and colluvium derived from siltstones, mudstones, shales, and sandstones of the Bridger Formation and the Laney Member of the Green River Formation. Most soils are moderately deep (40 to 60 inches to underlying rock), well drained, and moderately permeable. Surface textures are mostly medium, and the water table is typically more than 60 inches below the surface. Runoff varies from low to high, increasing with slope and with clay content of surface soil layer (topsoil). Erodibility is generally moderate; erosion potential ranges from slight to severe, increasing with slope, slope length, reduced coarse fragment content, and reduced protective cover. In localized areas within the MAA, reclamation efforts on these upland soils may be limited by elevated soil salinity and alkalinity (sodium) levels. In addition to areas of aeolian sand deposits, this geomorphic soils group supports areas of badland, totaling approximately 33% of this group.

3.4.2.2 Floodplains and Low Terrace Soils

Within the MAA, floodplain soils occur in bottomlands adjacent to major drainages, including the Hams Fork, Blacks Fork, and Smiths Fork Rivers, and Cottonwood Creek, Muddy Creek, and Little Muddy Creek. The majority of slopes range from 0 to 6%, with isolated slopes approaching 15%. These bottomlands comprise approximately 10% of the MAA. The alluvial soils are developing in water-transported materials/sediments eroded from upland soils and weathered shales and sandstones. Surface textures are medium, and the water table ranges from 30 to 60 inches below the surface. Soils are deep (greater than 60 inches to rock), poorly drained, and moderately permeable. Runoff potential is moderately high to high. Erodibility is moderate; erosion potential is slight to moderate based on the minimal gradient slopes of the drainage bottoms and the shortness of most sideslopes of shallow valleys in the MAA. Areas of elevated salinity and sodium, which may limit reclamation, are present in these soils.

3.4.2.3 Alluvial and High Terrace Soils

Alluvial fan and terrace soils occupy the remaining approximately 5% of the MAA. These soils are developing in alluvial deposits of similar origin at the mouths of ephemeral side drainages, and as terraces composed of coarser materials higher up in the drainages. Slopes range from 0 to 30%; areas of steep slope are limited. These fan and high terrace soils are mostly deep, well drained, moderately to rapidly permeable, gravelly to stony, sandy loams to loams, and can have a cobbly (rock covered) surface. Runoff potential ranges from low to moderately high with increasing slope. Erodibility is low to moderate; erosion potential is slight to high, with higher potentials associated with steeper slopes and lower coarse fragment content. These soils typically do not pose limitations on reclamation success; however, excessive coarse fragment content may make them droughty.

3.5 HYDROLOGY

Surface water resources in the MAA include rivers, streams, livestock ponds, small detention reservoirs, playas, seeps, and springs. Developed wells provide drinking water for livestock. Many of these same wells, along with wells drilled for oil and gas development, support small perennial and ephemeral impoundments.

The MAA lies within the Green River Basin, the northernmost part of the Colorado River Basin. The Green River Basin consists of lands in Wyoming, Colorado, and Utah that drain to the Green River, the largest tributary of the Colorado River (State West Water Resource Corporation 2001). Major water bodies within the basin include Fontenelle Reservoir bordering the north side of the MAA, and Flaming Gorge Reservoir to the southeast. The Hams Fork and Blacks Fork Rivers, major tributaries of the Green River, drain through the MAA. Peak flows usually occur in May and June as snowmelt water moves through the basin. Summer thunderstorms can add to summer and autumn base flows.

3.6 VEGETATION

Seven distinct vegetation cover types are dominant within the MAA (Table 2). The following descriptions were obtained from the previous Moxa Arch EIS Vegetation and Wetlands Technical Report (BLM 1995c).

Table 2. Primary Vegetation Communities in the MAA.

Vegetation Cover Type	Approx. Total Area (acres) in MAA	Approx. Percentage of MAA
Desert Shrub/Sagebrush	316,800	66.5%
Vegetated Sand Dunes	59,000	12.4%
Alkali Scrub	48,000	10.1%
Barrens/Exposed Rock and Soil	37,000	7.8%
Riparian/Wetlands	8,700	1.8%
Agriculture/Cropland	5,900	1.2%
Juniper Woodland	408	0.2%
Approximate Total	**475,808**	**100%**

Source: PIC Technologies 1996

3.6.1 Mixed Desert Shrub/Sagebrush Communities

The primary vegetative community type in the MAA is mixed desert shrub and sagebrush. The mixed desert shrub community includes numerous complexes, the most dominant being Wyoming big sagebrush (*Artemisia tridentata*) and mixed-grass prairie. Communities change with elevation, soil depth, slope, and precipitation. On average, mixed desert shrub is 40 to 70% shrubs, 30 to 60% grasses, and 10% forbs. Overall cover ranges from 6 to 40%, depending on moisture.

Approximately 52%, or 243,000 acres, of the MAA is dominated by Wyoming big sagebrush, which occurs in low precipitation areas at elevations below 7,500 feet. Sagebrush, rabbitbrush (*Chrysothamnus* spp.), four-winged saltbush (*Atriplex canescens*), and broom snakeweed (*Gutierrezia sarothrae*) are the dominant vegetative species in this community.

Areas of rolling hills and windswept ridges are predominantly grass covered. Wheatgrasses (*Pascopyrum smithii* and *Elymus lanceolatus*) are the primary species, but other grasses and forbs are present, as well as occasional shrubs, including sagebrush and Gardner saltbush (*Atriplex gardneri).* Composition is typically 40 to 80% grasses.

3.6.2 Vegetated Sand Dunes

The MAA contains approximately 59,000 acres of stabilized, vegetated sand dunes forming a complex mosaic with associations of mixed desert shrub and alkali scrub (PIC Technologies 1996). Wyoming big sagebrush is dominant, and rabbitbrush commonly occurs, as well as alkali scrub species such as greasewood and Gardner saltbush.

3.6.3 Alkali Scrub

Alkali scrub communities encompass approximately 48,000 acres of the MAA. Vegetation in these communities consists primarily of shrub species (70 to 90%) including greasewood, horsebrush (*Tetradymia* spp.), Gardner saltbush, and sagebrush species. Overall ground cover averages 13%, but may be higher depending on moisture levels.

Alkali scrub communities occur in both upland and lowland areas in the MAA. Lowland alkali scrub occurs along poorly drained bottomlands and floodplains of perennial and intermittent streams with highly saline-alkaline soils.

3.6.4 Barren/Basin Exposed Rock or Soil

Areas classified as "barren" are subject to extreme geomorphological or environmental conditions that hinder vegetation establishment. Barren lands also include areas where human disturbance has resulted in exposed areas of reduced native vegetation, primarily in areas of oil and gas development, road construction, and concentrated grazing. Areas of shale and rock outcrops, eroding sand dunes, alluvial deposits, windswept and steep slopes, and ridges occur throughout the MAA, comprising approximately 7.8% of the total area. Vegetation common to these areas is either low-growing or adapted to extremes of wind, weather, and poor soil development. Primary species composition is small, mounding or "cushion" species, including stemless goldenweed (*Stenotus acaulis)*, spoonleaf milk vetch (*Astragulus spatulatus*), and moss phlox (*Phlox briodes*). Grass species and big sagebrush are also found in these areas in limited amounts.

Areas of eroding substrates support plant species that are tolerant of soil instability. These areas of shifting sandstone and shales, commonly called badlands, support Gardner saltbush, sagebrush, rabbitbrush, and wheatgrasses. Vegetative cover in these areas is low, ranging from 5 to 20%.

3.6.5 Riparian/Wetlands

Riparian and wetland communities are found along hydrologic features of water bodies, including rivers, streams, lakes, and drainages, and support distinct plant compositions that are dependent upon saturated soils. Areas included in this classification cover approximately 8,700 acres (1.8%) in the MAA. Additional details on riparian and wetland habitats are provided in Section 3.7 below.

3.6.6 Agricultural Lands

Agricultural and croplands comprise approximately 1.2% of the MAA and occur primarily along floodplains. Hay production occurs along the Hams Fork River, with orchardgrass (*Dactylis glomerata*), sweetclover (*Melilotus* spp.), alfalfa (*Medicago sativa*), timothy (*Phleum pretense*), smooth brome (*Bromis inermis*), and wheatgrasses providing vegetative cover.

3.6.7 Juniper Woodland

Juniper woodland occupies the least amount of area of all cover types (408 acres). Juniper woodland areas occur on shallow, rocky, poorly developed soils particularly on the drier south- and east-facing slopes. The juniper overstory (*Juniperus osteosperma* and *J. scopulorum*) is 8 to 20 feet high. A variety of understory shrubs and herbaceous species may occur, but groundcover is generally sparse (8 to 23%). Understory species include sagebrush, rabbitbrush, plains pricklypear cactus (*Opuntia polyacantha*), goldenweed (*Haplopappus* spp.), phlox, bluebunch wheatgrass (*Agropyrom spicatum*), Indian ricegrass (*Oryzopsis hymenoides*), junegrass (*Koeleria macrantha*), and needle-and-thread (*Stipa comata*).

3.7 RIPARIAN AND WETLAND AREAS

Jurisdictional waters of the U.S. within the MAA include special aquatic sites, jurisdictional wetlands, actively flowing stream channels, dry ephemeral drainages with active channels, and open waters. A reconnaissance-level field investigation of the MAA identified vegetation and waters of the U.S. for the 1995 Moxa Arch EIS and is detailed in the Vegetation and Wetlands Technical Report (BLM

1995d; ECOTONE Environmental Consulting 1995). The survey used USFWS National Wetland Inventory (NWI) maps and aerial photographs to locate and verify wetlands.

Table 3 summarizes cover types of waters of the U.S., including wetlands, identified within the MAA. The Cowardin classification system is used to define these wetland and special aquatic types (Cowardin et al. 1979).

Table 3. Cover Types of Waters of the U.S., including Wetlands, in the MAA, based on NWI and GAP Vegetation Mapping.

Waters of the U.S. Cover Type	Acres
Lowland Alkali Scrub*	--
Riparian Forest/Shrub	3,900
Wet Meadow	2,350
Marsh	200
Aquatic Bed/Open Water	300
Riverine	1,950
Total	**8,700**

* In the NWI map delineations, Lowland Alkali Scrub is included in the Riparian Forest/Shrub cover type.

Wetlands are lands between terrestrial and aquatic systems where substrates are at least periodically saturated with water (Cowardin et al. 1979). Plants and animals that live in wetlands are adapted for life in water or in saturated soil. According to the U.S. Army Corps of Engineers (USACE), a wetland has hydrophytic vegetation, hydric soil, and hydrology (USACE 1987). Wetlands that meet these three criteria are referred to as jurisdictional wetlands and are regulated by the USACE under Section 404 of the Clean Water Act.

3.7.1 Lowland Alkali Scrub

Refer to Section 3.6 for a description of this cover type.

3.7.2 Riparian Forest/Shrub

Based on vegetation mapping, forest-dominated riparian habitat occupies 351 acres of the MAA, and shrub-dominated riparian habitat occupies 3,566 acres. These coverages constitute approximately 0.1% and 0.8%, respectively, of the MAA.

Riparian forest and shrub communities are found along hydrologic features of water bodies, including rivers, streams, lakes, and drainages, and support distinct plant compositions that are dependent upon saturated soils. Dominant trees and shrubs include cottonwoods, willows, tamarisk, silver buffaloberry, black hawthorn, and boxelder. Other species include redtop, Baltic rush, and sedges. Fluctuating water levels, storm runoff, and occasional heavy livestock and wildlife use influence plant composition. The effects of erosion and irrigation withdrawals are apparent in portions of the MAA where altered stream channels have eliminated riparian vegetation access to water.

3.7.3 Wet Meadow

Wet meadow was delineated on approximately 2,350 acres of the MAA, primarily adjacent to the perennial Green, Hams Fork, and Blacks Fork Rivers. Wet meadows are characterized by a shallow or near-surface water table and remain saturated during part of the growing season. Grasses and grass-like plants, with some broadleaf herbs and few shrubs, dominate wet meadows. Dominant species in alkali wet meadows include scratchgrass (*Muhlenbergia asperifolia*), bulrushes (*Scirpus* spp.), and alkali cordgrass (*Spartina gracilis*). Species in freshwater wet meadows include sedges, Torrey rush (*Juncus torreyi*), bluegrasses (*Poa* spp.), reed canarygrass (*Phalaris arundinacea*), and bluejoint reedgrass (*Calamagrostis canadensis*).

3.7.4 Marsh

Marsh areas have been identified on approximately 200 acres of the MAA. In marshes, surface ponding and/or soil saturation is present for a longer portion of the growing season than in wet meadows. These wetland areas are associated with bottomlands of perennial reaches of streams and support typical emergent vegetation. Dominant species include cattails (*Typha* spp.) and bulrushes.

3.7.5 Aquatic Bed/Open Water

Approximately 300 acres of aquatic bed and open water have been mapped in the MAA, primarily associated with gravel pits and stock ponds. Aquatic bed and open water areas include man-made bodies of water such as reservoirs, stock ponds, detention ponds, sloughs, old meander scars of perennial streams; as well as surface waters with very low velocity flows. Aquatic bed water levels are shallow (<6.6 feet deep) with warm temperatures during summer months (Cowardin et al. 1979). Vegetation includes submerged-rooted or floating-leaved plant types such as watercress (*Nasturtium officinale*), buttercup (*Ranunculus* spp.), duckweed (*Lemna* spp.), and pondweed (*Potamogeton* spp.). Open water areas are usually deeper than aquatic beds (>6.6 feet deep) and lack rooted emergent or submerged vegetation (USACE 1987; Cowardin et al. 1979). Within the CIAA, Fontenelle and Flaming Gorge Reservoirs are considered open water areas.

3.7.6 Riverine

Riverine areas comprise approximately 1,950 acres of the MAA and contain flowing, channelized water on an ephemeral, intermittent, and/or perennial basis. Vegetation is usually present along the channel banks. The riverine cover type includes perennial rivers, such as the Green, Blacks Fork, Hams Fork, and Smiths Fork Rivers; Big Muddy Creek; and ephemeral and intermittent streams and their exposed channel banks.

3.8 NOXIOUS WEEDS

Noxious weeds are officially designated non-native plant species that are invasive and/or can become monocultures, and can cause harm to land value, native ecology, agricultural interests, wildlife habitat, livestock forage, riparian resources, and aesthetic and visual values of land. The spread of invasive, non-native plant species contributes to reduced structural and species diversity and loss of wildlife habitat, and creates economic concern due to loss of rangeland productivity and costs of control. Weeds are most common in areas of the MAA that have been disturbed and not properly reclaimed and revegetated. Examples include roadsides, livestock congregation areas, pipelines, and oil and gas drill sites.

In 1994, field investigators observed areas of infestation up to 20 acres in size of perennial pepperweed (*Lepidium latifolium*), Russian thistle (*Salsola iberica*), halogeton (*Halogeton glomeratus)*, and whitetop (*Cardaria pubescens*) (ECOTONE Environmental Consulting 1995). Perennial pepperweed was found in wet meadows and near Fontenelle Reservoir. The Fontenelle Reservoir area (including the campgrounds) also contains tamarisk (*Tamarix* spp.).

Halogeton is a weed of particular concern with regard to development activities within Wyoming and is known to occur within the MAA (Bezanson 2006). While not aggressively invasive, it is highly poisonous to sheep and is known to affect other livestock as well. Halogeton has been found within several well sites and pipeline ROWs, along roadsides and other disturbed places, including areas of livestock concentration.

Table 4 lists Wyoming noxious weed species and their occurrence within the MAA. Included in the table are weeds identified on the Wyoming Priority Pest List (Wyoming Weed and Pest Council 2004).

3.9 THREATENED, ENDANGERED, PROPOSED, AND CANDIDATE SPECIES

Threatened, endangered, and candidate species identified by the U.S. Fish and Wildlife Service (USFWS) that are known to, or have the potential to occur in Lincoln, Sweetwater, and/or Uinta Counties are listed in Table 5. Species accounts with habitat requirements are provided immediately after the table. Three ESA-protected or candidate species potentially occur in the MAA. In addition, four downstream Colorado River fish species may be affected by depletions to the Colorado River system. Two additional ESA-protected species may occur in the KFO but do not occur in the MAA. These are the Canada lynx and gray wolf. These species would not be found on or adjacent to the MAA because the Project Area differs considerably in habitat and range from where they are known to occur. Therefore, no accounts for these species are included in this document. There is no USFWS designated critical habitat in or adjacent to MAA (USFWS 2006a).

Table 4. Wyoming Noxious Weed Species.

Scientific Name	Common Name	Wyoming Noxious Weed List	2004 Wyoming Priority Pest List	County Noxious Weed List[1]	Occurs Within MAA[2]
Agropyron repens	quackgrass	X		L, S, U	
Arctium minus	common burdock	X		L, S, U	
Avena fatua	wild oat			L	
Cardaria draba, C. pubescens	hoary cress, whitetop	X		L, S, U	X
Carduus acanthoides	plumeless thistle	X		L, S, U	
Carduus nutans	musk thistle	X		L, S, U	X
Centaurea diffusa	diffuse knapweed	X	X	L, S, U	
Centaurea macculosa	spotted knapweed	X	X	L, S, U	X
Centaurea repens	Russian knapweed	X	X	L, S, U	
Centaurea solstitialis	yellow starthistle		X	U	
Chrysanthemum leucanthemum	ox-eye daisy	X		L, S, U	
Cirsium arvense	Canada thistle	X	X	L, S, U	X
Cirsium vulgare	bull thistle				X
Convulvulus arvensis	field bindweed	X		L, S, U	
Cynoglossum officinale	houndstongue	X		L, S, U	
Euphorbia esula	leafy spurge	X		L, S, U	
Fraseria discolor	skeletonleaf bursage	X		L, S, U	
Halogeton glomeratus	halogeton				X
Hordeum jubatum	foxtail barley			S	
Hyoscyamus niger	black henbane			S, U	X
Hypericum perforatum	common St. Johns wort	X			
Isatis tintoria	dyers woad	X		L, S, U	X
Lepidium latifolium	perennial pepperweed	X		L, S, U	X
Linaria dalmatica	dalmation toadflax	X	X	L, S, U	
Linaria vulgaris	yellow toadflax	X	X	L, S, U	
Lythrum salicaria	purple loosestrife	X	X		
Onopordum acanthium	scotch thistle	X		L, S, U	
Sonchus arvensis	perennial sowthistle	X		L, S, U	
Tamarix spp.	tamarisk	X	X		X
Tanacetum vulgare	common tansy	X			
Thermopsis montana	mountain thermopsis			S	X

Source: Wyoming Weed and Pest Council 2004

[1] L = Lincoln; S = Sweetwater; U = Uinta;

[2] Bezanson 2006

Table 5. Species with Federal Status that were Evaluated for the MAA.

Common Name	Scientific Name	County[1]	Federal ESA Status[2]	Likely to Occur in MAA?
Black-footed ferret	*Mustela nigripes*	L,S,U	E / experimental	Low likelihood
Colorado pikeminnow	*Ptychocheilus lucius*	L, S, U	E	No**
Humpback chub	*Gila cypha*	L, S, U	E	No**
Bonytail chub	*Gila elegans*	L, S, U	E	No**
Razorback sucker	*Xyrauchen texanus*	L, S, U	E	No**
Canada lynx	*Lynx canadensis*	L	T	No
Gray wolf	*Canis lupus*	L	T / experimental	No
Ute ladies'-tresses	*Spiranthes diluvialis*	L, S, U	T	Low likelihood
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	L, S, U *	C	Low likelihood

[1] L = Lincoln; S = Sweetwater; U = Uinta

[2] T = threatened, E = endangered, C = candidate for listing; experimental = populations have been re-introduced
* = formal county designations have not been made for this candidate species, however, potential habitat could be present in all counties
** = may occur downstream and be affected by water depletions to the Colorado River Basin

3.9.1 Black-footed Ferret

The black-footed ferret is listed as endangered by the USFWS, with non-essential experimental status given to re-introduced populations (USFWS 2006a). Black-footed ferrets are inhabitants of prairie dog (*Cynomys* spp.) colonies. The 1995 EIS determined that 63% of the MAA is suitable habitat for black-footed ferrets due to the numbers and densities of prairie dog colonies. Historic records of black-footed ferret include several sightings from the 1970s in the Seedskadee NWR (WyNDD 2006). Black-footed ferrets were reintroduced to northwest Colorado beginning in 2001, approximately 80 miles from the MAA, and are breeding and thriving (Colorado Division of Wildlife 2005). Black-footed ferret reintroductions also occurred in Coyote Basin in Uintah County, Utah, approximately 90 miles southeast of the MAA, and in the Shirley Basin, central Wyoming, approximately 150 miles east of the MAA.

An intensive white-tailed prairie dog (*C. leucurus*) colony mapping effort was conducted for the 1995 EIS to determine potential black-footed ferret habitat for reintroduction. The study determined that 10% of the MAA contained prairie dog colonies, over 89% of which had burrow densities greater than eight per acre and were considered "towns" by the USFWS (Figure 3). A USFWS-defined prairie dog complex (grouping of adjacent towns) comprises 63% of the MAA, and 3,982 acres within the complex qualified in 1995 as suitable black-footed ferret reintroduction habitat (BLM 1995d).

Additional information compiled for these species consists of contractor survey data collected primarily over the past 5 years (2001-2005) in support of various energy development projects. No black-footed ferrets were found during 34 surveys covering at least 83,840 acres within the MAA. Survey data provided valuable information on existence and relative abundance of the white-tailed prairie dog, a BLM sensitive species, and other shortgrass prairie wildlife.

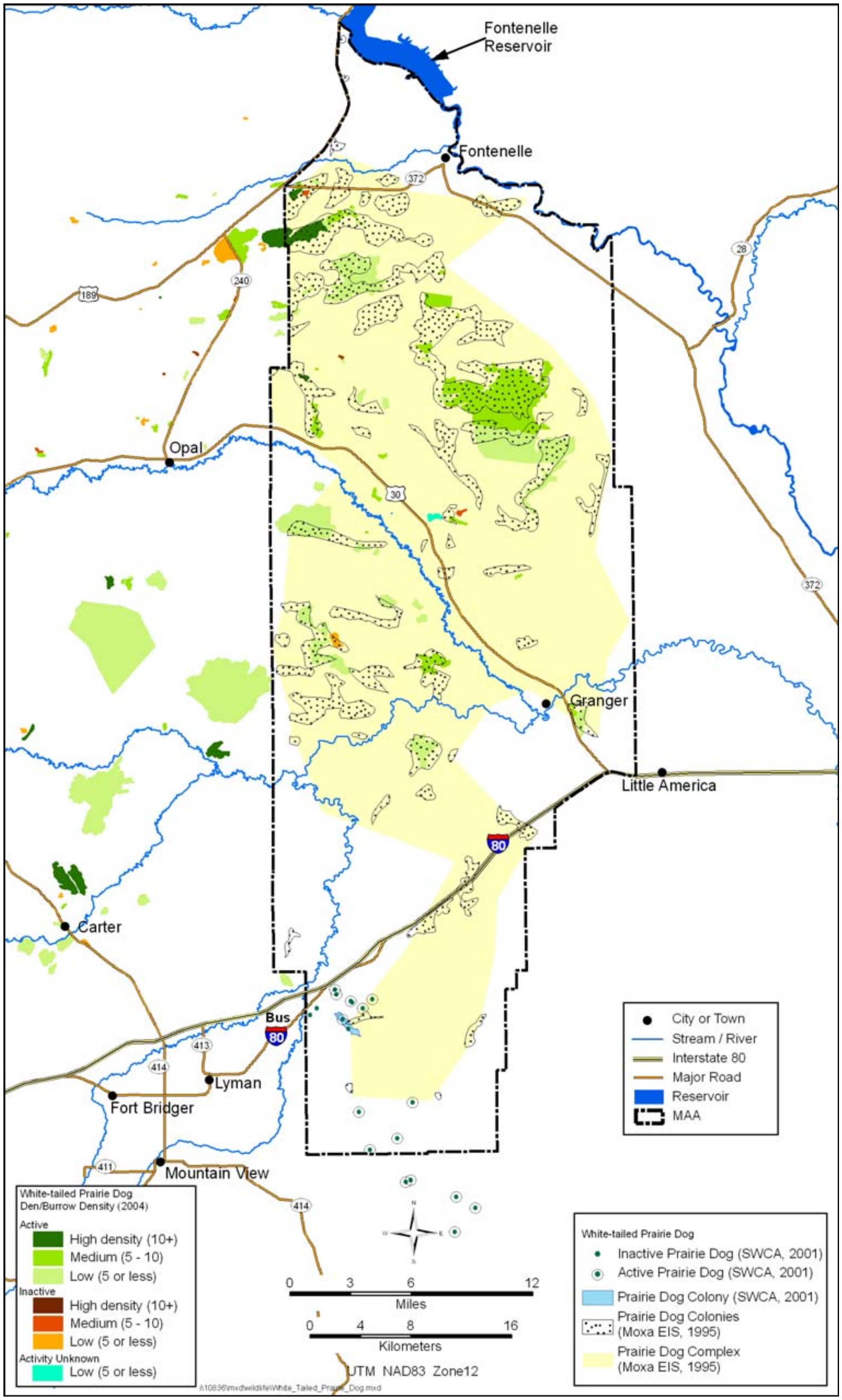

Figure 3. Prairie Dog Populations in the MAA.

3.9.2 Colorado River Fishes

The Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub are listed as endangered by the USFWS. They are endemic fish species that once thrived in the Colorado River system. Dam installation and the introduction of non-native fish changed the river environment and put these fish at risk (USFWS 2006b). Critical habitat was not designated in Wyoming for any of the four listed species (Federal Register 1994), but has been delineated in the Green River in northern portions of both Colorado and Utah near the Wyoming border. These species have not been documented within the MAA.

The primary concern for these fish species is effects due to upstream water depletions from the proposed project. Under the *Recovery Implementation Program for Endangered Species in the Upper Colorado River Basin* (RIP), water depletions from tributary waters jeopardize the continued existence of these endangered fish. Tributaries are defined as contributing to instream flow, and depletion is defined as water that would contribute to flows if not intercepted or removed from the system. The RIP was developed as a cooperative effort between the states of Colorado, Utah, and Wyoming; the Bureau of Reclamation; the USFWS; private water development interests; and various environmental groups. The RIP implementation agreement was signed by governors of the three states, the Secretary of Interior, and the Administrator of the Western Area Power Administration.

A 2000 Biological Opinion covering Colorado River depletions for livestock uses concluded that individual projects causing 100 acre-feet or more of average annual water depletion would not be included in a programmatic approach and would require further consultation with the USFWS and, potentially, a fee.

3.9.3 Ute Ladies'-tresses

Ute ladies'-tresses requires streamside or wet meadow habitats on sub-irrigated alluvial soils (Spackman et al. 1997). Its known range is along the Front Range of the Rocky Mountains of Colorado, with outlying populations in Nevada, Wyoming, and Utah. In Wyoming, the orchid is known from the western Great Plains in Converse, Goshen, Laramie, and Niobrara Counties on portions of Antelope Creek, Horse Creek, and Niobrara River watersheds (Heidel 2007). Recent information from the Wyoming Natural Diversity Database (WyNDD) indicates that there are nine occurrences of Ute ladies'-tresses in Wyoming (Heidel 2007. The nearest known location of this plant to the MAA in 1995 was more than 35 miles from the MAA in Daggett County, Utah, along the Green River (BLM 1995c).

A habitat occurrence study was conducted for the 1995 EIS (BLM 1995a), and probability of occurrence for Ute ladies'-tresses was determined to be "possible." Field reconnaissance trips were conducted to determine areas of potential habitat. Approximately 11,333 acres of "low-potential" habitat were identified for this orchid (BLM 1995a). Areas of potential habitat occurred primarily along the Hams Fork River, Blacks Fork River and its southern tributaries, and a narrow band along Slate Creek. The Wyoming Natural Diversity Database (WyNDD) reports that 18 sections along the Blacks Fork River have been surveyed for Ute ladies'-tresses, but none are recorded (WyNDD 2006).

No orchids have been found during four contractor surveys conducted for energy and communications ROWs in the MAA. Project-specific surveys may be necessary in suitable mesic habitats.

3.9.4 Western Yellow-billed Cuckoo

The Western yellow-billed cuckoo is listed as a Candidate Species by the USFWS, and is protected under the MBTA (USFWS 2007; MBTA 1918). This species occurs in relatively large, unfragmented stands of riparian habitat dominated by cottonwood and a well developed understory below approximately 7,000 feet elevation. The species' distribution, however, is patchy and fragmented into disjunct populations in the West (WyNDD 2005).

Population declines resulting from loss or disturbance of riparian habitat have been consistently reported in the West for this species (Finch 1992). The greatest factors affecting the yellow-billed cuckoo have been the invasion of exotic woody plants into riparian systems, and clearing of riparian woodlands for agriculture, fuel, development, and attempts at water conservation (Howe 1986). Although a population status review in 2001 determined that listing was warranted, the species was precluded from listing.

Suitable breeding habitat for the cuckoo consists of a mosaic of riparian vegetation, including healthy shrub or sapling thickets, multi-aged stands of trees, wet meadows, and open water. Mapped potential breeding distribution for the yellow-billed cuckoo includes portions of southwestern Wyoming in Lincoln, Sweetwater, and Uinta Counties, but its occurrence is considered "very rare" and transient or migratory (WyNDD 2005). Very little habitat for yellow-billed cuckoo may be present in the Hams Fork River floodplains and within the Green River corridor on the northern boundary of the MAA, where cottonwoods provide adequate cover.

Occurrence data received from WyNDD indicated that the nearest documented sightings of yellow-billed cuckoo in the MAA vicinity occurred along I-80 approximately 28 miles west of the MAA, along the Green River about 8 miles east of the MAA, and along SH 414 approximately 2 and 16 miles from the MAA boundary. No yellow-billed cuckoos have been documented within the MAA (WyNDD 2006).

4.0 DIRECT AND INDIRECT IMPACTS OF THE PROPOSED PROJECT

ESA-listed threatened, endangered, or candidate species that are known to occur, or potentially occur, in the MAA include black-footed ferret, Ute ladies'-tresses orchid, and western yellow-billed cuckoo. Impacts to these species from development in the MAA include habitat loss and increased stress from human presence and equipment. Four endangered Colorado River fish species (Colorado pikeminnow, razorback sucker, bonytail, and humpback chub) found downstream of the MAA could be affected by depletions to the Colorado River system. No USFWS-designated critical habitat has been mapped for federally listed species within the MAA.

Although the total acres of disturbance under the action alternatives is known, the distribution of disturbance will not be known until the actual site specific well locations and other disturbance activities are determined. Direct impacts from project implementation, development, and operations to federally listed species that may be present in the MAA would be loss of habitat and habitat fragmentation as a result of surface disturbing activities, and water depletions. Indirect effects would include impacts from additional noise, dust, and human presence. These species may alter their behavior and home range use within the area of potential effect and adjacent areas. Bird species tend to be more sensitive to noise impacts and would benefit from late summer project start dates. All federally listed species that breed in the area are most sensitive to disturbance during the spring season.

Impacts to federally listed species would be significant if activities adversely affected or jeopardized threatened, endangered, or candidate species and/or any recovery program. The Wyoming Game and Fish Department (WGFD) has characterized the severity of impacts to black-footed ferret and western yellow-billed cuckoo as follows: greater than 16 wells per section is extreme, 5 to 16 wells per section is high, and 1 to 4 wells per section is moderate within potential habitat for each species (WGFD 2004).

4.1 PROPOSED ACTION

The Proposed Action would result in short-term impacts to approximately 2,233 acres (4% of available habitat) of prairie dog habitat, which could also impact black-footed ferret, and 720 acres (1.3% of available habitat) after interim reclamation. Impacts to riparian habitat, which could impact Ute ladies'-tresses and yellow-billed cuckoo, would not be expected due to the 500-foot stream/riparian buffer BLM stipulation. The development of additional road crossings would be avoided unless no existing crossing can reasonably used to gain access to an area of potential development. In this case, impacts to riparian habitat would be assessed on a site-by-site basis. Pipeline crossings within the MAA on federal surface are typically drilled to reduce the impacts to perennial waters.

4.1.1 Threatened, Endangered, Proposed, and Candidate Species

4.1.1.1 Black-footed Ferret

No black-footed ferrets are known to occur in the MAA. Black-footed ferret presence-absence surveys could be required in prairie dog colonies not included in the USFWS block clearance areas to ground disturbing activities within the mapped prairie dog complex. Surveys would be conducted according to USFWS guidelines (USFWS 1989). If surveys are required, consultation with the USFWS would be initiated prior to surveys being conducted. If black-footed ferrets are found, no project related disturbance would occur within the prairie dog complex and all project related activities in such towns or complexes would be suspended. The USFWS would be notified within 24 hours if a black-footed ferret is observed. Although black-footed ferrets, if present, may be affected by this project, as long as the prescribed avoidance and protective measures (listed in the Section 5.0) are implemented, they are unlikely to be adversely affected.

4.1.1.2 Colorado River Fishes

Several streams within the MAA are tributaries to the Green River, which flows to the Colorado River. Impacts to streams within the MAA could potentially affect downstream suitable and occupied habitat for four federally endangered fish species: Colorado pikeminnow, razorback sucker, humpback chub, and bonytail chub. These impacts include water depletions, increased sedimentation, and alterations of stream flows. Because BLM-established BMPs and Wyoming Department of Environmental Quality storm water pollution prevention plans will be followed, which prevent alteration of stream flows and reduce soil movement into drainages, no significant additional sediments are expected to enter local stream systems or affect downstream water quality. Also, if water depletions over 100 acre-feet annually occur, consultation with the USFWS would need to occur and appropriate mitigation decided by that agency. There is potential for greater than 100 acre-feet in depletions for all alternatives.

4.1.1.3 Ute Ladies'-tresses

BLM stipulations restricting construction within 500 feet of streams and in wet meadows, springs, and seeps would protect potential habitat. Therefore, no effects to the Ute ladies'-tresses orchid are expected from any of the alternatives. If populations of Ute ladies'-tresses were discovered, a 500-foot buffer around those populations would be required.

Potential stream crossings could not be estimated at this time, but they would be analyzed on a project-specific basis during the APD process and through Clean Water Act (CWA) permitting, if necessary. Pipeline crossings within the MAA on federal surface are typically drilled to reduce the impacts to perennial waters. If pipelines are proposed to cross Ute Ladies'-tresses habitat adjacent to streams, surveys would be required prior to crossings.

4.1.1.4 Western Yellow-billed Cuckoo

BLM stipulations restricting construction within 500 feet of streams and in wet meadows, springs, and seeps would protect potential habitat. Therefore, no effects to the Western yellow-billed cuckoo are expected from any of the alternatives.

Potential stream crossings could not be estimated at this time, but they would be analyzed on a project-specific basis during the APD process and through CWA permitting, if necessary. Pipeline crossings within the MAA on federal surface are typically drilled to reduce the impacts to perennial waters. If pipelines are proposed to cross yellow-billed cuckoo habitat adjacent to streams, surveys would be required prior to crossings.

4.2 ALTERNATIVE A–NO ACTION

Alternative A would result in short-term impacts to approximately 1,898 acres (3.4% of available habitat) of prairie dog habitat, which could also impact black-footed ferret if present, and 524 acres (less than 1% of available habitat) after interim reclamation, which is a 0.3% decrease from the Proposed Action. Impacts to riparian habitat, which could impact Ute ladies'-tresses and yellow-billed cuckoo, would not be expected due to the 500-foot stream/riparian buffer BLM stipulation.

4.3 ALTERNATIVE B

Impacts to prairie dog habitat under Alternative B would depend on the distribution of wells across the MAA. Techniques employed to minimize surface disturbance could reduce impacts to prairie dog habitat compared to the Proposed Action. Impacts to riparian habitat, which could impact Ute ladies'-tresses and yellow-billed cuckoo, would not be expected due to the 500-foot stream/riparian buffer BLM stipulation.

4.4 ALTERNATIVE C

Alternative C would result in short-term impacts to approximately 5,970 acres (10.8%) of prairie dog habitat, which could also impact black-footed ferret, and 2,015 acres (3.6%) after interim reclamation, which is a 2.3% increase from the Proposed Action. Impacts to riparian habitat, which could impact Ute ladies'-tresses and yellow-billed cuckoo, would not be expected due to the 500-foot stream/riparian buffer BLM stipulation.

5.0 RECOMMENDED CONSERVATION AND MITIGATION MEASURES

The following procedures will be implemented to eliminate or substantially reduce potential adverse effects of the proposed project to threatened, endangered, proposed, and candidate species that may occur on or near the MAA or may be impacted by the project.

- If disturbance of the prairie dog complex can not be avoided, black-footed ferret surveys would be conducted according to USFWS guidelines (USFWS 1989) if the affected colonies meet the survey requirements;
- Well pads and disturbances would be placed outside of prairie dog colonies where feasible. In the non-block cleared areas of the MAA, any construction would require block surveys for the presence of black-footed ferrets. In those areas that are block cleared, attempts would be made to minimize disturbance on a site-specific basis to affect as few burrows as possible;
- Should black-footed ferrets be documented in a prairie dog complex located within the MAA, impacts to the species or its habitat would be suspended immediately;
- The Operators will conduct educational outreach to employees regarding the nature, hosts, and symptoms of canine distemper, and its effects on black-footed ferrets, focusing attention on why pets should be prohibited from work sites;
- All suspected observations of black-footed ferrets or carcasses within the MAA, however obtained, shall be promptly (within 24 hours) reported to the BLM and USFWS;
- In order to reduce the potential for vehicle-wildlife collisions, all drivers should undergo a training session describing the type of wildlife in the area that are susceptible to vehicular collisions. The circumstances under which such collisions are likely to occur, and the measures that could be employed to minimize them should be discussed. Reduced speed limits should be implemented to reduce the potential for vehicle-wildlife collisions;
- Remote monitoring of project facilities would be utilized to the extent possible to reduce human activity levels within the MAA during the production phase;
- All appropriate sedimentation, erosion control, and produced water control measures will be implemented to avoid changes in water quality or quantity in the streams within the MAA; and
- If any federally listed species are identified during construction or operation, the BLM shall be contacted immediately. Operations that would adversely affect the listed species must be discontinued until consultation with the USFWS indicates that impacts are ***not likely to adversely affect*** the species.

6.0 CUMULATIVE IMPACTS

The cumulative impact analysis approach is used to evaluate the influences of recent, past, present, and reasonably foreseeable future activities (RFFAs) on the ESA-listed threatened, endangered, or candidate species on a broad scale. This approach examines impacts associated with a proposed project in context with all other past and future developments, whether or not they are related. In addition to the current disturbance and anticipated future natural gas development previously discussed in this document, RFFAs in the MAA involve natural gas and liquids pipelines, geophysical exploration projects, trona mining, and wind energy projects.

The Cumulative Impact Assessment Area (CIAA) for affected federally listed species is the species' entire range within the Kemmerer Field Office (KFO) area. Cumulative impacts to listed wildlife generally include direct loss of habitat, as well as indirect impacts from increased fragmentation, noise, and human presence. Specific cumulative impacts for listed species that may be impacted by the MAA project are discussed below.

6.1 BLACK-FOOTED FERRET

As no significant impacts are expected under any project alternatives, future development in the MAA is not anticipated to add to cumulative impacts.

6.2 COLORADO RIVER FISHES

The CIAA for endangered Colorado River fish species is the Green River Basin downstream from the project that would be subject to project-related depletions. As no significant impacts are expected under any project alternatives, future development in the MAA is not anticipated to add to cumulative impacts.

6.3 UTE LADIES'-TRESSES

The CIAA for Ute ladies'-tresses is riparian habitat within the KFO. Cumulative impacts to potential Ute ladies'-tresses habitat on BLM lands within the CIAA are limited due to stipulations that protect riparian habitat and require site-specific surveys for this plant. Cumulative impacts could occur to this plant if activities on private and state lands within the CIAA result in the take of multiple populations.

6.4 WESTERN YELLOW-BILLED CUCKOO

The CIAA for western yellow-billed cuckoo is the riparian habitat within the KFO. Riparian habitat in the area is limited and this species is unlikely to occur regularly in the CIAA. RFFAs in the CIAA could cumulatively impact this bird by decreasing available habitat from road stream crossings that remove habitat. Cumulative impacts on BLM lands within the CIAA are limited due to stipulations that protect riparian habitat, but could occur if activities on private and state lands within the CIAA displace this species.

7.0 DETERMINATION OF EFFECTS FOR LISTED SPECIES

7.1 BLACK-FOOTED FERRET

Based upon the analyses of the alternatives, the current and potential status of the species in the Project Area, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives ***may affect*** but is ***not likely to adversely affect*** the black-footed ferret.

7.2 COLORADO RIVER FISHES

Based upon the analyses of the alternatives, the current and potential status of the species in the Project Area, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that project-related water depletions resulting from implementation of the alternatives ***may affect*** but are ***not likely to adversely affect*** the Colorado River fishes.

7.3 UTE LADIES'-TRESSES

Based upon the analyses of the alternatives, the current and potential status of the species in the Project Area, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives ***may affect*** but are ***not likely to adversely affect*** Ute ladies'-tresses orchid.

7.4 WESTERN YELLOW-BILLED CUCKOO

Based upon the analyses of the alternatives, the current and potential status of the species in the Project Area, other land use activities in the area, and incorporation of the conservation measures recommended in this BA, it is concluded that implementation of the alternatives ***may affect*** but are ***not likely to adversely affect*** the Western yellow-billed cuckoo.

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APPENDIX E. RECLAMATION PROCEDURES PLAN

1.0 INTRODUCTION

The following reclamation procedures plan is designed to attain successful reclamation of disturbed areas associated with the Moxa Arch Area (MAA) Infill Gas Development Project (Project). These measures are designed to establish the feasibility of reclaiming disturbances associated with this Project and were developed based on:

- Bureau of Land Management (BLM) Wyoming Interim Reclamation Policy (2007);
- Management directives presented in the Kemmerer Resource Management Plan (RMP);
- United States Department of the Interior (USDI) "Surface Operating Standards and Guidelines for Oil and Gas Exploration and Development," also known as the "Gold Book" (2006);
- Wyoming Department of Environmental Quality, Land Quality Division reclamation guidelines;
- Impacts identified in the Environmental Consequences chapter (Chapter 4) of this Environmental Impact Statement (EIS);
- Coordination with BLM staff; and
- Issues identified during the scoping process.

This reclamation procedures plan is intended to be adaptive to changing conditions and technologies. It is intended that BLM staff would have full discretion to update, modify, or change this procedures plan should it be deemed warranted due to site conditions or other factors.

Disturbed areas to be reclaimed include well pads, staging areas, access roads, and pipeline rights-of-way (ROWs). The measures presented in this plan are designed to minimize Project impacts to natural resources. Due to the large geographic area covered by the Project and the lack of site-specific locations of Project facilities, these measures are presented in a general, non-specific manner. Final selection of the measures to be applied at any given location, as well as modifications to these measures, would be identified by the BLM in coordination with EOG Resources, Inc. (EOG) and other companies (Operators).

This reclamation plan outlines measures that would be taken to effectively reclaim areas disturbed by the Proposed Action. These measures will be followed unless exceptions are granted or actions are modified by agreement between the BLM and the Operators. These measures describe how natural gas development activities would be managed to ensure compliance with the resource management goals and objectives for the general area, applicable lease and unit area stipulations, and resource limitations identified during interdisciplinary team (IDT) analyses. Initial monitoring for compliance and successful implementation of the mitigation measures would be under the direction of the Operators. Final approval and release would be under the direction of the BLM.

Reclamation measures covered in this plan fall into three general categories:

1) Initial – referring to measures applied immediately after well pad construction,
2) Interim - referring to measures applied to stabilize disturbed areas and to control runoff and erosion until well abandonment, and
3) Final reclamation - referring to measures that are to be applied concurrently with abandonment of facilities.

Reclamation potential may be limited by soil chemical characteristics (e.g., salinity, alkalinity), physical characteristics (e.g., texture classification), altitude, aspect, slope, shallow soils, depth to bedrock, precipitation zone, length of growing season, and seasonal high water tables. Special intensive land-use practices may be necessary to mitigate salt and sediment loading caused by surface-disturbing activities within the Project Area. Activity plans (e.g., applications for permit to drill [APDs]) would address site-specific issues and potential problems, including monitoring for salt and sediment loading (USDI-BLM 1990b).

Final reclamation measures, in general, involve re-grading the disturbed area to near pre-disturbance contour, re-spreading salvaged topsoil, applying soil amendments (if necessary), re-seeding with a BLM-approved seed mixture, mulching, and placing runoff and erosion control structures, such as water bars and silt fences. The duration of the resultant impacts to the various vegetation community types depends in part on the success of implementing the reclamation measures prescribed in this plan and the time required for primary succession to return disturbed areas to pre-disturbance vegetation conditions.

Proper re-seeding mixtures would be used to reclaim areas with native vegetation. According to established criteria, the seed mixture selection process would consider seed availability and price, growth form, seasonal variety, and prevailing dominant species. Suggested seed mixes for various habitat types are provided in Table E-2 through Table E-8 of this plan. The seed mixture would contain the following:

- No fewer than four herbaceous species, unless a proposed land use (e.g., managed hayland or pastureland) requires fewer species;
- The native dominant herbaceous species that support the post-disturbance land uses;
- Additional species native to the region that support the post-disturbance land uses, if needed;
- Naturalized, introduced species only if additional herbaceous species are needed, if suitable native species are unavailable, or if naturalized species are superior for a specialized land use (e.g., managed hayland or pastureland);
- Full shrub and/or sub-shrub species when these species will support the post-disturbance land uses; and
- Native forb species, if natural reestablishment of forbs will be limited by site-specific conditions.

2.0 OBJECTIVES

This plan is designed to meet the following objectives for reclamation of areas disturbed by the Project.

2.1 Initial (Temporary) Reclamation

- Immediately stabilizing the disturbed areas by mulching (if needed), providing runoff and erosion control, and establishing a sterile cover crop (required for problem areas; may be optional for other areas depending on consultation with the BLM).
- Controlling and minimizing surface runoff, erosion, and sedimentation using diversion and water treatment structures.

2.2 Interim (Short-Term) Reclamation

- Stabilizing the disturbed soil surface by mulching (if needed and as directed by the BLM), controlling runoff and erosion, and establishing new vegetation.

- Ensuring adequate surface roughness to reduce runoff and to capture rainfall and snow.
- Controlling and minimizing surface runoff, erosion, and sedimentation using diversion and water treatment structures.
- Restoring primary productivity of the site and establishing vegetation that will provide for natural plant and community succession.
- Establishing a vigorous stand of desirable plant species that will limit or preclude the invasion of undesirable species, including noxious/invasive species.
- Reseeding the disturbed areas with native plant species useful to wildlife and livestock.

2.3 Long-Term (Final) Reclamation

- Upon abandonment of facilities, recontouring to approximate pre-construction grade where necessary.
- Stabilizing the disturbed soil surface by mulching (if needed and as directed by the BLM), controlling runoff and erosion, and establishing new vegetation.
- Ensuring adequate surface roughness to reduce runoff and to capture rainfall and snow.
- Controlling and minimizing surface runoff, erosion, and sedimentation using diversion and water treatment structures.
- Restoring primary productivity of the site and establishing vegetation that will provide for natural plant and community succession.
- Establishing a vigorous stand of desirable plant species that will limit or preclude the invasion of undesirable species, including noxious/invasive species.
- Reseeding the disturbed areas with native plant species useful to wildlife and livestock.
- Enhancing aesthetic values; in the long-term, reclaimed landscapes would have characteristics that approximate the visual quality of adjacent areas, including location, scale, shape, color, and orientation of undisturbed major landscape features.

3.0 METHODS

3.1 Clearing, Topsoil Removal, and Storage

In general, topsoil would be handled separately from subsoil materials. Topsoil would be stripped to provide sufficient quantities to be re-spread to a depth of at least 4 to 6 inches over the disturbed areas to be reclaimed. Soil removal would be avoided in areas where deep soils exist, such as floodplains and drainage channel terraces. However, under certain circumstances, at least 12 inches of topsoil would be salvaged in these areas as determined by the appropriate BLM official.

As much topsoil would be salvaged as possible where soils are shallow or subsoil is stony. Topsoil would be stockpiled separately from subsoil materials. Topsoil stockpiles would not exceed a depth of 2 feet. Topsoil would be stockpiled separately from other earth materials to preclude contaminating or mixing and would be marked with signs and identified on construction and design plans. Runoff would be diverted around topsoil stockpiles to minimize erosion of topsoil materials. Salvaged topsoil from roads and well pads would be re-spread over cut-and-fill surfaces not actively used during the production phase. Upon final reclamation at the end of the Project life, topsoil spread on these surfaces would be used for the overall reclamation effort.

Operators are learning that it is not always necessary to remove all vegetation and strip all topsoil within a pipeline ROW. In many areas, such as deep soils on relatively flat smooth slopes with low gradients, it is possible to crush vegetation in place rather than clear it, and to leave topsoil in place, rather than blade and stockpile. This technique would reduce the magnitude and severity of disturbance impacts and hasten successful reclamation.

Pipelines would be bored under streams wherever possible, avoiding soil removal in these areas. In federal jurisdictional wetland areas, vegetation would be cut off only to the ground level, leaving existing root systems intact. Cut vegetation would be removed from wetland areas for disposal. Grading activities would be limited to areas directly over pipeline trenches and access roads. At least 12 inches of topsoil would be salvaged and replaced, except in areas with standing water or saturated soils.

Use of construction equipment in wetland areas would be limited. Dirt, rockfill, or brush riprap would not be used to stabilize pipeline ROWs. If standing water or saturated soils are present, wide-track or balloon-tire construction equipment would be used, or normal construction equipment would be operated on equipment pads or geotextile fabric overlain with gravel fill. Equipment pads would be removed immediately upon completing construction activities. Trench spoil would be placed at least 10 feet away from drainage channel banks for all minor and major drainage channel crossings.

3.2 Construction

3.2.1 Uplands

Construction would follow site-specific construction and design plans and applicable agency specifications. On well pads and along the areas of access road or pipeline ROW traversing steep slopes, slope angles would be minimized to enhance retention of topsoil and reduce erosion, as well as to facilitate revegetation and subsequent reclamation success. Slope-stabilizing revetment structures may be necessary in areas where the substrata materials are unconsolidated and loose and cannot be stabilized with revegetation and mulch.

Surface runoff would be controlled at all well pads using interception ditches and berms. A berm approximately 18 inches high would be constructed around fill portions of these well pads to control and contain all surface runoff generated or fuel or petroleum product spills on the pad surface. Water contained on the well pads would be treated in a detention pond prior to discharge into undisturbed areas in the same manner as discussed previously. This system should also serve to capture fuel and chemical spills, should they occur.

Runoff and erosion control along access road/pipeline ROWs would be accomplished by implementing standard cross drain, culvert, road ditch, and turnout design, as well as timely mulching and revegetation of exposed cut, fill, and road shoulders. All culverts would be constructed with riprapped entrances and exits using energy dissipaters or other scour-reducing techniques, where appropriate. Water discharged from culverts, cross drains, road ditches, and turnouts would be directed into undisturbed vegetation away from all natural drainages. Erosion and sedimentation control measures and structures would be installed across all cut-and-fill slopes within 100 feet of drainage channels. All runoff and erosion control structures would be inspected at regular intervals and after major runoff events. Sub-standard structures would be cleaned out and maintained in functional condition throughout the life of the Project.

3.2.2 Drainage Channel Crossings

Constructing drainage channel crossings would minimize the disturbance to drainage channels and wetlands and would occur during the low runoff period to the extent practicable (June 15 through March 1). Staging areas would be limited to the minimum size necessary and would be located at least 50 feet from drainage channels, where topographic conditions permit. Hazardous materials would not be stored and equipment would not be refueled within 100 feet of drainage channels.

Drainage channel crossings would be constructed perpendicular to the axis of the drainage channel and at the narrowest positions, as engineering and routing conditions permit. Pipelines would be bored wherever possible to minimize impacts within 500 feet of streams. Clean gravel would be used for the upper 1 foot of fill over the backfilled pipeline trenches within drainage channel crossings.

3.2.3 Wetlands

Access roads and pipelines would be rerouted and well pads located to avoid wetland areas to the maximum extent practicable. Staging areas would be limited to the minimum size necessary, and all staging areas would be located at least 50 feet from the edge of federally jurisdictional wetland areas, where topographic conditions permit. The width of the access road and pipeline construction ROWs would be limited to no more than 50 feet. Hazardous materials would not be stored and equipment would not be refueled within 100 feet of wetland boundaries.

4.0 SURFACE RUNOFF AND EROSION CONTROL

4.1 Temporary Erosion Control

Temporary erosion control measures may include applying mulch and netting of biodegradable erosion control blankets stapled firmly to the soil surface, re-spreading scalped vegetation, or constructing water bars. (See Section 0 for specific information pertaining to mulching).

The actual distance of a pipeline/road ROW requiring stabilization on each side of a drainage channel would be determined on a site-specific basis. To minimize sedimentation of drainage channels and wetlands during the interim period between construction activity and final reclamation, temporary erosion and sediment control measures would be applied. Silt fences or other sediment filtering devices, such as weed-free straw bales, would be installed along drainage channel banks where sedimentation is excessive and at the base of all slopes adjacent to wetlands. Sediment filtering devices would be cleaned out and maintained in a functional condition throughout the life of the Project. To avoid the possibility of mulching materials entering waterways, loose mulch (i.e., mulch not crimped into the soil surface, tackified, or incorporated into erosion control blankets) would not be applied to drainage channel banks.

If construction is completed more than 30 days prior to the specified seeding season for perennial vegetation, areas adjacent to the larger drainage channels would be covered with jute matting for a minimum of 50 feet on either side of the drainage channel. In addition, to protect soil from erosion, 2 tons/acre of weed-free straw mulch would be applied to all slopes greater than 10%. Temporary erosion control measures may include leaving the ROW in a roughened condition, re-spreading scalped vegetation, or applying mulch. As indicated by several Operators and the BLM, weed-free straw mulch is difficult to obtain in quantities and at costs suitable for all reclamation applications. Although this circumstance could reduce the application of the measure, the effectiveness of mulch in protecting the exposed soil from raindrop impact, erosion, and off-site sedimentation would not be overlooked. In addition to its effectiveness in erosion control, mulching also benefits the soil as a plant growth medium in many cases. Therefore, effective mulching is fundamental to reducing soil erosion to acceptable, non-significant levels.

Trench breakers would be used for pipeline construction in certain areas to prevent the flow of water in trenches that have been backfilled or temporarily left open. Trench breakers are particularly important in wetland areas to minimize subsurface drainage. Trench breakers would be constructed such that the bottom of one breaker is at the same elevation as the top of the next breaker down slope, or every 50 feet, whichever is greater. Factors that control applying trench breakers include the proximity to drainage channels and wetland areas, slope gradient, proximity of areas to shallow groundwater, and surface runoff source areas that can discharge water into the trench. Topsoil would not be used to construct trench breakers.

If a pipeline crosses roads at the base of slopes, vegetative strips would be maintained. If vegetation is disturbed within these limits, temporary sediment barriers such as silt fences and/or staked weed-free straw bales would be installed at the base of the slope adjacent to the road crossing. Temporary sediment barriers would remain in place until permanent revegetation measures have been judged successful.

4.2 Final Erosion Control

4.2.1 Uplands

Runoff and erosion control along all ROWs would be accomplished by constructing sediment trapping devices (e.g., silt fences and straw bales) and water bars, as well as by timely mulching and revegetating exposed disturbed areas. Runoff discharged from water bars would be directed into undisturbed vegetation away from all natural drainages. Erosion and sedimentation control measures and structures would be installed across all cut-and-fill slopes. All runoff and erosion control structures would be inspected after major runoff events and on a regular schedule. Substandard or ineffective structures would be cleaned out and maintained in functional condition until successful revegetation and soil stability are attained.

Water bars would be constructed across side slopes at appropriate intervals according to slope gradient immediately following recontouring the disturbed areas. The spacing would depend on whether mulching is applied in conjunction with placement of water bars. Water bars would be maintained in a functional condition throughout the life of the Project. Should the integrity of the water bar system be disrupted during seeding, water bars would be repaired and broadcast seeded with the seed raked into the soil.

Table E- 1. Water bar intervals according to slope gradient.

With Mulching		Without Mulching	
Slope Gradient (percent)	**Interval (feet)**	**Slope Gradient (percent)**	**Interval (feet)**
10	150	10	100
15	100	15	75
20	50	20	45
30	40	30	40
40	35	40	35
50	30	50	30
>50	30	>50	30

Based on Grah (1989)

4.3 Wetlands and Drainage Channel Crossings

Disturbance to ephemeral and intermittent drainage channels would be avoided and/or minimized. All channel crossings not maintained for access roads would be restored to near-predisturbance conditions. Drainage channel bank slope gradients would be regraded to conform to adjacent slope gradients. Channel crossings would be designed to minimize changes in channel geometry and subsequent changes in flow hydraulics. Culverts would be installed for ephemeral and intermittent drainage channel crossings. All drainage channel-crossing structures would be designed to carry the 25-year to 50-year discharge event, as directed by the BLM. Silt fences would be constructed at the base of slopes at all drainage channel crossings. To avoid washes, minor routing variations would be implemented during access road, pipeline, and well pad layout. Disturbance in the vicinity of washes would be minimized. Per the Kemmerer RMP, a 500-foot-wide buffer strip of natural vegetation would be maintained between all construction activities and drainage channels.

Trench plugs would be employed at non-flumed drainage crossings to prevent diversion of drainage channel flows into upland portions of pipeline trenches during construction. Applying riprap would be limited to areas where flow conditions prevent vegetative stabilization; riprap activities must comply with ACOE permit requirements. Pipeline trenches would be dewatered in such a manner that no silt-laden water flows into active drainage channels (i.e., prior to discharge the water would be filtered through a silt fence, weed-free straw bales, or allowed to settle in a sediment detention pond).

5.0 NOXIOUS WEED MANAGEMENT

On February 3, 1999, Executive Order (EO) 13112 (*Invasive Species*) was signed by former President Clinton. The primary purpose of this EO is to prevent the introduction of invasive species and to provide for their control and minimize the economic, ecological, and human health impacts that invasive species cause. In Wyoming, some 428 species have been documented as invasive (Hartman and Nelson 2000). Noxious weeds and their occurrence in the MAA and surrounding counties are detailed in Chapter 3 of the EIS. The presence, distribution, and density of noxious/invasive weeds in the Project Area would be monitored by the Operators. The well access roads, well pads, staging areas, and other Project-related soil disturbances would be inspected regularly to ensure that noxious/invasive weeds do not become established on newly disturbed sites. Control methods would be based on available technology, taking into consideration the weed species present. Methods of noxious/invasive weed control may include promptly revegetating disturbed sites to reduce the potential for weed invasion, mowing, hand-pulling, or applying appropriate registered herbicides. The control methods shall be in accordance with guidelines, rules, laws, and regulations established by the Environmental Protection Agency (EPA), BLM (1991), and state/local authorities and agencies. Prior to initiating a weed management program, the Operators would obtain written approval from the BLM Authorized Officer. The Operators would also prepare and submit a proposal and plan to the BLM Authorized Officer for an annual weed program that satisfies the requirements established in the MSUP and any additional Conditions of Approval.

6.0 INTERIM RECLAMATION OF WELL SITES

Interim reclamation consists of minimizing the footprint of disturbance by reclaiming all portions of the well site not needed for production operations. The portions of the cleared well pad not needed for operational and safety purposes would be recontoured to blend with the surrounding topography as much as possible.

In cases where the topography is relatively flat, it may be unnecessary to recontour the wellhead location at the time of final reclamation. The Operators would determine the necessity of final recontouring at the time of interim reclamation. If final recontouring would not be necessary, the Operators would set aside sufficient topsoil for final reclamation of the small unreclaimed area around the wellhead.

6.1 Topsoil Re-spreading and Seedbed Preparation

When feasible, Operators would respread topsoil over the entire location and revegetate to within a few feet of the production facilities. To inspect or operate the well, or complete workover operations, it may be necessary to drive or park on interim vegetation within the previously disturbed well pad. In preparation for seeding, topsoil that was initially removed would be evenly spread over all areas of other sites not required for production purposes.

If construction operations allow, the Operators would consider the use of topsoil livehaul - the direct placement of freshly salvaged (not stockpiled) topsoil onto graded overburden in another area of operation. Livehaul of salvaged soil eliminates the problems of stockpiling. Consequently, deteriorating fertility, micro-flora, and seed viability are avoided.

On locations in which final recontouring would not be necessary, the Operators would set aside sufficient topsoil for final reclamation of the small unreclaimed area around the wellhead. Any topsoil pile set aside would be revegetated to prevent it from eroding and to help maintain its biological viability.

Soil compaction usually results from heavy equipment working on disturbed soils prior to revegetation. Compaction can be minimized using single lift operations rather than repeatedly driving over the surface, scraping off thin layers. Soil compaction can inhibit adequate revegetation of disturbance areas. Therefore, all disturbances to be revegetated would be ripped to reduce the adverse effect of compaction. All disturbed areas would be ripped on 18-inch to 26-inch spacing and 12 inches to 16 inches deep. A spring tooth harrow equipped with utility or seedbed teeth, or ripper-teeth equipment mounted behind a large crawler tractor or patrol would be used to loosen the subsoil. The subsoil surface would be left in a rough condition. If topsoil is loose after re-spreading, it would be compacted with a cultipacker or similar implement to provide a firm seedbed. On steep slopes (greater than 40% and highly erosive), it may be difficult or impossible to replace topsoil and adequately prepare the seedbed. The disturbed areas on steep slopes would be ripped as described above. These areas would then be mulched with a hydromulch/seed/tackifier mix. Erosion control blankets with seed incorporated into the matting would be installed per manufacturer's specifications to enhance soil stabilization.

6.2 Seed Application

The Operators would reseed all disturbed areas to landowner or BLM approval. The following procedures are recommended for consideration to ensure that all disturbed areas are stabilized and that revegetation efforts are enhanced so that impacts are minimized (USDI-BLM 1990a, 1997, 1999).

- Scarification - Prior to reseeding, all compacted areas would be scarified by ripping or chiseling to loosen compacted soils. Scarification promotes water infiltration, better soil aeration, and root penetration. Scarification would be performed when soils are dry to promote shattering of compacted soil layers.
- Seedbed Preparation - Appropriate seed-bed preparation is critical for seed establishment. Seedbed preparation would be conducted immediately prior to seeding to prepare a firm seedbed conducive to proper seed placement and moisture retention. Seedbed preparation would also be performed to break up surface crusts and to eliminate weeds that may have developed between final grading and seeding. In most cases, chiseling is sufficient because it leaves a surface smooth enough to accommodate a tractor-drawn drill seeder and rough enough to catch broadcast seed and trap moisture and runoff. In low to moderate saline soils, a firm, weed-free seedbed is recommended. In high salinity levels, particularly when a high water table is involved, a fallow condition may not provide the best seedbed. If existing vegetation and weeds are chemically eradicated, the remaining desiccated roots and stems improve moisture infiltration and percolation, reduce evaporation from the soil surface, and protect emerging seedlings (Majerus 1996).
- Seed Mixtures - Seed mixtures would be approved by the BLM on a site-specific basis prior to final reclamation, and their selection would be justified in terms of local vegetation and soil conditions. Livestock palatability and wildlife habitat needs would be considered when determining seed mix formulation. Seed would be used within 12 months of viability testing. The seed mixtures suggested in Table E-2 through Table E-8, or similar mixtures as approved

by the AO, would be applied according to specific areas that are homogeneous in terms of overall ecosystem similarities, such as precipitation zones, elevational zones, dominant species, soil types, and inherent limitations in reclamation success potential.

These mixtures comply with EO No. 11987 (*Exotic Organisms*). EO 11987 also specifies that BLM approval is required prior to using any introduced plant species for federal lands. BLM guidance for native seed use is BLM Manual 1745, "Introduction, Transplant, Augmentation, and Reestablishment of Fish, Wildlife, and Plants."

Table E-2. Seed mixture[2] #1 – mountain shrub and juniper woodland.

Species	Cultivar or Variety	Seed Application Drilled Rate (pure live seed lbs/acre)	Planting Depth (if drilled) (Inches)
Grasses			
Western wheatgrass (*Agropyron smithii*)	Rosanna	2.0	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	3.0	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	2.0	0.5
Indian ricegrass (*Oryzopsis hymenoides*)	Nezpar	3.0	0.5
Needle-and-thread (*Stipa comata)*	-	1.0	0.5
Sandberg bluegrass (*Poa sandbergii)*	-	1.0	0.5
Forbs			
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	-	1.0	0.5
White yarrow (*Achillea millefolium*)	-	1.0	0.25
Silky lupine (*Lupinus sericeus*)	-	1.0	0.5
Northern sweetvetch (*Hedysarum boreale*)	-	2.0	0.5
Shrubs			
Wyoming big sagebrush (*Artemisia tridentate*)	-	0.5	0.25
Antelope bitterbrush (*Purshia tridentate*)	-	1.0	0.5
Winterfat (*Ceratoides lanata*)	-	1.0	0.5
Total		**19.5**	

2 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

Table E-3. Seed mixture[3] #2 – mixed desert shrub cover.

Species	Cultivar or Variety	Seed Application Rate (pure live seed lbs/acre)	Planting Depth (if drilled) (Inches)
Grasses			
Western wheatgrass (*Agropyron smithii*)	Rosanna	2.0	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	3.0	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	2.0	0.5
Indian ricegrass (*Oryzopsis hymenoides*)	Nezpar	3.0	0.5
Needle-and-thread (*Stipa comata*)	-	1.0	0.5
Sandberg bluegrass (*Poa sandbergii*)	-	1.0	0.5
Forbs			
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	-	1.0	0.5
White yarrow (*Achillea millefolium*)	-	1.0	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	2.0	0.5
Shrubs			
Wyoming big sagebrush (*Artemisia tridentate*)	-	0.5	0.25
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	-	1.0	0.25
Winterfat (*Ceratoides lanata*)	-	1.0	0.5
Shadscale (*Atriplex confertifolia*)	-	2.0	0.5
Total		**20.5**	

3 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

Table E- 4. Seed mixture[4] #3 – vegetated sand dune cover.

Species	Cultivar or Variety	Seed Application Rate (pure live seed lbs/acre)	Planting Depth (if drilled)(Inches)
Grasses			
Prairie sandreed (*Calamovilfa longifolia*)	Goshen	3.0	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	2.0	0.5
Sand dropseed (*Sporobolus cryptandrus*)	-	1.0	0.25
Indian ricegrass (*Oryzopsis hymenoides*)	Nezpar	3.0	0.5
Needle-and-thread (*Stipa comata*)	-	1.0	0.5
Forbs			
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	-	1.0	0.5
Desert Indian paintbrush (*Castilleja chromosa*)	-	1.0	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	1.0	0.5
Shrubs			
Wyoming big sagebrush (*Artemisia tridentate*)	-	0.5	0.25
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	-	1.0	0.25
Spiny hopsage (*Grayia spinosa*)	-	1.0	0.5
Douglas rabbitbrush (*Chrysothamnus vicidiflorus*)	-	1.0	0.5
Total	**-**	**16.5**	

4 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

Table E- 5. Seed mixture[5] #4 – alkali scrub cover.

Species	Cultivar or Variety	Seed Application Rate (pure live seed lbs/acre)	Planting Depth (if drilled) (Inches)
Grasses			
Sandberg bluegrass (*Poa sandbergii*)	-	2.0	0.5
Western wheatgrass (*Agropyrom smithii*)	Rosanna	2.0	0.5
Alkaligrass (*Puccinellia distans*)	Fults	3.0	0.5
Alkali sacaton (*Sporobolus airoides*)	Salado	3.0	0.5
Forbs			
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	-	1.0	0.5
Northern Sweetvetch (*Hedysarum boreale*)	-	1.0	0.5
Shrubs			
Spiny hopsage (*Grayia spinosa*)	-	1.0	0.5
Winterfat (*Ceratoides lanata*)	-	1.0	0.5
Gardner saltbush (*Atriplex gardneri*)	-	1.0	0.5
Black greasewood (*Sarcobatus vermiculatus*)	-	1.0	0.5
Total		**16.0**	

5 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

Table E-6. Seed mixture[6] # 5 – barrens/badlands cover.

Species	Cultivar or Variety	Seed Application Rate (pure live seed lbs/acre)	Planting Depth (if drilled) (inches)
Grasses			
Sheep fescue (*Festuca ovina*)	Covar	3.0	0.5
Bottlebrush squirreltail (*Sitanion hystrix*)	-	3.0	0.5
Alkali sacaton (*Sporobolus airoides*)	Salado	3.0	0.5
Forbs			
Gooseberryleaf globemallow (*Sphaeralcea grossulariaefolia*)	-	1.0	0.5
Northern sweetvetch (*Hedysarum boreale*)	-	1.0	0.5
Shrubs			
Spiny hopsage (*Grayia spinosa*)	-	1.0	0.5
Winterfat (*Ceratoides lanata*)	-	1.0	0.5
Gardner saltbush (*Atriplex gardneri*)	-	1.0	0.5
Total		**14.0**	

6 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

Table E-7. Seed mixture[7] #6 – wet meadow cover.

Species	Cultivar or Variety	Seed Application Rate (pure live seed lbs/acre)	Planting Depth (if drilled) (inches)
Grasses			
Nebraska sedge (*Carex nebrascensis*)	-	2.0	0.5
Redtop (*Agrostis stolonifera*)	-	2.0	0.5
Bluejoint reedgrass (*Calamagrostis canadensis*)	Sourdough	2.0	0.25
Tufted hairgrass (*Deschampsia cespitosa*)	-	4.0	0.25
Forbs			
Northern sweetvetch (*Hedysarum boreale*)	-	2.0	0.5
Blue-leaf aster (*Aster glaucodes*)	-	1.0	0.5
Golden banner (*Thermopsis montanus*)	-	2.0	0.5
Total		**15.0**	

7 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

Table E-8. Seed mixture[8] #7 – riparian forest and shrub cover.

Species	Cultivar or Variety	Seed Application Rate (pure live seed lbs/acre)	Planting Depth (if drilled) (inches)
Grasses			
Nebraska sedge (*Carex nebrascensis*)	-	2.0	0.5
Redtop (*Agrostis stolonifera*)	-	2.0	0.5
Bluejoint reedgrass (*Calamagrostis canadensis*)	Sourdough	2.0	0.25
Tufted hairgrass (*Deschampsia cespitosa*)	-	4.0	0.25
Forbs			
Northern sweetvetch (*Hedysarum boreale*)	-	2.0	0.5
Blue-leaf aster (*Aster glaucodes*)	-	1.0	0.5
Golden banner (*Thermopsis montanus*)	-	2.0	0.5
Shrubs			
Golden currant (*Ribes aureum*)	-	1.0	0.5
Red osier dogwood (*Cornus stolonifera*)	-	1.0	0.5
Silver buffaloberry (*Shepherdia argentea*)	-	1.0	0.5
Woods rose (*Rosa woodsii*)	-	1.0	0.5
Total	**-**	**19.0**	

8 Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

6.3 Timing of Seeding

Seeding should be conducted in the season which allows for greatest success depending on site and weather conditions. Fall seeding could occur from about September 15 until ground freeze or snow pack prevents critical seed soil coverage. It is currently believed that the optimum time to seed a forage or cover crop in saline-alkaline soils is late fall (mid-October to December) or during a snow-free period in the winter (Majerus 1996). Ideally, in saline-alkaline soils, the seed would be in the ground before the spring season so that it can take advantage of the diluting effects of early spring moisture. Spring seeding could be completed by April 15 or as approved by the BLM. An extension to May 15 usually entails minimal risk of failure in most years. Seed would be used within 12 months of testing. The actual choice of seeding time would be based on regional climatic conditions, site-specific environmental conditions, and operator preference and experience.

6.4 Seeding Method

Drill seeding or other appropriate planting methods could be used where the terrain is accessible by equipment. The planting depth for most forage species is 1/4 inch to 1/2 inch (5-10 mm). A double disk drill equipped with depth bands, a seed agitator, and packer wheels ensure optimum seed placement. The seed would be separated by boxes to prevent separation due to size and weight. Rice hulls or other appropriate material would be added to the seed as necessary to prevent separation. The drill would be properly calibrated so that seed is distributed according to the rates specified for each seed mix. If a sagebrush/grass mix is used, it is recommended to partition the seed boxes and drill to allow the slower developing shrub seeds to be planted in separate rows from the more rapidly developing grass and forb seeds. In areas where the goal is to simulate a natural appearance, the site would be drilled in multiple, cross, overlapping patterns. This would eliminate the row crop appearance of the site.

Broadcast seeding may be used where appropriate. Broadcasted seed would occur on a rough seedbed and then would be lightly harrowed, chained, or raked to cover the seed. The seeding rate would be doubled for the recommended mixtures because the mixtures would be developed for drill seeding. The method selected to cover the seed would ensure that the seed is lightly covered but maintains the surface in rough condition. The broadcast seeder would be properly calibrated or the seeding would occur over a calculated known area so that the proper seeding rate is applied.

The Operators are strongly encouraged to consider staggered seeding methods to facilitate the establishment of shrubs and/or to revegetate areas with poor quality substrates (e.g., see Coenenberg 1982, De Puit 1982). Small seeded species (e.g., big sagebrush) establish best when the seed is broadcast and lightly covered.

Any soil disturbance that occurs outside the recommended permanent seeding season, or any bare soil left unstabilized by revegetation, would be treated as winter-construction and mulching would be considered or the site would be stabilized. Watershed protection must be emphasized when reclaiming disturbed areas. The composition of rare and native species, if encountered, would be considered at the time of seeding; however, appropriate measures would be taken to ensure that the soil surface is adequately protected. Areas not exhibiting successful revegetation throughout the entire area disturbed by the Project would be re-seeded until an adequate cover of vegetation is established. Private and agricultural lands would be seeded with similar seed mixes unless the landowner requests different mixes.

6.5 Mulching

In sensitive sites where significant erosion is most likely to occur (e.g., large areas of disturbance or areas with high erosion rates), the seeded access road/pipeline ROW, staging areas, and the portion of the well pads not needed for production purposes could be mulched following seeding to protect the soil from wind and water erosion, noxious/invasive weed invasion, and to hold the seed in place. Placing crimped straw mulch, hydromulch, biodegradable plastic netting and matting, or biodegradable erosion control blankets would protect the exposed surface of disturbed areas, including topsoil stockpiles.

All sensitive disturbed areas would be mulched immediately following seeding with 1.5 tons/acre to 2.0 tons/acre of weed-free straw mulch. Mulching materials would be free of noxious/invasive weed species, as defined by state and/or county lists. Hay mulch would be applied only if cost-competitive and if crimped into the soil. Straw mulch is more desirable than hay mulch because it is generally less palatable to wild horses, wildlife, and livestock. Additionally, a hay mulch, such as smooth brome, timothy, or orchardgrass, tends to have a higher risk of introducing undesirable species. The lessee would maintain all disturbances relatively weed-free for the life of the Project through implementing a noxious/invasive plant species management program.

Wherever used, mulch would be spread uniformly so that at least 75% of the soil surface is covered. If a mulch blower is used, the straw strands would not be shredded to less than 8 inches in length to allow effective anchoring. On slopes less than 30%, straw mulch would be applied by a mechanical mulch blower at a rate of 2.0 tons/acre after seeding. The mulch would be crimped into the soil surface using a serrated disc crimper. Where broadcast straw mulch is applied on windswept slopes, biodegradable plastic netting would be staked firmly to the soil surface over the mulch, following the manufacturer's specifications. On slopes in excess of 40% or on slopes exceeding the operating capabilities of machinery, hydromulch or biodegradable erosion control blankets with seed incorporated into the netting would be applied and staked firmly to the soil surface.

Where used, hydromulch and tackifier would be applied at a rate of 1,500 lbs/acre. In general, erosion control and soil stabilization are directly related to the amount of mulch applied. Under certain conditions where degradation processes are slow (e.g., in extremely hot, cold, or dry climates), a trade-off between the degree of effectiveness of mulch and long-term degradation would be considered. In extremely dry areas where mulch degradation may be slow, mulching rates would be reduced to 1.0 ton/acre to 1.5 tons/acre. Special measures may need to be implemented in areas with sandy soils.

On steeper slopes with highly erodible, shallow, rocky soils and/or on windswept areas with loose, unconsolidated materials, the above recommended measures may not be sufficient to reduce erosion to non-significant levels. The following measure could be considered by the Operators and the BLM to stabilize such sites: incorporating a custom blend of seed into erosion control blankets. This method has proven cost-effective in many cases, with 98% of the cost being the blanket itself. The additional cost of incorporating seed into the blanket would average $1.00 to $1.50 per blanket, depending on current seed costs. In most cases, this additional cost would offset the repeated efforts of broadcast seeding, manual raking of seeds into the soil, and mobilizing a labor force. The final measure(s) to be implemented in such areas would be determined by agreement between the BLM and Operators.

7.0 FINAL RECLAMATION

Following well plugging, well sites on slopes steeper than 10% would be recontoured to blend seamlessly with the surrounding landform. To achieve final reclamation of these sites, topsoil and vegetation would be restripped from all portions of the site that were not previously contoured during interim reclamation. All disturbed areas would then be recontoured back to original contour, topsoil redistributed, and the site revegetated. Final seedbed preparation and mulching with native vegetation would follow the procedures outlined in the above sections.

In cases where the topography is relatively flat, it may be unnecessary to recontour the wellhead location at the time of final reclamation. The Operators would determine the necessity of final recontouring at the time of interim reclamation. If final recontouring would not be necessary, the Operators would set aside sufficient topsoil for final reclamation of the small unreclaimed area around the wellhead.

Since final reclamation is not expected to occur for 10 or more years, adaptive measures would be applied to limit impacts to the greatest extent possible while allowing for successful long-term reclamation of the MAA. Final reclamation requirements may be revised by BLM at the time of facility abandonment.

8.0 GRAZING MANAGEMENT

Livestock grazing would be monitored on and along all well pads, access roads, and pipeline ROWs. Should grazing negatively impact the revegetation success, measures would be taken to exclude livestock from the newly reclaimed areas. Depending on site-specific evaluations, it may be necessary to temporarily fence off certain riparian areas and wetlands to prevent excessive livestock grazing and trampling and to enhance drainage, channel bank stabilization, and overall revegetation success. Existing livestock control structures, such as fences and cattle guards, would be maintained in functional condition during all phases of the Project. Where access requires disrupting an existing fence, a cattle guard would be installed at the junction.

9.0 OFF-HIGHWAY VEHICLE MANAGEMENT

Off-highway vehicle (OHV) control measures would be installed and maintained following the completion of seeding. Examples of measures include a locking, heavy steel gate with fencing extending a reasonable distance to prevent bypassing the gate, with appropriate signs posted; a slash; a pipe barrier; a line of boulders; or signs posted at all access points at intervals not to exceed 2,000 feet indicating "Reclamation Area, No Motorized Vehicles Beyond This Point."

10.0 DUST ABATEMENT

Should fugitive dust created during construction of well pads, access road/pipeline ROWs, or staging areas become a problem, dust abatement measures would be implemented. Dust abatement using produced water would comply with all applicable WOGCC, WDEQ, or BLM requirements. Only water suitable for livestock use would be used for dust abatement, and only disturbed areas would be sprayed. Spraying would be conducted in a manner that would reduce runoff and channeled flow.

11.0 RECLAMATION STANDARDS

The following reclamation standards are based on the Wyoming Interim Reclamation Policy (BLM 2007). The standards are to be used as a guideline to determine whether a reclamation effort is successful and whether the reclamation liability (i.e., bonds) would be released.

- There shall be no contaminated materials remaining at or near the surface. All buried undesirable materials shall be physically isolated, using proven methods, for long-term stabilization, consistent with state and other federal regulations.
- The subsurface shall be properly stabilized, holes and underground workings (wells, etc.) properly plugged, and subsurface integrity and long-term stability ensured.
- The final reclaimed area shall be stable and exhibit none of the following characteristics:
    - Unnaturally large rills or gullies;
    - Perceptible soil movement, mass wasting, or head cutting on disturbed slopes;
    - Slope instability adjacent to the reclaimed area;

- Drainages showing signs of active down cutting or deposition; and

- The overall landscape contour shall be appropriate and useable for the planned post reclamation land use.
- The soil surface must be stable and have adequate surface roughness to reduce run-off and capture rainfall and snow melt. Additional short-term measures, (such as applying mulch or mechanical surface roughening), shall be used to limit surface soil movement.
- Vegetation production and relative species diversity shall approximate the surrounding undisturbed area. The vegetation shall stabilize the site and support the planned post-disturbance land use, provide for natural plant community succession and development, be self-perpetuating, and be free of noxious weeds. This shall be demonstrated by:
- Successful onsite establishment of desirable native species.
- Evidence of desirable vegetation reproduction, either spreading by rhizomatous species or seed production.
- Generally, native species shall be used in all revegetation efforts. However, BLM Manual 1745 describes those situations where non-natives may be substituted (cite).
- Integration with the adjacent undisturbed vegetation and compatibility with the post disturbance land use.
- The reclaimed landscape shall blend with the visual composition and characteristics of the adjacent area and not result in a change of the Scenic Quality Rating of the existing landscape. Overall location, landform, scale, shape, color, or orientation of major landscape features must be considered and meet the needs of the planned post disturbance land use.
- The proponent shall conduct routine monitoring during and following reclamation activities. This is further outlined in subsequent sections of this plan.

11.1 Specific Performance Standards

The following performance standards would be followed to attain successful revegetation.

Initial (Temporary) Reclamation:

- Protective cover - With the exception of drill rig pad and reserve pit, all disturbed areas that are left bare, unprotected, or un-reclaimed for more than 1 month would have at least a 50% cover of protective material in the form of mulch, matting, or vegetative growth. This includes designated equipment parking areas. All disturbed areas would have at least a 50% cover of protective material within 6 months after reclamation.

Short-term (Interim) Reclamation:

- Seedling density - The density and abundance of desirable species is at least three to four seedlings per linear foot of drill row (if drilled) or transect (if broadcast).
- Permanent photo points would be established so that repeatable measurements can be conducted annually through the 3-year monitoring period.
- Percent cover - Total vegetative cover would be at least 80% of pre-disturbance vegetation cover, as visually interpreted for establishing baseline conditions. This is required to achieve successful interim reclamation.

Long-Term (Final) Reclamation:

- Percent cover - Total vegetal cover would be at least 80% of pre-disturbance vegetative cover, as measured along the reference transect for establishing baseline conditions.

- Dominant species - At least 90% of the revegetation consists of species included in the seed mix and/or occurs in the surrounding natural vegetation, or as deemed desirable by the BLM, as measured along the reference transect for establishing baseline conditions.
- Erosion condition/soil surface factor - Erosion condition of the reclaimed areas is equal to or in better condition than that measured for the reference transect for establishing baseline conditions.

11.2 Reclamation Performance Monitoring

Successful reclamation and revegetation cannot always be ensured. Performance monitoring is required to evaluate the temporal condition of the effort, to determine the potential for success, and to determine if remediation is required. A designated official or responsible party would annually inspect and review the condition of all well pads, access road/pipeline ROWs, and any other disturbed areas associated with the Project. This official would assess the success and effectiveness of all runoff and erosion control and revegetation efforts, evaluate fugitive dust control needs, and recommend remediation measures, if necessary. Photographs would be taken at well pad sites and along access roads at specific areas each year to document the progress of the reclamation program at established photo-monitoring points. Each photo-point location would be recorded using Global Positioning System (GPS) technology, and the location would be recorded as Universal Transverse Mecator (UTM) coordinates using the CONUS NAD27 map datum. The UTM coordinates of each photo-point would be displayed and specifically identified on a GIS-generated topographic map of the area and made available to the Operators and BLM on an annual basis to reflect changes as the Project develops.

The following specific items would be evaluated during the monitoring process:

- Revegetation progress;
- Evidence of sheet and rill erosion, gullies, slumping, and subsidence;
- Soundness and effectiveness of erosion control measures;
- Sediment filtering devices along all active ephemeral and intermittent drainage channels;
- Water quality and quantity;
- Noxious/invasive weed species invasion and establishment;
- Degree of rodent damage on seed and seedlings;
- Locations of unauthorized OHV access;
- Soundness and effectiveness of OHV control structures;
- Degree of livestock grazing and wildlife browsing; and
- Overgrazing/trampling of riparian and wetland areas.

The Operators commit to monitor interim and final reclamation operations by performing inspections using an independent third party contractor. The objective is to provide a uniform performance-based evaluation of reclamation efforts and success across the Moxa area, regardless of surface ownership or lease operator. Reclamation performance assessment methodology will be based upon requirements of both the KFO and the State of Wyoming. The contractor would visit all Moxa locations to document the progress of interim and final reclamation efforts; providing location/lease/operator data to the agencies in GIS format.

The Operators would provide funding for inspection and enforcement to augment and provide assistance to KFO inspection and enforcement personnel if determined necessary by the KFO. The need for funding and KFO support would be re-evaluated annually by the KFO and the Operators, concurrent with receipt of the annual reclamation monitoring progress report. The Operators would agree on method to provide funding for the activities contemplated on a yearly basis. The Operators would select a lead party to handle the billing process and to provide supervision of the third party contractors, professionals and specialists. The Operators would meet annually in the fourth quarter to approve a budget and selection of the personnel required herein.

11.3 Reclamation Success Monitoring Specifics

Reclamation success would be based on the objectives specified in this plan; therefore, monitoring would be tied to these objectives. The actual monitoring procedures for quantitative and qualitative evaluations of reclamation success would be implemented as specified by the BLM or other authorizing agencies.

Reclamation success would be monitored both in the short term (interim reclamation) and in the long term (final reclamation). Monitoring short-term and long-term reclamation measures would include visual observations of soil stability and condition, effectiveness of runoff and erosion control measures, and a quantitative and qualitative evaluation of revegetation success, where appropriate. Long-term reclamation monitoring would include visual observations of soil stability, condition of the effectiveness of mulching and runoff and erosion control measures, and a quantitative and qualitative evaluation of revegetation success.

Revegetation success would be determined by the BLM. In general, reclamation success would include the following qualitative and quantitative vegetation parameters:

- Percent of vegetation cover,
- Percent of total ground cover,
- Density of shrub and sub-shrub species,
- Arial extent of shrub mosaics, and
- Species diversity and species composition.

Below-normal annual precipitation for an extended time during the initial 5-year monitoring period may prevent these goals from being realized and would be documented and accounted for. Initial failure of revegetation would result in the need for additional attempts to achieve the necessary success.

The pre-disturbance values of these parameters, estimated from the vegetation types actually affected by energy-related disturbances and/or from other undisturbed portions of the same type, which represent the affected vegetation types, are used to generate the post-disturbance, long-term revegetation success goals. The baseline vegetation inventory would generate a single quantitative or qualitative value for each vegetation type and its representative reference transect. Each quantitative and qualitative goal would be clearly presented in the final reclamation plan agreed to by the Operators and the BLM.

Soil stability would be measured using an erosion condition class/soil surface factor rating method to numerically rate soil movement, surface litter, surface rock, pedestalling, flow patterns, and rill or gully formation. Information obtained through this rating system represents an expression of current erosion activity and can be used to reflect revegetation success as a function of soil stability.

The access road boundaries, pipelines, and unused portions of the well pads would be monitored until attaining 80% of pre-disturbance vegetative cover within 5 years of seeding. This standard would include 90% of the vegetative cover being composed of desirable species, and the erosion condition of the reclaimed area being equal to or in better condition than pre-disturbance conditions.

The Operators would engage the services of reclamation professional/specialist to provide expertise/recommendations to the agencies and the operators. The goal would be to develop a workable written reclamation strategy specifically designed for the MAA that would be provided to the BLM and State of Wyoming. The strategy will incorporate the results of the ongoing monitoring effort and would be modified, if necessary, according to the reclamation monitoring results assessment. When monitoring results demonstrate that reclamation is being performed successfully, the strategy would be finalized as the "Moxa Area Reclamation Plan." The reclamation specialist would be responsible for:

- development of an Initial Reclamation Plan and periodic revisions, if monitoring results indicate the need to alter reclamation procedures;
- evaluation of reclamation techniques used by the mining/other industries, reclamation techniques used in other BLM Field Offices, and their applicability to oil and gas operations in MAA. The results of the evaluation would be included in the Initial Reclamation Plan; and
- determining how/if reclamation should vary in different areas of the MAA according to:
    - timing (including initiation, evaluation of results, etc.);
    - species composition, considering habitat viability, BLM cover requirements, and SWPPP requirements; and
    - best procedures for an arid environment/drought.

Offsite mitigation would be considered by the Operators if necessary and reclamation monitoring indicates poor results. The objective of offsite mitigation would be in part to improve/restore habitat in areas that would provide the most benefit to wildlife and result in the fewest conflicts with oil and gas development, as identified in the EIS analysis. The Operators need interagency commitment that any such efforts would be recognized by the BLM and State of Wyoming as actions to enhance species viability across land jurisdictions.

11.4 Reporting Requirements

Annual reports of reclamation monitoring would be submitted to BLM by the Operators at the time of submitting annual drilling plans. The BLM would review reclamation reports concurrently with annual plans to the extent practicable to allow for effective management of the MAA.

The third party contractor would develop quantifiable documentation to submit to the BLM and State (agencies) on a quarterly (TBD) basis; and provide annual summary "progress" reports to the Operators to track reclamation effectiveness.

12.0 RELEASE OF BONDS

If the well and associated facilities are covered by an individual lease bond, the period of liability on that bond can be terminated once the final abandonment has been approved. The Operators can request termination of the period of liability from the BLM State Office holding the bond. If the well is covered by a statewide or nationwide bond, terminating the period of liability of these bonds is not approved until final abandonment of all activities conducted under the bond have been approved. The Operators may request termination of the bond on the Final Abandonment Notice.

APPENDIX F. CULTURAL AND HISTORICAL RESOURCES TECHNICAL SUPPORT DOCUMENT

1.0 BENCHMARK SITES

The Class I Regional Overview (Bureau of Land Management [BLM] 2004) identifies and summarizes, by period of significance, the sampling of benchmark sites that have been confirmed in the Moxa Arch Area (MAA) of southwestern Wyoming (Project Area). As a baseline and sampling, these benchmark sites are not meant to capture the entire population of area sites that have substantially contributed knowledge of area prehistory and history. Benchmark sites represent the periods and phases that they help to culturally and chronologically define within the region.

Numerous significant archaeological sites from all Prehistoric periods and nationally significant historic sites have been recorded in the MAA. The Class I Regional Overview describes sites that have established the baseline and furthered the direction of regional investigations as 'benchmark' sites:

> Dozens of benchmark prehistoric sites have been scientifically studied [in the Green River Basin], most significantly including Austin Wash, Church Butte Four, Cow Hollow Creek, Dixie Cup, Disney, Fontenelle Twelve, Gemma, Hams Fork, MAK, Moxa Twenty-eight, Moxa Housepit, Old-and-in–the-way, Porter Hollow, Sevenmile Wash, Shute Creek Plant, Taliaferro and Vegan sites. Nationally significant historic resources also pass through this area, including the Oregon, California, Mormon, and Pony Express Trails and most of their variants, the Union Pacific Transcontinental Railroad and the Oregon Short Line Railroad, and the Lincoln Highway. Regionally significant routes also lie partially within the subregion, including the Opal Wagon Road and a small portion of the Bryan to South Pass City Road (BLM 2004:147).

Benchmark archaeological sites in the MAA represent the prehistoric era from the Paleoindian period; the Early Archaic period, Great Divide and Opal phases; the Late Archaic period, Pine Spring and Deadman Wash phases; and the Late Prehistoric, Uinta and Firehole phases. As such, the MAA has produced archaeological data from significant site investigations that have contributed to the definition of regional prehistory across all periods.

Benchmark historical sites in the MAA are defined by the nationally significant transcontinental transportation corridor that crossed the Continental Divide throughout the historic and modern eras in Wyoming, southern Wyoming in particular. These include the Emigrant Trails and their variants, such as the Oregon/California/Mormon trail and the Blacks Fork, Hams Fork, and Slate Creek cutoffs; stage, freight, and mail routes, such as the Overland Trail and the Pony Express; railroads, such as the Union Pacific Railroad main line and the Oregon Short Line Railroad; and highways, such as the Lincoln Highway.

2.0 BENCHMARK ARCHAEOLOGICAL SITES

Benchmark archaeological sites are primarily represented by prehistoric components in the MAA. No Protohistoric or Historic period Native American archaeological sites have been specifically identified. Archaeological sites are described below in chronological order by period of significance.

2.1 Paleoindian Period

Five Paleoindian period sites are established in the MAA. These include sites 48LN373, 48LN1658, 48LN2287, 48SW6911, and 48UT401. The Class I Regional Overview (BLM 2004) describes these sites as follows:

> The Shute Creek Plant site (48LN373) was first recorded in 1982 during the Belco Cow Hollow Unit #202 Well Pad and Access Road, Class III Cultural Resource Inventory. This site is described as an immense quarry that also features intact subsurface features and stratigraphy (Wheeler et al. 1986). Features were dated from 8,980+/-130 to 770+/-50 years ago [other components date to the Deadman Wash Phase of the Late Archaic period]. Confusion surrounds the interpretation and boundaries of this site, although it is understood that portions of this site are located within the Shute Creek Lithic Landscape. The Shute Creek Plant site is considered to be somewhat significant to the study of regional prehistory (Wyoming SHPO 2004c). (BLM 2004:16)
>
> Site 48LN1658 was identified in 1985 during the Exxon USA, LaBarge to Shute Creek Sourgas feed trunkline (85-WWC-6d) project (Miller and Bower 1986). This occupation consists of three buried hearth features, charcoal stained soils, bone, lithic debitage, and fire-cracked rock. The buried items were exposed during trenching operations. A single hearth was dated to 9,530+/-300 years BP. Artifacts observed in surface contexts included flakes and fire-cracked rock (BLM 2004:16).
>
> The Sevenmile Wash site (48LN2287) was first surveyed during the Amoco Production Company Whiskey Buttes Well Pad #55 survey in 1990. The site was described as an occupation site, possibly dating to the Paleoindian Period (Berrigan and Jess 1991). It included lithic scatters, assorted lithic tools, and hearth features. This site was considered significant because of the presence of good site conditions, early Paleoindian Period diagnostic artifacts [Goshen complex], and the probability of intact cultural deposits. Additionally, Paleoindian Period sites such as the Sevenmile Wash site are extremely rare west of the Green River (Wyoming SHPO 2004c). (BLM 2004:16)
>
> The Dixie Cup site (48SW6911) was initially recorded in 1987 in preparation for the ITR Pipeline. Resurvey occurred in 1994 as part of the Legacy 20-10 pipeline and again in 1998 as part of the Mountain Gas Resources 16" Loop Pipeline. During excavation three hearths dating to the Paleoindian [7,130±70 BP] and Archaic Periods [6,460±80 BP and 5,990±80 BP] were recorded below lag gravel-bearing levels (Rood et al. 1992). Additionally, fire-cracked rock, lithic debitage, and tool fragments were observed. Due to the existence of buried artifact-bearing deposits, this site was recommended as eligible for the NRHP (Wyoming SHPO 2004c). (BLM 2004:16-17)
>
> The Porter Hollow site (48UT401) is a multi-component site with Paleoindian [10,090±120 BP], Late Archaic [2,400±80 and 2,200±80 BP] and Late Prehistoric occupations. It was excavated in 1980 in preparation for a MAPCO project. Excavations have indicated that the site was used for tool manufacture and limited bison and antelope processing activities (Hoefer 1987). Site components remain intact and buried (Wyoming SHPO 2004c). (BLM 2004:17)

2.2 Archaic Period

The Class I Regional Overview (BLM 2004) identifies 17 sites with sufficiently confirmed Archaic period components within the MAA. These include Early Archaic period site components (48LN127, 48LN616, 48LN1296, 48LN1334, 48LN1404, 48SW7226, 48UT370, and 48UT1241), two Late Archaic period site components (48LN919 and 48SW1612), and seven sites with multiple Archaic period components (48LN373, 48LN1185, 48LN1468, 48LN1738, 48LN2450, 48SW1242, and 48UT199). Of these, 19 benchmark site investigations are described, encompassing 14 Early Archaic period and 5 Late Archaic components.

Nine of the Early Archaic period sites are from the Opal Phase (48LN127, 48LN616, 48LN1334, 48LN1404, 48LN1468, 48LN1738, 48LN2450, 48SW7226, and 48UT1241); one is from the Great Divide Phase (48UT370); and five are multi-component Archaic period sites (48LN1296, 48LN1738, 48SW1242, 48UT199, and 48UT1185), including from the Opal and Pine Spring phases of the Archaic period. The Class I Regional Overview (BLM 2004) describes these sections as follows:

> The Cow Hollow Creek site (48LN127) is a sizeable multi-component campsite initially excavated in the late 1970s and early 1980s (Van Essen et al. 1982). Site dates range from possibly as early as 5,000 BP (Early Archaic [Opal Phase]) to 1,400/900 BP (Late Prehistoric). This site includes hearth features, lithic scatters, stone tools, projectile points and ground stone (BLM 2004:24).
>
> The Moxa Housepit site (48LN616) was surveyed numerous times between 1980 and 1999 with mixed results. Initially, the site was noted to be an expansive, disturbed, lithic scatter. A house pit (the only such feature recorded in the Moxa Arch Gas Field) and associated features were recorded later. Radiocarbon dates from the site date to 5,790+/-50 BP [Early Archaic, Opal Phase.] A house pit feature is rare in southwestern Wyoming, and the site may hold potential to address research questions pertaining to subsistence, settlement and mobility (Wyoming SHPO 2004c). (BLM 2004:23)
>
> The Old and in the Way site (48LN1296) was initially surveyed in 1984 as part of the Exxon LaBarge Project Rail Spur and Access Road. The site is described as an Early Archaic through Late Prehistoric Period occupation site with a quarry component and a Historic Period sheepherder refuse scatter (Wheeler et al. 1986). The site is composed of a variably dense scattering of lithics and diagnostic tools, ground stone, ceramics and a light scattering of fire-cracked rock (Wyoming SHPO 2004c). Two burials were also recorded at this site (Wheeler et al. 1986:172-174). (BLM 2004:18)
>
> Site 48LN1334 was identified in 1983 during the Exxon Air Quality Monitoring Station project. This site was interpreted as an occupation site with a quarry and other activity areas. Lithic debitage, gravers, scrapers, fleshers, hammerstones and other tools were observed along with a single hearth feature (Wheeler et al. 1986). The site was well preserved… (Wyoming SHPO 2004c). (BLM 2004:24)
>
> Site 48LN1404 was initially identified in 1984 during the Exxon-Shute Creek Plant North-South Access project. This site was surveyed a second time during the Class III Cultural Resource Inventory of the proposed Farson Road No. 2-13 lateral pipeline project in 1994. It was described as consisting of three hearth features, fire-cracked rock, and lithic scatters. Some site features and artifacts were located in surface contexts, while others were observed eroding from dunes. Testing located a buried component with a date of 5,480+/-80 years BP [Early Archaic period, Opal Phase]. Subsurface investigations revealed eight more hearth features, fire-cracked rock, burned bone, broken bone and lithic scatters (Wheeler et al. 1986). Tools

recovered included: bifaces, flake tools, a knife and five projectile points. Postexcavation monitoring activities uncovered ten additional features (BLM 2004:24).

The Taliaferro site (48LN1468) was initially identified and partially excavated during a site inventory of the ExxonFeed Gas Pipeline in 1984. It was considered eligible for the NRHP following excavation and analysis. Since avoidance could not be accomplished, this site was excavated as part of the Exxon Company, USA, LaBarge Natural Gas Project in 1985. Eight occupation components dated between [the Early Archaic, Opal Phase] 5,290 and [the Late Prehistoric, Uinta Phase] 960 years BP (Smith and Creasman 1988). Diagnostic projectile points excavated from discrete cultural deposits at this site have refined the southwestern Wyoming cultural chronology. This excavation revealed the utility of large scale excavation with regard to data collection, and added a great deal of information to the southwestern Wyoming archeological record. Since much remains buried and possibly intact at the Taliaferro site, the site continues to be considered eligible for the NRHP (Wyoming SHPO 2004c). (BLM 2004:23)

Site 48LN1738 was initially recorded in 1987 during the Mountain Fuel Resources Shute Creek Pipeline project. In 1994, the site was re-surveyed during procedures involved with the Williams Field Services Bannon Cow Hollow 59 Pipeline. This site was described as an [Early Archaic, Opal Phase to Late Archaic, Pine Spring Phase] occupation site with lithic scatters, two projectile points, fire-cracked rock, burned sage, and charcoal [5,410 BP and 3,920±90 BP radiocarbon dates] (Hoefer and Darlington 1991). Subsurface testing indicated that buried horizons may contain cultural material (BLM 2004:25).

The Hams Fork site (48LN2450) was recorded in 1992 as part of the UPRC Kern River Tie-in to the Overland Trail Pipeline Class III site inventory. Surface and subsurface features and artifact scatters were recorded during pedestrian and subsurface investigations. Site dating is confused – possibly three site components have been dated. The oldest component dates to the Early Archaic Period, Opal phase or to the Late Archaic Period, Pine Spring phase at 3280+/-70 years BP, while the second dates to the Protohistoric Period. The existence of a third component that dates to the Historic Period remains a possibility (McKern 1996). Site activities included lithic tool maintenance or manufacture and food processing. The site has been interpreted as being a long term base camp based on its location on a terrace of the Hams Fork River. This site has been recommended as eligible for the NRHP due to its intact, buried features that may contribute to regional chronological and settlement and subsistence pattern studies (Wyoming SHPO 2004c) (BLM 2004:24).

The Fontenelle Twelve site (48SW1242) was surveyed in preparation for construction of the Amoco State of Wyoming AI Well & Access (Project# 1AC 89-WY-175) in 1986 (Hoefer 1986), and again 1993 as part of the Class III Inventory for the Williams Field Services State of Wyoming AI #2 pipeline... This is a Middle [Plains] Archaic [Opal Phase based on projectile point types and Pine Spring Phase, 3,000 to 4,200 BP from geomorphologic analysis] to Late Prehistoric [800 to 2,000 BP from geomorphologic analysis and 1,350±70 BP radiocarbon dated] occupation site which has been disturbed and was initially considered ineligible for the NRHP. Some intact components remain, so the site was later recommended as eligible for the NRHP. Lithic debitage, tools, ground stone, fire-cracked rock, a large number of hearth features, and rich quarry areas surround the site (Wyoming SHPO 2004c).

> Site 48SW7226 was first recorded in 1988 as part of the Questar Shute Creek Pipeline (88-WWC-45). The site consisted of five buried hearth features (Hoefer and Darlington 1991). One hearth was dated to [the Early Archaic Period, Opal Phase] 4,900+/-70 years BP. Very little fire-cracked rock was observed. No artifacts or features were recovered from surface contexts (BLM 2004:25).
>
> The Church Butte Four site (48UT199) was initially investigated by the University of Utah and others prior to 1979. It was officially recorded during the Trailblazer Pipeline Project. In the past 25 years, this site has been investigated and tested a number of times in preparation for various energy and fiber optic cable projects (Batterman and Smith 1989). Investigations have recorded Early through Middle [Plains] Archaic Period and Late Prehistoric Period occupations. These components include: lithic scatters, fire-cracked rock, bone and Late Prehistoric Period ceramics. Excavated features include: tri-hearths and stone-filled basins. The Church Butte Four site has been recommended as eligible for the NRHP due to intact subsurface deposits (BLM 2004:21).
>
> Site 48UT370 was initially recorded in 1980 during the MAPCO project (Metcalf and Anderson 1982). A second survey took place in 1982 as part of the Frontier Pipeline project. A third survey of the site took part in 1999 as part of the Williams Communications, Inc Midwest Cross Phase IIIB fiber optic cable project. Site 48UT370 was described as an occupation site where metates, manos, hearths, lithic scatters, and a fragment of a stone drill, were located in surface and subsurface deposits (Schroedl 1985). The site was dated to the Archaic Period [Great Divide Phase]… (Wyoming SHPO 2004c). (BLM 2004:22)
>
> The Moxa Twenty-Eight site (48UT1185) was recorded in 1982 and 1983 during the Amoco Moxa Arch Open Pipeline Trench Inspection (Project# ACB-82-231). This occupation site was described as three subsurface hearth features with surface components. The site included lithic scatters, stone tools, projectile points, and hearths (Hoefer and Darlington 1991; McDonald 1993). It dates from the Archaic through Late Prehistoric Periods [3,590±80 and 1,600±110 BP] (BLM 2004:21).
>
> Site 48UT1241 was initially recorded in 1987 and 1988 in association with the AT&T fiber-optic cable project (McNees 1989a). The site was rerecorded in 1993 in preparation for the US West fiber-optic cable project. Site artifacts and features included lithic and fire-cracked rock scatters, four fire-cracked rock concentrations, two lithic tool fragments, and assorted side-notched dart points. The site dates from the Early Archaic Period [Opal Phase, 5,500±100 and 5,110±90 BP]… (Wyoming SHPO 2004c). (BLM 2004:25)

Although not yet among the list of benchmark sites, preliminary results from 48LN3156 (McKern and Sines 1996; Reed et. al. 2006) suggests future Archaic-period research potential for this habitation site, contemporaneous to Middle Archaic studies for surrounding regions. Based upon McKean-complex projectile points, known for the Middle Archaic period on the Northern Plains, and identified in association with habitation features at 48LN3156, which was tested to positively contain subsurface archaeological deposits, MAA sites hold the potential for further elucidating the connection of the Early Archaic to Late Archaic transition in the Wyoming Basin in comparison to Middle Archaic traditions from neighboring regions.

In addition to the Middle Archaic period site (48LN3156), the two multi-component Opal Phase/Pine Spring Phase sites (48LN2450 and 48LN1242), and one Paleoindian/Deadman Wash Phase site (48LN373), described above, two Late Archaic period sites in MAA are from the Deadman Wash

Phase (48LN919 and 48SW1612) and another is estimated to be from the Pine Spring Phase (48SW1242). The Class I Regional Overview (BLM 2004) describes them as follows

> Site 48LN919 was initially recorded in 1981 as part of the Amoco Production Company's Cultural Resources Inventory of Shute Creek Unit #11 project. A second survey recorded this site in 1983 during the Shute Creek project. The site was rerecorded in 1984 during the Cow Hollow #1 Well Pad & Access Route Survey (IAC 84-49). The latest recording occurred in 1985 as part of the Exxon LaBarge Project Feed Gas Trunkline project (Wheeler et al. 1986; Miller and Bower 1986). The site was described as a large occupation site with lithic scatters, lithic tools, projectile points, manos, grinding slabs, ground stone, a ceramic sherd, bone and fire-cracked rock. Eroded hearth features, an intact buried hearth feature, and charcoal stains were also recorded. It was recommended as eligible for the NRHP because it contains information that may be important to an understanding of southwestern Wyoming prehistory, due to the presence of intact buried deposits and rare artifact types (Wyoming SHPO 2004c). (BLM 2004:28-29)
>
> The MAK site (48SW1612) was surveyed in 1979 as part of the Amoco Champlin 206 D-1 project. The site was resurveyed in 1981 as part of the Northwest Pipeline Corporation Amoco Champlin Federal 1-6a project. It was surveyed once again in 1988 as part of the 88-WWC-071 CIG Pipeline–Granger to Opal project. The final survey occurred in 1990 during a Presidio Oil Company-related project. This site was described as an occupation site and quarry that exhibited lithic scatters and tool assemblages. Bone was recovered as were fragments of a marine shell. A single hearth feature [from the Deadman Wash Phase, 1950±70 B.P.], possibly related to bone processing, was identified (Thompson and Pastor 1991). (BLM 2004:28)

In addition to the sites described above, a series of other sites identified along the edge of the Hams Fork River floodplain in 1979 (Lau 1981) produced additional radiocarbon dates indicating transitional or repeat occupation use of this region of the MAA from the Deadman Wash phase of the Late Archaic period into the Uinta phase of the Late Prehistoric period. Although arguably not a benchmark site or sites (Del Bene and Harrell 1994), the Wilson Ranch Road site complex (48LN541) produced seven radiocarbon dates across four site localities.

> These samples from [48LN541's] Locality 77 (assumed destroyed by 1979 excavation), Locality 71 (48LN2912), Locality 52 (48LN2902), and four from Locality 19 (48LN2888), resulted in dates ranging from 2320 B.P. to 1075 B.P. with a maximum range of error of ±130 years (Lau 1981). This places the… sites primarily in the Late Archaic period with transition into the Late Prehistoric period… Site 48LN2902 has a Late Archaic period date, consistent with the Deadman Wash phase, at 2320 B.P. ±130 years. Sites 48LN2888, 48LN2913, and Locality 77 all have dates consistent with the Uinta phase of the Late Prehistoric period at 1565 B.P. ±70 years, 1220 B.P. ±55 years, 1075 B.P. ±75 years, 1515 B.P. ±95 years, and 1460 B.P. ±75 years, respectively (with the first three dates being from 48LN2888). Additionally, 48LN2888 produced one date in transition between the Deadman Wash and Uinta phases at 1850 B.P. ±70 years (Reed et al. 2006:Appendix C).

2.3 Late Prehistoric Period

The Class I Regional Overview identifies 12 sites with sufficiently confirmed Late Prehistoric period components within the MAA: 48LN123, 48LN269/48UT122, 48LN919, 48LN1697, 48LN1813, 48LN3040, 48SW2302, 48SW3370, 48UT390, 48UT779, 48UT845, and 48UT1846. Sites

48LN269/48UT122, 48LN919, and 48UT390 are multi-component Archaic period sites, but 48LN269/48UT122 and 48UT390 are most notable for their Late Prehistoric components.

Six sites (48LN1697, 48LN1813, 48LN3040, 48SW3370, 48UT845, and 48UT1846) produced only Late Prehistoric (Uinta Phase) grayware ceramic sherds in the MAA, and have not yet had intensive testing excavation to prove that significant subsurface deposits are associated (BLM 2004:33). Of these, in addition to 48LN919 described above, five benchmark site investigations are described below (48LN123, 48LN269/48UT122, 48SW2302, 48UT390, and 48UT779):

> Site 48LN123 was first recorded in 1979 as part of the Stauffer Chemical Company's Whiskey Buttes Prairie Dog Lateral Project. A second recording occurred in 1991 as part of the NWP Lateral A-24 Pipeline project. This site was interpreted as an occupation site with buried components [apparently Firehole phase]. Trenching revealed hearth features. One large feature may be a house pit feature. Additionally, fire-cracked rock, charcoal stains and lithic scatters were located in areas that were previously disturbed by pipeline construction (BLM 2004:34).
>
> The Gemma site ([48LN269 and] 48UT122) was first recorded in 1978, but subsequent resurveys occurred in 1987 during the Mountain Fuel Resources Shute Creek Pipeline project, and in 1990 for the Northwest Pipeline A-16 Pipeline project. Site investigations recorded buried and surface site contexts with fire-cracked rock, lithic debitage, bone, egg shell, charcoal stains, and a hearth feature (Pastor et al. 1995). The [first] hearth feature was dated to 1,480+/-80 BP [Uinta phase, while a second hearth dated to 5,900 ± 80 years BP, Early Archaic, Opal phase]. [Other 1990 excavations produced single-component data elucidating Late Prehistoric period, Uinta Phase occupations of the site, averaging between 1,344 to 1,688 BP in age (Pastor 1998).] The Gemma site is believed to contain additional buried site components, and is recommended as eligible for the NRHP (BLM 2004:32).
>
> Site 48SW2302 was first recorded in 1982 during the MAPCO project (Metcalf and Anderson 1982). A subsequent investigation occurred during 1998 in preparation for the Questar Gas Management Blacks Fork Plant to the Northwest Pipeline Facility pipeline. The site was described as a Late Prehistoric Period occupation site dating from 1,345 +/-45 years BP and 1,189+/-95 years BP [Uinta phase]. The site also contained an historic component [EuroAmerican]. It includes a lithic scatter, fire-cracked rock, and an assortment of stone tools (BLM 2004:33).
>
> The Austin Wash site (48UT390) was identified and tested in 1981 during the MAPCO Pipeline Project (Metcalf and Anderson 1982), in 1982 during the Frontier Pipeline Project, in 1990 in preparation for the Halliburton Geophysical Seismic Line 15 project, in 1999 for the Williams fiberoptic cable project, and in 1999 for the PPLE project. This Late Prehistoric Period [1,070±80 BP, Uintah phase, and 3,030±70 BP, Late Archaic Period, Pine Spring phase], single-episode, antelope processing site features lithic tools, possible remnants of charcoal lenses and antelope bone. Excavation revealed the presence of postholes that may indicate the use of an antelope trap (Reese and Walker 1982; Schroedl 1985; Rood et al. 1992). Despite excavation and disturbance of half the recorded site, the Austin Wash site remains eligible for NRHP nomination because it holds research potential relating to the understanding of southwestern Wyoming prehistory (Wyoming SHPO 2004c). (BLM 2004:30)
>
> Site 48UT779 was first recorded in 1982 and 1983 as part of the Frontier Pipeline project (Schroedl 1985). [That pipeline project performed data recovery on the site,

> defining components that apparently include that of the Firehole phase.] The site was investigated again in 1987 in preparation for the AT&T fiber-optic cable project [but was not relocated]. The final investigation[s] occurred in 1993 [and 1997] during the US West fiber optic cable project [and the Eakin Ranch No. 1 Pipeline project, but were unsuccessful in relocating the site]. This site was described as a surface manifestation of an occupation site. It included fire-cracked rock, lithic scatters, and assorted tools. Initially it was recommended as eligible for the NRHP, but the later excavations were unable to relocate the site (Wyoming SHPO 2004c). (BLM 2004:34-35)

No specifically Protohistoric or Historic period Native American archaeological sites are known in the MAA. Two Protohistoric sites, 48UT1 (the Bridger Antelope Trap) and 48UT920 (the Bridger Gap Burial), are known in the Green River Basin subregion (BLM 2004:37).

3.0 BENCHMARK HISTORICAL SITES

The most significant historic sites present in the MAA are from the great westward emigration National Landmark Trails or historic transportation corridors that follow the general westward route of the Emigrant Trail system. The following is the Class I Regional Overview (BLM 2004) description of the history of historic transportation across the MAA using the Oregon/California/Mormon Trail (and their Blacks Fork, Hams Fork, and Slate Creek cutoffs), the Pony Express route, the Overland Trail, the Union Pacific Railroad main line, the Oregon Short Line Railroad, and the Lincoln Highway as benchmarks:

> Some 350,000 emigrants followed the Oregon Trail westward during the great 19th century migration to Oregon, California, and Utah… Farmers bound for the fertile valleys of Oregon, Mormons seeking religious freedom bound for the Salt Lake Valley, and adventurers bound for the California gold mines all ventured across the plains and mountains by way of the Oregon Trail. This route was also used for the first transcontinental telegraph, the federal Overland Mail service, and the Pony Express. From Independence, Missouri, to western Oregon, a wagon traveled 1,932 miles. For a journey of such magnitude, emigrants needed dependable sources of water and grass and a passable grade through the mountains. The Oregon Trail, crossing the mountains at the gentle South Pass in Wyoming, met these requirements and became the pathway of commerce, settlement, and development. All travelers followed the same "Emigrant Road" with only minor variations as far as Fort Bridger in southwestern Wyoming. Here the Mormon Trail diverged to reach the Salt Lake Valley in Utah. The California-bound travelers branched off from the main route near Fort Hall, Idaho. Although "Oregon Trail" is the name most commonly used today, emigrants who followed it simply called it "the road" (Natrona County Historic Preservation and Rosenberg Historical Consultants 2001:1). (BLM 2004:45)

Of these benchmark sites, only the Blacks Fork Cutoff and Slate Creek Cutoff trails retain known intact, integral trail segments within the MAA contributing to each site's National Register of Historic Places (NRHP) eligibility. The other transportation sites may retain NRHP-contributing portions outside of the MAA, but within the MAA their historic structures or their integral historic qualities have been substantially displaced or destroyed.

3.1 Emigrant Trail – Main Branch (48SW827/48UT261)

This main branch, or Bridger route, of the Emigrant Trail was the principal route used during the great westward migration and was used continuously from 1843 to the early twentieth century. Unfortunately, the Emigrant Trail corridor that passes through the MAA is largely not intact, disturbed by previous development. Improved roadways, transmission lines, buried cables, pipelines, and well field facilities have been built along and across the structure in this area. Much of this portion of the historic transportation routing is displaced by the recent Sweetwater County Road 2 and Road 8 and the Uinta County Road 233 structures. The Emigrant Trail segment, as known across the core MAA, has previously been considered a non-contributing portion of an otherwise eligible historic trail.

From east to west, the main branch of the Emigrant Trail enters the eastern flank of MAA along the north side of the Blacks Fork River. Across Sections 24, 23, 22, 21 (Township 19 North, Range 111 West) and crossing Highway 30 to Granger, Wyoming, the trail route is overlaid by Sweetwater County Road 8 and the Union Pacific Railroad line (48SW6357), which has destroyed the integrity of the Emigrant Trail according to Wyoming Cultural Resource Office (WYCRO) files for historic site portion 48SW827. In addition, several variants of the main branch of the Emigrant Trail are reviewed in WYCRO files where they connect between Green River crossings, at east, and the Blacks Fork River, at south-southwest. In the eastern flank of the MAA, the routings of these variants appear primarily set to maneuver around Sevenmile Wash, a north-northwestern tributary of the Blacks Fork River with confluence in Section 18, Township 19 North, Range 110 West. One trail variant intersects the eastern border of the MAA in Section 36, Township 20 North, Range 111 West, and Sections 1, 12, and 13, Township 19 North, Range 111 West, trending southward to cross Sevenmile Wash near the point of confluence. Another route crosses Sevenmile Wash upstream in Sevenmile Gulch, entering the eastern Flank of the MAA in Section 24 (Township 20 North, Range 111 West) and trending south-southwestward toward Granger, across Sections 23, 26, 27, 28, and 33 (Township 20 North, Range 111 West) and Sections 4, 5, 8, 16, 17, 18, 19, 30, 31, and 32 (Township 19 North, Range 111 West), as well as a southeastward split along an unnamed intermittent stream across Section 16 (Township 19 North, Range 111 West). These variant routes are primarily missing or overlaid by graded access roads accessing well field development around the Sevenmile Wash area. The Pony Express route (48SW6274) overlaid the Emigrant Trail from Senvenmile Wash southwestward. The Overland Trail (48SW1226) joins the Emigrant Trail on the north side of the Blacks Fork River at the east border of the MAA.

In the core of the MAA, Union Pacific Railroad and Granger development appear to have displaced the Emigrant Trail at the confluence of the Blacks Fork River and the Hams Fork River. Where the Emigrant Trail crosses the Hams Fork River and then the Blacks Fork River westward, WYCRO records indicate that the trail is non-intact and not contributing to NRHP eligibility of the National Historic Trail from Sections 32 and 31 (Township 19 North, Range 111 West) to where it is joined by Sweetwater County Road 2 and Uinta County Road 233, which parallel and overlap the Emigrant Trail corridor across the rest of the MAA. Recent WYCRO files for 48SW827 and 48UT133 documentation of the Emigrant Trail indicate it to be non-intact along county road corridors from Sections 6 and 7 (Township 18 North, Range 111 West); Sections 12, 11, 10, and 9 (Township 19 North, Range 112 West); Sections 24, 25, 26, and 35 (Township 19 North, Range 113 West); and Sections 2, 3, 10, 15, 16, 21 and 28 (Township 18 North, Range 113 West) to exit the western flank of the MAA along the Blacks Fork River. These county road corridors also represent the route of the Lincoln Highway (48SW1834/48UT255) and Old Highway 30 (48UT1633). Church Butte (48UT251) appeared as a landmark on this route for historic travelers from all eras.

Exceptions occur in sections where the Emigrant Trail remains unassessed as to whether the trail trace is intact or not. In Sections 8, 17, and 18 (Township 19 North, Range 112 West), the Emigrant Trail diverges from the county road corridor in crossing Porter Hollow. In 1992, Western Wyoming Community College addressed a segment of trail in Section 18, which has been designated as contributing to the NRHP eligibility of site 489UT261 (Western Wyoming Community College 1992); however, the 1992 documentation gave no description of the trail condition or structure at this location, so it actually remains unassessed. Additionally, where the Emigrant Trail exits the western flank of the MAA in Section 28 and 33 (Township 18 North, Range 113 West) and Section 6 (Township 17 North, Range 113 West), before it reaches the Interstate 80 corridor, it remains unassessed where it crosses private lands encompassing the Blacks Fork River plain in these sections. These unassessed portions include the Names Rock site (48UT650) in Section 33 (Township 18 North, Range 113 West).

The Emigrant Trail was designated a National Historic Trail by Congress in 1978, recognizing historic development of the Oregon Trail. The majority of segments in the core and flank of the MAA have been severely damaged by previous development, seriously impacting overall integrity. This assessment is based on the lack of any visible presence of intact trail portions by previous studies in the MAA, as well as the lack of integrity and feeling resulting from development of the area. The Emigrant Trail site has been changed sufficiently here, such that its setting and feeling no longer contribute to a historic sense of place. The corridor generally lacks visual integrity and historical associations, given infrastructure development in the vicinity (e.g., other equally prominent raised and paved roads, utility lines, buried cables, mineral wells, and pipelines).

3.2 Blacks Fork Cutoff (48LN946/48SW4196/48UT666)

The Class I Regional Overview (BLM 2004) describes the history of the Blacks Fork Cutoff trail corridor within the MAA as follows:

> The Blacks Fork Cutoff of the Oregon Trail is a poorly documented shortcut of the main Oregon Trail. The main trail headed southwesterly to Fort Bridger and then swung northwesterly before heading west out of present-day Wyoming. The Blacks Fork Cutoff proceeded due west from Granger, following a portion of the Blacks Fork and the current Lincoln-Uinta County line, bypassing Fort Bridger to close the top of an imaginary "V" formed by the main Oregon Trail. It rejoined the main trail east of Cumberland Gap. The primary evidence for this trail is the General Land Office survey plats dating to 1874… Maps drawn for the Wyoming Recreation Commission by Paul Henderson… also depict the Blacks Fork Cutoff. However, no emigrant diaries or guidebooks have been located describing this cutoff. The prominent ruts and swales along its course indicate that the Blacks Fork Cutoff received heavy usage in the past (BLM 2004:60).

In this region, the trail has generally been replaced by many improved roads within the Moxa Arch well field, which itself has infrastructure that is widely visible across the landscape surrounding the current Project Area. The Blacks Fork Cutoff has been previously determined eligible for nomination to the NRHP under Criterion A because of its association with a nationally significant event: the emigration to, and settlement of, the Western United States. However, the Bureau of Land Management (BLM) has previously determined that segments of the Blacks Fork Cutoff in the core MAA are non-contributing segments of this otherwise NRHP eligible trail site. Only fragments in the core MAA and segments departing the core MAA into the MAA flank at west, in Uinta County, still retain intact trail traces, contributing to NRHP eligibility. Determination of non-contributing portions is generally based on the lack of any visible indications of the trail at the proposed crossing and the lack of integrity and feeling caused by modern infrastructure construction and gas development in the area.

Across Lincoln County, intact trail segments (48LN946) remain in Sections 27, 28, and 30 in Township 19 North, Range 112 West, and Sections 35 and 36 in Township 19 North, Range 113 West (Retter et al. 2006). In Sweetwater County, intact trail segments (48SW4196) remain in Sections 27 and 36 in Township 19 North, Range 112 West (Retter et al. 2006). The integrity and intactness of the trail as it crosses Section 31, Township 19 North, Range 112 West, in Sweetwater County, remain unassessed eastward to where the Blacks Fork Cutoff splits from the main Emigrant Trail Route near present-day Granger, Wyoming. In Uinta County, intact trail segments (48UT666) remain in Section 4, Township 18 North, Range 113 West along the north bank of the Blacks Fork River (Frizell 1991), and appear to extend east into adjacent Section 3, where the trail remains unassessed. An intact segment of the trail appears to descend the ridge spine in the northeast corner of Section 3, Township 18 North, Range 113 West, southwestward to the Blacks Fork River floodplain, following a U.S. Geological Survey (USGS)-mapped two-track road route (Polk 1991). Where the trail exits the flank of the MAA westward along the Blacks Fork River, the trail remains unassessed through Sections 5, 6, and 7, Township 18 North, Range 113 West. The Uinta County portions of the trail are in the western flank of the MAA where the visual setting of the trail may retain integrity, while the Lincoln and Sweetwater County portions of the Blacks Fork Cutoff are in the core of the MAA, which generally has impacted visual setting.

3.3 Hams Fork Cutoff (48LN947/48SW4162)

The Class I Regional Overview (BLM 2004) describes the history of the Hams Fork Cutoff trail corridor within the MAA as follows:

> This poorly documented cutoff was a well-watered route that diverged from the main Oregon Trail at Granger and followed the Hams Fork upstream in a northwesterly direction to the Sublette Cutoff, north of today's Kemmerer, bypassing Fort Bridger. Today most of this route is paralleled by U.S. Route 30 between Granger and Kemmerer. The Oregon Shortline Railroad was built along this same route in 1881 and 1882. Portions of the Hams Fork Cutoff are depicted on 1874 General Land Office plats. It is also associated with the Trappers' Rendezvous of 1834, which was held along Hams Fork, and the Mormon War of 1857-58. Several government expeditions of the U.S. Geological Survey also used portions of the route in the 1870s (BLM 2004:59).

A review of previous investigations and background research is available from previous investigations, such as the Preliminary Management Recommendations for the Hams Fork Cutoff, Site 48LN947, and the Oregon Short Line Railroad, Site 48LN2327, in the Proposed Hams Fork 3-D Geophysical Exploration Project Area, Lincoln County, Wyoming (Phillips 2004). That account notes that the Hams Fork Cutoff does not retain any identifiable portions other than at its northwest junction with the Sublette Cutoff Trail (48LN225). All other tracks previously investigated appear to be later roads or two-track developments unrelated to the Hams Fork Cutoff, mostly appearing after 1882 and after the Oregon Short Line Railroad was developed. These later roads and two-tracks do not tend to appear on GLO plat maps from 1904 and earlier. Previous recordings of the Hams Fork Cutoff indicate that the roads appearing on 1874, 1882, and 1904 plats along the Hams Fork River Valley have largely been displaced by railroad development, highway development, county road development, ditch development, hay field development, and general fluvial action of the Hams Fork River. Based on these observations, this portion of the site contains no integrity. However, lack of trail structure may not preclude the future discovery of archaeological sites associated with the trail route, such as 1834 Rendezvous campsites, 1857 Mormon campaign sites, or even the Hams Fork Station site (48SW939) at the confluence of the Hams Fork and Blacks Fork Rivers.

The overall Hams Fork Cutoff Trail has been determined eligible for listing on the NRHP under Criteria A and B. However, those portions in the MAA, and along the Hams Fork River between Granger and Kemmerer and beyond, have been previously considered non-contributing portions of this otherwise eligible property. BLM and SHPO have previously concurred with this recommendation. The setting of the Hams Fork Trail corridor has been humanly or naturally altered from its historic state, leaving no evidence of the historic trail (Phillips 2004; Tanner 2004). Previous records and the 2001-2002 BLM aerial fly-over of the corridor also resulted in no identifications of trail segments in this area. Thus, several efforts have determined that no physical remains of the Hams Fork Cutoff are present in this area (Tanner 2004). Because of the lack of physical integrity, the Hams Fork Cutoff no longer retains its original association with significant historic events, other than general use of the travel corridor (Tanner 2004). Additionally, because the trail no longer retains integrity of location, the historic setting is no longer relevant or deserving of consideration, regardless of the quality of the surrounding landscape (Tanner 2004). Furthermore, no visual horizon protection is considered relevant or necessary.

3.4 Slate Creek Cutoff (48LN948)

The Class I Regional Overview (BLM 2004) describes the history of the Slate Creek Cutoff trail corridor within the MAA as follows:

> The Slate Creek Cutoff or Trail was one of the southerly shortcuts of the Sublette Cutoff of the Oregon Trail located between the Big Sandy River on the east and the Green River on the west. Many 19th century emigrants chose these shortcuts to avoid the almost 50-mile desert crossing of the Sublette Cutoff to the north. The Kinney Cutoff, the Baker and Davis Road, and the Mormon Road, shortcuts on the east side of the Green River, converged into one trail on the west side of the river. The Slate Creek Cutoff followed the Slate Creek drainages, then joined the main Sublette Cutoff on Slate Creek Ridge north of Kemmerer. The Slate Creek Cutoff was utilized mostly between 1852 and 1859, when the Lander Cutoff diverted much of the emigrant traffic. Emigrant diaries from the 1852 and 1853 seasons invariably used the general term Kinney Cutoff to describe all the southern shortcuts located in the triangle of land formed by the confluence of the Big Sandy and Green rivers. The names “Baker and Davis Road” and the “Mormon Road” (trails on the east side of the Green River) appear to have come into use after 1853 (BLM 2004:58).
>
> The Slate Creek Cutoff diverged from Big Timber Station on the main Oregon Trail. Emigrants followed the more northerly Baker and Davis Road or the more southerly trails variously known as the East Bank Kinney (Slate Creek Cutoff) or the Mormon Road (West Bank Kinney). These trails crossed rolling sagebrush country, reaching the Green River and crossing via one of several ferries. The various alternates generally converged at the Green River into the main Slate Creek Cutoff, which turned south to the Slate Creek drainage, then followed westward. Emigrants generally made camp about 10 miles west of the Green River; it was another 10 miles to Emigrant Springs, then 3 miles to the junction of the Slate Creek Cutoff and the main Sublette Cutoff. These distances are generally agreed upon by trail diaries.
>
> General Land Office plats dated 1892 clearly show trails labeled “Road from Slate Creek Ferry to Opal” running east-west on both the north and south sides of Slate Creek. By the early 1890s, more than 30 years had passed since the Slate Creek Cutoff was used as an emigrant route, and the area was being settled by ranchers dependent on Opal, the nearest railhead to the south (Rosenberg 1990a:2-13; 1995: 7-8). (BLM 2004:58)

The MAA contains the main Slate Creek Cutoff from its Green River crossing, near Fontenelle, westward to Highway 189 and paralleling Highway 372. It was first recorded on the ground in the Project Area in 1984 during the Exxon LaBarge Trunkline project. It was found to be a two-track road generally following the Slate Creek drainage, marked by historic trail monument posts and labeled “Emigrant Trail” on contemporary USGS topographic maps. At that time, the trail was noted to already be impacted by existing area pipelines and road use. That same year the Slate Creek Cutoff was described in *Overland Journal* (Decker 1984). Based on previous records, from near the Fontenelle town site approximately 1.5 miles westward to Slate Creek Butte, the trail is fairly displaced by improved road, powerline, and other modern developments. From Slate Creek Butte west to Highway 189, the trail has intact segments variously retained and still used as two-track roads along Slate Creek and fading, eroded disused portions that are still visible.

In 1995, Robert Rosenberg noted intact portions, contributing to site NRHP eligibility, to occur for 3,300 feet across Section 11 (T23N, R112W), which experiences some erosion and an overhead powerline, but had no mineral field intrusions at the time; the 7,100-ft portion trending northeastward from Section 11 into Section 1 (T23N, R112W) was documented as non-contributing due to obliteration (gravel pit at the Green River) and the presence of powerlines, a relay tower, and a paralleling, non-trail roadway from a buried utility line (Rosenberg 1995a).

Also in 1995, Elizabeth Rosenberg investigated the trail route eastward from Section 11 through Section 7 (T23N, R112W) and Section 13 (T23N, R113W) across the MAA, including all possible variations. She found a 5,280-foot-long contributing segment in Section 11; 7,920 feet spanning Section 15 and 16; and an 11,760-foot segment beginning in Section 17 (T23N, R112W) and continuing through Section 13 (T23N, R113W) and beyond, westward (Rosenberg 1995b). These were interspersed with non-contributing portions, due to map inaccuracies, erosion, intervening non-trail roadways, pipeline corridors, fence line corridors, and similar interruptions.

The Slate Creek Cutoff appears to retain more intact trail portions than other Emigrant Trail variants across the MAA; although, it too is segmented and affected by surrounding infrastructure development and natural weathering. In this region, the trail appears alternately intact and replaced by many improved roads within the Moxa Arch well field, which itself contributes to the infrastructure that is widely visible across the landscape surrounding the current Project Area. The Slate Creek Cutoff has been previously determined eligible for nomination to the NRHP under Criterion A because of its association with a nationally significant event: the emigration to, and settlement of, the Western United States. Various segments within the core MAA, in Lincoln County, still retain integrity. Determination of non-contributing portions is generally based on the lack of any visible indications of the trail at the proposed crossing and the lack of integrity and feeling caused by modern infrastructure construction and gas development in the area.

3.5 Overland Trail (48SW1226/48UT261)

The Class I Regional Overview (BLM 2004) describes the history of the Overland Trail corridor within the MAA as follows:

> The western end of the Overland Trail is located in the Kemmerer Planning Area. The history of the Overland Trail overlaps and postdates that of the early westward migration on the Oregon/Mormon Pioneer Trail [48UT261]. It was one of the major transportation routes in the Trans-Mississippi West between 1862 and 1869… The value of this route as an emigrant road was first officially recognized in 1850 by Captain Howard Stansbury of the Corps of Topographical Engineers… The route was first known as the Cherokee Trail and was used by the Evans party in 1849 bound for the California gold fields…
>
> This new route continued to be used by an unknown number of emigrant parties, as well as several military expeditions… But it was overland mail service that brought this route into prominence. Until the Civil War, overland mail had been transported on a southern route through Texas, Arizona, and New Mexico. With the onset of the war, a more northern route was encouraged, and in 1862 the southern route was discontinued in favor of an unspecified central route. Alternate routes were proposed, including one through Denver, but ultimately the mail was carried over the established Oregon Trail (Hafen 1926:92-93, 213-222; Root and Connelley 1901:41).

> On July 21, 1862, mail service began on the new line [provided by Ben Holladay's stage line], which was called the Overland Stage Line, and the route became known as the Overland Trail (Hafen 1926:232). The route diverged from the Oregon Trail near today's North Platte, Nebraska, swung through northeast Colorado and back north into southern Wyoming. It continued westward, generally paralleling the Oregon Trail to the south and rejoining that trail near the east boundary of the Kemmerer Planning Area. Stage stations were established at 10 to 12- or 15-mile intervals, and a telegraph line was constructed to connect many of the stations… Hams Fork or South Bend Station and Lone Tree Station were the only stops located in Kemmerer Planning Area (Rosenberg 1981:7). (BLM 2004:61-63)

In Sweetwater County, within the BLM Kemmerer Field Office area, the Overland Trail tends to lack integrity. In the MAA, the site is primarily represented by a bladed, crowned, ditched, and graveled county road (Sweetwater County Road 2/Uinta County Road 233), which is used as a major off-Interstate access road between Granger and Church Butte. These later road developments between Granger and Lyman, Wyoming, include overlap of the Overland Trail route with portions of the Emigrant Trail site (48SWUT261) and the historic Lincoln Highway (48SW1834/48UT255). Church Butte (48UT251) served as a historic landmark and a Church Butte stage station (48UT643) and Granger stage station (48SW939) historically served the Overland Trail in the MAA.

No historic integrity or evidence of the original historic transportation structures remain. Additionally, transmission lines, buried cables, and pipelines have been built along and across the structure at this location. This road segment has been previously recommended as a noncontributing portion of an otherwise eligible historic trail. This assessment is based on the lack of visible indication of historic road structure and the lack of integrity of setting and feeling caused by the construction of modern infrastructure and gas development facilities in the area. The road corridor lacks visual integrity and historical associations. The site has been changed sufficiently that its setting and feeling no longer contribute to a historic sense of place.

3.6 Pony Express (48SW6274)

The Pony Express route is not discussed separately from other Emigrant Trail routes in the Class I Regional Overview (BLM 2004). Through the MAA, the Pony Express route typically follows the main branch of the Oregon Trail or the Overland Trail and, like them, is principally overlaid by the later Lincoln Highway and recent Sweetwater County Road 2/Uinta County Road 233 developments. The only location in the MAA that the Pony Express diverges from the Emigrant Trail is from Sevenmile Wash (Section 27, T20N, R111W) northeastward toward the Green River; however, this stretch is displaced by the now bladed Lombard Road (Darlington 1996).

The Pony Express began running in 1860 between Saint Joseph, Missouri and Sacramento, California as a faster mail system than overland freight, but was discontinued six months later after a transcontinental telegraph system was established in 1861. The Lombard Road is a later, mid-nineteenth century variant of the Emigrant Trail connecting to the Lombard Ferry site (48SW1848) on the Green River. Based on previous records, the Lombard Road has been destroyed in the MAA by recent grading and both it and the Pony Express route lack integrity. Recent transmission lines also cross this route portion. Cement monument posts mark the Pony Express corridor.

No historic integrity or evidence of the original historic transportation structures remain. Additionally, transmission lines and well access roads have been built along and across the structure in the Project Area. This Pony Express segment has been previously recommended as a noncontributing portion of an otherwise eligible historic transportation route. This assessment is based on the lack of visible indication of historic trail trace and the lack of integrity of setting and feeling caused by the construction of modern infrastructure and gas development facilities in the area. The road corridor lacks visual integrity and historical associations. The site has been changed sufficiently that its setting and feeling no longer contribute to a historic sense of place.

3.7 Transcontinental Railroad (48SW6357/48UT668)

The Class I Regional Overview (BLM 2004) describes the history of the Transcontinental Railroad corridor within the MAA as follows:

> Finding a suitable transcontinental route was one of the reasons for the military exploring and mapping expeditions across the West in the 1840s and 1850s. A charter for a transcontinental railroad was approved by Congress in 1861, but construction did not begin until after the close of the Civil War in 1865. From at least 10 possible routes that had been investigated, a central route was chosen from the Missouri River at Omaha, Nebraska, to the Pacific Coast in California. From Omaha, the route would course westward to a pass in the Medicine Bow Mountains in eastern Wyoming, with the future cities of Cheyenne to the east and Laramie to the west. The route then roughly followed the old Overland Trail westward to the Green River and then further westward toward the Great Salt Lake. The railroad route cut off the old trail dogleg to Fort Bridger, so that the railroad passed several miles to the north of the fort (Stone 1924:82)…
>
> After entering Uinta County, the UPRR [Union Pacific Railroad] coursed nearly due west to the junction of Muddy Creek with Blacks Fork River. The first station was Verne, which consisted only of a section house and a water tank. About five miles west of Verne was a station called Church Buttes, named for a nearby landform to the south. From Church Buttes, the railroad followed the valley of the Big Muddy Creek about six miles to a station called Hampton for an early ranch near the station. Six miles from Hampton Station was Elkhurst Station, and Carter was about six miles to the southwest of Elkhurst. Carter became the main shipping point for Fort Bridger, about 15 miles to the south, and for the agricultural settlement in Bridger Valley (BLM 2004:63-64).

The Union Pacific Railroad main line, connected coast to coast in 1869, is the Transcontinental Railroad. Today, the main line is a standard gauge railway on creosoted wooden ties on a raised and bermed bed. Recent investigations of the railroad in the MAA have noted that the majority of the site has undergone considerable modern changes since construction, losing all elements of integrity other than retaining its original location and remaining a functioning railroad in design. Potential for significant early historic structural remains could remain at the Granger, Verne, and Church Buttes sidings within the MAA; Granger rail yard is considered a contributing component to overall site NRHP eligibility.

Within the MAA, the Union Pacific Railroad has generally lost historical integrity. Due to the continuous upgrade of the railroad and incorporation of new materials, as well as development of the adjacent gas field, the integrity of association, setting, materials, workmanship, and feeling have by in large been compromised on this portion of the site. Within the MAA, physical features and attributes of the original railroad have generally been altered by regular maintenance and upgrades over time. Although the railroad is still used to transport materials among population centers in the rural West, the railroad has been substantially modified from its circa-1869 origins in an effort to function safely and efficiently. The structure itself has changed sufficiently so that the setting and feeling no longer contribute to the property’s historic sense of place. Given the diminished integrity of the railroad’s historical features and recent infrastructure development in the vicinity (e.g., raised and paved roads, utility lines, mineral wells and plants, pipelines, and radio towers), the railroad corridor in the MAA tends to lack visual integrity and historical associations.

3.8 Oregon Short Line Railroad (48LN2327/48SW1838)

The Class I Regional Overview (BLM 2004) describes the history of the Oregon Short Line Railroad corridor within the MAA as follows:

> In February 1881, the UPRR announced plans to build a standard gauge railway from its main transcontinental line at Granger, Wyoming, to Baker City, in eastern Oregon. The UPRR incorporated the Oregon Short Line Railroad in April 1881, with a stated purpose not only to build to Baker City but also from that point to 'such point or points on the Columbia River or the Pacific Ocean as the Company may select.'…
>
> From the Union Pacific main line at Granger, the Oregon Short Line Railroad route ran up the Hams Fork Valley, over a relatively low gap between Oyster Ridge and the Hogsback, descended Twin Creek, and then followed Bear River northward into Idaho. Initial and subsequent stations along the main line of this railroad were, from southeast to northwest, Moxa, Nutria, Opal, Waterfall, Hams Fork (Kemmerer), Fossil, Nugget, Sage, Beckwith, Pixley, Cokeville, and Marse. From Granger to Sage Station, the route closely followed the Hams Fork Cutoff of the Oregon Trail. The railroad was completed from Granger to Sage in 1881, to Shoshone, Idaho in 1882, and to Portland, Oregon in 1884 (Rosenberg 1984).
>
> The Oregon Short Line Railroad… encouraged coal mining development and other economic changes in the Kemmerer Planning Area. Opal and Fossil became important livestock shipping points for the extensive ranches of the region, and annual stock drives terminated at the railroad yards (Henry 1940:35; Rosenberg 1984). Opal and Kemmerer became important collection and shipping points for the pioneer LaBarge oil field, and the first pipeline in the region was built from the LaBarge field to Opal in 1928. By far the most important effect of the railroad was encouragement of coal mining… (BLM 2004:65).
>
> Previous inventories in, or near, the current Project Area indicated that the operating portions of the Oregon Short Line Railroad in the MAA, and along the Hams Fork River from Granger past Opal, are non-contributing portions of an otherwise eligible site. One 2004 investigation described the site condition as follows:

The physical features and attributes of the OSLR (Site 48LN2327) have been altered by regular maintenance and upgrades through the years. Although still working to transport materials between population centers and the rural West, the railroad has been substantially modified to maintain its viability in transition from its locomotive beginnings, circa 1883, and its diesel-powered present. The structure itself has changed enough for its setting and feeling to no longer be applicable to the property's historic sense of place. The visual integrity of the railroad corridor lacks historical associations, given the diminished integrity of the historical features of railroad structures and recent infrastructural development in the vicinity (e.g., raised and paved roads, utility lines, mineral wells and plants, pipelines, and radio towers) (Phillips 2004).

3.9 Lincoln Highway (48SW1834/48UT255)

The Class I Regional Overview (BLM 2004) describes the history of the Lincoln corridor within the MAA as follows:

> Automobile travel was a relatively new phenomenon in the U.S. in 1903, when the first transcontinental automobile journey was made… Their route was from San Francisco northeastward to Sacramento and then to Caldwell, Idaho; then southeastward through Pocatello and Soda Springs, Idaho and Diamondville,

> Wyoming, to Green River; and then eastward along the old Overland Trail route… A great automobile race from New York to Paris in 1908 followed much the same route from New York to Rock Springs, but from that point the route diverted to Granger, Wyoming, Ogden, Utah, and southwestward to Los Angeles (Nicholson 1969:8)…
>
> …in 1912… began… a plan to create a "Coast-to-Coast Rock Highway" that could be traveled in all seasons… the prospective highway became known as the Lincoln Way or Lincoln Highway… Most of the route was marked with stakes in 1913, but the route actually included multiple wagon trails in several locations across Wyoming. From Rawlins westward nearly to Wamsutter, the route adopted a grade of the UPRR that had been abandoned in 1901. Beginning at Point of Rocks, the Lincoln Highway route coursed westward along the old Overland stage route, and the highway route followed the main Oregon/Mormon/California trail from Granger to Fort Bridger. The highway followed the Mormon/Utah trail for many miles westward from Fort Bridger toward the Great Salt Lake. The highway also followed the Pony Express Route from near Granger most of the way to California (Hokanson 1988:60-61)… As originally improved in the 1920s, the highway had a graveled surface 16 feet wide on a 24-foot-wide grade. Multiple improvements were made to the highway in the following years, including realignments and paving (Franzwa 1999:1-2, 40).
>
> In 1925, a simplified numbering system was initiated for major highways, to replace the confusing names applied to many major roads, including the Lincoln Highway. Most of the Lincoln Highway was designated as part of U.S. Highway 30, which ran from Atlantic City, New Jersey to Astoria, Oregon, and the Lincoln Highway officially ceased to exist. In Wyoming, U.S. Highway 30 diverted from the Lincoln Highway route at Granger, and followed a course to the northwest. To the west of Granger, the Lincoln Highway was initially known as 30 South, and segments of the road were subsequently incorporated into other roads (Franzwa 1999:50-58). Franzwa (1999) prepared maps showing the precise location of the Lincoln Highway through the Kemmerer Planning Area (BLM 2004:66-68).

The Lincoln Highway through the MAA both corresponds to and splits from its later transformation into historic U.S. Highway 30 (48UT1633). The portion of the Lincoln Highway at Sweetwater County Road 2/Uinta County Road 233 corresponds to a 1920s era Highway 30 alignment, when the highway came into being, and the southerly alignment along the I-80 corridor corresponds to a 1940s era realignment of Highway 30. Sweetwater County Road 2 is also the "Old Little American Road," and the original, historic Little America site (48SW1835) was along this route of Old Highway 30 in the MAA. Uinta County Road 233 is a Granger Road.

As with many other historic linear features crossing the Moxa Arch well field and following the I-80 corridor, most segments of the Lincoln Highway here have been destroyed or redeveloped such that they no longer retain their historic character. Transmission lines, buried cables, pipelines, and other infrastructure have been built along and across the structure at this location. This road segment has been previously considered a noncontributing portion of an otherwise eligible historic trail. This assessment is based on the lack of visible indication of historic road structure in the vicinity and the lack of integrity of setting and feeling caused by the construction of recent roadways, modern pipelines, utility lines, and gas development facilities in the area.

Although still working as a rural connector rather than an interstate highway, this roadway has been substantially modified to meet modern improved road standards, including widening the crown and deepening and clearing the ditches. The site has been changed sufficiently that its setting and feeling no longer contribute to a historic sense of place. The road corridor lacks visual integrity and historical associations, given infrastructure development in the vicinity (e.g., other equally prominent raised and paved roads, utility lines, buried cables, mineral wells, and pipelines).

4.0 REFERENCES

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